

P5 - Hidro-Aerolaestic Modelling for +10 MW floating Offshore wind turbines: Evaluation of Uncertainties in wind turbulence intensity

One of the important variables for the development, design and operation of wind farms is the Turbulence Intensity at a given vertical level h , which is defined as the ratio between the standard deviation and the mean of the 10-minute wind speed. Given that measurements are rare, turbulence intensities are often determined using simplified formulations. These formulations only account for a dependence on wind speed and include a neutral atmospheric stability assumption. However, the turbulence intensity is expected to depend on the vertical atmospheric stability and offshore to also depend on the surface roughness

However, the impact of the turbulence intensity has been widely neglected. In this project, the student will characterise the wind turbulence intensity based on the most recent reanalysis datasets from the European Centre for Medium-Range Weather Forecasting (ECMWF), evaluate its uncertainty by means of statistical techniques, develop wind signals with different levels of turbulence intensity and implement them in a hydro-aeroelastic model where the impact of the turbulence intensity uncertainty can be evaluated.

Objectives

- Understanding the wind resource and turbulence intensity
- Estimation of the turbulence intensity uncertainty
- Development of realistic wind signals
- Estimating energy generation for different turbulent intensity wind signals
- Quantifying the uncertainty of the final energy generation

Tasks

- i. Wind resource characterisation via the ECMWF re-analyses
- ii. Turbulence intensity modelling
- iii. Turbulence intensity uncertainty quantification
- iv. Wind signal development including different levels of turbulence intensity
- v. Design and implementation of a generic floating offshore wind turbine
- vi. Energy generation estimation for different wind signals
- vii. Energy generation uncertainty quantification based on turbulence intensity

Bibliography

[1] S. Caires et al (2019) Uncertainties in offshore wind turbulence intensity. J. Phys.: Conf. Ser. 1356 012037. <https://iopscience.iop.org/article/10.1088/1742-6596/1356/1/012037/pdf>