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Best Practice in MRE Risk Assessment: Experience from the Bay of Fundy.

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ABSTRACT

Determining the acceptability of marine renewable energy is a ballet with three Acts: I – Context and Problem Definition; II – Project Definition and Risk Assessment; and III – Adaptive Management. Increasingly, there are calls for a statement of best practices to guide developers, regulators and communities in determining the acceptability of energy development proposals, but the best practices need to cover a bewildering and diverse spectrum of activities and contexts. Nova Scotia – which generated nearly 90% of its electricity from fossil fuels in 2007 – established a target of > 40% of its electricity to come from renewable energy such as wind and tidal power by 2020. The environmental and socio-economic trade-offs required for a rapid transition to renewable energy necessitates an aggressive but adaptive strategy based upon the best scientific and socio-economic information, cross-sectoral cooperation, extensive public engagement, and a sophisticated process of risk evaluation.

INTRODUCTION

The tidal power potential of the Bay of Fundy has been under study for over a century[1]. It is clear that there is more than enough power to supply all of Nova Scotia's electricity needs using either tidal range or tidal stream approaches, both of which have been proposed. A Strategic Environmental Assessment (SEA)[2,3] concluded in 2008 that new tidal stream devices could be used to supply an important fraction of provincial needs, but that public acceptability depended upon: a) conviction that environmental and socio-economic implications were well understood and acceptable; b) that development occur incrementally and should be managed adaptively, allowing progressive re-evaluation of risks as larger arrays are deployed; and c) that the scale of development should be matched to local or regional needs.

In response, the Nova Scotia government initiated development of a major test facility for tidal stream turbines in Minas Passage (the Fundy Ocean Research Centre for Energy, or FORCE), introduced supportive legislation, and established Feed-In Tariffs (FITs) for both large production arrays and small scale community-owned energy developments. Since the 2008 SEA, coordinated research by academia, government agencies and the private sector has identified, assessed and examined many of the expected environmental effects, and the results made widely available to increase public awareness. Nova Scotia has essentially pursued a process that emphasises adaptive management and extensive public participation and consultation. The extreme conditions of the Bay of Fundy will require effective monitoring and mooring/deployment technologies, many of which are not readily available; as a result, much effort has been committed to evaluation of alternative sensors and platforms, and development of new ones where necessary. A repeat of the SEA has just been completed[4]. It summarises the research and legislative activities completed in the last 5 years, but also confirms the cautious support of the public for the systematic and incremental approach being taken in development of tidal power in Nova Scotia.

PROCESS

The process being followed in assessment of tidal power in Nova Scotia has three phases:

- Context and Problem Definition (Act I).

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- Project Definition and Risk Assessment (Act II).
- Adaptive Management (Act III).

In each phase, emphasis is placed upon collaboration and communication between the principal stakeholders: regulators, developers, researchers, First Nations, and the public at large.

Act I commenced with the first SEA, which included a series of public consultations to increase public understanding of tidal stream energy capture and to assess public attitudes to development. Hydrodynamic models were used to provide more precise calculations of resource potential at different sites, resulting in a substantial increase in the estimate from 300MW to more than 2500MW[5,6] for Minas Passage alone, with proportionately smaller estimates for other sites in the Bay.

Potential environmental effects of marine renewable energy were collated into Pathways of Effects models[7] that were subjected to extensive peer review, and then used as a basis for establishing research priorities (see Figure 1). A wide array of collaborative research projects was initiated to address important knowledge gaps and to identify suitable technologies for research and monitoring under extremely high flow conditions. Priority issues included: effects of energy extraction on tidal dynamics; presence and movements of marine mammals, fish and birds; substrate characteristics; benthic communities; sedimentation processes and their relationship to tidal dynamics; shoreline erosion; ice properties and movements; durability and design of moorings and support structures; supply chain characteristics and opportunities; and local socio-economic capacity. A non-profit organization, the Fundy Energy Research Network (FERN), was created to ensure a maximum of information exchange and cooperation between device developers, researchers, regulators, First Nations and the public at large.

A single 1.2 MW turbine was installed at the FORCE site in November 2009. While the device failed after only a few weeks, much was learned about the challenges of deployment and retrieval under high flow conditions.

Because of the high tidal range (~12-13 m on spring tides) and associated currents (up to 6m.sec^{-1}) and turbulence, many common environmental sensors used for monitoring fish or mammal movements (etc.) work poorly or only during low flow periods (at or near slack water). Submersed moorings and subsurface floats have needed to be redesigned, involving academic and private sector innovation, and leading to development of a recoverable and relocatable instrument platform (e.g. FAST – Fundy Advanced sensor Technology) that can support a suite of sensors to provide real-time information on environmental conditions and turbine operations and effects.

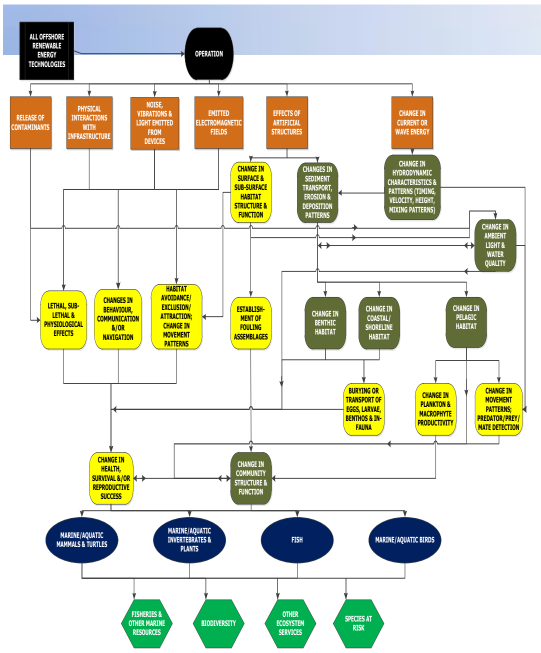

Figure 1. Pathways of Effects Model[7]

Evaluating the risk of tidal energy conversion requires an understanding of the dynamic properties of the whole tidal system, accurate knowledge of environmental conditions at each deployment site, and detailed information of turbine characteristics. After one hundred years of research, the tidal and ecological dynamics of the Bay of Fundy are moderately well known and recent high precision site investigations (using acoustic sensors, multibeam bathymetry etc.) have filled in many of the knowledge gaps. A generic model of the risk assessment process has been developed[8], but until turbines are installed some of the components of risk assessment, e.g. to marine mammals and fish, cannot be completed.

Engagement of the public as an integral part of decision-making has been a central feature of both SEAs through public consultations and creation of representative stakeholder groups. To facilitate information transfer to the public, and to provide a guide for developers and other interest groups to collaborate, a comprehensive Tidal Energy Toolkit has been developed[9], together with a Handbook[10]to assist developers and others in the appropriate practice of community engagement.

Act II is just beginning, as specific tidal power projects are being proposed for various locations in the Bay of Fundy. Each proposal over 5 MW will require an environmental assessment that will assess both near- and far-field effects. The EA will be subject to public examination, and to ensure that the public is adequately informed in advance, a pro-active phase of community engagement will be expected. Larger arrays (more than 50 MW) will be subject to a joint provincial-federal assessment under the Canadian Environmental Assessment Act (CEAA – amended 2013) and will also be subjected to public scrutiny.

Act III will be initiated when a specific project has been approved. It is expected that the dynamic and variable conditions of the Bay of Fundy will still be insufficiently known to allow for a confident assessment of the maximum level of energy conversion consistent with conservation of ecosystem properties. Monitoring technologies are still inadequate[11-14]: they need to be robust, able to operate under extremely turbulent conditions, and not be influenced by environmental noise. Turbine properties are varied, and effects of operating turbines on the behaviour of mammals and fish cannot be predicted accurately. For these reasons, the last phase of development will have to be a well-defined case of adaptive management. Similar to the strategy used for demonstration projects by the Northern Ireland Department of Environment for Strangford Lough and the US Federal Energy Regulatory Commission (FERC) in Cobscook Bay (Maine), approval for large scale arrays in the Bay of Fundy will be for incremental development, with continuous reassessment on completion of each increment. The approach should minimise the risk of catastrophic effects to the environment, to regulators and to developers, but requires establishment of a great deal of trust between all stakeholders.

CONCLUSIONS

In spite of difficulties associated with the extreme hydrodynamic conditions in the Bay of Fundy, the lack of adequate monitoring technologies, and potential effects on other resources, Nova Scotia is moving steadily toward development of tidal energy in the Bay of Fundy using a process that combines extensive collaboration between regulators, researchers, developers and local communities. Emphasis is placed upon this as a collective social enterprise in which all stakeholders must accept and share the risks, and enable effective decision-making under conditions of incomplete knowledge. As in a ballet, the approach needs to be well structured and sequenced, requires precise and coordinated actions by a diverse group of participants, and depends upon a shared vision for the outcome. Without this, the social license to obtain renewable energy from the world's best tidal resource will not be forthcoming.

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