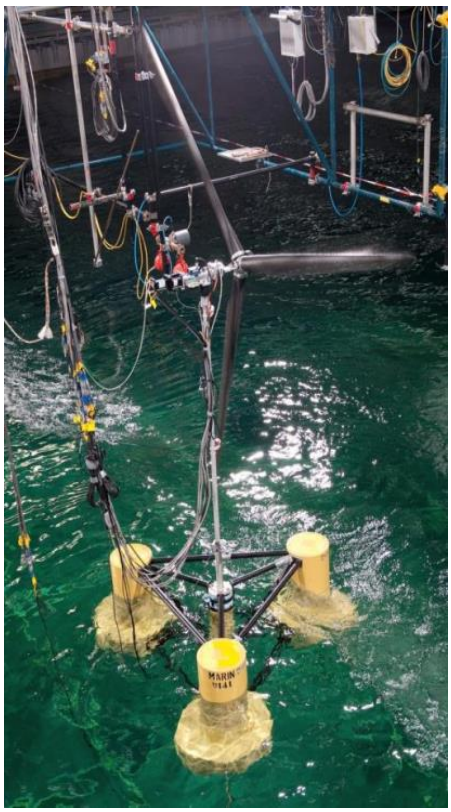
Msc Thesis

Title: **Aerodynamic Analysis of Floating Offshore Wind Turbines: Modelling Approaches**

Requirements: Fluid Mechanics, Aerodynamics, Numerical Methods, Linux
Knowledge on CFD, grid generation, Paraview, Python, HPC is a pre
Duration: 6-9 months
Location: IST and WavEC-Offshore Renewables (www.wavec.org) (Lisbon, Portugal)
Supervisors: **Dr. João Baltazar (IST), Dr. Guilherme Vaz (WavEC)**

Description



Floating offshore wind turbines (FOWT) are taken up by the mainstream research community in recent years. Taking the advantages of more abundant wind energy far from shore, deploying wind turbines into deep water with a floating support structure would be the most economical solution at some sites. In Portugal, this October of 2019 the first WindFloat-Atlantic FOWT started to be installed. FOWT are exposed to the critical loading of wind, current and wave at far shore environment. The challenges of dangerous environmental loads and large motions of both rotor and platform potentially render current techniques applied for fixed-bottom offshore turbines insufficient for accurately describing the dynamics of floating ones. Also, fully description of the dynamics of FOWT can be decomposed into three parts: aerodynamics of wind turbines, hydrodynamics of the support platform and dynamics of the mooring system.

In order to numerically model the aerodynamic performance of the turbine several methods may be used: Blade-Element-Momentum (BEMT); Boundary-Element-Methods (BEM) or Panel Methods; Reynolds-Averaged Navier-Stokes (RANS); simple RANS-based actuator disks (AD); or even combinations of the previous like RANS-BEM or RANS-BEMT coupled methods;

In this project, we propose to analyze the aerodynamic behavior of NREL 5MW turbine and/or Marin FOWT benchmark cases using some of these methods. Advantages and disadvantages of all these should be identified, having in mind both accuracy and computational costs. In particular, the objectives are to perform the following studies:

- Analysis of the turbine at model-scale and full-scale. Study of RANS turbulence and transition models (use of open-source multiphase viscous-flow CFD code ReFRESCO (www.refresco.org)). Study of SRS (Scale-Resolving Simulation) approaches.
- Application of BEMT (OpenFAST), BEM (PROPAN) and a tuned AD to the turbine.
- Comparison of all methods/results. Comparison with experimental data.

All this involves thorough verification and validation against available experiments (MARIN and OCx NREL consortium). Studies on the influence of grids, time-steps, numerical schemes and other CFD-relevant issues will be also performed. For this work, the candidate will have access to Portuguese and European HPC super-computers. Upon good performance of the candidate the work may be presented in a conference and/or in a Journal.

Bibliography

1. Maciel, P., Koop, A. and Vaz, G., “Modelling Thruster-Hull Interaction with CFD”, In Proceedings of OMAE2013, Nantes, France, June 2013.

2. https://nwtc.nrel.gov/OpenFAST
3. Some references on RANS-BEM.
4. Make, M. and Vaz, G., “Analysing Scale Effects on Offshore Wind Turbines using CFD”, In Journal of Renewable Energy, Volume 83 pages 1326-1340, November 2015 (http://doi.org/10.1016/j.renene.2015.05.048).
5. De Ridder, E.-J., Otto, W., Zondervan, G., Huijs F. and Vaz, G., “Development of a Scaled-Down Floating Wind Turbine for Offshore Basin Testing”, In Proceedings of OMAE2014, San Francisco, California, USA, June 2014.