Issue 4
Fall 2011

Currents

OEER Offshore Energy Environmental Research Association

Studies of Tidal Energy– Marine Environment Interaction

Highlights

In this issue of 'Currents' OEER Association (OEER) is pleased to announce and feature three new tidal projects that were awarded funding this fall. Also in this issue, we provide information on our bi-annual Research and Development (R&D) Forum that will be held May 16th and 17th, 2012; and highlight the grand opening of the FORCE Visitor Centre in Parrsboro, in which OEER partnered in the development of its interpretive displays. OETR Association has also just completed a gap analysis for small scall in-stream tidal technology.

FORCE Visitor Centre Grand Opening

On November 7, 2011, the Fundy Ocean Research Centre for Energy (FORCE) held a grand opening of its new Visitor Centre in Parrsboro. FORCE Board Chair, John Woods, hosted the ribbon-cutting ceremony that included speeches by Premier Darrell Dexter, Keith Hunter, Warden for the Municipality of the County of Cumberland, and Lois Smith, Mayor of Parrsboro. The Centre is now open to the public and offers visitor information, videos and interactive displays surrounding tidal energy developments in the Bay of Fundy. Hours of operation can be found by visiting

From left to right: *FORCE Board Chair, John Woods; and Premier Darrell Dexter.*

Photos courtesy of the Province of Nova Scotia.

the FORCE website at www.fundyforce.ca. Please note the Centre is now closed for the season and will reopen in Spring 2012.

In 2010, OEER Association (OEER) received funding from the Nova Scotia Department of Energy to support the development of tidal interpretive, multimedia research and education material to be displayed in and around the FORCE Visitor Centre. Over the last year, OEER has partnered with FORCE in the creation of this material with Skyline Atlantic, who designed and installed the interpretive displays.

The Visitor Centre has a dedicated area that showcases the research currently underway by OEER/OETR and FORCE. As part of the interpretive display material, three subject-specific videos have been developed to highlight the tidal energy research projects funded by OEER and OETR. Lead researchers from each project were interviewed at various research institutions and scenic field sites throughout the province. The videos will play at the Visitor Centre alongside the interactive displays on the research funded to date. FORCE and OEER want to thank the researchers who contributed their time and expertise to the development of the interpretive material – it wouldn't have been possible without their support.

SAVE THE DATE: Nova Scotia Research & Development Forum 2012

The OEER and OETR Associations, in partnership with the Nova Scotia Department of Energy, are pleased to announce our 5th bi-annual Research & Development Forum at the World Trade and Convention Centre in Halifax May 16th and 17th, 2012.

The 2010 R&D Forum demonstrated increased student participation, registration, and positive delegate feedback. We brought together local, national, and international representatives from government, industry, and academia to build on the current state of knowledge - over 50 experts presented their research. Once again we will use the two days to network, become informed about the work of others and to be inspired about research opportunities and capabilities.

We will continue to build on the success of the R&D Forums with an agenda that highlights world-class research in the areas of **Marine Energy, Offshore Resources and Renewable Energy**. We will keep you informed as our program and registration becomes available and any information will be posted on our website at www.offshoreenergyresearch.ca.

In 2010, an incredible response was received for the student research presentation component of the R&D Forum. Thirty-four high calibre posters were displayed and presented to judges. The exceptional quality of research and professionalism demonstrated by students is expected once again for the upcoming R&D Forum. We are excited to again invite students to attend the R&D Forum and bring poster presentations highlighting their energy-related research to share with R&D Forum participants. Students presenting posters will not be charged a registration fee and a prize will be awarded for the best student poster in each project category. There will also be opportunities to sponsor the R&D Forum. More information on the call for research posters and sponsorship is available on our website.

New Research on Tidal Marine Energy

OEER is happy to update you on important new research taking place in the Bay of Fundy. In March 2011, OEER released a Request for Proposals (RFP) that addressed topic areas in relation to Tidal In-Stream Energy Conversion (TISEC) devices. The RFP was divided into two stages. The two projects awarded funding from the first stage were described in the last issue of 'Currents'. This fall, five projects were awarded funding for the second stage and details on three projects are featured in this issue. Note: the additional two will be included in future issues of 'Currents'. We thank the researchers who provided the following information on their projects.

Testing of Temporal Monitoring Techniques for Benthic Habitat Impacts from Tidal Power Developments

McGregor GeoScience Ltd.
Principal Investigator: Dr. Craig Brown - Chief Environmental Scientist
Dimitri Tzekakis - MSc Student/Marine Geoscientist
Christopher Wedler - Hydrographer
Ulrich Lobsiger - Ocean Science Manager
Dr. Lin (Luke) Lu - Senior Marine Ecologist
Jessica Gould - Co-op Student, Dalhousie University
Dr. Evan Edinger - Supervisor for Dimitri Tzekakis, Memorial University

Over the last two decades we have witnessed the development of new technologies, in particular, multibeam sonar echosounders (MBES) that are used to map the sea floor. These acoustic systems offer the opportunity to collect full-spatial coverage acoustic data over

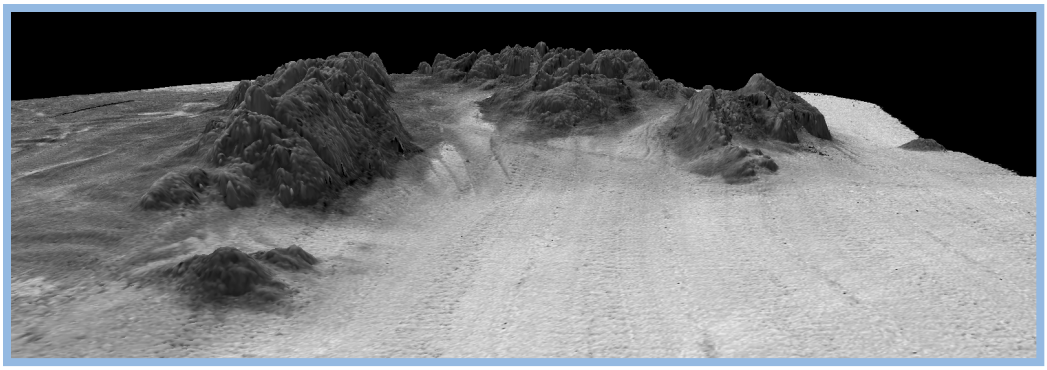

Figure 1: *An example 3D view of an area of seafloor from multibeam sonar data collected for the purpose of generating a seafloor habitat map. The example shows a rocky reef (dark grey-scale regions) surrounded by soft sediments (light grey-scale regions). The McGregor GeoScience project in the Bay of Fundy will utilize this type of data to test the application of repeat acoustic surveys for monitoring change around TISEC devices.*

large areas of the ocean floor which can be related to seabed bathymetry, texture and composition (Figure 1). Integrating the sonar data with conventional point-sampling data (i.e. seafloor sediment grabs, underwater video and photographs) has the potential to significantly improve our spatial understanding of the ecological, geological, and oceanographic processes taking place in coastal and offshore areas. These methods can now be used to produce maps of seafloor habitats, with a high degree of confidence and accuracy. However, there are very few examples of repeat habitat mapping surveys for the purpose of monitoring changes in seafloor conditions, even though these methods offer tremendous potential for measuring change over broad spatial scales.

In the fall of 2011, McGregor GeoScience Ltd. began a two year research project to test and develop monitoring procedures for assessing the impact of the placement of TISEC devices on the seafloor environment. The placement of these structures has the potential to influence surficial geology and seabed biological characteristics around the TISEC structures through alterations to the hydrodynamic conditions, resulting in sediment movement and scour formation. The research project will test the application of repeat seafloor habitat mapping surveys for monitoring the impact of TISEC devices (e.g. tidal turbines, cables and other seafloor hardware) on seafloor ecosystems. The project will collect test data over case study sites in the Bay of Fundy using high-resolution multibeam sonar and seafloor biological sampling methods (underwater grabs, video, and photographs). By comparing time series data the most appropriate survey methodology will be determined for future monitoring needs. Survey work will commence in the spring of 2012, with follow-on repeat surveys in the spring of 2013.

McGregor GeoScience is currently building relationships with other institutions including Acadia University, COGS and NRCan to strengthen this research program in the Bay of Fundy.

Turbulence and Bottom Stress in Minas Passage and Grand Passage

Dalhousie University: *Dr. Alex Hay (Principal Investigator), Justine McMillan (Ph.D. candidate), Doug Schillinger (Research Assistant)*
Acadia University: *Dr. Richard Karsten (Co-Investigator), Dr. Joel Culina (Postdoctoral Fellow)*

The primary objective of this project is to investigate turbulence and bottom stress at two of the sites being targeted for in-stream tidal power development in Nova Scotia: Minas Passage in the upper Bay of Fundy and Grand Passage in the lower Bay. An instrumented bottom lander previously

developed for studies of flow and turbulence on the inner continental shelf during energetic storm conditions will be deployed to obtain comprehensive measurements of the turbulent flow and bottom roughness conditions in these tidal passages. The primary instrument suite will include acoustic current profilers and a vertical array of single-point acoustic velocimeters to obtain velocity measurements from close to the bed to the near-surface. The resulting data set will provide redundant estimates of bottom stress and the bottom drag coefficient, the nearbed turbulent kinetic energy spectrum and energy dissipation rate, and the shear and kinetic energy of fluctuations associated with macro-turbulence. The first deployment is set for spring 2012. The results from these measurements will add to, and complement, the existing data base on flow in the two passages, contributing new direct measurements of bottom stress and the spectrum of nearbed velocity fluctuations, which will be used to estimate the hydrodynamic forces on cables lying on the seabed and, in the case of mobile beds, erosion and transport of sediment which impact the stability of both cables and seabed structures. The results will also be used, in collaboration with Dr. Richard Karsten (Acadia University), for further validation of a numerical tidal circulation model and refined estimates of the energy available in these passages.

Cross-coupling between Device-level CFD and Oceanographic Models Applied to Multiple TISECs in Minas Passage

Triton Consultants Ltd
Michael Tarbotton - Project Leader, Oceanographic modelling
Clayton Hiles - Oceanographic modelling, Model coupling
Roy Walters - Oceanographic modelling, Model coupling

Mavi Innovations
Voytek Klaptocz - CFD modelling, Model coupling

The University of Victoria
Dr. Curran Crawford - Experimental modelling, CFD modelling
Michael Shives (PhD Candidate) - Experimental modelling, CFD modelling

Acadia University
Dr. Richard Karsten - Oceanographic Modelling, model coupling

A team of ocean modelling experts from industry and academia has been assembled for this project to develop a link between oceanographic computer models and Computational Fluid Dynamics (CFD) models. Efficient linkage of these modelling techniques will advance the state of the art of tidal energy resource assessments and siting of single and multiple tidal turbines.

Oceanographic tidal models can calculate tidal height and associated current velocity for large coastal areas spanning hundreds of kilometres over periods of days or even months. To achieve this by practical means oceanographic models neglect some of the small scale physics that can be important to the performance of in-stream tidal devices.

Conversely, CFD models are much better suited at simulating small scale physics to capture interactions between turbines, but are very computationally expensive. Typically, CFD models simulate turbine performance in an idealized channel for a specific current speed and for short durations no more than a few minutes. CFD models therefore neglect the effects

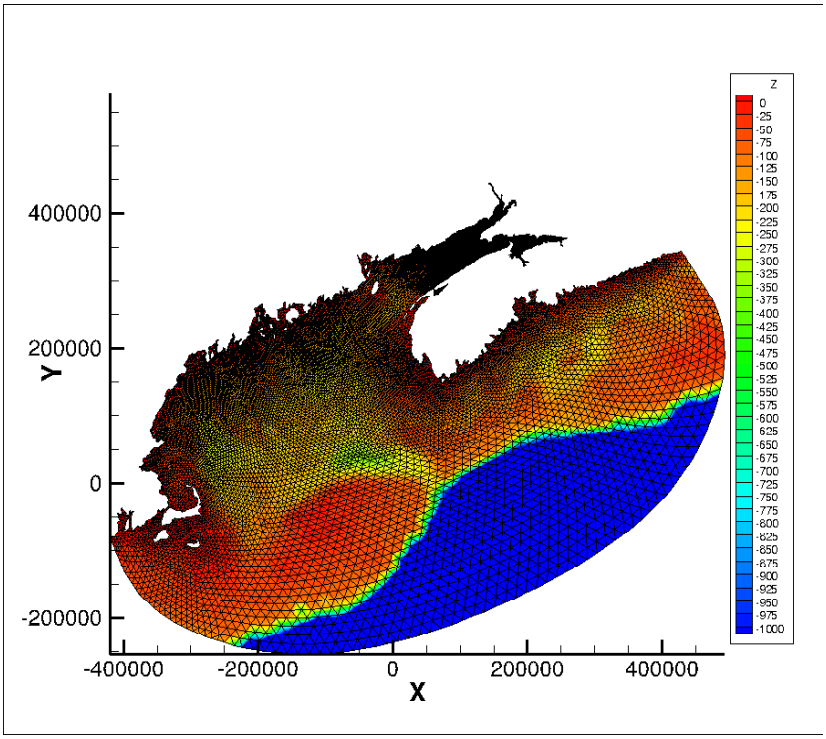

Figure 1: *Computational grid for an oceanographic model of the Bay of Fundy.*

that energy extraction has on the overall tidal resource and fail to account for the complexity of a real world tidal flow.

Traditionally, oceanographic models are used for assessing the magnitude of tidal resources in large areas such as the Bay of Fundy while CFD models are used by technology developers to predict turbine performance. This project sets out to draw from the strengths of both modelling approaches by developing a method of combining the ability of oceanographic models to capture far field effects and CFD models to accurately predict the flow in very close proximity to the Tidal In-stream Energy Conversion (TISEC) device. This will benefit both tidal turbine farm developers for site assessment as well as machine designers for better understanding local inflow conditions.

The first phase of this work will focus on generating high quality experimental data using the University of Victoria flume tank for validation and developing CFD simulations for the idealized cases of single and multiple turbines in a straight channel and a closed basin. Methods of combining CFD and oceanographic models will be tested on the idealized cases and compared to experimental and existing published data.

The second phase of the project will apply the methods developed for idealized cases to an existing oceanographic model of Minas Passage developed by Triton Consultants. Multiple turbines will be

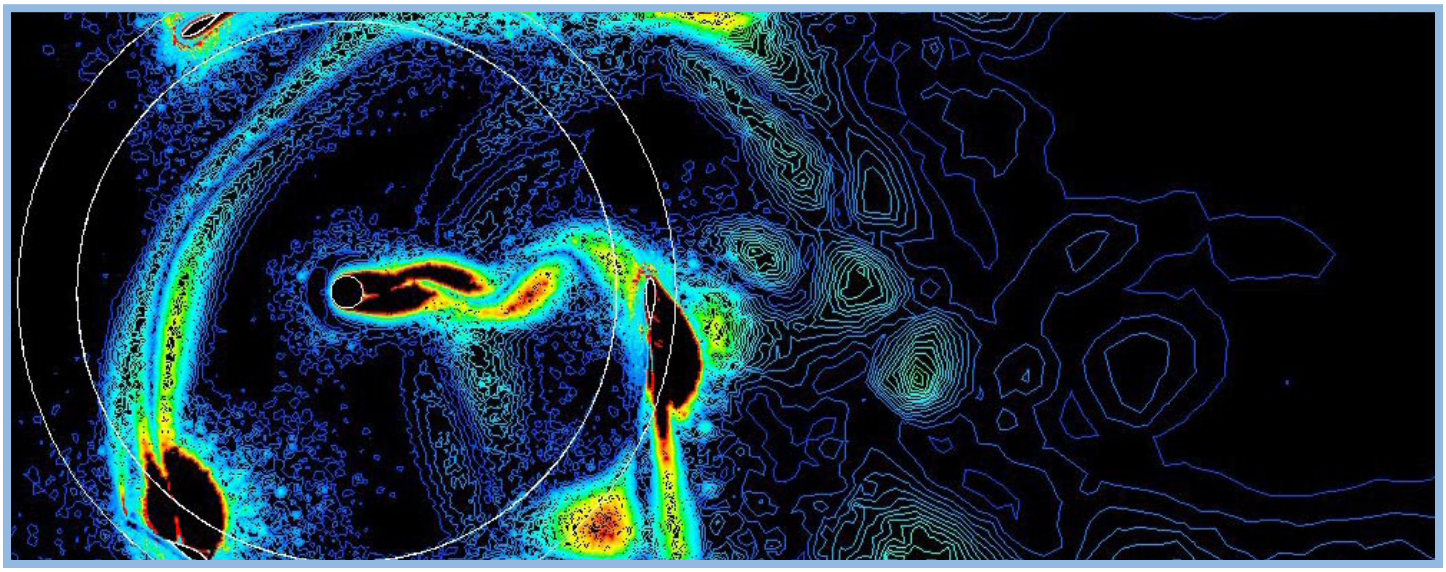

Figure 2: *Colour contours results of a CFD simulation of tidal turbine blades.*

included in the model to capture interaction effects between the devices.

Gap Analysis for Small Scale In-stream Tidal Technology

OETR Association has just completed a gap analysis for small scale in-stream tidal technology. The project addresses key components such as device demonstration sites and facilities, assessment of the state of the technology for device efficiency, and assessment of the environmental impacts associated with these devices. Phase I of this work, the analysis stage, was to identify gaps in knowledge to further advance small scale tidal in-stream technology design, and identify key components that need to be addressed.

On July 7 & 8, 2011, the Department of Energy held a two-day Tidal Symposium in conjunction with the New England Governors and Eastern Atlantic Premiers' Conference to provide a "working symposium" where key players in the sector collaborated, shared information and discussed future opportunities to move the industry forward. Attendance drew from amongst a broad range of groups interested in tidal energy, representing Canada, New England, the United Kingdom, and Korea. As part of the symposium, OETR Association contracted Stantec Limited to facilitate a small scale in-stream tidal workshop and develop a report of its outcomes. The full report, including findings on the gaps/barriers and recommendations resulting from the workshop, can be found on the OETR website at www.offshoreenergyresearch.ca.

The workshop served to support phase I of the project, the gap analysis for small scale in-stream tidal technology, whereby the findings will be used to guide the development of phase II of the project.

OEER Offshore Energy Environmental Research Association

For more information about the Tidal Energy Research Program contact:

Jennifer Matthews
j.matthews@offshoreenergyresearch.ca
5151 George Street, Suite 602, Halifax
Nova Scotia B3J 3P7 Canada
P: (902) 424-2493 • F: (902) 428-2200

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.