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Crossflow Turbine Wakes and Simulation Speed-up Using Wake Initialisation

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ABSTRACT

Crossflow turbines are a niche technology for harvesting tidal energy particularly attractive for use in shallower sites [1]. The hydrodynamics of such turbines involves several complex flow features - including blade wake interaction, large variation of angle of attack, and stall conditions during each blade revolution [2] - which pose difficulties for the application of numerical design tools. These flow features prohibit the use of quasi steady state methods like multiple reference frames, potential flow solutions or symmetry conditions often used for conventional horizontal axis turbines (HAT) and also mean that, even for steady inflow conditions, simulations require many more turbine revolutions to achieve convergence than conventional HAT.

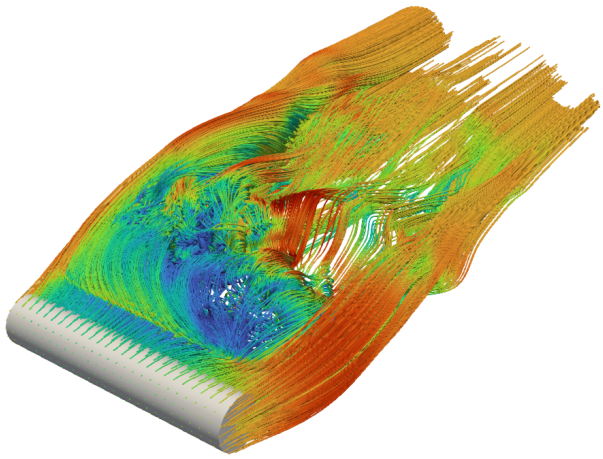

Figure 1: Illustration of the complex streamlines encountered behind a helical crossflow turbine.

Accurate high fidelity models capturing the wake [e.g. 3] (see Fig. 1) will be required for the next development stage, which is the optimisation of arrays of crossflow turbines. This paper presents a first attempt to compare the wake of crossflow turbine simulations with a popular engineering wake model. Also discussed is the potential to significantly accelerate the convergence of such simulations by initialising an estimated wake field based on such models.

References

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[3] Masoumeh Gharaati et al. "Large-eddy simulations of turbulent wake flows behind helical- and straight-bladed vertical axis wind turbines rotating at low tip speed ratios". In: *Physical Review Fluids* 9.074603 (2024). DOI: 10.1103/PhysRevFluids.9.074603.