Design, Development, and Performance Evaluation of Hybrid Cross Axis Wind Turbine

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Abstract : The increasing demand for sustainable energy solutions has driven significant interest in the development of innovative designs of wind turbines. The horizontal axis wind turbine (HAWT) and the vertical axis wind turbine (VAWT) are the dominant type of wind turbine used for power generation. However, these turbines have their respective merits and demerits, which affect their performance. This study introduces a Hybrid Cross Axis Wind Turbine (HCAWT), which integrates the blades of both horizontal axis wind turbines (HAWTs) and vertical axis wind turbines (VAWTs) in a cross-axis configuration with a Savonius rotor to form a hybrid system. The HCAWT combines the self-starting capabilities of Savonius rotors with the high-efficiency characteristics of Darrieus rotors and HAWT, aiming to optimize performance across a range of wind conditions. The performance of the HCAWT was tested and evaluated against a cross-axis wind turbine (CAWT) and a conventional VAWT under similar experimental conditions. The study's results indicate that the HCAWT outperformed both the CAWT and the conventional VAWT. The power coefficient (Cp) of the HCAWT increases by 83% and 132% compared to that of the CAWT and conventional VAWT, respectively. The findings show that the HCAWT offers better start-up performance and maintains higher efficiency at lower wind speeds compared to CAWT and conventional VAWT. The findings suggest that the HCAWT offers significant improvements in energy capture, particularly in turbulent wind conditions, and greater adaptability to changing wind conditions, making it a viable option for both urban and rural energy applications.
Keywords : renewable energy, hybrid, cross axis wind turbine, energy efficiency
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