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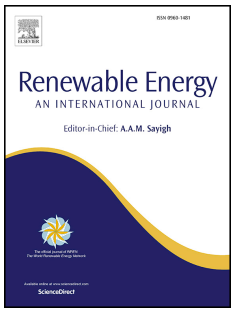

On the sources of cyclic loads in horizontal-axis wind turbines: The role of blade-section misalignment

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On the sources of cyclic loads in horizontal-axis wind turbines: the role of blade-section misalignment.

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Abstract

In this paper we investigate the sources of cyclic loads affecting the structural solicitation and power production in Horizontal Axis Wind Turbines, in particular the role of blade-section misalignment. These loads could become determinant in future designs of extra-large turbines, limiting lifespan due to fatigue of structural and mechanical components. Gravity loads would also become more significant in future up-scaled machines due to the square-cube law relation between energy capture and rotor mass.

We identify the different constructive factors and physical mechanisms which constitute the sources of the cyclic loads on the rotor, and present a methodology to analyze the contribution of each one of them. We propose six hypothetical scenarios to illustrate the individual effect of each of the aforementioned sources on the aerodynamic and structural variables that characterize the operational state of the turbine.

We analyze the evolution of aerodynamic variables which characterize rotor interference and its relation with the angle of attack on the blade sections. Structural variables are also analyzed, showing the contribution of both aerodynamic and gravity loads, inducing out-of-plane bending and torsional oscillations, and how these could be activated by bend-twist coupling on the blade structural response.

Keywords: Wind energy, Horizontal Axis Wind Turbines, Cyclic loads, Aerodynamic misalignment