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Currents

OEER Offshore Energy Environmental Research Association

Studies of Tidal Energy–Marine Environment Interaction

Nova Scotia's Tidal Power: The Role of Research

The OEER Association (OEER) is pleased to introduce its 'Currents' newsletter as a means of sharing tidal energy research information, activities and progress taking place in the Bay of Fundy region. Each issue of 'Currents' will highlight OEER-funded researchers and their projects. In this issue, we discuss the background of how and why the OEER Tidal Energy Research Program was created, we feature an OEER-funded research project led by Dr. Richard Karsten (Acadia University), as well as provide an update on the recent OEER/FORCE (Fundy Ocean Research Centre for Energy) Tidal Energy Workshop.

The Fundy Research Story

In 2007, the Nova Scotia Department of Energy commissioned OEER to carry out a Strategic Environmental Assessment (SEA) focusing on tidal energy development in the Bay of Fundy. The focus of the SEA was to provide advice on whether, when, and under what conditions, tidal energy demonstration and commercial projects should be allowed in the Bay of Fundy. Completed in April 2008, the SEA made 29 recommendations to the Province of Nova Scotia, one of which indicated that the Province should facilitate the development of a collaborative research program for marine renewable energy development in the Bay of Fundy. In response, OEER and OETR developed a comprehensive research program focusing on the following research areas:

- Tidal energy resource assessment
- Sediment dynamics
- Animal behaviour
- Near- and far-field effects
- Potential effects of ice and debris
- Potential effects of tidal lagoons

The intent of this program is to provide developers and decision makers with a comprehensive body of research concerning new Tidal In-Stream Energy Conversion (TISEC) devices, tidal lagoons and other tidal development technologies in the Bay of Fundy.

In April 2009, OEER and OETR held a workshop on hydrodynamic modeling of the Bay of Fundy at Dalhousie University in Halifax, Nova Scotia. The workshop brought together leading experts in hydrodynamic modeling to discuss models, challenges and priorities for future research. As a result of the workshop, OEER and OETR have jointly funded eight research projects for tidal energy development in the Bay of Fundy that derive from the established research areas from Page 1. Combined, the studies create the largest research program ever undertaken on hydrodynamic modeling in the region. The eight projects focus on such diverse research topics as sediment dynamics, tidal energy resource assessment, hydrodynamic modeling, ecosystem responses, fish monitoring and tracking, and near- and far-field effects. These studies, ranging in duration from two to three years, are currently in their second year of funding. The next section provides an update on one of these projects being carried out by Dr. Richard Karsten (Acadia University) and a team of researchers.

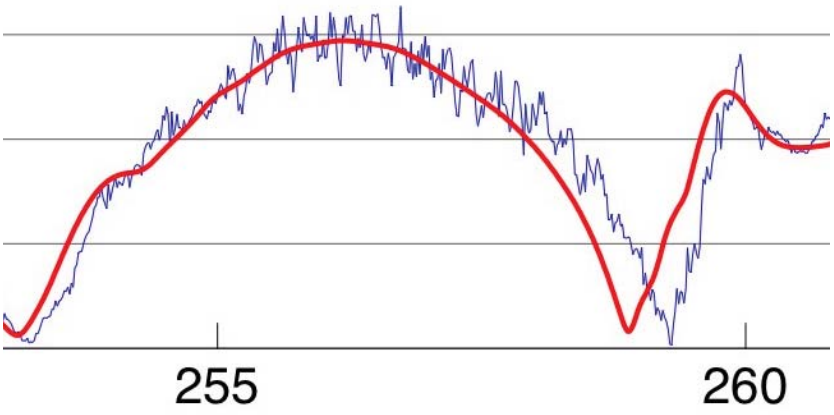

Figure 1: *A comparison of simulated velocity (red line) and ADCP measurements (blue line) for a location in the Minas Passage. While the simulation can capture the large scale variation, it does not model the high frequency fluctuations.*

Dr. Richard Karsten
Associate Professor, Acadia University

Assessment of the Potential of Tidal Power from Minas Passage and Minas Basin

Dr. Richard Karsten, Acadia University; Dr. David Greenberg, Fisheries and Oceans Canada; and Michael Tarbotton, Triton Consultants Ltd.

This research project was undertaken to accurately estimate the power potential of the tides and tidal currents in the Minas Basin and Minas Channel regions of the Bay of Fundy. The goal of the project is to make a power estimate that is both attainable and sustainable; it will be based on available turbine technology and will include an estimate of the impact on the tidal range and currents.

To date, the project team has completed a number of high resolution 3D simulations with and without turbines. Working with colleagues at Bedford Institute of Oceanography (BIO), Dr. Karsten and his team are validating these numerical models with comparisons to acoustic doppler current profiler (ADCP) data gathered from Minas Passage and Minas Basin. Through this validation process they have seen that while this simulation can capture the tidal flow and the large-scale variations in the flow, it cannot capture the higher frequency, smaller scale variations seen in almost all ADCP time series

analysis (see Figure 1). Future research will examine these smaller scale motions and whether they affect power generation.

The simulations continue to illustrate the strong asymmetry between the flood and ebb tides and the importance of the strong jet that forms around Cape Split on flood tide (see Figure 2). The simulations are also revealing a much more complicated flow through the Minas Passage where there are strong eddies formed by the various topographic features located there. The project team has also completed simulations that include all the tidal constituents in month long simulations. This has improved the comparison to observations and allows prediction of the variations in the currents, and thus power, on monthly and yearly scales. The variations in the water speeds over the monthly and yearly scales are large and will affect the design of the turbines in TISEC devices.

The researchers have used power curve data from test turbines, in particular the SeaGen turbine in Strangford Lough, to make more accurate assessments of the tidal power from tidal currents. This analysis has again illustrated the importance of the turbine design. A turbine which is rated for flows of 3 metres/second may not be able to take full advantage of the currents in the centre of Minas Passage which exceed 4 metres/second. However, there are regions with more moderate flows in the Minas Channel, to the west of Minas Passage, that are possible deployment sites.

Finally, Dr. Karsten and the team have developed a simple model to examine arrays of turbines. This model adapts theoretical work on the interaction between fences of turbines and tidal currents, to the specific flow through the Minas Passage. The model allows for a quick assessment of a turbine array, both the power generated and reduction of flow through the channel. The model has indicated that it is possible to extract 1000-2000 megawatts from Minas Passage currents with gravity based turbines depending on the water depths the turbines are restricted to. According to the model, the efficiency of the turbines is reduced, but only when a very large number of turbines (more than 500) are deployed.

OEER/FORCE Tidal Energy Workshop

Purpose & Discussions

In conjunction with the Fundy Ocean Research Centre for Energy (FORCE), OEER recently hosted a Tidal Energy Workshop, held October 13th and 14th at The Old Orchard Inn in Wolfville, Nova Scotia. The focus of the workshop was on the environmental impacts associated with tidal power development in the Minas Basin and Minas Passage of the Bay of Fundy. Specifically, its purpose was to review the results achieved to date from the eight research projects funded by OEER and OETR, and with that as background, provide

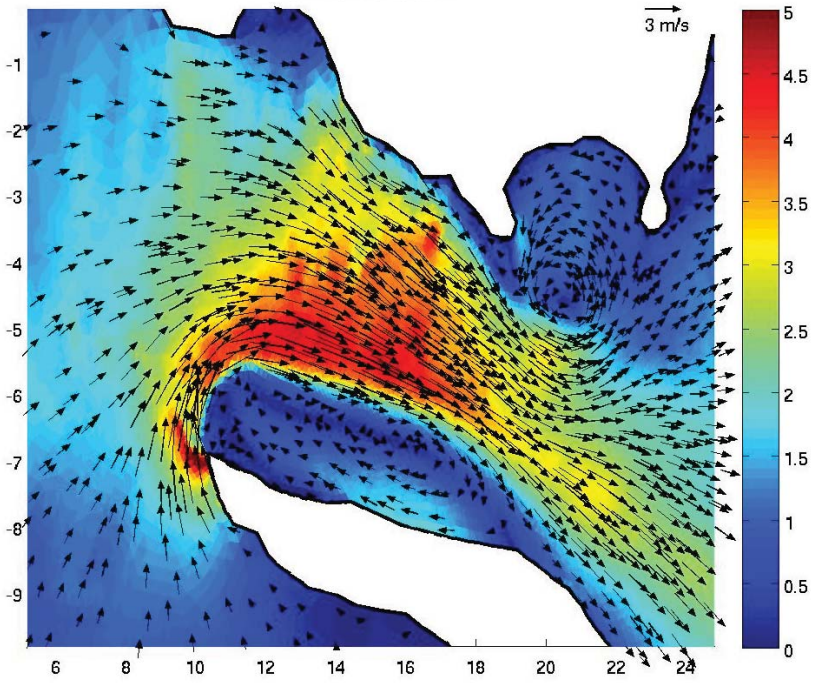

***Figure 2**: A plot of the speed and direction of the flood jet from high resolution 3D simulations of the flow through Minas Passage. Note the asymmetry of the jet and the large eddies north and south of the jet.*

guidance for future research to address remaining important questions concerning the environmental impacts of tidal energy.

Attendance of the workshop reached 88 participants – a large turnout for an event of this type and an indication of both the interest and extent of relevant research capability that exists in the province. The majority of participants were drawn from the research community, but also included were a number from the private sector (largely consultants and some involved in project development) and government officials, including representation from the State of Maine.

The workshop agenda focused on three broad components – introductory and background presentations (given by FORCE, the Province of Nova Scotia, the State of Maine and OEER-funded researchers); concurrent breakout sessions to allow discussion of research needs and priorities under three themes (environmental effects monitoring, resource assessment and extraction potential, and near and far-field effects); and reporting of results from the breakout group discussions to all workshop participants. In addition, there was an opportunity to discuss linkages between, and common challenges facing the three areas, as well as present some of the key engineering issues facing tidal power development.

Potential Future Priority Areas

- Marine engineering challenges
- Grid interconnection and system integration problems
- Data management and analysis
- Ecosystem interactions
    - Potential interference with original movements and migration

Outcomes

Taking account of research underway or already completed, a goal of the workshop was to identify additional priorities for future research which will help OEER define future priority areas of interest. The OEER and OETR funded projects are at various stages of completion, and as projects wrap up, OEER and OETR will examine ways to integrate the results.

The tidal research and development taking place now will determine Nova Scotia's place on the international stage. This workshop provided a valuable opportunity to take stock of where we are and where we need to go to ensure that there is a clear understanding of the energy resource potential in the Minas Basin and the potential environmental effects associated with its development.

A full workshop report can be found on the OEER website, as well as Powerpoint presentations that were given at the workshop.

OEER Offshore Energy Environmental Research Association

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OEER is a not-for-profit corporation dedicated to fostering offshore energy and environmental research and development, including the examination of renewable energy resources and their interaction with the marine environment. OEER's members include Acadia University, St. Francis Xavier University, Cape Breton University and the Nova Scotia Department of Energy.