Role of waves on tidal turbine wake dynamics

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ABSTRACT

At present tidal stream turbines are commonly deployed in relatively shallow waters that enable quick operations with maintenance at a low cost. The environmental flow conditions at such sites is mainly driven by turbulence from the free-stream flow or that induced from irregular bathymetry features, and by waves that can feature a breadth of wavelengths or periods [1]. Depending on the wave nature both the turbine loads and wake recovery can notably change, which needs to be understood so that future tidal turbine arrays can be optimally designed.

We have conducted high-fidelity simulations with the large-eddy-simulation code DOFAS [2] that adopts a level-set method to resolve the air-water interface to accurately capture the wave-induced velocities and pressure fluctuations. We have simulated a single tidal stream turbine operating at peak efficiency considering four different wavelengths that cover from shallow to deep water wave conditions. The wake dynamics is notably influenced by the wakes, especially at short wavelengths, directly impacting the wake recovery rate, but also changes the frequencies of the load variation which affects the fatigue loading on the device. Our study shows that a range of wave characteristics needs to be studied to ensure the turbine is able to withstand loadings over its design lifetime.

REFERENCES

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