# (Doctorat : D4)

# RESUME DE THESE[1]

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| **Titre de la thèse** | Numerical investigation of horizontal axis wind turbine rotor under yaw conditions |
| **Discipline/ Spécialité** | Mécanique - Energétique |
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**Résumé :** (150 mots)

Wind turbine technology has benefited from advances in the aerospace sector, but these turbines still face challenges related to energy and mechanical reliability. Power reliability is closely related to the aerodynamic efficiency of the wind turbine rotor. Aerodynamics, in particular, addresses several reliability issues that affect wind turbine availability. Wind turbines operate in an unstable environment affected by atmospheric turbulence, the earth's boundary layer, and variability in wind direction and intensity. These conditions cause cyclic vibrations from aerodynamic forces, resulting in oscillations, deformations, and vibrations in the rotor and structure. Estimating the upstream wind field is highly related to the prediction of the aerodynamic loads. This research study aims to investigate the behavior of a wind rotor under yaw misalignment conditions, causing cyclic variations in relative wind speed and angle of attack due to the inclined wind speed relative to the rotation axis. These conditions promote dynamic stall phenomena, characterized by a hysteresis cycle affecting aerodynamic forces during operation. To address these challenges, CFD and BEM computational methods were implemented, leading to the development of a simplified BEM/CFD coupling code for load evaluation and HAWT power prediction. The study showed that the combination of CFD simulations and the modified BEM method provides a faster and more efficient approach. Additionally, the research delved into the challenges posed by dynamic stall phenomena and proposed the integration of the Beddoes Leishman dynamic stall model with yawed BEM technique to account for the complex environmental conditions and blade rotation effects. The model demonstrated good correlation with experimental data, addressing slight limitations in predicting unsteady forces and blade behavior. The study's main findings include the importance of accounting for 3D effects, tip losses, stall delay, and dynamic stall in computational codes is essential for improving the accuracy of wind turbine aerodynamic predictions



Mots clés : Wind Turbine – Yaw misalignement – dynamic stall – BEM – CFD simulation – stall delay


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