Poster presentation

APPLICATION OF A CORRECTION FACTOR IN THE BEMT MODEL FOR ANALYZING THE CASCADE EFFECT ON MULTIBLADED HORIZONTAL AXIS WIND TURBINES

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Among the various technologies used for generating energy from the wind, horizontal-axis wind turbines are the most common. However, turbines with multibladed still face challenges related to their efficiency, including the presence of the cascade effect. This phenomenon results from the proximity between the turbine blades, causing deviations in the wind streamlines and altering the pressure distribution across the blade sections. The main objective of this study is to develop a new model capable of predicting the cascade effect in horizontal-axis wind turbines with multibladed, using the Blade Element Momentum Theory (BEMT). The proposed model focuses on optimizing the corrections needed to mitigate the cascade effect, incorporating four phenomena identified by Selig et al., (1995): buoyancy, solid blockage, wake blockage, and aerodynamic curvature. The equations used in this study specifically aim to correct the angle of attack (α_c), resulting in adjusted lift (C_{lc}) and drag (C_{dc}) coefficients. This approach aims to improve the accuracy of aerodynamic parameters in turbines with multibladed. The study for correcting the cascade effect was based on the model proposed by Pereira (2021), where the formulations proposed by Wood (2011) were adopted for the specific case of isolated flat plates. The choice to use formulations for isolated flat plates, despite the curved blades in an experimental rotor, can be justified by the need to simplify the analysis and calculations of the study. This decision is based on the analytical simplicity of these formulations compared to more complex ones intended for curved profiles, facilitating the theoretical approach. The geometric simplification is adopted by treating the blades as two-dimensional structures, which can be appropriate when the differences in aerodynamic characteristics between curved blades and flat plates are not considered significant for the study's objectives. The validation of the BEMT model was carried out by comparison with experimental data obtained by John, Vaz, and Wood (2020). To determine the values of Power (C_P), Torque (C_T), and Thrust (C_E) Coefficients for rotors with multiple blades (N = 6 and 12), data from Bruining (1979) were incorporated into the model, thus validating the effectiveness of the developed code. The results show a significant increase in the analyzed coefficients compared to turbines with a smaller

number of blades, indicating an improvement in the efficiency of wind energy conversion. The introduction of the correction factor (k_c) in the BEMT model played a crucial role in achieving greater theoretical-experimental agreement, mainly by adjusting the C_P, C_T, and C_E coefficients. These adjustments reflect a higher precision of the corrected BEMT model, which considers the cascade effect, resulting in predictions more aligned with the experimental data. The results demonstrated that the proposed model is effective in correcting the cascade effect, highlighting its importance for improving the efficiency of wind turbines in the global context of renewable energy production.

Keywords: Horizontal-axis wind turbines. Cascade effect. Blade Element Momentum Theory.

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