Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Experimental/Numerical Comparison of Turbine Efficiency and Wake Structure in an Array of 3 Scale-Model Marine Hydrokinetic Turbines DANNY SALE, JOHN BATES, BRIAN POLAGYE, ALBERTO ALISEDA, University of Washington, Seattle — Numerical simulations and experiments are conducted for axial-flow Marine Hydro-Kinetic (MHK) turbines operating in a flume. This study aims to understand the influence of coherent structures in high Reynolds number wakes on energy extraction and dynamical rotor control processes. In experiments, rotor torque and rotational position measurements are collected, and the flow field characterized by simultaneous imaging with particle image velocimetry. The performance of 3 turbines are characterized under varying downstream spacing and lateral offsets. To study effects of unsteady hydrodynamics, the turbines are outfitted with open-loop and close-loop feedback controls and compared to the case of uncontrolled rotor. In numerical simulations, different tiers of turbine models are evaluated to discern tradeoffs in fidelity to physics versus cost. Analogous "actuator methods" are included from Large-Eddy-Simulations and Reynolds-Averaged-Navier-Stokes, where the models impose body forces upon the flow field in form of disks, lines, or surfaces. An aeroelastic model coupled to LES predicts the dynamical response of rotors to upstream wakes and ambient turbulence. These comparative studies inform how simulations can be scaled up to inform design of utility-scale MHK power plants.

Danny Sale
University of Washington, Seattle

Date submitted: 01 Aug 2015 Electronic form version 1.4