

## INTEGRATION OF OPEN TYPE WIND TUNNEL STRUCTURAL DESIGN AND PERFORMANCE ANALYSIS OF BAYU MICRO POWER PLANT TRANSMISSION SYSTEM

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### Abstract

In the midst of global efforts to reduce dependence on fossil energy, the development of renewable energy technology in Indonesia is a strategic priority, especially in achieving the national energy mix target of 23% by 2025. This research integrates two fundamental aspects in the development of laboratory-scale wind energy research infrastructure: structural *design* of the open type wind tunnel *body* and performance analysis of mechanical transmission systems in micro-wind power plants operated in them. The first part of the research focuses on the validation of the structural design of wind tunnels using the *finite element analysis* (FEA) method with carbon steel and acrylic materials. The analysis carried out included the evaluation of *von Mises* voltage, strain, *displacement*, and safety factors in the components of the contraction chamber, *turbine box*, *test section*, and *diffuser*. The simulation results showed an exceptionally high structural integrity, with a *Safety Factor* value of 677,006 on the *diffuser* components, indicating a very safe design but leaving room for material optimization. The second part of the study evaluated the effectiveness of the transmission system using a *1:1 ratio pulley timing* and a V-belt on the Savonius turbine (3 and 4 spoons). Empirical tests show that a 4-blade turbine produces superior performance with a rotational speed of 137.3 RPM and an electrical power of 16.8 Watts, compared to a 3-blade turbine that produces only 3.6 Watts. However, an inefficiency in the transmission system was found due to a mismatch in the belt dimensions that caused *mechanical losses*. The integration of these two studies provides a comprehensive blueprint for the development of robust and functional aerodynamic test tools for renewable energy applications in academic environments.

**Keywords:** Wind Tunnel, *Finite Element Analysis* (FEA), Savonius Turbine, Transmission System, Renewable Energy, *Safety Factor*.

### Background

The development of modern human civilization is inseparable from the ever-increasing need for energy. However, global reality shows that the world's fossil energy reserves are decreasing significantly every year. The International Energy Agency (IEA) predicts global energy demand will increase by 45% by 2030,