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Advanced Design and Detailed Modelling of Vertical Axis Wind Turbines with Addressing Challenges and Innovating Solutions: A Review

Mr. Akash P. Yakurke[1], Prof. S. M. Nagure[2], Dr. B. S. Allurkar[3], Dr. N. A. Rawabawale[4]
M.Tech Student, Department of Mechanical Engineering (Manufacturing Process)[1]
Professor, Department of Mechanical Engineering (Manufacturing Process)[2,3]
HOD, Department of Mechanical Engineering (Manufacturing Process)[4]
College of Engineering, Ambajogai, Maharashtra, India

Abstract: *Vertical Axis Wind Turbines (VAWTs) have emerged as promising alternatives to traditional horizontal axis turbines, offering advantages such as easier maintenance, scalability, and omnidirectional wind capture. This paper provides a comprehensive review of the advanced design methodologies and detailed modelling techniques employed in the development of VAWTs. Key challenges inherent to VAWT designs, including aerodynamic efficiency, structural integrity, and dynamic performance, are addressed through innovative solutions proposed in recent research. The review synthesizes findings from theoretical analyses, computational simulations, and experimental validations to assess the state-of-the-art in VAWT technology. Insights gleaned from this review aim to guide future research directions and inform the ongoing evolution of VAWTs towards greater efficiency, reliability, and practical implementation in renewable energy systems.*

Keywords: Savonius, Vertical Axis Wind Turbine (VAWT), design methodology, modeling, aerodynamic efficiency, torque variation, structural optimization, renewable energy