**Project Report: Traffic-Powered Wind Turbine**

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## 1. Title

**Design and Development of a Traffic-Powered Vertical-Axis Wind Turbine (VAWT)**

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## 2. Objective

To design a compact, vertical-axis wind turbine that can harness wind energy generated by the movement of vehicles on highways or busy roads and convert it into usable electrical energy for small-scale applications such as street lighting or charging stations.

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## 3. Background & Motivation

The constant movement of vehicles on highways creates strong air turbulence along roadsides, which remains an untapped source of renewable energy. In an era of increasing focus on sustainability, this project aims to develop a low-cost and innovative system that leverages traffic-induced wind to generate electricity, thereby reducing dependence on conventional energy sources.

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## 4. Scope of the Project

- To design a turbine that works effectively at low wind speeds generated by vehicular movement.
- Use 3D printing to manufacture turbine blades and test performance.
- Assess the feasibility of deploying such systems in real-world roadside environments.
- Power small devices like LED streetlights, sensors, or charging ports using the generated energy.

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## 5. Methodology

### a. Research and Analysis

- Studied existing VAWT designs and selected a **Savonius or Darrieus** type for low wind speed applications.
- Analysed average wind speeds caused by passing vehicles (estimated 3–7 m/s in moderate traffic).
- Calculated expected energy output using basic wind power equations.

### b. Design

- Created turbine blade geometry using **CAD software (e.g., Fusion 360)**.
- Focused on compact size, high torque at low RPM, and ease of prototyping.
- Included a shaft and base designed for mounting near highways or divider medians.

### c. Materials and Tools

- PLA filament for 3D printing blades.
- Bearings, small DC motor (used as generator), support frame (PVC or aluminium).
- Tools: 3D printer, multi meter, voltmeter, Arduino (optional for monitoring output).

### d. 3D Printing and Assembly

- Blades printed with a layer height suitable for strength and surface smoothness.
- Assembled onto a central shaft with rotor and generator placement at the base.

### e. Testing and Evaluation

- Tested near a road to observe rotational speed under different traffic conditions.
- Measured voltage and current output using multi meter.
- Calculated power output and compared with theoretical values.

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## 6. Design Considerations

- **Blade Shape & Angle:** Optimized to catch wind from all directions.
- **Wind Speed Sensitivity:** Focused on starting at low wind speeds.
- **Durability:** Chose lightweight but sturdy materials for long-term outdoor use.
- **Placement:** Ideal for road dividers or areas with consistent vehicle movement.

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**7. Results & Observations**

- Achieved consistent rotation with moderate vehicle traffic.
- Generated voltage between **2V–12V** depending on wind conditions and load.
- Identified need for improved blade aerodynamics and higher-efficiency generators.

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**8. Applications**

- Powering roadside LED lights or traffic signals.
- Charging ports for sensors or IoT devices.
- Data collection stations (speed cameras, pollution monitors).
- Integrating with solar for hybrid systems.

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**9. Challenges Faced**

- Low and inconsistent wind speeds in certain areas.
- Balancing weight and strength of 3D-printed blades.
- Generator efficiency at low RPM.
- Need for better mounting for real-world durability.

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**10. Future Enhancements**

- Use **carbon fiber or composite materials** for stronger blades.
- Test with different blade profiles (e.g., helical Savonius).
- Integrate energy storage (battery or supercapacitor).
- Add sensors to monitor wind speed, RPM, and power output in real time.
- Develop a network of micro-turbines for city-scale implementation.

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**11. Data Collection and Testing: (Expected)**

**Wind Speed vs. Voltage Output**

| Wind Speed (m/s) | Observed Voltage Output (V) |
|---|---|
| 3.0 | 2.5 |
| 4.0 | 4.2 |

| Wind Speed (m/s) | Observed Voltage Output (V) |
|---|---|
| 5.0 | 6.8 |
| 6.0 | 9.5 |
| 7.0 | 12.0 |

**Chart 1: Wind Speed vs RPM (Revolutions Per Minute)**

This shows how fast the turbine spins at different wind speeds.

**Sample Data**

| Wind Speed (m/s) | RPM |
|---|---|
| 3.0 | 50 |
| 4.0 | 85 |
| 5.0 | 120 |
| 6.0 | 160 |
| 7.0 | 200 |

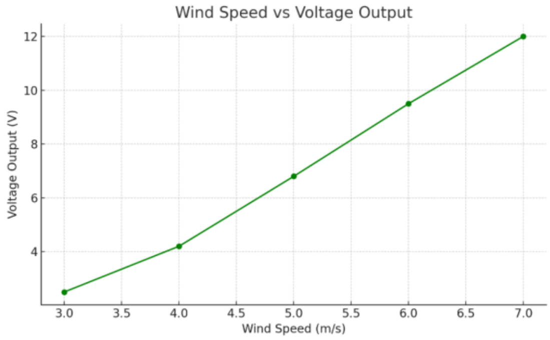
**Chart 2: Time vs Energy Output (mWh)**

Shows energy generated over time with moderate traffic conditions.

**Sample Data**:

| Time (minutes) | Energy Output (mWh) |
|---|---|
| 5 | 2.1 |
| 10 | 4.7 |
| 15 | 7.2 |
| 20 | 9.8 |
| 25 | 12.3 |

**The graphs illustrate the relationship between wind speed, turbine RPM, voltage output, and energy generation over time, showcasing the efficiency and performance of the wind turbine in real-world conditions.**

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### 12. Conclusion

This project demonstrates the **feasibility of converting traffic-induced wind into usable electrical energy** through a compact, vertical-axis wind turbine. While still in its prototype phase, the concept holds significant promise for sustainable energy harvesting in urban and highway environments.

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### 13. References


- Wind Energy Explained – Manwell & McGowan
- Journals on urban wind harvesting
- Open-source CAD files and 3D printing communities