NOVA SCOTIA ENERGY
R&D CONFERENCE 2014
ENERGY FOR CHANGE

Abstract:

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Category: Marine Renewable Energy

Three Dimensional Simulation of Horizontal Axis Tidal Turbine

Demand for renewable energy continues to rise worldwide. Compared to some popular renewable energy sources, tidal energy has high power density and predictability. In-stream tidal energy is an emergent technology with great opportunity globally. Technological and environmental issues are numerous, however, and require innovation and inspiration to be overcome. These issues are a challenge for design testing but further fundamental knowledge is necessary to help tidal energy become a burgeoning industry.

Small scale experiments and numerical modelling of designs are far cheaper and quicker methods of evaluation. Designers are able to test their prototypes by utilizing these two approaches simultaneously. Experimental results can be used to validate numerical models. Key parameters can then be adjusted for turbine optimization or investigation of enigmatic phenomena.

This study aims to accurately produce three dimensional numerical simulations, in ANSYS CFX, of a three bladed horizontal axis turbine (HATT). The resultant power and thrust coefficients of these simulations will be compared to experimental results [1] at various tip speed ratios (TSR = 2-12) and blade root angles (15°-30°). Near and far field wake propagation will also be investigated. In addition to these variances, three common turbulence models will be applied for insight into their HATT application suitability. The results of this study will provide: validation of experimental results, further information on the turbulent flow in the near and far wake fields, and possible implications on the effectiveness of tidal arrays.

The turbine geometry in question has a design that matches experimental studies. The 800 mm diameter turbine, varying in pitch angle, has a blade geometry that interpolates five NACA profiles. The rotational velocity of the turbine is determined by the desired TSR (2-12). The total transient simulation time, up to 10 seconds, is chosen by allowing the turbine to complete ten full revolutions.

This investigation is ongoing and a mesh convergence study is currently underway. The resultant power and thrust coefficients are within a reasonable magnitude of experimental. An example of the streamline result is presented below. The completion of these simulations will provide further insight into the usefulness of numerical modelling in the tidal energy industry.