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Design of Hybrid Blade Profile for Stand-Alone Wind Turbine Generator Systems

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Vertical Axis Wind Turbines (VAWT) play a key role in wind energy technologies, where wind energy is one of the most cost-effective sources of renewable green energy (Yokoi, 2005). VAWTs are not sensitive to the direction of the wind and do not require any special mechanism to point out the turbine towards wind direction like in Horizontal Axis Wind Turbines (HAWT). Different designs of VAWTs are being used in the world and VAWTs excluding the Savonius type are taken into consideration under this project scope, where its aerofoil blade profile is crucial for efficiency. Generally, the VAWTs are less efficient relative to HAWTs. Also, the VAWTs have a poor starting torque. Typical VAWTs utilise only the lift force acting on the blades to make the turbine rotate. However, a limited number of hybrid blade profiles are found to be invented for VAWTs, by which they can utilise both lift and drag forces for the rotation of the turbine. In this study, a hybrid blade profile for VAWTs is developed to make use of the combined effect of lift and drag forces with the ultimate goal of achieving a higher efficiency in harnessing wind energy and to overcome the problem of poor starting torque. CFD simulations were performed to evaluate performance of existing hybrid blade profiles, and the best design out of those profiles was further modified and evaluated to meet the objectives. Prototype of the modified blade profile was fabricated and tested with a comprehensive testing equipment developed and fabricated to evaluate the practical performance of the blade profiles.

Keywords: *Vertical Axis Wind Turbine (VAWT), hybrid blade profiles, Horizontal Axis Wind Turbine (HAWT), Computational Fluid Dynamics (CFD)*