Performance Modeling of an Articulated Tidal Turbine for Hydraulic Energy Generation and Storage Applications

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Yourbrook Energy Systems is developing an articulated horizontal cross-flow tidal turbine that converts tidal energy into hydraulic energy by pumping seawater. The pumped water is directed through a micro-hydro generation system to produce electricity, while excess water is stored in an elevated reservoir for later use during periods of increased demand or reduced tidal resource availability. By combining energy generation and storage within a single system, the technology has the potential to improve the reliability and dispatchability of tidal energy resources for remote coastal communities.

The articulated rotor follows a non-circular trajectory, resulting in complex blade kinematics and hydrodynamic interactions that are not adequately represented by conventional tidal turbine performance models. This work presents the development of a coupled computational fluid dynamics (CFD) and kinetic modeling framework to predict the performance of the articulated rotor and its hydraulic energy output.

The CFD model is used to characterize the hydrodynamic forces acting on the turbine foils throughout their rotational cycle under representative tidal flow conditions. These force distributions are subsequently incorporated into a kinematic and hydraulic model to evaluate rotor torque, pumping performance, flow rate, and hydraulic power output. The modeling framework is being developed to investigate key design parameters, including foil configuration, rotor geometry, and foil spacing.

The resulting model will be used to predict hydraulic energy production and water delivery rates for deployment at Kamdis Point in Masset Sound, British Columbia. CFD simulations, kinetic modeling results, and performance predictions for selected operating conditions will be presented and discussed. The work contributes to ongoing efforts to evaluate innovative tidal energy technologies capable of supporting reduced diesel dependence and increased energy resilience in remote coastal communities.