Modelling of rotating vertical turbines using a multiphase finite element method

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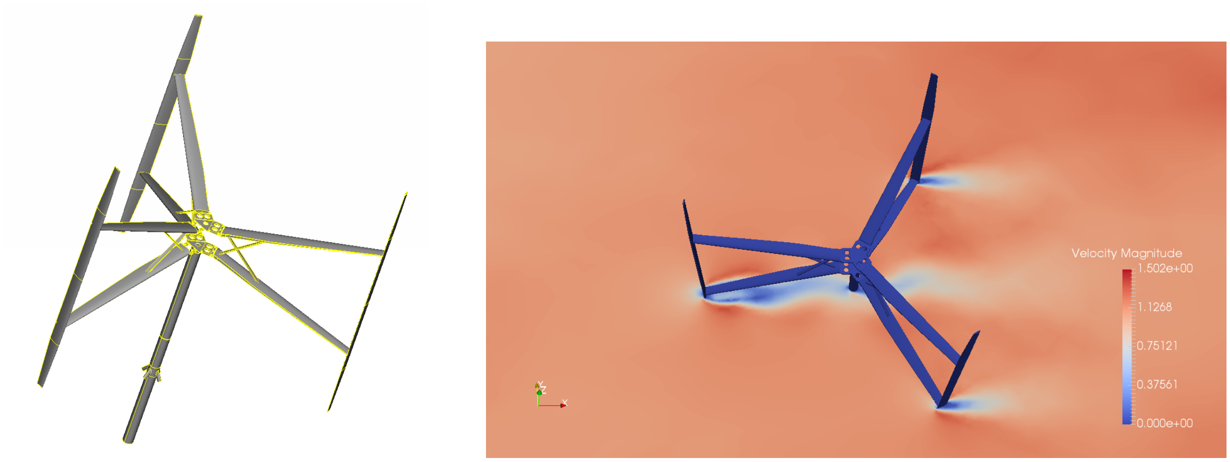
ABSTRACT

We combine the unified continuum fluid-structure interaction method [1] with a multiphase flow model [2] to simulate turbulent flows and fluid-structure interaction of rotating turbines in offshore environments (see figures). This work is part of a project of the Swedish Energy Agency, which focuses on sustainable energy systems combining ecological sustainability, competitiveness and reliability of supply. The mathematical model in use comprises the Galerkin least-squares finite element method, coupled with the arbitrary Lagrangian-Eulerian method in order to allow us to compute weak solutions of the Navier-Stokes equations for high Reynolds numbers on moving meshes. Mesh smoothing methods help improve the mesh quality when it undergoes large deformations. The simulations have been performed using the Unicorn solver in the FEniCS-HPC framework, which runs on supercomputers with near optimal weak and strong scaling up to thousands of cores.



A vertical turbine (left) and a simulation of the flow past the rotating turbine (right).

REFERENCES

[1] J. Hoffman et al. *Unicorn: Parallel adaptive finite element simulation of turbulent flow and fluid–structure interaction for deforming domains and complex geometry*, *Computers & Fluids*, Vol. **80**, pp. 310–319, (2013)

[2] J. Jansson et al. *Adaptive simulation of unsteady flow past the submerged part of a floating wind turbine platform*, 6th International Conference on Computational Methods in Marine Engineering, MARINE 2015