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Reference Model MHK Turbine Array Optimization Study within a Generic River System

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Abstract

Increasing interest in marine hydrokinetic (MHK) energy has spurred to significant research on optimal placement of emerging technologies to maximize energy conversion and minimize potential effects on the environment. However, these devices will be deployed as an array in order to reduce the cost of energy and little work has been done to understand the impact these arrays will have on the flow dynamics, sediment-bed transport and benthic habitats and how best to optimize these arrays for both performance and environmental considerations. An "MHK-friendly" routine has been developed and implemented by Sandia National Laboratories (SNL) into the flow, sediment dynamics and water-quality code, SNL-EFDC. This routine has been verified and validated against three separate sets of experimental data. With SNL-EFDC, water quality and array optimization studies can be carried out to optimize an MHK array in a resource and study its effects on the environment. The present study examines the effect streamwise and spanwise spacing has on the array performance. Various hypothetical MHK array configurations are simulated within a trapezoidal river channel. Results show a non-linear increase in array-power efficiency as turbine spacing is increased in each direction, which matches the trends seen experimentally. While the sediment transport routines were not used in these simulations, the flow acceleration seen around the MHK arrays has the potential to significantly affect the sediment transport characteristics and benthic habitat of a resource.