Experimental Design Table and Research Plan

How Does the Design of a Wing Mounted Wind Turbines Blade Affect its Power Output

Hypothesis (Draft): If a Parallel to Wind Wind Turbine is used then the energy generated will be more than other Wind Turbines integrated into a plane's wings.
Independent Variable: Type of wind turbine
Dependent Variable: Quantitative - How much energy is generated
Constants: ● Design of wing ● Design of wind tunnel ● Location of Fan ● Location of Wing in Tunnel
Control Group: N/A Experimental Group(s): Horizontal axis wind turbine: 3-Bladed Vertical axis wind turbine: 3-bladed H-Rotor 3-bladed Savonius Custom: 6-bladed Parallel to Wind Wind Turbine   Number of trials in each group: 5

Independent and Dependent Variables Paper Format:

The independent variable in this experiment was the design of the WIWT. Four distinct designs were tested: a horizontal-axis wind turbine, a three-bladed H-Rotor vertical-axis turbine, a three-bladed Savonius vertical-axis turbine, and a six-bladed parallel-to-wind turbine. Each design possesses unique structural and aerodynamic characteristics that influence energy capture. Horizontal-axis turbines, commonly used in large-scale wind farms, perform well in consistent high-speed winds but are less effective in turbulent airflow, such as that found on aircraft wings. Vertical-axis turbines, including the H-Rotor and Savonius designs, capture wind from multiple directions, making them more adaptable to variable airflow. The parallel-to-wind turbine, a novel concept developed for this study, features a low-drag configuration aligned with airflow over the wing to maximize energy capture while minimizing aerodynamic resistance.

The dependent variable was the electrical power output of each turbine, measured in volts (V). This variable reflects each turbine's efficiency in converting airflow into usable electrical energy under controlled conditions. Output was measured with a digital voltmeter connected to each turbine's terminals, with readings recorded systematically during wind tunnel tests. Multiple trials were conducted to account for variability, and the average voltage output was used for analysis to ensure reliable comparisons across turbine designs.

The relationship between the independent and dependent variables is grounded in aerodynamic theory, which suggests that blade shape and orientation directly affect energy conversion efficiency. Designs that reduce drag while optimizing exposure to accelerated airflow, such as the parallel-to-wind turbine, exploit pressure differentials along the wing surface to enhance power generation. Previous research on small-scale and experimental turbines supports this relationship, demonstrating that blade geometry and alignment are critical determinants of energy output, particularly in turbulent or variable wind conditions.