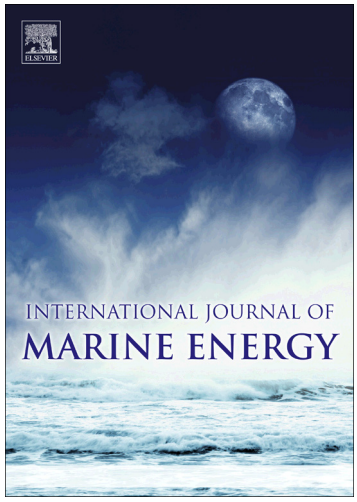

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A Tuned Actuator Cylinder Approach for Predicting Cross-Flow Turbine Performance with Wake Interaction and Channel Blockage Effects

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Abstract

This article presents a practical method for predicting the power output of cross-flow tidal/river turbines with wake interaction and channel blockage effects. In a turbine farm, the power generated by each rotor depends on the cube of the local velocity, which is influenced by the bottom topology, by other turbines' wakes and also by finite channel cross sectional areas restricting wake expansion. Therefore, the accuracy of power predictions depends strongly on proper modelling of rotor wakes and the influence of the channel/river boundaries. This is a critical issue for the tidal and river kinetic turbine power industries because best practise for predicting energy yield has yet to be established, while project revenue streams are primarily a function of yield.

This article introduces a simulation-based method to predict individual turbine and total farm power output with modest computational expense, named the *tuned actuator cylinder approach* (TACA). Rotors are represented in the simulations as momentum sink terms, using approximately 21 elements across their diameter, allowing for very fast simulations of multiple rotors. The model is tuned to match known (from experiments or high-fidelity blade-resolved simulation) thrust and power operational profiles for a particular turbine, with known inflow conditions. Once tuned, the TACA model can be applied to a wide range of turbine array configurations, and arbitrary flow environments. Thus, TACA is an appropriate tool for case-studies and/or optimization of turbine array layout at real-world tidal/river energy sites.

Keywords: actuator cylinder, RANS, turbine farm, simulation, tidal, river

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