SHOULD WE USE VERTICAL AXIS WIND TURBINES ON IRISH MOTORWAYS?

Investigating the potential of small-scale VAWTs to harness wind energy from traffic on Irish motorways.

SciFest National Final

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1. Abstract

My project investigates the design and feasibility of a Vertical Axis Wind Turbines (VAWT) for installation along Irish motorways to harness wind energy generated by passing vehicles. Unlike conventional Horizontal Axis Wind Turbines (HAWT), VAWT can capture wind from any direction, making it suitable for urban and roadside environments. This study focuses on optimizing the turbine design for efficiency, safety, and sustainability. Computational analysis and prototype testing were conducted to evaluate blade shape, rotational speed, and energy output under varying wind conditions. The results indicate that a strategically designed VAWT can contribute to clean energy production while minimizing space and visual impact. The project highlights the potential of integrating renewable energy solutions into existing infrastructure, supporting Ireland's transition to sustainable energy systems.

2. Hypothesis

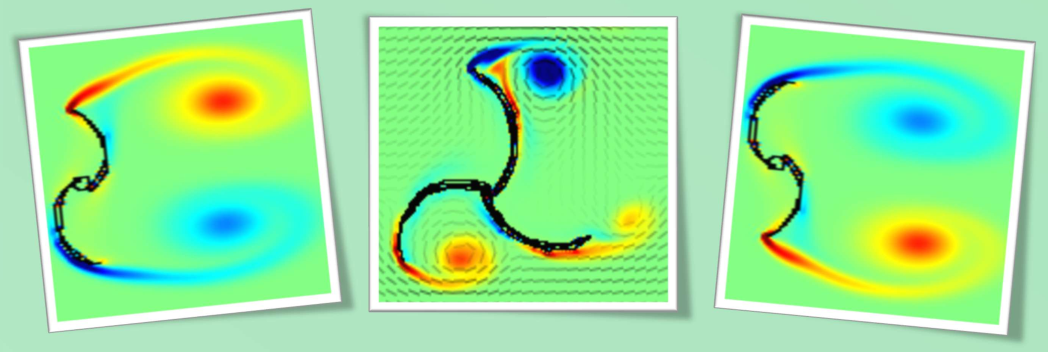
- An optimised VAWT will convert roadside airflow into usable electricity.
- Mounting a VAWT on a motorway pole will improve energy capture from both natural wind and traffic wind.

3. Objectives

- Design a VAWT suitable for installation along Irish motorways.
- Investigate efficiency of blade shapes & rotation parameters.
- Measure the energy output from natural wind and airflow created by passing vehicles.
- Compare the performance of the prototypes.
- Evaluate the feasibility of roadside VAWTs.
- Highlight the eco-friendly impact and potential contribution to renewable energy production.

4. Designs & Methodology

- Designed & Tested a 2-blade Savonius, 3-blade Savonius, Helical 2-blade Savonius Turbine Models
- Used CAD modelling to design and refine blade shapes.
- Generated CFD-style airflow visualisations to compare pressure and flow patterns.
- 3D-printed prototypes and mounted them on the motor shaft.
- Tested turbines in low-speed airflow simulating motorway turbulence.
- Recorded RPM, stability, and starting torque for each blade type.



6. Analysis

- Power in the Wind: The turbine's swept area is "A = H × D" = 0.15 × 0.12 = 0.018 m²A=H×D=0.15×0.12=0.018 m².
- Estimated Power Output: Using the formula Pwind = 0.5ρAv3 and assuming Wind speed v = 12 m/s, the wind carries ~20 W of energy through the turbine area.
- With the helical design converting roughly 20% of this energy, the turbine produces ~5 W.
- Observed Trends: Power output increases quickly with wind speed. ∴Helical blades smooth torque and help the turbine start more easily.
- Size Limitation: Small dimensions (H = 150 mm, D = 120 mm) limit maximum output, but the design shows potential for roadside energy generation.

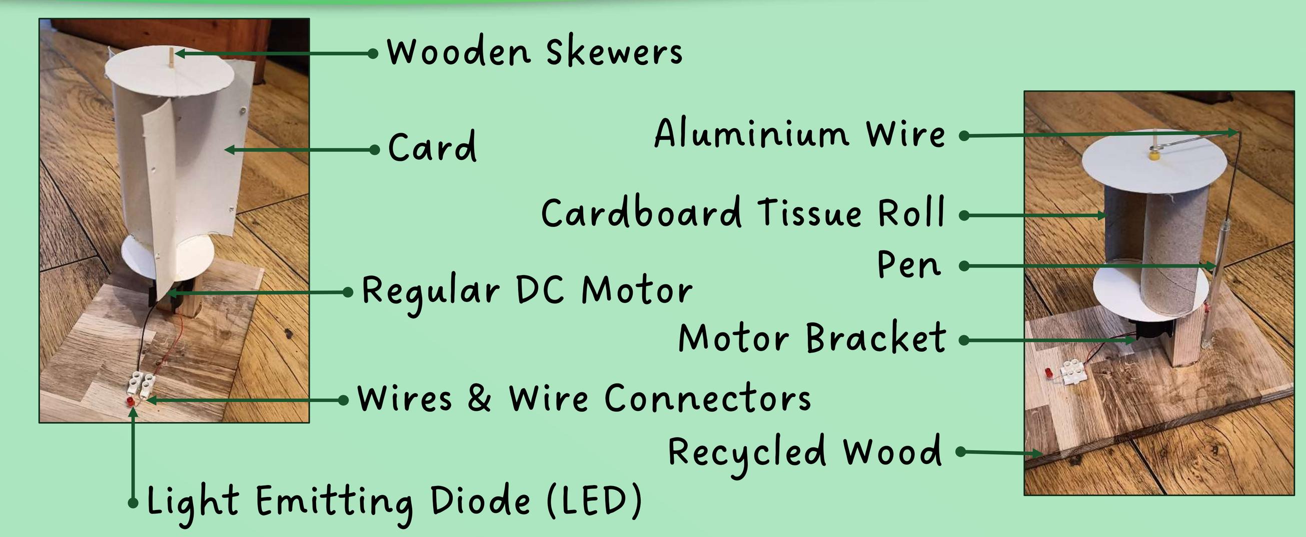
10. Conclusion

The helical 2-blade Savonius VAWT demonstrates that small vertical-axis turbines can generate electricity from wind, producing around 5 W at 12 m/s. The helical design improves torque smoothness and starting performance, making it more efficient than straight blades. While small turbine size limits total output, this project shows that VAWTs are feasible as a supplementary renewable energy source along Irish motorways, particularly if scaled or installed in multiple units.

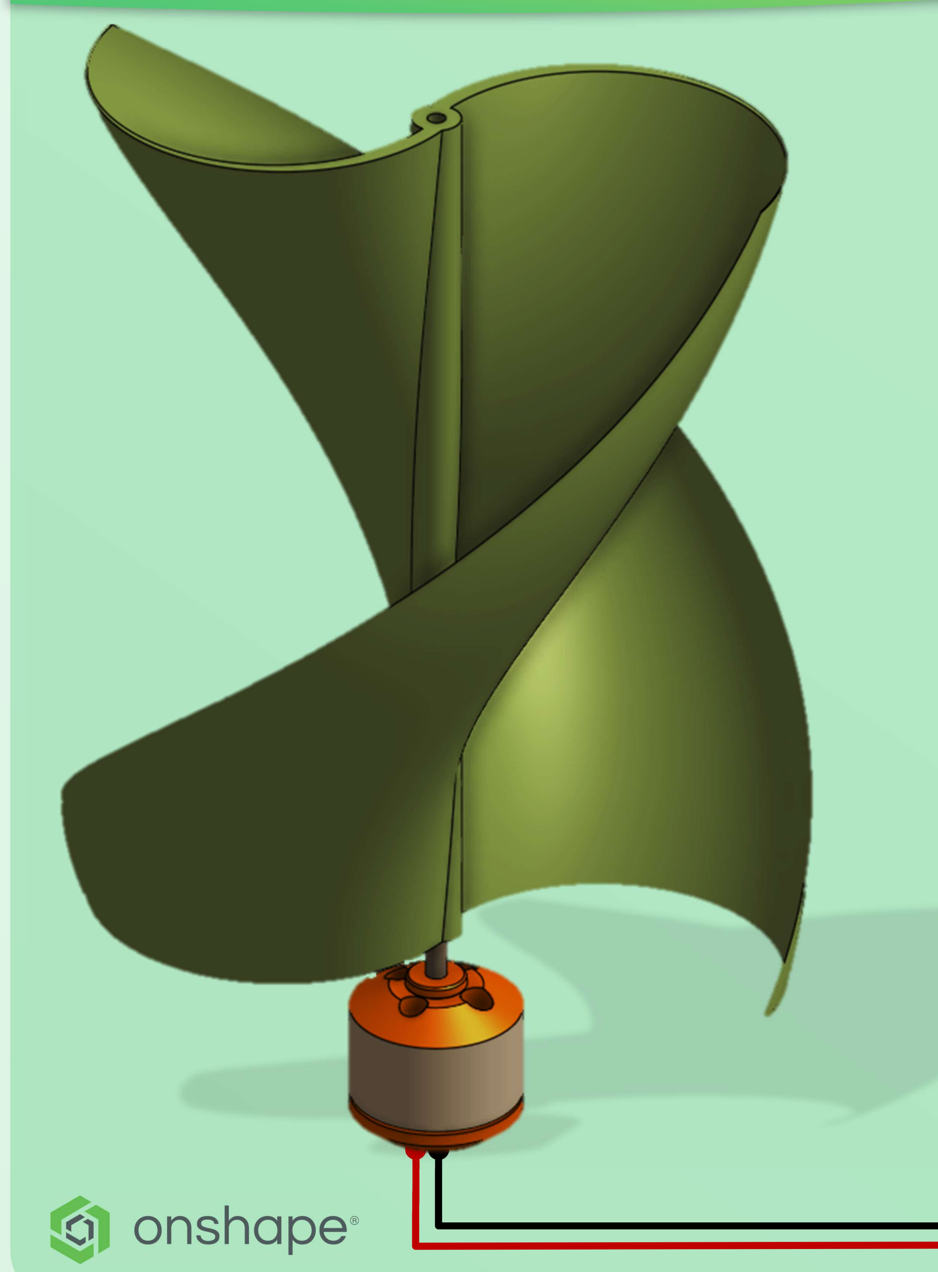
9. Recommendations & Future Plans

- Increase turbine size or number of units to generate more electricity.
- Test in real motorway and railway conditions to measure performance under turbulent, variable winds.
- Explore alternative blade shapes or materials (e.g., lightweight composites) for higher efficiency, durability and eco-friendliness.
- Integrate with roadside or railway infrastructure, such as light poles or vehicle charging stations for practical deployment.
- Consider energy storage or direct use for low-power applications like lighting or sensors.

8. Previous Prototypes & Materials

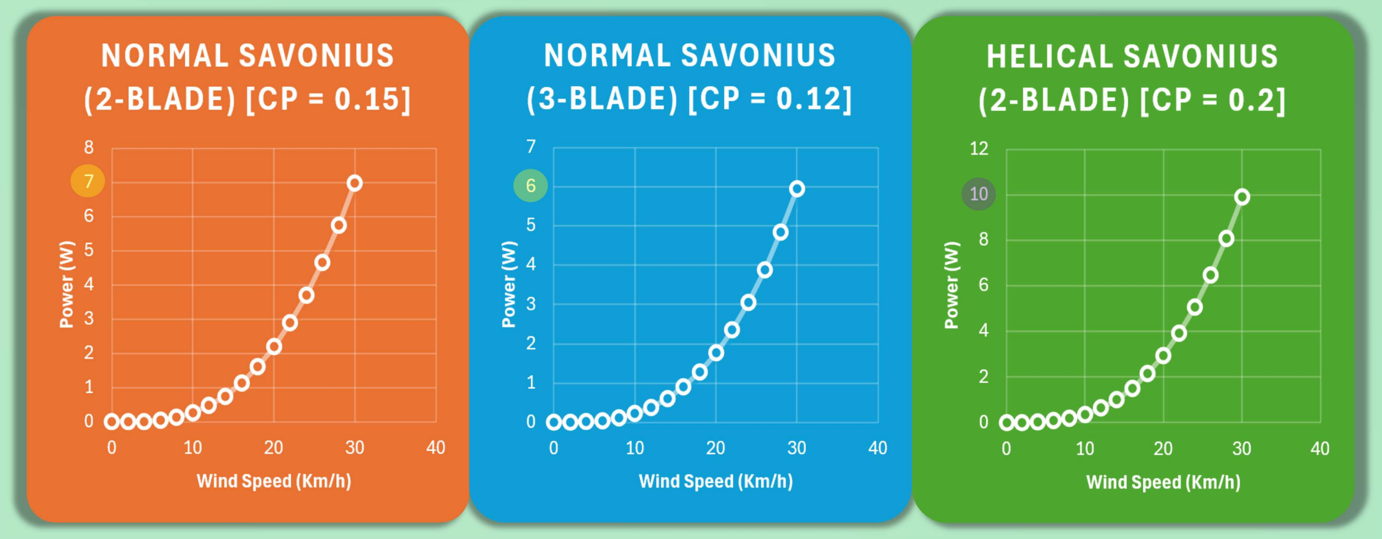


7. Current Prototypes & Materials



- Light Emitting Diode (LED)
- Polylactic Acid (PLA)
- Motor Casing
- Aluminium Tube
- Genie Board
- Paint
- Aluminium Railing
- Bushes
- Aluminium Brackets
- Wiring
- A2212/13T Brushless Motor
- Geared Motor
- 3D Printed Car
- Rack & Pinion Mechanism
- Pine Wood Base
- Rubber Tubing
- Air Blower

5. Results & Key Findings



- Power vs Wind Speed: Electrical output increases rapidly with wind speed, consistent with the cubic relationship of wind energy.
- Helical 2-Blade Savonius: Produces ~5 W at 12 m/s wind, demonstrating effective energy capture for small-scale VAWTs.
- Blade Design Advantage: Helical shape smooths torque, improves starting at low wind speeds, and enhances efficiency compared to straight blades.
- Size Limitation: Small turbine dimensions (H = 0.15 m, D = 0.12 m) limit maximum power output.
- Assumptions & Real-World Conditions: Values assume steady, uniform wind, actual motorway conditions are turbulent, so output may vary.

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