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Experimental Validation of Numerical Simulation of Tidal Power Plants (Deep Green) using ADCP Measurements

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Tidal turbines harnessing power from tidal currents, have the prospective to become an important source for renewable energy production. The tidal power plant studied here, the Deep Green, rather than being fixed like conventional horizontally mounted axial tidal turbines, uses a 'flying' kite with a turbine attached to it. The kite, which is tethered to the bottom, converses in a lemniscate trajectory (□) perpendicular to the direction of the tidal current. In the trajectory, the apparent flow velocity experienced by the turbine is several times the tidal flow, thereby allowing utilization of sites with lower tidal current velocities than most traditional tidal power plants. To study the operation of single power plants and for designing efficient arrays of tidal power plants Computational Fluid Dynamics (CFD) are used.

Through previous studies, the Deep Green is modelled using Large Eddy Simulations (LES) and the Actuator Line Model (ALM). While using ALM, the Deep Green wing and its turbine are represented as a momentum source that moves in a prescribed trajectory (lemniscate). Using the numerical simulations, the impact of the Deep Green on the tidal flow is studied by analysing the changed velocity field and turbulence characteristics downstream of the power plant. Before conducting large-scale numerical studies on the design of arrays, the numerical model needs to be validated against observations.

The measurements used for this study were performed by Minesto AB in the site Holyhead deep using a vessel mounted ADCP (Acoustic Doppler Current Profiler) downstream of the kite. A domain and boundary conditions similar to the measurements are set up in the numerical simulation. The velocity downstream of the power plant is compared with the measured velocity data, and the preliminary study shows good agreement between ADCP observations and output from the CFD model. The results of the validation will be helpful to strengthen the methods used in numerical modelling in order to conduct sound tidal power array analysis.