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Numerical Investigation of a Spiral Bladed Tidal Turbine

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Abstract : From the perspective of research innovation, the tidal energy industry is still in its early stages. While a very small number of turbines have progressed to utility-scale deployment, blade breakage is commonly reported due to the enormous hydrodynamic loading applied to devices. The aim of this study is the development of computer simulation technologies for the design of next-generation fibre-reinforced composite tidal turbines. This will require significant technical advances in the areas of tidal turbine testing and multi-scale computational modelling. The complex turbine blade profiles are designed to incorporate non-linear distributions of airfoil sections to optimize power output and self-starting capability while reducing power fluctuations. A number of candidate blade geometries are investigated, ranging from spiral geometries to parabolic geometries, with blades arranged in both cylindrical and spherical configurations on a vertical axis turbine. A combined blade element theory (BET-start-up model) is developed in MATLAB to perform computationally efficient parametric design optimisation for a range of turbine blade geometries. Finite element models are developed to identify optimal fibre-reinforced composite designs to increase blade strength and fatigue life. Advanced fluid-structure-interaction models are also carried out to compute blade deflections following design optimisation.

Keywords : tidal turbine, composite materials, fluid-structure-interaction, start-up capability
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