P6 - Design of a health-informed hidro-aeroelastic model for Offshore wind turbines: Impact of blade erosion, gearbox and electrical generator faults

Faults in wind turbines can arise in different and diverse components, such as the pitch control system, the gearbox, electrical generator, etc. Mathematical models either focus on the dynamic behaviour and energy generation prediction at healthy states or the analysis of faults and reliability aspects. However, the dynamic behaviour and energy generation capabilities are hardly separable from the faults and reliability issues.

Therefore, a health-informed mathematical model that is able to predict, both the energy generation under different failure situations and the wear of a specific component due to the dynamic behaviour, is highly valuable.

In the present project, the student will work on a coupled non-linear aero-hydro-servo-elastic mathematical model for a generic floating offshore wind turbine, where several fault cases are intentionally implemented. This mathematical mode will be evaluated over a wide range of environmental conditions based on correlated wind and wave data from a specific location.

Hence, the impact of the different failures will be evaluated and, eventually, final annual energy generation will be estimated based on failure statistics, comparing the realistic results with the ideal estimations where failure do not occur.

Objectives

- Identifying the most relevant wind turbine failures
- Implementing these failures in the usual “ideal” wind turbine mathematical models
- Evaluation of the impact of the failures on the dynamic behaviour, structural loading and energy generation

Tasks

i. Classification of the most relevant failures in wind turbines
ii. Determination of the impact of the different failures on the wind turbine
iii. Development of failure modelling techniques
iv. Integration of failure models or failure impacts on hydro-aeroelastic models
v. Evaluation of ideal and faulty wind turbines:
    a. Dynamic behaviour: motion
    b. Structural integrity: Loads and tensions in different components
    c. Energy generation
vi. Quantification of the impact of the “real” performance on the final energy generation estimates.

Bibliography

[1] Erin E. Bachynski, Mahmoud Etemaddar, Marit I. Kvittem, Chenyu Luan, Torgeir Moan. Dynamic Analysis of Floating Wind Turbines During Pitch Actuator Fault, Grid Loss, and Shutdown. Energy Procedia, Volume 35, 2013, Pages 210-222, https://doi.org/10.1016/j.egypro.2013.07.174.