Fundy Tidal Energy
Strategic Environmental Assessment
Final Report

Prepared by the OEER Association
for the Nova Scotia Department of Energy
Submitted April, 2008

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PREFACE

OEER was commissioned by the Nova Scotia Department of Energy to carry out a Strategic Environmental Assessment (SEA) focusing on tidal energy development in the Bay of Fundy. The SEA was led by an OEER Technical Advisory Group (TAG).

Throughout the SEA process, OEER received input through community forums, workshops, and written submissions. OEER also appointed twenty-four members to a Stakeholder Roundtable to provide a range of perspectives. The Roundtable held seven day-long meetings in which TAG members also participated. Roundtable members discussed the need for basic sustainability principles to underpin tidal development and the need to ensure that Nova Scotia communities benefited from tidal development, reviewed the Background Report in detail, and suggested recommendations for consideration by OEER.

While OEER is responsible for the conclusions of this SEA Report, all members of the Roundtable indicated that they are in general agreement with the intent of the 29 recommendations.OEER greatly appreciates the work of the Roundtable, which has added immense value to the SEA process.

Recognizing that SEA processes have not been widely used in Canada, OEER also commends the Nova Scotia Department of Energy for initiating the SEA, a process that focuses on both the sustainability of strategic decisions and the early involvement of stakeholders.

Thank you to Communications Nova Scotia, Richard Sanders, Marke Slipp, Minas Basin Pulp and Power, Nova Scotia Power, Clean Current, Nova Scotia Department of Energy, Tidal Electric Canada, AMEC Wind, and GE Wind Energy for contributing photos.

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EXECUTIVE SUMMARY

The Bay of Fundy has the largest tidal range in the world. The development of new tidal energy technologies, together with the imperatives of climate change and energy security, has resulted in renewed and more urgent interest in harnessing tidal power. Nova Scotia has legislated Renewable Energy Standards that will require up to 500 megawatts of new renewable energy capacity to be added to the system by 2013 — a target that is unlikely to be reached through ongoing wind power development alone.

Because of the renewed interest in tidal energy, the Nova Scotia Department of Energy commissioned OEER to carry out a strategic environmental assessment (SEA) to provide advice on whether, when and under what conditions tidal energy demonstration and commercial projects should be allowed in the Bay of Fundy. The SEA process, which took approximately one year, addressed all forms of marine renewable energy technology — offshore wind, wave, and various tidal energy approaches — but focused on tidal in-stream energy conversion (TISEC) devices.

The process was guided by the SEA Technical Advisory Group (TAG) and included:

- a background study, jointly commissioned by OEER and New Brunswick Energy, and prepared by a team led by Jacques Whitford;
- two rounds of community forums held in six locations in the Bay of Fundy Region;
- appointment of a 24-person Stakeholder Roundtable that met monthly;
- funding for community-based participation and research initiatives; and
- an extensive website and a monthly newsletter.

Using existing information the Background Report described the different technologies, assembled baseline information about the region, and explained how marine renewable energy developments might interact with both the biophysical and socioeconomic environment. The Report also identified information gaps and suggested how they should be filled.

Using the findings of the Background Report together with input from the Stakeholder Roundtable and the public, and ideas brought forward through the Participation Support funding process, OEER has made 29 recommendations to guide a strategic approach to the development of marine renewable energy in the Bay of Fundy.

OEER recommends adoption of ten Sustainability Principles intended to ensure that marine renewable energy developments respect ecological integrity and make positive contributions to the social, economic and cultural well-being of Nova Scotia as a whole and of rural communities in particular. The Principles should be incorporated into various planning and approval processes and also into new legislation that will provide a framework for the testing and development of marine renewable energy technologies. OEER also recommends that Nova Scotia proceed in a cautious and incremental manner, beginning with a Demonstration Program to include the proposed Demonstration Facility but also other technologies suitable for application at different scales and locations. The Demonstration Program should also initiate longer term research needed to predict cumulative and far-field effects in the commercial phase. Demonstration projects and any future commercial developments should be designed to be removable, and effects thresholds should be established to determine under what circumstances devices should be taken out of the water.

Other recommendations address long term research requirements and standards; how tidal energy should be integrated into Nova Scotia's overall energy strategy; ensuring that the fishery and other marine resource uses are not adversely affected and that compensation procedures are in place if required; the creation of regional and community benefits, including opportunities for community-based access to the tidal energy resource; and the importance of implementing an Integrated Coastal Zone Management approach and establishing effective collaboration with New Brunswick and the federal government.

Throughout the SEA Report, OEER stresses the necessity of meaningful stakeholder engagement through future environmental assessment processes, the creation of a Stakeholder Advisory Board to build on the work already begun by the SEA Stakeholder Roundtable, and consultation with fishers, other marine resource users, and communities at every stage of tidal development.

In addition to the Province's duty to consult with First Nations regarding marine renewable energy projects, OEER recommends ongoing engagement with Mi'kmaq communities by requiring proponents to facilitate discussion and information sharing at the earliest stages, and through the preparation of a Mi'kmaq Ecological Knowledge Study.

As a follow-up to the SEA process, OEER recommends a major inter-jurisdictional workshop in 2009 involving Nova Scotia, New Brunswick, Canada and Maine to examine integrated management issues and organization options for the Bay of Fundy.

CHAPTER ONE
Introduction

Context

The OEER Association (Offshore Energy Environmental Research) is a not-for-profit corporation dedicated to fostering offshore energy and environmental research and development, including examination of renewable energy resources and their interaction with the marine environment. The association was incorporated in March 2006, with funding from the Nova Scotia Department of Energy. OEER's members are Acadia University, St. Francis Xavier University, Cape Breton University, and the Nova Scotia Department of Energy.

The objective of OEER is to build research capacity in Nova Scotia and to assess the potential impacts of: petroleum exploration, development and production, and renewable energy technologies (ocean currents, wind, tides and waves) on the marine environment. In February 2007, OEER sponsored a workshop in Wolfville on *Tidal Power and the Environment in the 21st Century*. The workshop brought together proponents, engineers, environmental scientists, regulators and non-government organizations to discuss the opportunities and implications of using tidal stream generators to capture energy from the Bay of Fundy tides in Nova Scotia. At the workshop, the Department of Energy indicated that there was funding available for a Strategic Environmental Assessment (SEA) for offshore renewable energy and put forward the idea of OEER carrying out this assignment. Workshop participants concluded that OEER could proceed if there was a broad-based multi-stakeholder advisory group formed to work with OEER's TAG. On March 29th, the Province of Nova Scotia and OEER signed an agreement to proceed with the SEA.

The Province informed OEER that:

> *The objective of the SEA is to assess social, economic and environmental effects and factors associated with potential development of renewable energy resources in the Bay of Fundy with an emphasis on in-stream tidal. The SEA will inform decisions on whether, when and under what conditions to allow pilot and commercial projects into the water in the Bay of Fundy and under what conditions renewable energy developments are in the public interest over the long term.*
> [Letter of Agreement, signed by Bill Dooks, Minister of Energy, April 2, 2007]

The Role of Strategic Environmental Assessment

> *"A good-quality Strategic Environmental Assessment (SEA) process informs planners, decision makers and affected public on the sustainability of strategic decisions, facilitates the search for the best alternative and ensures a democratic decision making process. This enhances the credibility of decisions and leads to most cost- and time-effective EA at the project level."*
> [IAIA 2002. Strategic Environmental Assessment Performance Criteria]

SEA is a special future-oriented environmental assessment process that takes place before specific projects are considered. It provides opportunities for stakeholders to influence decisions relating to planning, policies, regulation and management, and is an effective tool to help decision-makers promote

sustainable development. SEA is proactive rather than reactive, and focuses on defining goals and objectives and then evaluating alternative means of achieving them. Given that the marine renewable energy technologies under consideration are still largely unproven, and given also the complex nature of the Fundy environment, SEA is a valuable tool to address the potential introduction of this new industry.

It should be noted that there is no one universally accepted definition of an SEA process. It means different things to different people and can be carried out in different ways. However, it is increasingly being positioned as a way to develop sustainability policies, plans and programs.

In 2001, the European Union created a directive on SEA with the result that the practice of SEA has started to increase dramatically. Many other countries and international development institutions have also begun to experiment with or implement SEA. In Canada, a Cabinet Directive, updated most recently in 2004, encourages use of SEA based on public concern about the possible consequences of a proposed policy, plan or program submitted to a Minister or to Cabinet, and also to help implement sustainable development goals. However, it would appear that SEA is only being used under the Cabinet Directive on a limited basis and is usually not a public process. The federal Environment Minister's Regulatory Advisory Committee (RAC) on Canadian Environmental Assessment Agency has identified SEA as a priority and is investigating ways to increase its use.[1]

Thus, it can be seen that the Nova Scotia Department of Energy's decision to address marine renewable energy through an SEA process is both innovative in the Canadian context and also in line with developments in other parts of the world.

Objectives of the Fundy Tidal SEA

The mandate of the Fundy Tidal Energy SEA was to address a range of marine renewable energy technologies (wind, wave and tidal), however the Province specified that the main focus should be on a tidal in-stream energy converters (TISEC), also known as tidal in-stream turbines.

The purpose of the SEA, as determined by OEER, was to:

(1) Determine, through a consultative process:

- Whether ocean renewable energy technologies, and specifically tidal in-stream technologies, can be developed in the Bay of Fundy without significant impacts on the marine ecosystem;
- Whether these technologies can be developed without significant socio-economic impacts on fishers and the fisheries and on other marine and coastal resource users;
- What contribution ocean renewable energy technologies can make to community and regional economic development in Nova Scotia; and

(2) Advise the Government of Nova Scotia on:

- Whether, and under what conditions pilot projects should be permitted;

1 M. Doelle, 2008. The Federal Environmental Assessment Process: A Guide and Critique (Markham, Ont.: LexisNexis Butterworths

SEA TAG Members

Meinhard Doelle,
Dalhousie University, Co-Chair

Bruce Cameron,
Nova Scotia Department of Energy

Sandra Farwell,
Nova Scotia Department of Energy

Jay Lugar, SPANS

Vanessa Margueratt,
Nova Scotia Department of Environment

Peter Underwood,
Nova Scotia Department of Natural Resources

Andy Sharpe,
Clean Annapolis River Project

Heather Quinn,
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Ken Lee,
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Andrew Parker,
Retired, CNSOPB

Dick Stewart,
Atlantic Herring Fisheries Marketing Co-op, Full Bay Scallop Association

Jeff Garnhum,
Nova Scotia Department of Environment

Tim Smith,
Canadian Environmental Assessment Agency

Graham Daborn,
Acadia Centre for Estuarine Research

- What ongoing research and monitoring is required to gather the information needed to make decisions about commercial developments; and
- Other steps required to determine whether, where and how commercial projects should be developed, regulated and managed.

SEA Process

The SEA was guided by an OEER TAG, co-chaired by Dr. Meinhard Doelle and Dr. Joshua Leon.

Members were appointed from OEER's Research Advisory Committee and also as members-at-large. The TAG then appointed Lesley Griffiths as Process Lead. Lesley facilitated all community forums, chaired the meetings of the Roundtable, and authored the SEA Report under the guidance of the SEA TAG.

In May 2007, the New Brunswick Department of Energy approached the Province of Nova Scotia to enquire about possible SEA collaboration opportunities. It was agreed that the proposed background research report would be cost-shared by the two provinces and that the study area covered would include the entire Bay of Fundy. Consequently, Heather Quinn, NB Energy, joined the TAG and participated in the consultant selection process. New Brunswick is carrying out a similar SEA process.

OEER selected a consulting team, led by Jacques Whitford, to prepare the Background Report. They were asked to address:

- Nova Scotia and New Brunswick's current energy demand and supply situation, policies, programs and renewable energy goals;
- the existing biophysical and socioeconomic environment;
- the location and properties of high renewable energy potential locations;
- types of ocean renewable energy technology ;
- potential pilot and commercial development scenarios;
- potential interactions between renewable technologies and the biophysical and socioeconomic environments;
- cumulative effects;
- the contribution of ocean renewable energy to economic development in Nova Scotia and New Brunswick and to community economic development in coastal areas; and
- information gaps, and recommendations for addressing them.

A website was constructed for the SEA, with opportunities for participants to post their own information, and a monthly newsletter was initiated.

In August 2007, six community forums, attended by nearly 300 people, were held in Yarmouth, Digby, Wolfville, Parrsboro, Truro and Halifax. The forums included short presentations on the SEA and on marine renewable energy technologies, followed by discussions organized around two key questions:

- What information do we need before decisions are made about tidal energy?
- What information do you know of that could help the SEA process?

A report was prepared on the community forum feedback and posted on the website.

In order to encourage participation in the SEA and broaden the scope of information received, the TAG agreed to set aside a Participation Support Fund (PSF), totalling $20,000, to be awarded in small grants in two categories:

- initiatives that would bring views and ideas to the SEA process from stakeholders who might otherwise not participate; and
- initiatives that would bring new information to the SEA process through small locally-based research projects.

PSF Awards were made in two rounds in November 2007 and January 2008 to a total of seven projects:

- Atlantic Policy Congress of First Nations Chiefs, research on First Nations fisheries;
- Bay of Fundy Marine Resource Centre, research on citizen engagement and models for community benefit from energy development;
- Bay of Fundy Marine Resource Centre, tele-learning session with rural communities;
- Ecology Action Centre, research on integrated resource management in the Bay of Fundy region;
- Nova Scotia Environmental Network, workshop for network members;
- Richard Sanders of Sanders Resource Management Inc., secondary research on submerged ice; and
- Scotia Fundy Mobile Gear Fishermen's Association, documenting fleet's activities and catches and interviews with fishers to collect traditional knowledge.

In September 2007, OEER appointed 24 members to a Stakeholder Roundtable through a sectoral nomination process. Members brought to the table views from a wide range of perspectives including:

- Municipalities;
- Fisheries;
- Aquaculture;
- Community development;
- Environmental organizations;
- Tourism;
- Marine transportation; and
- Tidal developers

In addition, OEER invited the Assembly of Mi'kmaq Chiefs and the Native Council of Nova Scotia to nominate Mi'kmaq persons to participate on the Roundtable. TAG members also attended Roundtable meetings when able to do so.

The Roundtable met a total of seven times, between October 2007 and April 2008. Minutes of all meetings were posted on the website. Members reviewed the Background Report and developed a list of

Roundtable Members

Doug Bertram, *Aquaculture Association of Nova Scotia*

Diana "Dee" Campbell, *Union of Nova Scotia Indians*
Vance Hazelton, *Full Bay Scallop Association/Atlantic Herring Coop*
Chief Gerard Julian, *Assembly of Nova Scotia Mi'kmaq Chiefs*
Franz Kesick, *Maritime Aboriginal Aquatic Resources Secretariate*
Eric Mark Langdon, *Fundy Gypsum Company*
Art MacKay, *Sierra Club*
Bruce McCulloch, *Maritime Tidal Energy*
Charles McCulloch, *Municipality of East Hants*
Simon Melrose, *Ecology Action Centre/Oceans Ltd.*
Lisa Mitchell, *Nova Scotia Environmental Network*
Dana Morin, *Fundy Tidal Inc.*
Peter Newton, *Municipality of County of Annapolis*
John Scott, *Partnership for Sustainable Development of Digby Neck*
Marke Slipp, *Member-at-large*
Lois Smith, *Town of Parrsboro*
Roy Sollows, *Heavy Current Fisheries Association*
Madonna Spinazola, *Destination Southwest Nova Scotia Tourism Association*
Mark Taylor, *Heavy Current Fisheries Association*
Jim Taylor, *Municipality of Kings County*
Terry Thibodeau, *Annapolis Digby Economic Development Agency*
Terry Toner, *Nova Scotia Power*
John Wheatley, *Tidal Electric Canada LLC*
Robert Young, *Environmental Services Association of Nova Scotia*

potential SEA recommendations. At the final meeting in April, the Roundtable discussed the draft SEA report.

The Background Report was completed in December 2007 and made public through the website and by depositing printed copies at libraries in the Fundy Region. Written comments were requested, and OEER received over 60 submissions.

In April 2008, OEER made public the draft SEA report including draft recommendations in preparation for the community forums in May. On April 30, the SEA Report will be submitted to the Minister of Energy, to be followed in early May 2008 by a second round of community forums to gather feedback on the report. This feedback will also be submitted to the Minister as a Community Response Report on May 16th.

The Minister has committed to providing a written response from the Province of Nova Scotia to the SEA Report by May 30, 2008.

Aboriginal Engagement in the SEA Process

OEER was fully aware of the Province's duty to consult with First Nations with respect to potential tidal projects. The Province has agreed to a separate consultation process with the Mi'kmaq of Nova Scotia through the Mi'kmaq-Nova Scotia-Canada Terms of Reference Consultation Process and has discussed its plans to develop a tidal energy demonstration facility with the Mi'kmaq through the Energy Consultation Table. OEER understands that the Crown will also carry out its duty to consult on specific projects once they are established.

OEER asked the Minister of Energy to confirm in a letter to the thirteen Mi'kmaq Chiefs and Councils that the SEA process was not intended in any way to take the place of formal consultation requirements and that Mi'kmaq communities could feel free to participate in our process without fear that this would adversely affect their right to be consulted on specific projects. This letter was followed by one from OEER inviting aboriginal communities and organizations to share their perspectives by participating in the SEA process. Subsequently, letters were sent to inform aboriginal people about the two rounds of community forms. These letters were sent to:

- Chiefs and Councils;
- Confederacy of Mainland Mi'kmaq;
- Union of Nova Scotia Indians; and
- Native Council of Nova Scotia.

OEER also invited the Assembly of Nova Scotia Mi'kmaq Chiefs and the Native Council of Nova Scotia to nominate members to the Roundtable.

Acknowledgements

OEER acknowledges the contributions made by all participants in the SEA process, including those who attended one or more of the community forums, those who contributed to the website, individuals and organizations who sent in written submissions, and everyone involved in contributing additional information and ideas through the Participation Support Funding Program.

In particular, OEER recognizes the work of the Stakeholder Roundtable members who generously shared their time and knowledge, in many cases travelling long distances to meetings. The breadth of perspectives brought to the Stakeholder Roundtable played an essential role in carrying out this SEA.

OEER also acknowledges the sterling work of OEER staff throughout the SEA Process -- Wanda Barrett, John Cianfaglione, and particularly Jennifer Harrie who, among other tasks, recorded the lengthy proceedings of the Roundtable and TAG meetings and designed this report.

CHAPTER TWO
Energy Context

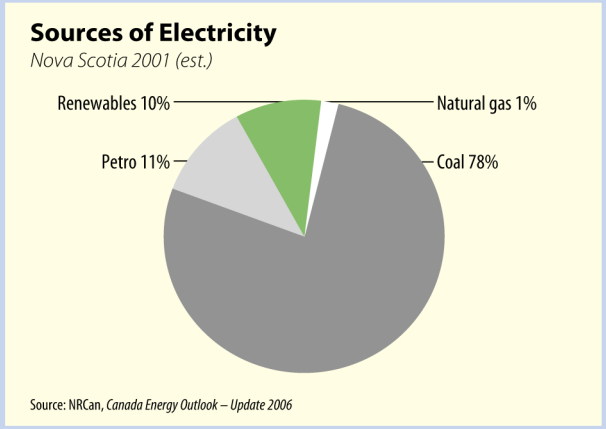
The information in this chapter on Nova Scotia's energy context has been provided by the Nova Scotia Department of Energy.

Supply and Demand

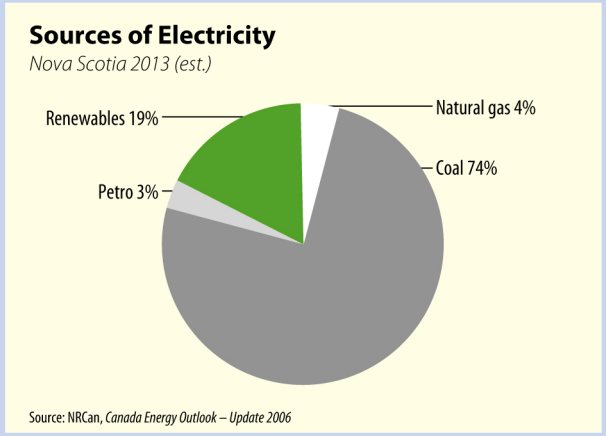
Nova Scotia's domestic energy supply (renewable and non-renewable) is small compared to its energy imports. Most of our energy supply is imported in the form of coal and petroleum (for electrical generation) and petroleum products (for transportation). Our domestic supply provides:

- heating (natural gas, biomass);
- electricity generation (hydro power, biomass, wind, tidal, natural gas, domestic coal); and
- vehicle fuel (biofuels from fish-oil).

Demand for energy in Nova Scotia is growing faster than population growth. But there are technologies, building designs, and practices that are affordable and effective in reducing energy use. Therefore Nova Scotians must decide what are the most effective policies to encourage energy efficiency and conservation.



Energy use is clearly connected to climate change and air pollution. Fossil fuels create greenhouse gas (GHG), and greenhouse gas contributes to climate change. As a coastal province, Nova Scotia is vulnerable to many of the effects of climate change including impacts on our homes, our power grid, and our offshore oil and gas infrastructure. Air quality is also greatly affected by fossil fuel use.



Nova Scotians need a reliable supply of energy. A diverse energy supply with both local and regional energy sources can help balance market fluctuations and supply disruptions. The current cost of many green energy sources (such as wind, solar, and tidal) is more than conventional energy supplies. Nova Scotia will need to find ways to help those without the financial resources to make the investments that lead to energy efficiency and conservation savings.

Recent Changes in Energy

A number of major changes in energy have taken place since development of the 2001 Nova Scotia Energy Strategy. These include:

- a continual rise in energy prices ;
- major shifts in knowledge and policy from energy exploration;
- public awareness and desire to address climate change and energy use; and
- emerging technologies.

Due to major global changes in supply and demand, the price for fossil fuels has risen dramatically over the past six years. In Nova Scotia this has meant a substantial increase in the price of gasoline, home heating fuel, and to a lesser degree, electricity. Meanwhile, accessible and inexpensive supplies of fossil fuels are on the decline and this has introduced unpredictability to the marketplace. Sharp rises in fossil fuel prices due to natural disasters and political instability have often been short-term, but prices are settling permanently at levels higher than before. The complexity of prices includes the fact that price increases tend to encourage both resource exploration and development as well as energy efficiency and conservation.

Since 88 per cent of Nova Scotia's electrical power currently comes from fossil fuels, the cost of our electricity is also rising, although at a slower pace, since coal is still the least expensive and most available fossil fuel.

Renewable Resources

Renewable energy sources (wind, solar, ocean, bio-mass, bio-fuels, hydro) will play an increasing role in Nova Scotia's future energy supply, both locally and regionally. This increase will come partly from marketplace demand, due to the rising cost of competing fossil fuels, and partly from government regulation, requiring a more diverse supply to address both energy security and climate change.

Technical challenges and higher costs are associated with many renewable sources, especially intermittent and unpredictable sources such as wind. Intermittent renewables do not run at full capacity all the time, so actual power production often falls short of the total capacity. These sources require backup supply, and because Nova Scotia lacks a large hydro supply, our backup is often by fossil fuel–based power plants. Nova Scotia is now conducting a technical study to determine the optimal amount of wind capacity to keep the system reliable, sustainable, and affordable.

The direct cost of most renewable power is currently higher than coal. Adding renewable energy to our electricity system will likely raise prices for consumers. But those prices may be balanced by longer-term price stability as fossil fuel prices continue to rise and fossil fuel supply diminishes.

Since the release of the 2001 Energy Strategy, approximately 60 megawatts of renewable power projects have been either built or are committed to be built. In 2007, NSPI called for proposals for an additional 130 MW of renewable energy generation.

Because of the requirements of the new Renewable Energy Standard, up to 500 megawatts of new renewable energy capacity must be added to the system by 2013. That translates into over 100,000 homes powered by renewable energy, and up to 750,000 tonnes of greenhouse gas emissions displaced from the atmosphere. Options are as follows:

Wind energy will fulfill most of the 2013 standard. Nova Scotia enjoys world-class average wind speeds, and the number of turbines in the province is expected to grow from 40 to over 250 in the next six years.

Tidal power in the Bay of Fundy may eventually play a prominent role in Nova Scotia's renewable power mix. Although tidal power is intermittent, it is predictable, and therefore valuable as a source of electrical energy.

Hydro power in Wreck Cove (225 MW capacity, almost 10 per cent of NSPI total capacity) has been a foundation of renewable power in the province for years. Large hydro resources in other provinces may be economically viable and could play a large role in both diversifying our supply and meeting our climate change goals.

Solar energy (thermal and photo-voltaic) will become increasingly viable options for homes and buildings as prices becomes more affordable.

Biogas energy from landfill sites has potential, but modern waste practices in Nova Scotia divert much of the material used to produce methane away from landfills.

Biomass from forestry waste is now burned in some locations, and it is a potentially larger source of energy in Nova Scotia. Although biomass fuel emits carbon dioxide, it is considered carbon neutral because as forests regenerate they use CO2. However the impacts from particulates also need to be considered.

Biofuel can reduce vehicle and home heating emissions significantly. Biofuels are a developing technology and have some challenges to overcome. For example, some biofuels have less potential energy by volume than conventional fuels, and emissions of some air pollutants increases with biofuels.

Electricity

The Energy Strategy (2001) set the course for a gradual opening of electricity markets. Key recommendations were implemented through both the Nova Scotia Utility and Review Board (UARB) and government legislation.

In the spring of 2005, the UARB approved Nova Scotia Power's (NSPI) Open Access Transmission Tariff (OATT). This tariff ensures there is open and non-discriminatory access to Nova Scotia's transmission grid for those suppliers who are eligible. On February 1, 2007, the government brought into force Nova Scotia's Electricity Act (including the Renewable Energy Standard); approved an initial set of Wholesale Market Rules; and adopted the Wholesale Market Regulations. Although only six small municipal owned utilities are currently eligible to participate in these markets, regulatory changes are intended to result in further market-openings and competition.

Further market openings may depend on the state of the electrical transmission system in Nova Scotia. Electricity cannot be efficiently stored and must be ready when a switch is thrown. With limited ability to import quick backup power, intermittent sources of energy such as tidal and wind add to the challenge.

Building new transmission facilities is costly. For example, strengthening Nova Scotia's transmission ties to New Brunswick could cost hundreds of millions of dollars. But such an investment is essential for many solutions, and could also open the possibility of using regional energy sources that emit fewer GHGs such as hydro power from Labrador's proposed Lower Churchill project.

The scope and scale of the cost of making a transition to lower emissions and greater sustainability are difficult to estimate due to many unknowns, such as:

- the future cost of each energy source;
- technological breakthroughs;
- the level of efficiency and conservation achieved; and
- future caps on emissions.

Without a large source of renewable hydro energy close at hand, Nova Scotia has more difficult policy options than some provinces when it comes to meeting GHG reductions. For example, Manitoba gets 99 per cent of its electricity from hydro power, while Quebec and British Columbia generates 97 per cent from hydro. Nova Scotia (like Alberta, New Brunswick, PEI, and Saskatchewan) is not so fortunate. Without large-scale local clean energy sources, Nova Scotia will likely require a mix of energy options, including some imports of stable predictable clean-energy sources to sustain our energy future. Creating a diversity of energy sources rather than a dependence upon any particular one will likely continue to be a key principle of Nova Scotia's energy planning.

CHAPTER THREE
Marine Renewable Energy Technologies and their Interactions with the Environment

The Background Report describes the full range of marine renewable energy technologies, and the current environment, and analyses the potential ways in which the two would interact. This chapter provides a brief summary of some of this information, but the reader is encouraged to refer to the complete Background Report, available on OEER's website www.bayoffundysea.ca, for more complete coverage.

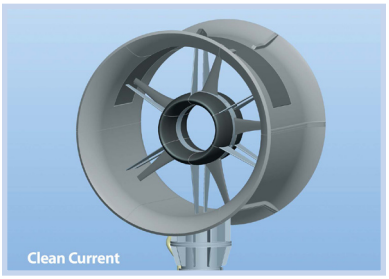
Technologies and Development Scenarios

Four types of marine renewable energy technology are described:

- offshore wind energy conversion;
- tidal in-stream energy conversion (TISEC);
- tidal lagoon energy conversion; and
- wave energy conversion.

© AMEC Wind

Offshore Wind. Commercial applications of wind energy typically cluster turbines in wind farms or wind parks. The turbines are usually mounted on steel towers and connected to either a monopile or a gravity foundation. While average wind energy is predictable over long periods of time, in the short-term wind energy can be quite variable, making it more of a challenge to integrate into a mixed electrical grid. Most turbine designs are in the 3 MW range, but 4-5 MW turbines are now being deployed. Floating turbine foundations are also being examined but are not yet commercially available. Offshore wind farms have proven their viability in the European electricity markets. Ice and the strong tidal currents in the Bay of Fundy could present construction challenges, although the best wind regimes are encountered near the mouth of the Bay of Fundy, where winter ice is rare.



TISEC. Tidal in-stream technology uses devices similar to wind turbines to capture tidal energy. However, water is much denser than air, and tidal currents are more predictable than wind. The blades may be mounted either on a vertical axis or on a horizontal axis (the most common approach). In some designs the blades are ducted. The duct or "tunnel" concentrates and accelerates the flow of water past the blades. A different type of design uses an oscillating hydrofoil. TISEC technology may either be rigidly attached to the seafloor by means of a piling or a gravity-based structure, or may be anchored to the bottom and float in the water column. The Background Report notes that there about 20 TISEC devices currently on the market at various stages of development. Large scale commercial applications have not yet been developed, but are expected to appear in European and South Korean waters in the next few years. There is much interest in developing TISEC applications in the Bay of Fundy.

Architectural Rendering by Delta Marine Consultants

Tidal Lagoon. Tidal lagoon technology involves the creation of a large impoundment in a location with high tidal range, and uses conventional low-head turbines. It is similar to the traditional barrage approach (as in the Annapolis Tidal Generating Station), in that it captures energy from the difference in water level (i.e. the potential energy), rather than the kinetic energy of flowing water as in TISEC devices. The lagoon technology shares some of the environmental issues associated with barrages, but these are somewhat different because the structure does not extend the full width of the estuary or river. No full commercial tidal lagoon has yet been constructed anywhere, but there are proposals in other locations and one proponent is interested in developing a lagoon in the Bay of Fundy. More information on tidal lagoons is included in Chapter 10.

Wave Energy. There are many different types of wave environment and also many types of device under development. The three main design concepts are floating, oscillating water-column and overtopping devices, with variations in each concept. The devices all rely on a high energy wave location to be financially viable. So far, one commercial wave energy project has been approved in Portugal and additional projects are probable within the next 5-10 years, however, the Report concludes that the Bay of Fundy does "*not offer a regular or reliable wave energy climate*" [BR 3-11], and so far there have been no expressions of interest in demonstrating wave energy technology in the Bay.

Development Scenarios

Potential TISEC projects in the Bay of Fundy can be divided into three scales:

- short-term pilot projects, not connected to the grid, that are used to carry out initial testing;
- demonstration projects that will likely generate no more than 5 MW in total, designed to provide information about technical performance, integration with the grid or other use, and environmental effects, that might be expected in a commercial scale development; and
- commercial development.

A commercial development could mean a single unit for local use, or a larger commercial project that could involve numerous devices, generating up to a few hundred MW. Criteria for finding suitable sites would include current velocities, water depth, seafloor geology, navigation and competing uses.

The Electrical Power Research Institute (EPRI) in a report[2] commissioned by the Province identifies a total of eight very promising tidal resource areas in Nova Scotia waters (see Figure 3.1). More information about the estimation of tidal potential can be found in Chapter 5. The Background Report selected two of these areas as examples (Minas Passage and Digby Gut) and provides detailed information about the implications of developing commercial scale projects at each of them.

2 EPRI. 2006. Nova Scotia Tidal In-Stream Energy Conversion (TISEC):Survey and Characterization of Potential Project Sites

Figure 3.1 – Tidal Energy Potential in the Bay of Fundy

The Existing Environment

The Background Report describes the Bay of Fundy as *"an integral part of a complex coastal oceanographic system [. . .] that includes the Gulf of Maine, Georges and Brown Banks, and the various channels between them"*. The Report stresses the dynamic oceanographic processes that are continuing to change the physical characteristics of the Bay with the result that it is *"constantly in a process of transition towards a future, somewhat different state"*.

The Report provides baseline information about the Bay's physical components — geology, sediments, wind and waves, tides and currents, ice, water quality and contaminants; and its biological components — the phytoplankton, seaweeds, benthic algae and salt marshes that collectively make up the Bay's primary production, and the zooplankton, benthos, fish, birds and mammals that are supported by this primary production. The Report draws biophysical distinctions between the different regions of the Bay and particularly the clearer, deeper waters and harder substrate of the Outer

Bay and the shallower, more turbid waters and thicker sediments of the Inner Bay.

The Report also provides information on fisheries and aquaculture, species at risk, ecological reserves, tourism and recreation, marine and coastal historic resources, and marine transportation.

Interactions

The Background Report addresses how the different phases of a TISEC Project, from seabed preparation through to eventual decommissioning at the end of the project's life, would likely interact with different aspects of the biophysical and socioeconomic environment. Table 3.1 provides a summary of these interactions.

Table 3.1 Typical Environmental and Socioeconomic Interactions with TISEC Projects

Project/ Construction Phase	Physical Process Interaction	Biological Component Interaction	Socioeconomic Component Interaction
Seabed Preparation	▪ Sediment transport ▪ Waves/currents through channel modification ▪ Noise and vibrations ▪ Introduction of additional hard-substrate	▪ Marine Benthic Habitat and Communities ▪ Fish and Fish Habitat ▪ Marine Mammals	▪ Marine Transportation ▪ Economic Development ▪ Marine and Coastal Archaeological and Heritage Resources ▪ Fisheries ▪ Aquaculture ▪ Tourism and Recreation
Pile Installation	▪ Sediment transport (sediment suspension and initiation of scour) ▪ Noise and vibrations	▪ Marine Benthic Habitat and Communities ▪ Fish and Fish Habitat ▪ Marine Mammals	▪ Marine Transportation ▪ Economic Development ▪ Fisheries ▪ Aquaculture ▪ Tourism and Recreation
Gravity Foundation Installation	▪ Sediment transport (sediment suspension and initiation of scour) ▪ Introduction of additional hard substrate	▪ Marine Benthic Habitat and Communities ▪ Fish and Fish Habitat ▪ Marine Mammals	▪ Marine Transportation ▪ Economic Development ▪ Fisheries ▪ Aquaculture ▪ Tourism and Recreation
Scour Protection Installation	▪ Sediment transport (sediment suspension) ▪ Introduction of additional hard-substrate (if traditional protection is used)	▪ Marine Benthic Habitat and Communities ▪ Fish and Fish Habitat	▪ Marine Transportation ▪ Economic Development ▪ Fisheries ▪ Aquaculture ▪ Tourism and Recreation
TISEC Installation	▪ Modified currents ▪ Reduction in total tidal energy	▪ Marine Benthic Habitat and Communities ▪ Fish and Fish Habitat ▪ Marine Mammals ▪ Marine Birds (especially if surface-piercing structures are involved)	▪ Marine Transportation ▪ Economic Development ▪ Fisheries ▪ Aquaculture ▪ Tourism and Recreation
Cable Installation	▪ Sediment transport (sediment suspension, exposure of fines, scour)	▪ Marine Benthic Habitat and Communities ▪ Marine Mammals (temporary displacement) ▪ Fish and Fish Habitat	▪ Marine Transportation ▪ Economic Development ▪ Fisheries ▪ Aquaculture ▪ Tourism and Recreation

Table 3.1 Typical Environmental and Socioeconomic Interactions with TISEC Projects

Project/ Construction Phase	Physical Process Interaction	Biological Component Interaction	Socioeconomic Component Interaction
Project Operation	▪ Reduced currents ▪ Modified waves ▪ Degradation of anti-fouling coatings ▪ Electro-Magnetic Fields (EMF)	▪ Marine Benthic Habitat and Communities ▪ Marine Mammals ▪ Fish and Fish Habitat	▪ Marine Transportation ▪ Economic Development ▪ Fisheries ▪ Aquaculture ▪ Tourism and Recreation
Maintenance	▪ New anti-fouling agents ▪ Spills from maintenance vessels ▪ Re-introduction of lubricating oils	▪ Removal of marine life affixed to TISEC unit ▪ Spill impacts on Marine Mammals, Marine birds, and Fish and Fish Habitat	▪ Marine Transportation ▪ Economic Development ▪ Fisheries ▪ Aquaculture ▪ Tourism and Recreation
De-commissioning	▪ Similar to construction	▪ Similar to construction	▪ Similar to construction

Some of the key interactions noted are as follows. It is important to note that the Report describes interactions that may occur and does not try to predict environmental effects or evaluate their significance. This would be the role of project-specific environmental assessments.

Reduction of downstream current velocity. Because the TISEC device extracts a portion of the tidal energy, downstream current velocities are expected to decrease. This could change the rates of both sediment resuspension and deposition, affect the settlement of marine larvae, diminish the food supply brought to benthic filter feeders, decrease upwelling (the process that mixes nutrient-rich waters from the bottom), influence primary production, or have indirect effects on fish and birds that feed on the benthic community. There is more potential for velocity and sediment-related effects in the Upper Bay.

The Report concluded that it is *"not likely that one TISEC device installed as part of a demonstration project will have measurable effects on any of these processes beyond the immediate area. However the cumulative effect of many such devices arrayed as part of commercial scale projects could modify these processes sufficiently to induce unacceptable changes in other properties".*[BR 6-3]

The effects of velocity change would depend on how narrow or constrained the location was, with greater effects in the narrower passages. In the Minas Passage area, a demonstration scale project would be unlikely to have a detectable effect, however, "*large scale commercial developments [. . .] might do so if they effectively reduce the kinetic energy of water entering Minas Basin by more than a few per cent. At present there is a great deal of uncertainty about what level of energy reduction is likely to be acceptable."* [BR 6-4] This means that both comprehensive modelling hydrodynamic field studies are required.

The Report also cautions that *"The whole dynamic character of the Minas Basin sediment regime hinges upon the velocity, circulation and mixing properties of the water moving into and out of the Basin. Reducing the velocity to any extent will likely change the dynamics for at least the central region of the Basin. A significant reduction in turbulence over portions of the basin would result in a drop in turbidity, increasing light levels, and therefore effects on both productivity in the water column"* [BR 6-4]

Research and monitoring requirements will include:

- very precise site-specific surveys of sediments and currents;
- long-term data on water movements and sediment distributions;
- hydrodynamic modelling; and
- ongoing monitoring.

Fish and fish habitat. Construction will likely destroy or eliminate some habitat, but the structures themselves may create new habitat. Sediment, noise and vibration could affect the fish themselves during construction. These effects could be particularly important with respect to migratory stocks. While the migration period may be relatively short or a given species, "*collectively there will be little time during the year when there are no movements of fish through the energy generating site".* More than 30 species of fish use Minas Passage once or more during their lifetime to access Minas Basin. Some fish, such as the American shad, move in-and-out with the tide over a period of days or weeks and therefore, could pass repeatedly through a TISEC development each season.

Little is known about how fish might behave around TISEC devices during operation or how electrical fields around subsurface cables might affect groundfish and mobile invertebrates, such as lobster. The Report points out that "most TISEC installations have a small individual footprint, but arrays of such devices established in passages of limited expanse may have proportionately larger cumulative effects". [BR 6-13]

The Report states that *"there is a real shortage of information about the distribution, seasonality and trophic relations of many non-commercial species of fish [. . .]".* Therefore, there needs to be surveys of local and migratory stocks before installation of TISEC devices, and monitoring of occurrence and behaviour during operations. There is virtually no information about the risks of direct damage or mortality. It is likely that species that move in the mid-water zone are more likely to interact with the devices, and that species that school tightly could be more vulnerable. Research will need to be adapted to the specific design of each type of TISEC device. The Report concludes*"The fundamental knowledge described above does not exist anywhere else; consequently, building the research knowledge base among the scientific community of the Bay of Fundy represents a valuable asset that will amplify the potential for the Maritime region to become a global centre of excellence in marine energy developments"* [BR 6-16].

Marine benthic habitat and communities. The benthic fauna is a critical foundation for important fisheries in the Bay and could be affected by direct impacts during the construction process through disturbance of habitat or remobilization of sediments. Biofouling — the capacity of certain benthic organisms to settle on new structures which could be problematic for TISEC operation — may be more of an issue if devices are deployed in areas with lower velocity currents.

Very little is known about the benthos in the Minas Passage. Energy extraction could reduce turbulent mixing, and change patterns of sediment distribution. Some of the most important benthic species that play a critical role in the food web sustaining both migratory fish and migratory birds in Minas Basin are associated with a specific sediment grain size. Research is needed to understand if these species could be significantly affected by TISEC development.

In the Outer Bay area benthic and epibenthic fauna is much more diverse than in the Upper Bay area. They are less exposed to high suspended sediment concentrations and therefore, could be more susceptible to sediment plumes generated during construction.

The Report recommends a long-term monitoring program with reference sites established outside the zone of influence, so that *"effects on the benthic community associated with long-term natural cycles or other ecosystem changes can be distinguished from those resulting from the energy development itself"* [BR 6-20].

Pelagic communities. Planktonic forms range from tiny organisms through to jellyfish, squids and larval and juvenile fish. They mostly drift rather than swim. The Upper Bay in particular acts as important nursery grounds and the water column carries fish larvae in abundance. It is not certain whether the TISEC devices would have an adverse effect on any of the plankton as they pass through.

The Report states that the main concern regarding invertebrate pelagic organisms would be in the Outer Bay. Existing information may be patchy and may not address mid-water species that might come into contact with a TISEC device. As with benthic species, baseline data and ongoing monitoring is required.

Marine mammals. Possible effects on marine mammals could include construction effects of noise, vibration and lights; noise and vibration during operation affecting species that use sonar to pursue prey or affecting communication between animals; direct collision or contact; and indirect effects on the distribution and abundance of prey species. There is however little evidence that marine mammals come into contact with large stationary objects. Minas Basin and Cobequid Bay are regularly visited by harbour seals, harbour porpoise and longfin pilot whales. Occasionally grey seals, humpback and minke whales and white-sided dolphins are also see in Minas Basin. The Report concludes that it is not possible to assess whether TISEC devices in Minas Passage would impede their ability to move into Minas Basin. In the Outer Bay area, many species of marine mammals are likely to travel through the various passages. Again, their behavioural responses are not known. The Report recommends expanding existing mammal surveys in the Outer Bay, recruiting other marine users, such as local fishers and whale-watching organizations, to assist with monitoring, tracking porpoises and seals at the proposed demonstration facility in Minas Passage, and experimental studies on behavioural effects in the Outer Bay.

Marine Birds. Diving birds such as eiders might possibly come into direct contact with a TISEC device in parts of the Outer Bay. Decreases in turbulence downstream from a TISEC device could affect the ability of surface-feeding birds such as terns, phalaropes, gulls, shearwaters and petrels to obtain their food. Migratory shorebirds depend on benthic intertidal invertebrates, the abundance and distribution of which might be altered by tidal development through sediment changes.

A major concern in the Minas Passage area would be to understand the effects of decreasing tidal energy on migratory birds feeding on intertidal invertebrates in Minas Basin. Another issue is disturbance of seabird roosting areas by human activity. In the Outer Bay there is a much larger array of marine birds that might be affected by excessive vibration during construction.

Existing surveys of marine bird occurrence and movements should be augmented for each proposed TISEC site. Indirect effects on birds can be difficult to monitor because of the large areas over which they forage. It will be important to recruit local naturalists, fishers and other marine traffic to help increase the scope of information.

Species at risk. Five mammals, eight birds and nine fish that occur in the Bay of Fundy have been designated as species at risk. Under Canadian law, activities that increase risks to these species must be carefully evaluated. Principal species at risk in the Minas Basin area are the Atlantic Salmon and the porbeagle shark, listed as Endangered by COSEWIC, and the striped bass, listed as Threatened. Inner

Bay of Fundy salmon populations have been significantly reduced through habitat losses and fishing mortality. The salmon need to negotiate the Minas Passage between their spawning grounds in the Salon, Shubenacadie and Gaspereau Rivers, and their feeding grounds in the North Atlantic.

Most of the listed species occur in Outer Bay areas. Although abundant in the Outer Bay, harbour porpoises are listed as a species of Special Concern because of their vulnerability to by-catch mortality in fishing gear, and the effects of acoustic devices in aquaculture operations.

The Report calls for research into the prevalence of species at risk in vicinity of areas of potential TISEC development.

Fisheries. The main types of interaction would be exclusion zones during both construction and operation, possible conflicting demands on shore-based wharves and storage facilities, and any deleterious environmental effects on commercial stocks. Exclusion zones would likely be larger during the construction period. During the operations phase exclusion zones could be reduced depending on the fishery involved. During construction noise and vibrations would affect different species in different ways. Pile driving would likely affect schooling fish or any species with a swim bladder. Effects on other species would be less certain. Effects could be direct, by damaging sensory or sensitive tissues, or indirect, by changing behaviours. Sediment remobilization or suspension during construction might have short-term effects on fish or possibly longer-term effects on benthic species. During the operations phase noise and vibrations could continue to affect some species.

In the Minas Passage, the most valuable fishery is for lobster. The value of 2002 landings was recorded as being $2.5 million. The records do not show what percentage of these lobsters came from the Passage as opposed to adjacent areas. Effects on lobster could include direct displacement of trap setting activities, removal of habitat, and indirect effects on migrating lobster during construction. The effects on lobster of electrical fields associated with transmission cables are largely unknown.

Other fisheries in the Minas Basin include dragging or handlining for pollock, haddock and spiny dogfish, and drift or gillnetting for Atlantic herring and American shad. There is little information on either the indirect effects of noise and vibration or the direct effects of possible fish damage or mortality. The Report indicates that the forces and factors affecting fish that might pass through a TISEC device are different from those that affect fish passing through turbines in conventional barrage systems, such as the Annapolis Generating Station. However, there is little information on the effects of the newer technology on fish.

Demersal fishes that traverse Minas Passage include smooth and winter flounder and Atlantic sturgeon. These could be particularly susceptible to electrical field effects.

Direct displacement of scallops or soft-shell clam fisheries would not be expected, but these species could be affected indirectly through noise or sediment dispersion.

In the Outer Bay the Report stated that TISEC developments could intersect with a wider variety of fishing activities than in the Upper Bay. Greater prevalence of bedrock would reduce excavation requirements, but noise and vibration effects would remain. If TISEC developments occurred in the Digby Gut area, fishing activities could also be affected by navigational restrictions during the construction period.

The Report concludes that there are three major data gaps:

- how fish and mobile invertebrates behave in the vicinity of TISEC devices;
- the effects of electrical fields on health and behaviour; and
- site specific research on fishing operations, vessels and products.

Aquaculture. At present there would be little competition for sites between aquaculture and TISEC development because each use has different site criteria. Aquaculture operations could be affected by construction related effects such as sediment, noise and vibration, depending on proximity. There are no marine aquaculture sites in the vicinity of Minas Passage and sea-based rearing operations would not likely be established in the Passage. In the Outer Bay, there are a number of marine aquaculture lease sites. Research on noise and vibration effects of TISEC developments is needed to determine the setback distance required between TISEC devices and aquaculture operations.

Marine transportation. Commercial shipping could be affected by exclusion zones required during construction and by the movements of construction-related vessels to and from the site. During operations TISEC devices should not impede shipping, because they would be located well below the draft depth of the largest vessels.

In the Minas Passage area there were 251 gypsum carrier movements to and from Hantsport and 156 tug movements in 2006. Gypsum carriers have only a small window of opportunity to load cargo in order to avoid grounding. Any reduction in water depth might result in a decrease of cargo carrying capacity. Consultations with the gypsum company and the Atlantic Pilotage Authority would be needed. In the Digby Gut area, the Digby/Saint John ferry operates twice a day in the summer, and navigates a restricted channel through the Gut. Any further restriction of the channel could affect navigational safety. Again, early consultation is required.

Tourism and recreation. These activities may be affected during the construction phase through marine exclusion zones and possible visual impacts, but might be positively influenced by the novelty of large scale commercial installations. The Report indicated the importance of the Bay of Fundy to Nova Scotia tourism and local communities, and recommended that site-specific research be carried out to determine tourism operations and activities in the vicinity and possible interactions.

Archaeological and heritage resources. Driving piles and installing cables could disturb or destroy unknown heritage resources that could include sites of significance to First Nations and Aboriginal peoples and communities. The operations phase could affect the rate of shoreline erosion or sedimentation, thus disturbing or exposing archaeological resources.The Report records 16 shipwrecks in the Minas Channel area, five archaeological sites (2500 to 500 years ago) within Minas Passage, and seven historic archaeological sites in the area. In the Digby Gut, area there are at least seven shipwrecks recorded, and just one 19th century archaeological site. In both locations, the numbers of recorded archaeological sites are probably reflective of the level of investigatory effort rather than of potential.

Each potential TISEC site should require a detailed archival background study, followed by a comprehensive archaeological survey. Similar investigations would be required for shore-based facilities.

Economic development. In the Report, this section addresses the types of support services required at each stage of TISEC development, which might be filled in part or in whole by local or regional businesses. Possible approaches could include coordinated tender postings, community tender information meetings, breaking project tenders into smaller components, providing training to the local workforce, benefit agreements with tidal developers, and collaborative research opportunities.

The Report recommends the development of service and supply capability information to assist local communities.

Cumulative Effects

Cumulative effects are *"changes to the environment that are caused by an action in combination with other past, present and future human actions"*[3]. The Report comments that cumulative effects are especially evident in the aquatic environment because effects may extend over considerable distances, and identifies six types of cumulative effects.

Effects of energy extraction. Many of the biophysical characteristics of the Fundy ecosystem — fate of sediments, movement of migratory fish, feeding potential of birds and baleen whales — depend on high tidal flows. The greater the total energy extracted by tidal projects, the more these tidal flows could be affected. Hydrodynamic modelling could be applied both to develop more accurate estimates of the available tidal energy and to predict the cumulative effects of removing some portion of it. However, this modelling needs long-term records of current velocity at different depths, and present data are extremely limited.

Effects of exclusion zones. The different types of marine renewable energy technologies will be compatible with some resource uses and not with others, leading to potential requirement for exclusion zones of different scales and purposes. This *"creates the need for clear policy and fair allocation to prevent or reduce marine use conflicts*". [BR 7-3]

Effects of other developments. The Report refers to current or likely proposals to develop LNG terminals, conserve natural habitats and species through creation of protected areas, and recreation and tourism initiatives; and future activities such as commercial fishing, aquaculture, infilling, industrial marine terminals, and other energy projects. Even small projects or minor activities can, cumulatively, exert a negative effect. *"A Bay-wide planning concept is needed to avoid what has been called the 'tyranny of small, independent decisions'"*. [BR 7-4]

Effects of other ecosystem changes. The example cited in this category is the decision to remove a large part of the Petitcodiac Causeway in New Brunswick and consideration of a similar move for the Windsor Causeway in Nova Scotia. These actions could remobilize vast amounts of sediment and increase current velocities.

Effects of Site Preparation. Disturbance of the substrate could induce progressive changes in water depth and movement of sediments away from the site — *"even subtle changes to the integrity of this layer may yield, over subsequent years, progressive changes to the hydrodynamics of the channel with consequent effects on sediment and biota".* [BR 7-5]

3 CEAA. 1999. Cumulative Effects Assessment Practitioners Guide

Background Report Conclusions

The Report concludes that there is a need for a coordinated research and monitoring program that combines the resources at universities and research agencies with those of other stakeholders *"to address the existing lack of data with respect to dynamic processes, nature of the bottom topography, prevalence of species of interest in areas of potential TISEC deployment, and responses of fauna to the technology and site modifications"*. The program should also incorporate the advice and assistance of First Nations, non-governmental organizations and industry representatives.

Development of tidal resources also requires collaboration between Nova Scotia and New Brunswick because of ecological linkages, the potential for cumulative effects that might affect the whole Bay, and to realize socioeconomic advantages.
The Report also states that tidal development should conform to an Integrated Coastal Zone Policy in each province — and the completion of such a policy should be a high priority.

Finally, the Report recommends that a cautionary, staged approach be taken to TISEC development with significant monitoring and adaptive management plans. *"This would allow for future expansion into demonstration and commercial scale developments, provided environmental and socioeconomic components in the Bay of Fundy are not compromised, to the satisfaction of government and local stakeholders. This would be accomplished by gathering data to address the data gaps and allow for design considerations and development of appropriate mitigation measures. The end result would be confident predictions of potential environmental effects through project-specific environmental impact assessment"*. [BR 8-6]

CHAPTER FOUR
Sustainability Principles and Overall Recommendation

A major advantage of a Strategic Environmental Assessment process is that it encourages discussion of fundamental goals and objectives. The OEER heard from stakeholders that sustainability was the key issue with respect to the possible development of tidal energy in the Bay of Fundy.

In a research monograph on sustainability and environmental assessment prepared for CEAA[4] , Robert Gibson defines seven sustainability principles:

Integrity
Build human-ecological relations to maintain the integrity of biophysical systems in order to maintain the irreplaceable life support functions upon which human well-being depends.

Sufficiency and opportunity
Ensure that everyone has enough for a decent life and that everyone has opportunity to seek improvements in ways that do not compromise future generations' possibilities for sufficiency and opportunity.

Equity
Ensure that sufficiency and effective choices for all are pursued in ways that reduce dangerous gaps in sufficiency and opportunity (and health, security, social recognition, political influence, etc.) between the rich and the poor.

Efficiency
Reduce overall material and energy demands and other stresses on socio-ecological systems.

Democracy and civility
Build our capacity to apply sustainability principles through a better informed and better integrated package of administrative, market, customary and personal decision making practices.

Precaution
Respect uncertainty, avoid even poorly understood risks of serious or irreversible damage to the foundations for sustainability, design for surprise, and manage for adaptation.

Immediate and long term integration
Apply all principles of sustainability at once, seeking mutually supportive benefits.

In our discussions with Roundtable members and other SEA participants, all seven principles were addressed at various times in various ways. In general, OEER heard that:

4 Gibson, Robert B. 2000. Specification of sustainability-based environmental assessment decision criteria and implications for determining "significance" in environmental assessment. CEAA Research and Development Monograph Series.

- Marine renewable energy in the Bay of Fundy could play an important role in securing a more sustainable energy supply for Nova Scotia;
- The development of marine renewable energy must not be allowed to significantly affect the complex biophysical systems in the Bay of Fundy or the livelihoods that depend on harvesting renewable resources from the Bay;
- Marine renewable energy development should not be permitted to outpace our understanding of its effects (short and long term, near and far-field) and our ability to mitigate them. A cautious approach is essential;
- In the Bay of Fundy region, marine renewable energy has potential to contribute to rural development and thereby help redress the growing economic disparity between urban and rural areas in the province; and
- The Bay of Fundy ecosystem crosses provincial and jurisdictional boundaries; therefore collaboration between Nova Scotia, New Brunswick and Canada is essential.

Based on these key understandings, OEER believes that any development of marine renewable energy in the Bay of Fundy — wind, wave or any form of tidal — should be guided by and answerable to a set of sustainability principles. The purpose of these principles is to ensure that renewable energy developments respect ecological integrity and make positive contributions to the social, economic and cultural well-being of Nova Scotia as a whole and of rural communities in particular. Principles are, of course, easy to develop and harder to implement. Therefore we recommend how and where the principles should be applied.

Recommendation 1
Sustainability Principles

OEER recommends that the Province of Nova Scotia adopt the following ten sustainability principles to guide marine renewable energy development in the Bay of Fundy. These principles should be incorporated as appropriate into:

- **provincial policy on marine renewable energy development or coastal zone management;**
- **any new legislation regarding marine renewable energy development;**
- **guidelines for all environmental assessments of marine renewable energy proposals;**
- **terms of reference for future phases of the SEA; and**
- **terms of reference for any ongoing research, integrated management, or stakeholder involvement body or process.**

1.1 **The marine renewable energy resource in the Bay of Fundy should remain under public control and management.**

1.2 **Marine renewable energy developments should be planned, approved and managed within a strategic context that will ensure net reductions of Nova Scotia's greenhouse gas emissions.**

1.3 **Nova Scotia, New Brunswick and the Government of Canada should collaborate in the management of the marine renewable energy resource to ensure protection of the entire Bay of Fundy ecosystem.**

1.4 **Commercial application of marine renewable energy developments should go ahead only when a proponent can demonstrate that there will be no significant adverse effects on the fundamental hydrodynamic processes of the Bay of Fundy tidal regime (energy flow, erosion, sediment transportation and deposition) or on biological processes and resources.**

1.5 **Until near and far-field effects of marine renewable energy are well understood and deemed to be acceptable, development should take place incrementally, supported by an effective and transparent research and monitoring program, installations should be removable, and clear thresholds should be established to indicate when removal would be required.**

1.6 **Adverse effects on the fishery or on aquaculture by energy developments should be avoided, or should be minimized. If displacement takes place, or if adverse environmental effects occur, compensation must be addressed.**

1.7 **Development of marine renewable energy should be planned and managed to ensure lasting stewardship of the resource in order to deliver durable socioeconomic benefits to present and future generations in Nova Scotia.**

1.8 **Nova Scotia's marine renewable energy development strategy should strengthen local community development capacity, through measures such as access to the resource, encouragement of community-scale technology developments and uses, or revenue sharing.**

1.9 Marine renewable energy development should be part of an Integrated Coastal Zone Management approach for the Bay of Fundy, including the informed participation and cooperation of all stakeholders in order to balance environmental, economic, social, cultural and recreational objectives, within the limits set by ecosystem dynamics.

1.10 Research, monitoring and decision making related to marine renewable energy should be carried out in an open and transparent manner. The public should have access to all environmental information. The public should have access to resource assessment information, respecting the need to keep certain commercial information confidential. Requests by proponents to keep information confidential should undergo stringent review.

OEER recognizes that there is an urgent need to stabilize then reduce total overall greenhouse gas emissions. Nova Scotia's emissions have been moving in the opposite direction. The most recent inventory information available shows that in 2005 Nova Scotia's emissions had increased by 16 percent over 1990 levels, though with a slight decrease between 2004 and 2005[5]. Reducing energy use through conservation and energy efficiency is the first imperative. The second imperative is to switch to non-fossil fuel based sources of energy. There has long been interest in tapping the powerful Fundy tides, but consensus emerged that the earlier barrage technologies would have unacceptable environmental impacts in the Bay of Fundy. The newer in-stream turbine technologies, while still unproven, particularly in the Fundy context, show significant promise.

Based on the information provided in the Background Report and government and stakeholder responses, OEER concludes that there is no evidence that precludes moving to the next stage of TISEC development — one or more carefully designed, located and managed demonstration projects — provided a number of conditions are met. These conditions are included in the recommendations found in subsequent chapters.

Recommendation 2
Allowing the Demonstration of TISEC Technologies

OEER recommends that the Province of Nova Scotia give the necessary approvals, contingent on satisfactory completion of a project-specific environmental assessment, to allow demonstration of a range of TISEC technologies in the Bay of Fundy.

The purpose of demonstration projects should be to determine (a) operational feasibility, (b) the extent of environmental impacts, and (c) the effectiveness of mitigation approaches. Demonstration projects and facilities should be subject to conditions specified in this Report.

OEER recognizes that the development of renewable energy resources in the Bay of Fundy is a new area of opportunity for the Province. It also notes the absence of an established legislative framework specific to the development of this potentially important resource. In keeping with Sustainability Principles 1.1 and 1.2, OEER believes the Province should clarify in legislation that the resource is owned by the Crown and provide a framework for the testing and development of offshore energy in the Bay of Fundy.

5 Environment Canada. 2007. National Inventory report, 1990-2005: Greenhouse H+Gas Sources and Sinks in Canada.

OEER also recognizes that the Province is looking to the private sector to lead the testing and development of the offshore renewable energy in the Bay of Fundy. OEER supports this approach

provided the people of Nova Scotia is the principal beneficiary of the development, while at the same time recognizing that the private sector will need to be profitable.

The development of the renewable energy resources in the Bay of Fundy should be undertaken in a transparent manner. OEER believes that the Province should use the information disclosure models for technical information related to oil and gas exploration and development as a model for disclosure provisions for legislation related to renewable energy resource.

OEER sees this legislation as a means for the Province to include requirements for benefits from tidal development to the province in general, and local communities directly affected by tidal development (see Chapter 9). The legislation could also provide incentives for the development of offshore energy from the Bay of Fundy that will directly lead to net reductions of greenhouse gas emissions in the Province.

Recommendation 3
Marine Renewable Energy Legislation

OEER recommends that, before large-scale commercial development proceeds, the Province of Nova Scotia enact legislation respecting the renewable energy resources in the Bay of Fundy. The legislation should incorporate the Sustainability Principles in Recommendation 1 and provide a framework for the testing and development of offshore renewable energy that will, among other things:

- **Encourage the development of marine renewable energy resources in a safe and environmentally sound manner;**
- **Require interested parties to obtain licenses for the rights to develop. Such licenses should be conditional on undertaking activity that will promote timely development;**
- **Provide for immediate disclosure of all environmental information and, after appropriate confidentiality periods, disclosure of technical information related to the resource;**
- **Provide for the Province to receive revenues from the licensing and/or development of the resource;**
- **Provide opportunities for affected communities to benefit from the development; and**
- **Provide incentives for the net reductions of greenhouse gases in the Province.**

CHAPTER FIVE
Information Gaps and Research Requirements

When OEER and New Brunswick Energy commissioned the Background Report, the consulting team was specifically mandated to identify *"information gaps, the significance of those gaps, and recommendations for addressing them".* In addition, OEER also heard from a number of stakeholders and from two Aboriginal organizations about information gaps in the Background Report itself.

Table 5.1 is the summary of data gaps identified by the Background Report, together with Jacques Whitford's recommendations for filling them.

Table 5.1 - Summary of Data Gaps and Recommendations

Key Environmental Issue	Data Gap	Recommendation
Critical Physical Processes	▪ Lack of detailed, site specific information on vertical and horizontal current structure and substrates for validation of models. ▪ Inadequate fine-scale hydrodynamic and sediment models relevant to selected sites of tidal energy development. ▪ Limited knowledge of the overall distribution and dynamics of sediments in the Bay of Fundy. ▪ Limited application of hydrodynamic models to assess the impacts of TISEC developments.	▪ Gather site specific information about substrates and sediment movement and currents for proposed development locations using in situ monitoring with ADCP and sediment sensors. ▪ Complete high density multibeam bathymetric studies of the Bay, and complete the analysis of existing data. ▪ Adapt or refine hydrodynamic models to provide adequate small-scale analyses of the potential and effects of energy extraction developments. ▪ Hydrodynamic modeling should be used to assist with the selection of sites for TISEC developments in order to optimize the extractable tidal energy potential and minimize cumulative effects on physical or biological processes.

Table 5.1 - Summary of Data Gaps and Recommendations

Key Environmental Issue	Data Gap	Recommendation
Fisheries	▪ Absence of information on fish behaviour with respect to TISEC technologies. ▪ Inadequate knowledge on the effects of remobilized sediments on commercially important species of fish and shellfish. ▪ Questions about EMF from sub-sea cables and the effects on demersal fish and shellfish. ▪ More specific information is required regarding the number of fishing operations, vessels and products, and locations of fixed gear fisheries. Present data gathered for fisheries management purposes is insufficient for assessment of tidal power implications. ▪ Assumed existing infrastructure such as wharves would be used to support TISEC development projects—infrastructure status and availability or requirements for tidal power development is not well known. ▪ Lack of clarity on set-back requirements for marine energy developments.	▪ Conduct experimental and field-based monitoring studies of fish behavior and mortality, in the vicinity of tidal power devices. ▪ Conduct experimental studies of fish responses to vibrations or noise generated by TISEC devices. ▪ Conduct experimental studies of effects of high suspended sediments on migratory and commercial fish species. ▪ Work with fishing groups to obtain better fisheries data particularly with respect to activities near proposed development sites. ▪ Determine specific infrastructure requirements (e.g., wharves, supply bases) and necessary upgrades for each proposed project. ▪ Gather detailed information on potential adverse effects on local fisheries, and necessary mitigative measures (including project site selection). ▪ Establish consultative group including fishers and developers to create effective set-back guidelines.
Fish and Fish Habitat	▪ Data on distribution, seasonality and trophic relations of many non-commercial species of fish are not available. ▪ Absence of information on fish behaviour and/or mortality with respect to TISEC technologies, particularly with respect to noise and vibration. ▪ Questions about EMF from sub-sea cables and the effects on demersal fish.	▪ Conduct experimental and field-based monitoring studies of fish behavior and mortality, in the vicinity of tidal power devices. ▪ Conduct experimental studies of fish responses to vibrations or noise generated by TISEC devices ▪ Establish an ongoing and updatable database of knowledge about local and migratory fish stocks. ▪ Identify potential mitigative measures for effects on fish populations based on experimental results.

Table 5.1 - Summary of Data Gaps and Recommendations

Key Environmental Issue	Data Gap	Recommendation
Marine Habitat and Benthic Communities	▪ Available data on existing benthic communities are limited in the Outer Bay. ▪ Available data on existing benthic communities of the Upper Bay are limited, especially in view of some significant changes that have happened in the Bay since the data were obtained. ▪ Little existing data for many areas in the Bay.	▪ Replication of broad benthic surveys that were conducted in the 1970's. ▪ Establishment of long-term survey transects of benthic habitats and communities in priority areas for energy developments, including reference (*i.e.* non-impacted) sites. ▪ Creation of a coordinating agency to ensure consistency and quality of monitoring activities.
Pelagic Communities	▪ Similar to Fisheries and Fish and Fish Habitat issues noted above with respect to pelagic species.	▪ Similar to Fisheries and Fish and Fish Habitat issues noted above with respect to pelagic species.
Marine Mammals	▪ Lack of data on marine mammal behavioural responses to TISEC devices. ▪ Limited data available on the occurrence of marine mammals in the Upper Bay of Fundy.	▪ Study long term effects of health and behavior (*e.g.*, mortality, migration, avoidance, attraction) of tidal power development on marine mammals including monitoring of results from pilot and demonstration projects in the Bay of Fundy and elsewhere. ▪ Establish long term monitoring programs for marine mammals in the Upper Bay of Fundy, incorporating NGO resources. ▪ Identify and assess possible mitigative measures for effects of TISEC development on mammals.
Marine Birds	▪ Lack of data on marine seabird and shorebird activity in the area of priority sites. ▪ Lack of information on the trophic relationships of many marine birds, and their ability to adjust feeding preferences.	▪ Establish long term monitoring programs for marine birds in the Upper Bay of Fundy, incorporating NGO resources. ▪ Surveys to support project-specific environmental assessment prior to deployment. ▪ Identify and assess possible mitigative measures for effects of TISEC development on birds, including the secondary effects associated with changes in prey availability.

Table 5.1 - Summary of Data Gaps and Recommendations

Key Environmental Issue	Data Gap	Recommendation
Species At Risk	▪ Requirement for better site -specific information on species presence (depending on species and location).	▪ Establish an ongoing and updatable database of knowledge about local and migratory species at risk in the Bay of Fundy. ▪ Identify and assess potential mitigative measures for different species at risk. ▪ Work with Species Recovery Teams to develop comprehensive strategies for species at risk that use areas of high priority for energy extraction. ▪ Where necessary, conduct species-specific surveys in high priority areas.
Aquaculture	▪ Similar to Fisheries above (including lack of knowledge concerning appropriate setback distance from TISEC devices).	▪ Similar to Fisheries above.
Marine Transportation	▪ Uncertainty regarding level of interaction with other marine transportation users in the study area.	▪ Stakeholder consultation (other marine users). ▪ Regulatory consultation (*e.g.*, *NWPA* process). ▪ Detailed navigation safety assessments and underkeel clearance surveys in the context of site specific project EA and project site selection.
Tourism and Recreation	▪ Lack of information on informal and unregulated recreational activities.	▪ Project-specific data gathering as part of site specific EA process (including shore-based facilities).
Marine and Coastal Archaeological and Heritage Resources	▪ Uncertainty regarding the location and condition of many potential archeological and heritage resources (marine and shore-based) in the study area.	▪ Detailed site specific bathymetric survey using side-scan sonar as part of project specific EA process. Follow up with ROV survey if sonar shows potential resources. ▪ Detailed archeological survey may be necessary as part of shore-based facility site selection and EA process.

Table 5.1 - Summary of Data Gaps and Recommendations

Key Environmental Issue	Data Gap	Recommendation
Economic Development	▪ Uncertainty in identification of specific business opportunities for local business. ▪ Local capacity not clear.	▪ Local economic benefits study in context of project specific EA process. ▪ It is recommended that an Energy Sector Capability Study be commissioned for Atlantic Canada to address the barrier to supply-chain deficiencies within Atlantic Canada's Energy Sector, particularly within Nova Scotia and New Brunswick. ▪ Study potential benefit agreements. ▪ Project-specific job fairs.

The data gaps identified in the table fall into two main categories:

- baseline information about the biophysical and socioeconomic environments; and
- information about the interaction between marine renewable energy technologies and the environment.

In addition, the Background Report and a number of stakeholders addressed the issue of knowledge about the tidal resource itself — the total energy in the tidal system and the portion of this energy that could be extracted without causing significant problems. In 2006, the Electric Power Research Institute (EPRI) was commissioned to prepare studies of the tidal resource in both Nova Scotia and New Brunswick waters. The Nova Scotia report[6] identified seven resource areas in the Bay of Fundy, estimated the total available energy in these areas, and then applied a preliminary assumption that up to 15% of this energy could be extracted without significant alteration of the estuarine circulation. The total extractable energy was estimated to be 330 MW, of which almost two thirds were represented by just two sites, Minas

Channel and Minas Passage. A separate study carried out by Triton[7] used a different approach to identify the total available energy, and their estimates for the Minas Passage location were 73% higher than EPRI's. [BR 4-4]

The Background Report also indicated that definition of the extractable portion of the total energy, assumed in EPRI's preliminary inventory assessment to be 15%, would need to be refined. The Significant Impact Factor (SIF) is the fraction of the energy that can be removed from a system before negative environmental or socioeconomic effects occur. The Background Report acknowledges that determining a SIF *"is highly subjective. Verifying this limit of extractable energy would necessarily begin with quantification of the existing site-specific conditions and establishment of acceptable deviation from those physical and environmental norms. However, the task of establishing acceptable deviations from*

6 EPRI, 2006. Nova Scotia Tidal In-Stream Energy Conversion (TISEC): Survey and Characterization of Potential Project Sites.
7 Triton Consultants Ltd, 2006. Canada Ocean Energy Atlas (Phase 1) Potential Tidal Current Energy Resources Analysis Background)

the existing conditions alone would involve experts from a variety of disciplines (computational fluid dynamics [CFD] modeller, hydrologist, biologist, etc.), coordination with the jurisdictional agencies and applicable regulatory processes". [BR 4-7] OEER notes that it would also require the substantive involvement of stakeholders.

With respect to the gaps in baseline information, the Background Report noted that during the 1970s and 1980s there was extensive collaborative research carried out, overseen by the Fundy Environmental Studies Committee, in support of investigations into tidal power potential, focussing on the earlier barrage technology. Since that time, there has been less focus on the Bay of Fundy region, although more recent initiatives have included the preparation of the Minas Basin Ecosystem Overview and Assessment Report by DFO and a substantial level of effort to collect multi-beam bathymetry data by the Atlantic Geoscience Centre.

There are gaps in information about interactions between marine renewable energy technologies and the environment because all technologies under consideration are very new, with the exception of offshore wind. There are no tidal lagoons in operation anywhere in the world, and wave and TISEC devices are just beginning to be tested at other locations. The Background Report addressed four TISEC demonstration projects and concluded that:

> *At this time, a majority of the recent environmental study information relating to the tidal energy demonstration projects is not publicly available, so it is difficult to identify what study information exists from these projects and how much of it is applicable to the Bay of Fundy. One of the lessons learned from the demonstration projects is the extensive efforts involved in scoping and designing appropriate studies that will address the concerns of regulators and resource agencies while also understanding the limitations imposed in working in a difficult environment. Furthermore, the potential effects to be studied are typically site and TISEC device specific. For example, the blade spacing and tip speeds can vary considerably among the different TISEC device designs. Therefore, the ability of fish or marine mammals to avoid one particular TISEC design may not necessarily be the case for another design. Further, it is uncertain how data collected for a small demonstration project can be scaled up to evaluate larger developments.* [BR 4-20]

At the first round of community forums, stakeholders had many questions about marine renewable energy technologies and about the current state of knowledge of the Fundy environment. Feedback on the findings of the Background Report also came through discussions at the Roundtable and written submissions. Issues raised in relation to data gaps included the following:

- It is very important to have adequate long-term baseline data in order to understand the natural variability of the system.
- The Background Report was criticized for having inadequate socio-economic information. This is an area of great importance to local communities and residents. How will these gaps be filled?
- Baseline information about the lobster industry must be collected in order to know the effects of tidal development.
- Filling the gaps about possible effects on fisheries in general, and how mitigation would proceed, should be given priority.
- There is other research and development in tidal energy happening in other locations not covered by the Background Report.
- Comments were received about the accuracy and completeness of information regarding marine mammals, birds, species at risk, the impacts of ice.
- Little information was provided on the possible impacts of tidal lagoon technology.

Nova Scotia Power Inc. provided an analysis of the information gaps identified in the Background Report, emphasizing that the information will be needed at different stages of marine renewable energy development, and certainly not all before a demonstration project proceeds. NSPI identified four stages of information collection and suggested what should be required at each stage:

1. *Baseline data collection/collation and field work phase to support the approval and installation of the demonstration project; the size and scope of scientific investigation should be appropriate for this scale of demonstration.*

2. *Monitoring and adaptive feedback phase during operation of demonstration unit. This information can be used to inform decisions for commercial scale generation.*

3. *Baseline data collection/collation and field work phase for commercial scale development. This will build upon preliminary investigations made during the demonstration project; the size and scope of scientific investigation should be appropriate for this scale of development.*

4. *Monitoring and adaptive feedback phase during commercial operation to ensure environmental integrity, sufficient generation and positive socioeconomic outcomes.*

[NSPI. Strategic Environmental Assessment Final Report Comments, February 29, 2008]

DFO provided comments on the Background Report, together with an indication of some of the activities that DFO plans to undertake with respect to research and consultation. DFO concludes in their comments that:

> *"As a background report, the document does a reasonable job of describing the Bay of Fundy environment and the technologies being considered for evaluation. The physical and geological settings are detailed and provide good context."*
> [DFO. Comments on the "Background Report for Strategic Environmental Assessment for Bay of Fundy Tidal Power Development – Offshore Energy Environmental Research Association – prepared by Jacques Whitford Ltd." February 29, 2008]

However, a number of issues were noted including:

- the likelihood of far-field effects in the commercial development phase and whether these would be reversible;
- the need to address potential developments in other areas besides Minas Channel and Minas Passage;
- the storage of data in open databases; and
- errors in the Background Report particularly with respect to species at risk.

Subsequently, DFO held an internal workshop[8] as part of their science advisory process to discuss the Background Report and research requirements relating to tidal energy. Some of the issues raised included the following:

8 DFO. Workshop on Tidal Power in the Maritimes Region, March 11 2008. Proceedings pending.

- Near-field and far-field effects should be distinguished, recognizing that there is no clear dividing line.
- Construction impacts are seen as comparable to those of other offshore and near-shore developments. They are well known and likely to be easy to assess.
- The near-field impacts of a demonstration-scale development would likely not be of great concern provided the site was carefully chosen. It would also likely be impossible to discern far-field impacts at the demonstration scale.
- Research at smaller projects will shed light on some aspects such as fish impacts, but not on effects of energy removal.
- The main concern is with the effects of commercial scale developments.
- What knowledge and experience has been gained from other demonstration projects? There is need for a process to review and evaluate "gray literature" (reports that have not been peer-reviewed).
- More baseline information is needed on the possible presence of "contaminants".
- The Background Report lacks emphasis on primary productivity effects.
- There is potential for greater impacts in areas of high suspended sediment.
- The SARA information in the Report must be updated and kept current.
- Modelling will be the only answer to understanding far-field, cumulative effects. It will not be possible to simply scale up the effects at the demonstration facility.
- It is also essential to understand the natural variability of the Fundy system which is enormous. Modelling should address the "extremities" of the Bay because early effects would likely show up as changes in circulation at river mouths.
- The biggest modelling challenge will be sediment.
- A geo-referenced database should be developed to indicate preferred areas and no-go areas for marine renewable developments. No-go areas should include critical areas for Atlantic salmon and Right Whale.

DFO is in the process of identifying research priorities and potential funding sources.

The Atlantic Policy Congress of First Nations Chiefs and the Native Council of Nova Scotia both put forward critiques of the Background Report, and criticized the lack of information and analysis in the report regarding Aboriginal commercial and social/ceremonial/food fishery in the Bay of Fundy, and raised concerns regarding how and when effects on these fisheries will be assessed.

Sanders Resource Management Inc. received funding through the SEA Participation Support program to address the issue of submerged ice in the Bay of Fundy, a potential phenomenon about which little is known[9]. Tidal currents could potentially carry large blocks of sediment-laden ice below the surface of the water where they might come into contact with tidal in-stream turbines. Richard Sanders' paper concluded that there was sufficient circumstantial evidence to investigate this issue further and recommended that:

Photo Courtesy of Richard Sanders

9 Sanders, Richard E., Conrad Byers, Emile Baddour, 2008. Tidal Power and Migratory Sub-Surface Ice in the Bay of Fundy, Canada.

- all sites being considered for TISEC deployment should be monitored in 2009 for *"all macroscopic submarine traffic, including submerged floes of ice, waterlogged trees and large marine vertebrates";*
- sites should only be selected for development where risks of encountering large submerged ice blocks and other objects are low;
- in the long-term tidal devices are engineered to withstand occasional contact with submerged ice and objects; and
- additional research be carried out to rule out the presence of additional submarine phenomena *"such as reciprocating tidal current-driven seabed waves of mud, silt, sand, cobbles or boulders, which might interfere with the deployment, mooring, operation, servicing, replacement or decommissioning of the arrays of modular tidal current harvesting devices".*

OEER recognizes that the development of an appropriate marine renewable energy development strategy for the Bay of Fundy that observes the Sustainability Principles recommended by this report, and meets ecological and socioeconomic objectives will be both a challenging and exciting task requiring an interactive process of determining research and monitoring objectives, designing and resourcing appropriate programs, evaluating and interpreting the results, taking action as appropriate, and identifying new research objectives. This process will need to be collaborative, involving all levels of government, research institutions, and stakeholders. This also fits firmly into OEER's research mandate. OEER believes research and information gathering related to the assessment and management of marine renewable energy projects will be required in six major categories (that will likely overlap):

- developing a better understanding of the dynamics of the Fundy ecosystem to guide an integrated management approach;
- determining the ultimate carrying capacity of the Bay with respect to energy extraction and other factors;
- baseline data before demonstration projects commence;
- monitoring and adaptive feedback for demonstration projects;
- baseline data before commercial projects commence; and
- monitoring and adaptive feedback for commercial projects.

The tasks of research, monitoring and analysis will need to be apportioned fairly between proponents, government and stakeholders. OEER would hope that BIO would play a central role in addressing the information gaps that have been identified and bring in science to bear on the challenges of managing risks and uncertainties. At a provincial level, OEER has been specifically established as a body to address research in energy and environment in a marine context and therefore, would likely also play an important role. Collaboration with other research institutions will also be needed.

Recommendation 4
Research Program

OEER recommends that the Province of Nova Scotia facilitate the development of a collaborative research program for marine renewable energy development in the Bay of Fundy. The research agenda would address:

- **immediate needs related to demonstration projects;**
- **longer term requirements relating to the development of an integrated management; approach to the commercial development of marine energy renewables;**
- **consideration of non-TISEC technologies;**
- **the understanding, prediction, mitigation and monitoring of far-field and cumulative effects; and**
- **the eventual determination of ecosystem carrying capacity limits.**

The design of the research program should include all levels of government, Aboriginal peoples, research institutions, and stakeholders. The program should determine research priorities, timing, and responsibilities.

OEER recognizes the significance of the Bay of Fundy to the Mi'kmaq people, through their involvement in commercial and social/ceremonial/food fisheries, and the social, cultural and spiritual importance of the area. OEER believes that the development of an overall research program should include a Mi'kmaq Ecological Knowledge Study. A single study could be carried out for the whole Bay of Fundy as part of the core research program with or without a proponent cost-sharing process, or separate studies could be made a requirement of project-specific environmental assessments.

Recommendation 5
Mi'kmaq Ecological Knowledge Study

OEER recommends that the Province of Nova Scotia ensure that a Mi'kmaq Ecological Knowledge Study is carried before marine renewable energy projects proceed in the Bay of Fundy, either as part of the research program identified in Recommendation 4 or as a requirement for project-specific environmental assessment.

OEER understands that the establishment of a TISEC Demonstration Program, Site-Specific Environmental Assessments and commercialization of the technology will require primary research, baseline ecological studies and on-going monitoring that will likely be carried out by a range of parties. In order for this wealth of information to be successfully managed, accessed and analyzed, requirements must be stipulated on how this data is recorded and organized.

Recommendation 6
Provincial Standard for Ecological Data

OEER recommends that the Province of Nova Scotia require all marine renewable energy proponents and their consultants to ensure that ecological data is geo-referenced and metadata compiled in accordance with the relevant provincial standard. This should be completed in consultation with the Nova Scotia Geomatics Centre and other provincial centers, where relevant.

OEER recognizes that the Background Report placed considerably more emphasis on biophysical information than on socioeconomic information. The Roundtable identified this as a particular concern. The Report did not describe the Fundy Region and its communities in any detail. As a result the SEA process is unable to fully address *"the contribution of ocean renewable energy to economic development in Nova Scotia and to community economic development in coastal areas"*[10]. OEER believes that it will be important to fill this information gap well before commercial phase projects are contemplated, and that it will assist the Province in determining how best to meet the Sustainability Principles that address durable socioeconomic benefits, local development capacity, and the development of an Integrated Coastal Zone Management Policy. It will also assist local communities and residents to prepare for, participate in, and benefit from the development of this new industry and energy source.

Recommendation 7
Bay of Fundy Socioeconomic Background Study

OEER recommends that the Province of Nova Scotia undertake a socioeconomic background study, as soon as possible to describe fully the communities, economies and cultures of the Bay of Fundy region and Mi'kmaq communities with fishing interests in the Bay; to address in more detail how development of marine energy renewables would interact with the socioeconomic environment; and to identify opportunities, constraints and risks. The study process should engage communities and stakeholders.

10 OEER, 2007. Request for Proposals. Ocean Renewable Energy: Environmental and Socio-Economic Impact Assessment Report To Support a Strategic Environmental Assessment for the Bay of Fundy

CHAPTER SIX
Implementing an Incremental Approach

Demonstration Phase

The development of the TISEC industry is still at an early stage even though there are already many players. The Background Report identifies over 40 device developers at various stages. The majority of the devices are horizontal axis turbines, but other designs — vertical axis, oscillating hydrofoil, and venturi turbine — are in the works. The more advanced projects are now either in the demonstration stages or are looking for an opportunity to install their devices in order to determine:

- the feasibility of installing, operating and maintaining the TISEC device under higher velocity current conditions; and
- the environmental effects of the devices.

In addition, demonstration projects allow regulatory bodies to determine how best to assess, approve, and manage this new industry. It is not expected that demonstration projects will contribute significant amounts of power to the grid.

In particular, there is significant interest in being able to test devices in the Fundy environment because of the potential resource and because a device that can operate successfully in what is considered to be a hostile environment in terms of currents, shifting seafloor conditions, sediment loads, and ice conditions, may well be able to operate anywhere — the so-called "Bay of Fundy Standard".

The Background Report reviewed the results of three demonstration projects that have occurred or are under way.

- Clean Current Power Systems at Race Rocks, BC
- Verdant Power, Inc. in the East River, New York City
- Open Hydro at the European Marine Energy Centre (EMEC), Scotlandb

The Report indicated that *"At this time, a majority of the recent environmental study information relating to the tidal energy demonstration projects is not publicly available, so it is difficult to identify what study information exists from these projects and how much of it is applicable to the Bay of Fundy."* [BR 4-20]

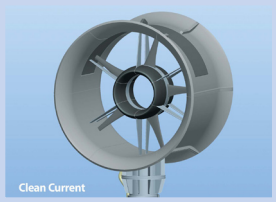
The Report also concludes that the potential effects that need to be studied are very specific to the design of each turbine and to the site where it is operating.

The cost of electricity produced by TISEC devices is uncertain, but can initially be expected to exceed the cost of conventional generation by a considerable margin. A report prepared by the Carbon Trust in the UK in 2006 estimated present costs of approximately 18-36 cents/kWh[11]. In general, conventional fossil generation production costs are currently in the 1.5 to 12 cent/kWh range depending on the fuel. However, the longer-term perspective is that:

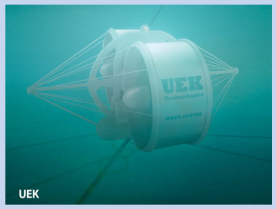
11 Carbon Trust, 2006. Future Marine Energy. Results of the Marine Energy Challenge: Cost competitiveness and growth of wave and tidal stream energy

- the costs of fossil fuel generation will increase, including the cost of future carbon taxes or similar climate change initiatives;
- as commercial sized projects are developed economies of scale will apply; and
- technology design and operating and maintenance parameters will be optimized, reducing costs.

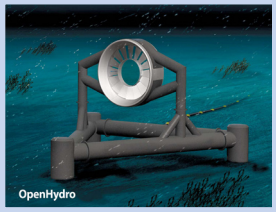
Clean Current



UEK



Open Hydro



The demonstration stage is expected to play a key role in producing efficient designs and significant learnings in how to operate and maintain the technology. Nova Scotia Energy is currently proposing to provide funding to partially support construction of a tidal energy demonstration facility in the Bay of Fundy. The facility, consisting of three or more berths, underwater cable connections and a shore based monitoring facility with connection to the grid, would be owned and operated by a non-profit entity whose members would include a representative of the Province and of the proponents demonstrating their technologies. Berth-holders would lease their berths for two years, renewable for a further two. The plans for this demonstration facility are subject to receipt and consideration of this SEA Report by Nova Scotia Energy.

The proponent that will build the facility, if approved, has been selected (Minas Basin Pulp and Power) as well as three technologies to be demonstrated — Clean Current, Open Hydro (Nova Scotia Power) and UEK Hydrokinetic Turbine (Minas Basin Pulp and Power). A site has not yet been selected, but would likely be in the area of the Minas Channel, an area of deep water, fast currents and high sediment loading. The proposed facility will have to undertake a site-specific environmental assessment.

Nova Scotia Energy has indicated that the demonstration facility should stay in operation after the first round of technologies have been tested, potentially evolving into a Centre of Excellence for tidal energy.

Stakeholders have raised a number of issues with respect to the purpose of the demonstration phase, the role of a demonstration facility, how technologies should be selected for demonstration, and how technologies should "graduate" to commercial development.

- Conditions vary dramatically around the Bay. The Province should encourage the development of different types of technologies to suit different circumstances.
- Should there be other demonstration facilities, or at least the ability to locate a demonstration project in another area?
- How long is required to assess a technology, or to assess its environmental effects?
- Will there be future opportunities for tidal developers who were not selected to participate in the proposed demonstration facility?
- The Province should encourage and facilitate ongoing technological innovation to maximize efficient energy production and minimize environmental effects. Will the current proposed process "shut the door" behind the successful proponents?
- Will the proposed facility be sited in the Minas Channel? Will it obstruct migration pathways and fishing activities in this area, given that the Channel is narrow?
- Should the facility be located in the area of fastest currents or it would it make more sense to

- begin in a less harsh environment? (The opposite opinion was also expressed, that technologies should be tested under the most demanding circumstances).
- How will the proposed demonstration facility project be assessed and will the public be consulted?
- What types of research and monitoring will be required, will local fishers be involved in the monitoring, and will the results be available to the public?
- The demonstration facility should include a 'before and after' lobster catch and release program including a focus on seeded lobster.
- To what extent will a demonstration project fill the information gaps that have been identified? Will it be possible to simply "scale up" monitoring results in order to know what the effects of a commercial scale project would be?

Fisheries and Oceans Canada indicated that

> *"In general, it is assumed that impacts of test installations will be localized and far field impacts will likely remain undetectable. The effects of construction of test turbines will be similar to those of other construction projects, the impacts of which are well understood [. . .] Without prejudging the outcome of the environmental assessment the Fisheries Act authorization(s), processes are anticipated to be straight forward for the demonstration scale projects. However, at the commercial scale, the extent of far field effects and the likelihood of their reversal are unknown and should be the major focus of the next steps in the SEA."* [DFO Submission, February 29, 2008]

As previously indicated (Recommendation 2), OEER has concluded that the Province of Nova Scotia should permit carefully designed and managed demonstration tidal energy projects in the Bay of Fundy subject to various conditions. OEER understands that being able to install and operate TISEC devices in a high energy environment is crucial to moving the industry ahead and making the potential of cost effective, carbon-free energy generation a reality. However, OEER believes that the Province should think more broadly in terms of a tidal energy demonstration program that would include, but not be limited to, the proposed demonstration facility. The program should have as its overall goal exploration of the potential for smaller-scale, decentralized tidal energy applications, as well as large-scale tidal energy farms.

The objectives of the demonstration program should be to:

- encourage the ongoing development and testing of a wide range of TISEC devices suitable for application at different scales and in different marine environments;
- encourage the optimization of technologies in terms of efficiency, life-cycle cost, and environmental effects;
- research and monitor both near and far-field environmental effects and to develop effective mitigation strategies;
- encourage the development of Nova Scotia-based technologies; and
- facilitate community capacity-building and rural development through decentralized renewable electricity generation.

The demonstration program should include an advisory board composed of a range of stakeholders. The Program should address:

- a strategic plan for technology development and demonstration to meet Nova Scotia's diverse needs;
- the need for and benefits of one or more additional demonstration facilities in other parts of the Bay (areas with slower currents, lower sediment loading);
- criteria for technology selection;
- criteria for site selection;
- protocols for proponents with respect to community consultation;
- research, monitoring and reporting requirements;
- financial and other incentives; and
- procedures for assessing and certifying technology at the end of the demonstration phase.

A number of models for the Stakeholder Advisory Board exist including the SEA Stakeholder Roundtable that contributed significantly to the preparation of this report and also the Regional Aquaculture Advisory Committees (RADAC) appointed by Nova Scotia Fisheries and Aquaculture to review aquaculture developments in a specific area.

Recommendation 8
Marine Renewable Energy Demonstration Program

OEER recommends that the Province of Nova Scotia establish a Marine Renewable Energy Demonstration Program to (a) encourage the development of a range of tidal energy and other marine renewable technologies, applicable at different scales of application and in different operating environments, (b) gather knowledge about environmental and socioeconomic impacts and benefits, and (c) initiate longer term research needed to predict cumulative and far-field effects in the commercial phase. The Development Program should establish a Stakeholder Advisory Board to review proposed demonstration projects, provide advice on research and monitoring required, review monitoring results, and address requirements for the transition to commercial projects. Demonstration projects will include, but not be limited to, the proposed demonstration facility. The Demonstration Program will be guided by the Sustainability Principles outlined in Recommendation 1 and will provide provincial (and possibly federal) assistance in an equitable manner to a range of projects that meet appropriate criteria. The Program should also ensure that demonstration projects are assessed, implemented, and monitored in an environmentally and socially acceptable manner and that an appropriate compensation process is in place.

OEER understands that the proposed demonstration facility will allow several promising tidal technologies access to Bay of Fundy waters in a structured and cost effective manner, and that the three proponents will make a considerable investment in the facility in return for being the first to demonstrate their devices here. The facility will then be available to help test and incubate future technologies. OEER believes that it will be important to develop and operate the demonstration facility in as transparent a manner as possible, involving adjacent communities and other marine resource users on both sides of the Bay in the process of site selection, the development of research and monitoring objectives and the review of the results. OEER notes that Minas Basin Pulp and Power has already begun this process of consultation.

Siting the facility is the crucial first step and OEER understands that this will be a complex and difficult process in order to find a location where the devices can be installed in an area with very high tidal flows and a very rough and mobile seafloor. Two major siting issues were brought to the SEA process — the possible displacement of fishing activity, and concerns about possible interference with fish and crustaceans migrating through the Minas Channel, given that the Channel is narrow. OEER believes that the displacement of fishing activity should be avoided if possible (Sustainability Principle 1.6), and that the issue of understanding and protecting migratory movements must be addressed both during the siting process and through subsequent monitoring. The Province and proponents must utilise both scientific information and traditional knowledge in addressing this issue.

Recommendation 9
Siting Demonstration Projects

OEER recommends that the Province require proponents to consult with local fishers, other marine resource users including marine transportation stakeholders, and adjacent communities in the selection of sites for demonstration projects and to avoid or compensate the displacement of productive fishing activity. In addition, the Province of Nova Scotia and proponents should consult broadly with science advisors, including DFO, and fishers on the issue of interference with migration patterns and consider this advice in (a) selecting a location that will have a low risk of impact, (b) developing mitigation measures including determining time periods when construction should not take place, (c) designing a monitoring program for this issue, and (d) determining a threshold effect level that would require devices to be removed from the water.

OEER understands that all demonstration projects will require site specific environmental assessments (EA). A federal environmental assessment under CEAA will be triggered and a provincial EA may be triggered. OEER understands that the existing provincial environmental assessment regulations would not necessarily require the proposed demonstration facility to undertake a provincial assessment, however changes to the regulations are being considered. OEER also understands that the provincial and federal governments support a coordinated and cooperative approach to the environmental assessment process and that it is probable that there would be a joint federal-provincial environmental assessment review process.

OEER recognizes that demonstration and commercial projects could vary significantly in size, and that risk of adverse impacts would be related to scale, duration and location. OEER believes that projects should provide levels of data for the EA that are proportionate to the risk and scale of potential environmental effects. Where greater risks are identified, assessment requirements should be more rigorous, and any mitigation measures and monitoring requirements should be more onerous. It will be important for a dialogue with stakeholders to be maintained during the life of the projects to enable proper assessments.

During stakeholder consultation it was suggested that the demonstration facility should be subject to a full federal-provincial panel review because of a predicted high level of public concern. OEER cannot prejudge what requirements the federal government may feel will be necessary. However, while uncertain that a full panel review is justified in this case, we agree that every effort should be made to ensure that communities and stakeholders are well informed and have ample opportunity to express their views.

Recommendation 10
Environmental Assessment of the Demonstration Facility

> **OEER recommends that the Province of Nova Scotia amend the provincial Environmental Assessment Regulations to designate tidal energy projects that produce 2 megawatts or more of energy as Class I undertakings. In the case of the proposed demonstration facility OEER recommends that the provincial Minister of Energy require a provincial project-specific environmental impact assessment (EIA), including the production of an environmental-assessment report. The EIA should provide ample opportunity for adjacent communities and stakeholders to be informed and to express their views, concerns and suggestions, through a process involving early consultation and community meetings. Stakeholder perspectives should also be obtained through the involvement of the Stakeholder Advisory Board (see Recommendation 8).**

Before the demonstration facility proceeds or any other demonstration projects are approved under the Demonstration Program, OEER believes that the Province should discuss with both Province of New Brunswick and the Federal Government the establishment of a collaborative Bay of Fundy Tidal Energy Research Committee with a mandate to determine what research and monitoring requirements should be placed on demonstration projects, and what protocols regarding release of results should be applied (see Sustainability Principle 1.10). This Research Committee could be formed under the aegis of the existing Federal Provincial Tidal Power Working Group or as a separate entity. Alternatively the Province could delegate this responsibility to OEER. While leadership for this initiative should be provided by government, other research and environmental institutions and organizations should be included as appropriate. The research requirements should be coordinated with the broader Fundy tidal research mandate and activities of the federal government and other agencies such as OEER and universities.

OEER notes that a specific recommendation for research into the effects of the demonstration facility on lobster was brought forward through the Roundtable, which should be addressed by the Research Committee.

OEER believes that adequate baseline data collection at the site of the demonstration facility and any additional demonstration projects will be essential in order to determine changes brought about by the installation and operation of tidal energy projects.

Recommendation 11
Fundy Tidal Energy Research Committee

> **OEER recommends that the Province of Nova Scotia initiate the formation of a federal-provincial Fundy Tidal Energy Research Committee, also involving the Province of New Brunswick, if interested, to determine baseline research requirements and to develop research and monitoring requirements for demonstration and future commercial projects. This Committee should have a close relationship with the Stakeholder Advisory Board, to help identify research questions relevant to stakeholders. Non-government participants from other institutions, or agencies carrying out relevant research, should also participate as appropriate. The Research Committee should also play an active role in helping to determine the broader research program (see Recommendation 4).**

Commercial Phase

At present, nobody can predict exactly how long it will take before tidal proponents are ready to apply for approvals for commercial projects. Also OEER understands that a commercial application could range from a single off-grid device used to supply electricity to a dedicated end use or to pump water for use by a fish plant or aquaculture operation, through to a large scale TISEC farm involving many devices.

OEER understands from the Background Report and from subsequent feedback, including that of DFO, that:

- effects can be usefully divided into near-field and far-field effects;
- some near-field effects (of construction for example) relate to those of other marine industrial developments and can likely be fairly reliably predicted;
- more information about other near-field effects (for example, fish and marine mammal behaviour around turbines) will be gathered through the demonstration phase;
- far-field effects of larger projects or multiple projects will be more difficult to assess and will likely not be predictable by simply scaling up the results of demonstration projects; and
- there is much uncertainty about the total extent of the tidal energy resource, and the percentage of the energy that could be removed without causing unacceptable impacts.

An obvious reality is that the Bay of Fundy is a single ecosystem divided by a provincial boundary and by federal-provincial jurisdictional divisions. As part of the wider Gulf of Maine, the Bay of Fundy also influences and is influenced by factors relating to another country.

OEER heard from the Roundtable and other stakeholders that before moving into a commercial phase, and certainly before any larger-scale projects are contemplated, the results of research and monitoring carried out through the Demonstration Program must show, convincingly, that it is safe to proceed to the next stage.

OEER concludes that a process is needed to determine:

- when a technology can be “released” from the demonstration phase;
- under what circumstances a demonstration project can roll over or expand into a commercial project *in situ*;
- if and when a technology is no longer required to go through a demonstration phase (as the industry matures);
- what information is needed before commercial projects at different scales can be put forward for assessment and approval; and
- what cap should be placed on the total extraction of tidal energy from the Bay of Fundy (in Nova Scotia and New Brunswick waters) in order to prevent adverse cumulative and far-field effects.

This process could be complex because it will involve research and modelling, inter-jurisdictional collaboration, and regulatory decisions. However, the 2-4 years required for the first stage of demonstration will allow time for a commercial development framework to be developed. This could take place within a second phase of the existing Strategic Environmental Assessment or as a separate process.

Recommendation 12
Commercial Development Framework

Recognizing that the Bay of Fundy is one resource shared by two provinces, OEER recommends that the Province of Nova Scotia work with New Brunswick and the Government of Canada to develop a commercial development framework for marine renewable energy, either through an expansion of the existing SEA process, or through a new process that includes stakeholder involvement. The commercial development framework should be guided by the sustainability principles included in Recommendation 1, and should address the transition from demonstration to commercial, scales of development, research and modelling needs, and the capacity of the Bay of Fundy marine ecosystem to absorb different energy extraction levels without significant cumulative environmental effects, taking the Precautionary Principle into consideration.

OEER also concludes that incremental development, coupled with a design and regulatory commitment to removability (Sustainability Principle 1.5), will be vital to ensure that "hard-to-predict" far-field effects are avoided or mitigated at the earliest stages.

Recommendation 13
Incremental Development and Removability

OEER recommends that larger commercial developments be required to develop incrementally in stages with an appropriate effects monitoring program; that all installations be designed in such a way that the machines, their footings and all cables can be completely removed if necessary and the site remediated to close to its former condition; and that effect thresholds be established at which the proponent would be required to remove some or all of the machines from the water if unacceptable adverse effects are observed.

CHAPTER SEVEN
Integration of Marine Renewables and End Uses

Nova Scotia Power Inc. (NSPI), a private company whose operations are supervised by the Nova Scotia Utility and Review Board (UARB), serves approximately 450,000 customers and has total generation capacity of almost 2300 megawatts . Three-quarters of this electricity is generated by burning coal. Most of this coal is imported. NSPI's generation capacity includes four combustion turbine sites, two wind turbine sites, five thermal plants, 33 hydro plants and one tidal plant (the Annapolis Power Project that uses the older barrage technology). Electricity generation is the largest single contributor to Nova Scotia's greenhouse gas emissions (48%). The Renewable Energy Standard Regulations, made under the Electricity Act, now require NSPI to provide customers with renewable low-impact electricity equivalent to at least 5% of its annual sales by 2010 and equivalent to at least 10% by 2013. While NSPI may well be able to meet the 2010 requirement through wind power, integrating variable generation into NSPI's system has cost implications, and it may not be feasible to meet the 2013 requirement through wind. Tidal energy on the other hand, although intermittent like wind power, is entirely predictable and therefore more easily integrated.

NSPI recently completed an Integrated Resource Plan in collaboration with the UARB that identified that demand for electricity has increased fairly steadily[12]. NSPI considers that they have a two-year window (to 2010) before needing to make a decision about adding large-scale generating capacity. They anticipate that investments of up to 5% of total revenues in Demand Side Management (promoting and enabling conservation and energy efficiency) could produce positive benefit, and also conclude that renewable generation would be cost-effective compared to adding new fossil fuel based capacity, however generation from existing NSPI base load fossil fuel plants is low cost compared to alternatives. NSPI also indicated that the introduction of "hard carbon caps" could change their analysis. These would put an absolute rather than a relative limit on greenhouse gas emissions.

Nova Scotia Energy is currently preparing a Renewed Energy Strategy and Climate Change Action Plan that will be released after the publication of this SEA Report.

Stakeholders raised a number of questions and issues relating to the overall purpose for developing tidal energy, how it should be integrated into the system, who should have access to the power produced, and what uses it could or should be applied to. The main points raised included the following:

12 Nova Scotia Power Inc. 2007. Integrated Resource Plan

- Should tidal energy be developed before the potential of wind has been fully utilized? Will tidal energy be used in Nova Scotia or will it be exported?
- There was significant support for the idea of not permitting export. Why should Nova Scotians accept any degree of risk to the Bay of Fundy environment in order to supply electricity to another state or province?
- Should NSPI be required to purchase all tidal energy offered for sale?
- What will be the cost of electricity generated by tidal energy and how could this be made competitive and affordable?
- Conservation and efficiency should be the first priority.
- Tidal energy should replace coal-fired generation rather than be used to meet increased demand.
- Nova Scotia should consider using tidal energy to produce hydrogen gas instead of electricity.
- Local direct end uses should be explored and promoted — using tidal energy to heat local greenhouses or run ferries.
- The grid needs to be upgraded to accommodate tidal energy.
- What will be the role for decentralized power generation?

OEER recognizes that this is a complex issue and one that the SEA process has not been able to examine in depth. OEER understands that a revised energy strategy and climate change action plan will shortly be released and will presumably address the role of tidal energy. Marine renewable developments for Nova Scotia will be driven in the short-term by the Renewable Energy Standards and the penalties that could accrue after 2013. In the longer term, they will be driven by much higher targets for greenhouse gas reductions that will be inevitable and by the introduction of measures such as carbon cap and trade systems.

From the stakeholder input OEER TAG identifies four main issues for consideration:

- Whether proponents or NSPI should be allowed to export electricity generated from marine renewable;
- Whether NSPI should be required to reduce coal-fired generation as marine renewable generation is brought on line, on a one-for-one megawatt basis;
- What role decentralized generation should play in Nova Scotia's energy future and how this would apply to marine renewables; and
- Whether the value and efficiency of marine renewables can and should be enhanced by matching the power they generate to appropriate end uses.

OEER understands that there is currently at best a 300 MW export capability from Nova Scotia to New Brunswick and that, on any given day, this is already partially taken up by regular commerce. Therefore, using the existing grid capacity, export of marine renewable energy would not be an option and that significant grid upgrading or a new dedicated cable would be required. OEER has identified as a guiding sustainability principle that "*Marine renewable energy developments should be planned, approved and managed within a strategic context that will ensure net reductions of Nova Scotia's greenhouse gas emissions.*" OEER understands that Nova Scotia currently operates more or less as an "electricity island" at the end of the overall North American distribution system and that efficiencies may eventually be achievable by a more regionally-based transmission system which could see surplus tidal electricity being fed into New Brunswick at certain times, therefore OEER does not endorse a strict ban on export. Nonetheless, OEER agrees that reducing Nova Scotia's greenhouse gas emissions should be a fundamental objective and that measures should be taken to diversify our portfolio of energy sources and increase domestic energy security.

Recommendation 14
Nova Scotia Energy Priorities

OEER recommends, in accordance with Sustainability Principle 1.2, that the Province of Nova Scotia takes steps to maximize the benefits of commercial marine renewable energy projects to Nova Scotia. The Province's first priorities should be to (a) satisfy provincial, national and international greenhouse gas reduction commitments and (b) improve provincial energy security. Projects that are proposed primarily to export electricity should not be considered until these priorities have been met. Proposed export projects should be required to go through a public consultation process, and to guarantee significant benefits to Nova Scotia.

OEER supports the general principle of reducing the use of fossil fuels and particularly conventional coal technology to generate our electricity from the perspective of both climate change and air pollution concerns and of energy security. OEER is nonetheless uncertain about the practicalities of requiring a fixed linkage between tidal and coal-fired generation. Instead, we support the introduction of a system that will penalize carbon-intensive technologies and reward renewables. In addition we endorse placing the highest priority on conservation and efficiency to reduce demand and wastage.

Recommendation 15
Conservation, Efficiency and Carbon Credits

OEER recommends that the Nova Scotia Renewed Energy Strategy and Climate Change Action Plan (a) place high priority on conservation and efficiency measures, and (b) implement a carbon credit trading scheme, or comparable measures, to strengthen the economic viability of the tidal energy industry.

OEER heard that the current grid system has evolved to carry electricity from NSPI's major generating stations in Cape Breton to other parts of the province and has considerable limitations with respect to accommodating more decentralized generation in other locations. The grid system is also aging and vulnerable to outages. NSPI controls access to the grid though a new division has been set up within the company to separate the interests of NSPI as producer and distributer.

The SEA process did not address this issue in detail but OEER believes that it must be studied as marine renewable energy developments proceed. The issue relates to the overall ability to feed marine renewable energy into the grid (and therefore develop commercial projects), the potential advantages of decentralized generation, and to rural and community development.

Recommendation 16
Grid Capacity

OEER recommends that the Province of Nova Scotia study (a) the advantages and disadvantages of developing more decentralized generation, (b) the current capacity of the grid to support additional renewable energy developments, and (c) required upgrades and how these should be financed.

OEER believes that Nova Scotia should look at marine renewable energy with the broadest perspective possible and that this should include maximizing the potential of these technologies and the electricity they produce by matching it to the most appropriate end uses. Some stakeholders have recommended that the deregulation of electricity, should be pursued to allow for independent power production and sale to retail markets. Stakeholders suggested not only generating electricity to feed into the grid, but also providing energy, in the form of either electricity or hydraulic power, directly to fish plants, aquaculture operations, or other local industries. Power could also be provided to industries able to use a predictable but intermittent source.

Recommendation 17
End Uses

OEER recommends that the Province of Nova Scotia study alternate uses of marine renewable power generation to maximize benefits. The study should address small-scale applications, on and off-grid, new energy applications such as hydrogen, storage methods, and how the current regulation of electricity contributes to both opportunities and constraints.

CHAPTER EIGHT
Interactions with the Fisheries and other Marine Resource Users

Fisheries

The Background Report indicated that diversified commercial fisheries and aquaculture activities in the Bay of Fundy (Nova Scotia and New Brunswick) have an estimated value of $1 billion. In the Outer Bay, the commercial fisheries consist of high volume species such as herring, cod, haddock, lobster and scallops. In the Inner Bay, the main species exploited are herring, flounder, shad, dogfish, lobsters, and clams. Because of product demand from other countries, fisheries for sea urchin, marine worms and seaweed have been initiated or expanded. This diversification has helped to strengthen the regional commercial fishery. The fisheries in the broader Scotia-Fundy region are the most valuable in Canada. During 2004, lobster contributed $340 million, scallops, $110 million and herring, $21 million of the landed value of fisheries in the Scotia-Fundy region, of which approximately $96 million came from DFO Production Areas in the Bay of Fundy. The landed value of all species of ground fish from the Bay of Fundy during 2004 was $1.5 million and sea urchin, marine plants and clams contributed approximately $10 million.

While mariculture is a very important economic activity in the Bay of Fundy, the majority of the operations are in New Brunswick waters with the exception of a few sites in the Digby-Weymouth area in the Outer Bay.

Stock declines have resulted in some fish becoming listed as species at risk and the closure of their commercial fisheries. Inner Bay of Fundy Atlantic salmon and striped bass have been listed under the Species At Risk Act (SARA) and have been assessed for Allowable Harm. In the case of Atlantic salmon, DFO has concluded that "any level of human-induced harm could jeopardize its survival or recovery".[13]

Table 8.1 provides information on the fisheries resources, their status and the gear used to harvest them.

13 DFO, 2004. Allowable Harm Assessment for Inner Bay of Fundy Atlantic Salmon. DFO Can. Sci. Advis. Sec. Stock Status Rep. 2004/030.

TABLE 8.1 Fisheries Resources of the Bay of Fundy Region: Their Status and Comments on Fishing Gear

Group	Common Name	Scientific Name	Commer. Fishery?	Recrnl. Fishery?	Aqua-culture?	Stock Status	Comments on Fishery
Pelagic Fishes	Porbeagle	*Lamna nasus*	X, closed			+	gill net;
							COSEWIC status: Endangered
	American shad*	*Alosa sapidissima*	X	X		+++	commercial drift gillnet and weirs;
							Upper Bay
	Gaspereau*	*Alosa pseudoharengus*	X			+++	weirs; Upper Bay
		Alosa aestivalis					
	Atlantic herring	*Clupea harengus*	X	X		++++	purse seine, gillnet all BOF;
							weirs, Upper Bay
	Atlantic salmon*	*Salmo salar*	X, closed	X, closed	X	+_	drift, gill net, angling; COSEWIC status: Endangered
							large aquaculture production
	Mackerel	*Scomber scombrus*	X			+++	weir fishery, Outer Bay
	Bluefin tuna	*Thunnus thynnus*	X			+	taken offshore, landed in BOF ports;
							occasional in weirs in Outer Bay
	Swordfish	*Xiphius gladius*	X			+	offshore longline fishery, landed in
							BOF ports
Ground Fishes	Spiny dogfish	*Squalus acanthias*	X			++	drags, longline and handline; all Bay
	Atlantic cod	*Gadus morhua*	X			+++	drags mainly Outer Bay, some Upper Bay
							gillnet
	Silver hake	*Merluccius bilinearis*	X			++++	drags Outer Bay;
	Haddock	*Melanogrammus*	X			++++	drags Outer and Upper bay
		aeglefinus					
	Pollock	*Pollachius virens*	X	X		+++	gillnet, handline, drags, Upper and Outer Bay
							angling Upper and Outer bay
	White hake	*Urophycis tenuis*	X			+++	drags, Outer Bay
	Wolffish	*Anarhichas lupus*	X, closed			+	drags, Outer Bay
							COSEWIC status: Threatened
	Monkfish	*Lophius americanus*	X			++	drags, Outer and Upper Bay

TABLE 8.1 Fisheries Resources of the Bay of Fundy Region: Their Status and Comments on Fishing Gear

Group	Common Name	Scientific Name	Commer. Fishery?	Recrnl. Fishery?	Aqua-culture?	Stock Status	Comments on Fishery
	Witch flounder	*Glyptocephalus cynoglossus*	X			++	drags, Outer Bay
	Winter flounder	*Pseudopleuronectes*	X	X		+++	drags entire Bay;
		americanus					Upper Bay: weirs and angling
	Smooth flounder	*Liopsetta putnami*	X			+++	caught with winter flounder in Minas Basin
	American plaice	*Hippoglossoides platessoides*	X			+++	drags, Outer Bay
	Halibut	*Hippoglossus*	X	X		++	drags and longline, entire Bay
		hippoglossus					angling in Minas Basin
	Lumpfish	*Cyclopterus lumpus*	X			++	drags Outer Ba
Diadromous Fishes	Atlantic sturgeon	*Acipenser oxyrhinchus*	X	X		+++	gillnet and angling Saint John River;
							closed to other fishing in rest of Bay
	Shortnose sturgeon	*Acipenser brevirostrum*		X		+++	angling in the Saint John River; COSEWIC status:Endangered
	American eel	*Anguilla rostrata*	X			+++	trap and fykenet fishery, all Bay tributaries
	American shad*	*Alosa sapidissima*	X	X		+++	weirs Upper Bay; angling most Bay
							tributaries; gillnet Saint John estuary
	Gaspereau*	*Alosa pseudoharengus*	X			++++	weirs entire Bay; gillnet and
		Alosa aestivalis					traps Bay tributaries
	Atlantic salmon*	*Salmo salar*	X closed	X, closed	X	+	inner BOF stocks: COSEWIC status: Endangered
							COSEWIC status: Endangered
	Rainbow smelt	*Osmerus mordax*	X	X		+++	small recreational fishery
	Tomcod	*Microgadus tomcod*		X		++++	small recreational fishery
	Striped bass	*Morone saxatilis*	X, closed	X		+++	COSEWIC status: Threatened;
							angling restricted
	White perch	*Morone americana*		X		++++	angling most estuaries

TABLE 8.1 Fisheries Resources of the Bay of Fundy Region: Their Status and Comments on Fishing Gear

Group	Common Name	Scientific Name	Commer. Fishery?	Recrnl. Fishery?	Aqua-culture?	Stock Status	Comments on Fishery
Crustaceans	American lobster	*Homarus americana*	X			++++	trap fishery, stocks at 100 year high
	Rock/Jonah Crab	*Cancer sp*	X			++++	taken from lobster traps, small fishery
Molluscs	Sea scallop	*Placopecten*	X	X	X	+++	drags Outer and Inner Bay; divers.
		magellanicus					
	Soft-shell clam	*Mya arenaria*	X	X		++++	Intertidal rake fishery,
							Outer Bay and Minas Basin
	Blue mussel	*Mytilus edulis*	X	X	X	++++	permanent closure in BoF because of PSP
	Periwinkle	*Littorina littorea*	X	X		++++	intertidal and sub tidal collection, Outer Bay
	Squid	*Illex sp., Loligo sp.*	X	X		++++	weirs and drags, some jigging;
							angling Passamaquoddy Bay
Echinoderms	Green sea urchin	*Strongylocentrotus droebachiensis*	X			+++	Commercial scuba diving fishery
	Sea cucumber	*Cucumaria frondosa*	X				drag fishery in Outer Bay
Polychaetes	Bloodworm	*Glycera dibranchiata*	X			+++	intertidal rake
	Sandworm	*Arenicola sp*	X			+++	intertidal rake
	Clamworm	*Nereis sp*	X			+++	Intertidal rake
Marine Plants	Dulse	*Palmeria palmata*	X			+++	collected at low tide
	Irish moss	*Chondrus crispus*	X			+++	rake collection
	Rockweed	*Ascophyllum*	X			++++	collected from intertidal zone
		nodosum					

* some species listed in two categories because they are taken in different fisheries.
Key: ++++ = abundant, healthy stock and sustainable exploitation rates
+++ = stock is abundant, but exploitation rate is at a maximum
++ = low abundance or overexploited
+ = stock depleted; required rebuilding

Many stakeholders identified protection of the fisheries as an issue of prime importance.

- How does the Province plan to protect the fisheries?
- This tidal project is a big gamble for the fisheries, fish migration and the livelihood of Nova Scotia.
- A traditional knowledge survey involving local fisherman should be carried out.
- Fishers should be involved in monitoring, there should be ongoing relationships between the fishing industry and developers to ensure proper monitoring, and fishers should not be excluded any more than necessary from fishing.
- "There is a symbiotic relationship between the tidal system and the livelihoods of the fishers in the area [. . .] This needs to be protected in both the short and long term."
- If tidal development would displace some fishing activity, what would be an acceptable level, who would decide and by what process?
- Will the provincial and federal governments be open to actively involving Bay of Fundy fishers in tidal energy-related research?

[Comments from the Community Forums, August 2007]

Interactions between tidal in-stream turbines and fisheries could include both direct effects on either fish or on fishing or aquaculture activities, or indirect effects on other components of the ecosystem such as plankton or the benthos that would eventually impact fish.

Exclusion Zones

The requirement for an exclusion zone will likely be specific to each location and the design of each tidal device. Exclusion zones will also apply to specific activities or marine uses — such as construction, commercial navigation, commercial fishing, recreational boating and fishing, dredging and anchoring. During the construction period it is likely that an exclusion zone would include the entire site to enable construction vessels to manoeuvre safely and prevent dangerous interactions with other vessels. The zone would also likely be larger in areas of highest currents.

Because there are presently no commercial TISEC deployments in other areas it is not clear exactly what types and sizes of exclusion zone might be sought by proponents during the operations phase. If devices are installed at sufficient depth there may be no interference with marine navigation, however anchoring and trawling would likely need to be precluded, especially along cable corridors. In a commercial array, the location and spacing of turbines would depend on their design and on the specific characteristics of the site. The Background Report indicates that

> *"Little information is available on the potential footprints of tidal device arrays. Based on current information, a 30-unit tidal array could typically be expected to occupy 0.5 km^2, arranged in an oblong shape, the short dimension of which would be dependent on the width of the high energy tidal stream."* [BR p4-8]

How this type of layout would translate into an exclusion zone requirement is not known, nor are the practical operating implications for fishing vessels deploying different types of gear.

The authors of the Background Report concluded that:

> *As the size and/or number of tidal energy developments increases in the Bay of Fundy, especially in areas currently used for aquaculture or active commercial fisheries, the conflicts are expected to grow. In order to facilitate TISEC development, a comprehensive policy of allocation of coastal resources is needed. [. . .] Ongoing communication and consultation, together with site specific environmental impact assessments for proposed tidal power developments in the Bay of Fundy, will be essential components in identifying conflicts among users and identification of specific mitigative measures. Regulatory authorities, such as Transport Canada and Fisheries and Oceans Canada will have specific responsibilities for ensuring the reasonable allocation of marine uses and addressing potential conflicts, particularly with respect to any new exclusion zones*. [BR 7-3]

Stakeholders have expressed four types of concerns about exclusion zones for TISEC devices:

- implications of individual exclusion zones;
- the cumulative effects of multiple exclusion zones;
- the degree to which fishers will be involved in deciding whether and where exclusion zones will be permitted; and
- who will be compensated for displacement of fishing activity and how.

Some stakeholders anticipate that while the main focus to date has been on testing technologies in the areas of highest currents (the "hot spots"), the TISEC industry may well develop turbines that can efficiently use 3-4 knot tidal currents therefore potentially opening up larger areas of the Bay to tidal development. Displacement of fishing activity, particularly lobster fishing, may not simply be a case of fishers moving gear to another location. While their licence may permit them to fish in any part of the district, in practical terms fishing areas are allocated through traditional agreement and moving to another area can impact on other fishers and may cause significant conflict. One suggestion has been made that, if necessary, licences should be bought out and retired if exclusion zones make continued fishing in a certain area untenable.

There are also concerns that appropriate compensation programs should be negotiated in advance of tidal development being allowed to proceed, with varying views on whether this means having the final program in place before construction begins on any demonstration facility or whether the deadline should apply to the first commercial deployment.

OEER agrees with the authors of the Background Report that "*a comprehensive policy of allocation of coastal resources is needed*" to address the issues around exclusion zones. This is in keeping with the recommended Sustainability Principle that marine renewable development should be part of an integrated coastal zone management approach.

OEER understands that exclusion zones for other purposes have generally been dealt with in a piecemeal manner, and that other offshore energy developments in Nova Scotia (oil and gas) do not provide much precedent to guide what could be major components of tidal energy development.

OEER believes that the Province should strategically allocate access to the tidal resource in such a way as to (a) minimize the requirement for exclusion zones, and (b) minimize the impact of such zones as are necessary. In order to do this, a comprehensive database of fishing activities and requirements is needed. OEER heard from the Roundtable that any such database should include data collected by local fishers and other marine resource users, assuming that it meets certain agreed-upon standards.

Recommendation 18
Fisheries Database

OEER recommends that the Province of Nova Scotia (a) assist DFO to develop and maintain a geo-referenced database of fisheries resources and activities to be used to determine where tidal energy development would have least impact on the fishery and other marine resource uses, and (b) develop a detailed study of potential tidal energy exclusion zone requirements by type of activity (including different types of gear use), potential impacts and possible mitigative strategies.

Shore-based facilities

The Background Report identifies the potential for tidal energy development to compete with the fisheries and aquaculture sectors in terms of access to shore-based facilities (wharves and storage facilities). Many of these facilities are either over-subscribed or in need of upgrading, and there is concern that traditional fisheries that are economically marginal could be displaced. [BR 6-8] Stakeholders have recommended that local harbour authorities be consulted at an early stage of project planning. Roundtable discussion indicated, however, that existing mechanisms to allot access to shore-based facilities are working well, that local fishers generally form part or all of local harbour authorities, and that tidal development requirements could likely be absorbed without much problem.

Compensation and Liability

OEER recognizes that, if tidal development is to proceed, and even following the recommended strategy of minimizing requirements for exclusion zones, there is potential for the displacement of fishing activity, temporarily during construction, and long-term or permanently during the operations phase. There are also concerns about potential liabilities with respect to both damage to fishing gear caused by the devices or cables, and the reverse situation, damage to tidal devices or cables caused by fishing gear. In addition, OEER recognizes that there will always be some element of risk that, in spite of thorough environmental assessment, modelling, environmental effects monitoring, and adaptive management, adverse environmental effects caused by marine renewable energy developments could affect the fishery or aquaculture.

Recommendation 19
Compensation and Liability

> **OEER recommends that the Province of Nova Scotia facilitate the development of a preliminary mitigation process to address compensation for fisheries displacement, damage to gear, and other environmental impacts, and limits to liability before any demonstration project proceeds. Before any commercial scale development proceeds, this process should be evaluated, and adjusted if necessary for application to future commercial developments. The mitigation process should ensure that compensation, if required, goes to resource users who have a demonstrated dependency on and investment in the area in question. The mitigation process should also address the potential for impacts in other areas if fishing activity is relocated.**

Aquaculture

The Background Report observes that at present most aquaculture operations are in areas of lower current velocity than those likely to be targeted by tidal developers. *"Therefore potential competition between aquaculture sites and ocean energy development sites is not an immediate concern".* [BR 6-30]

However, this situation could change if the range of acceptable operating conditions changed for either or both industries — tidal devices operating in slower currents or aquaculture cages being deployed in higher currents.

With existing operations, of which there are only a few in Nova Scotia waters but considerably more in New Brunswick, the main concerns would be the possible effects (noise, sedimentation) during the construction period, depending on proximity.

First Nations Fisheries

In 1990, the Supreme Court of Canada's Sparrow decision affirmed that a constitutionally protected Aboriginal right to fish for food, social, and ceremonial purposes has priority over other uses of the resource, after conservation. In 1999, the Supreme Court decisions related to the Marshall case also recognized a First Nations Treaty right to fish commercially.

The Atlantic Policy Congress of First Nations Chiefs (APC) prepared a report on First Nation fishing activity in the Bay of Fundy that was funded through a SEA Participation Support award. APC identified 11 First Nations communities in Nova Scotia with access to the Fundy fishery, including the five bands in Cape Breton. An additional 6 First Nations communities in New Brunswick participate in the Fundy fisheries as well. First Nations (both provinces) hold a total of 70 lobster licenses and APC estimates that the landed value of lobsters in 2004 to the First Nations fishery was in the order of $13.3 million. First Nations hold 16 full bay scallop licenses, 10 mid-bay licenses and 1 upper bay license, landing an estimated $3.1 million of scallops in 2004. First Nations hold 32 licenses for groundfish and also participate significantly in the clam, sea urchin, herring and eel fisheries. In addition the Inner Bay of Fundy Atlantic Salmon stock is of particular interest to Bay of Fundy First Nation communities because historically, Atlantic Salmon have held a very important food and ceremonial significance.

OEER recognizes the assertion of Aboriginal and Treaty rights in the Bay of Fundy and the Province's duty to consult, and acknowledges First Nations' concerns over the protection of fish and fish habitat, and also access to fishing grounds.

Recommendation 20
Aboriginal Fisheries

OEER recommends that the Province of Nova Scotia require marine renewable energy proponents to engage with aboriginal communities at an early stage of project development to address issues and concerns, and facilitate discussion and information sharing. This engagement would be in addition to, and would not replace, the Province's duty to consult with First Nations.

Involvement of fishery and aquaculture stakeholders

Fishers have expressed a need to be consulted and involved in the planning of tidal energy developments from the earliest stages, and through the various phases, including site selection, construction, operations and monitoring environmental effects. There is no single fisheries organization in the Bay of Fundy, nor is it probable that one will emerge in the near future. Local fishers in the Minas Channel area have organized as the Heavy Current Fishers Association in response to tidal energy interest in this area. The Bay of Fundy Marine Resources Centre headquartered in Cornwallis has endeavoured to play a coordinating role, but struggles with limited resources. A similar marine resources centre was initiated in the Upper Bay but is currently inactive.

OEER considers that the proposed demonstration facility will provide an opportunity for both tidal energy and fishing interests to identify how best to work together, and to provide input into a process that can be used in future development phases.

Recommendation 21
Fisheries Consultation and Involvement Protocol

OEER recommends that the Province of Nova Scotia work with marine renewable energy proponents, local fishers and other fisheries interests to develop procedures and protocols to ensure that fishers and fisheries stakeholders are informed and consulted at every stage of tidal development, both by the Province and by proponents.

Other Marine Resource Users

The Background Report identifies the possibility of navigational overlap with tidal devices depending on the depth at which they are sited, the depth of unobstructed water above them and the draft of existing and future vessels. Again, it will be important to allocate access to the tidal resource within an integrated coastal zone management framework to ensure that conflicts between legitimate coastal and marine uses are avoided or minimized. In the case of marine transportation OEER is satisfied that existing regulatory processes are sufficient to protect existing navigational passage.

Neither the Background Report nor stakeholders identified any significant potential conflicts with recreational and tourism uses of the Bay and its coastline, with the exception of possible temporary disruptions or inconveniences during construction. However it will be important for proponents to identify local tourism and recreation activities and users and any potential interactions during project specific environmental assessments and to consult at the early stages with tourism operators. A number of people felt it likely that tidal energy could act as a tourism draw, if interpretive facilities were developed. Based on current thinking, it is probable that TISEC devices would be essentially invisible until they were brought to the surface for repair or maintenance. OEER endorses the concept of including Fundy marine renewable energy as part of a sustainable tourism experience in the Bay of Fundy, particularly as it meshes with the sustainability principle of building local community development capacity (see Chapter 9).

CHAPTER NINE
Maximizing Regional and Community Benefits

The message from SEA stakeholders was clear — they believe that future economic benefits derived from marine renewables must be retained within Nova Scotia to the greatest extent possible, and that coastal communities adjacent to marine renewable energy development areas and whose livelihoods could potentially be affected by these projects should benefit in substantial ways. Particularly there was an emphasis on the idea that communities should participate not only as possible purveyors of labour and services to renewable energy projects, but also more directly as owners, investors and users of the produced energy.

During the past ten years rural communities in Nova Scotia have seen a continuing decline in population, including four of the counties in the Bay of Fundy region as shown in Table 9.1 below. Exceptions are Hants County, Kings County and Colchester County — all areas within commuting distance of Halifax.

Table 9.1 - Population changes by County in the Bay of Fundy Region, 1996 – 2006

Place	1996 Population	2006 Population	Percentage of population change
Nova Scotia	909,280	913,465	+0.5%
Halifax County	342,965	372,855	+8.7%
Annapolis County	22,325	21,440	-4.0%
Colchester County	49,260	50,020	+1.5%
Cumberland County	33,805	32,045	-5.2%
Digby County	20,500	18,995	-7.3%
Hants County	39,480	41,180	+4.3%
Kings County	59,195	60,035	+1.4%
Yarmouth County	27,310	26,275	-3.8%

The Background Report mainly addressed service and supply chain opportunities, including potential Nova Scotia involvement in primary manufacturing and metal fabrication for turbine rotors, blades, generators, turbine ducts, gravity-based and fixed mounting structures and other proprietary TISEC components. The Report recommended development of a directory focusing on local supply capabilities for the entire energy sector including renewables, and also suggested tendering procedures to encourage participation of smaller businesses, training and job fairs. On a provincial level, the report talked about benefit agreements with potential developers and collaborative research initiatives to facilitate technology development, innovation and service capabilities.

A number of stakeholders criticised the Background Report for its lack of detailed coverage of socioeconomic issues and recommended that this gap should be filled.
Other issues raised by stakeholders included the following:

- What are the economic costs and benefits of tidal energy? Who gains and who loses?
- Would this be a short-term economic boom or would it bring lasting benefits?
- Will the Province charge royalties and how would they be spent?
- Nova Scotia should learn from the example of wind power, where technology developments and benefits have been concentrated in other countries.
- Are there useful models as examples of how local benefits can be realized?
- Local communities that will potentially be affected should be able to say no to a project.
- How could energy be stored or used to maximize local benefit?
- Local harbour authorities need to be involved in the planning process so that they can ensure harbour facilities can accommodate marine renewable energy development needs.
- The Bay of Fundy has developed real community spirit and there are many examples of community collaboration. There is scope to develop community stewardship with respect to marine renewables.
- Could marine renewables drive "zero emissions community development"?
- Communities could own and operate marine renewable developments.
- Some way should be found to ensure that municipalities receive some revenues from tidal development. One possibility would be to extend municipal boundaries out into the Bay.
- Local communities or municipalities should benefit by being charged lower rates for electricity, which would act as an incentive for local development.

The Bay of Fundy Marine Resource Centre prepared a report[14], funded through a Participation Support grant, that explored how models relating to local benefits in other areas and sectors, developed rationales for linking energy development with local communities, and suggested some options. The process of preparing the report involved input from communities and community organizations in the area. The report's five recommendations addressed developing a principle of direct benefits to adjacent communities, and researching:

- a "green model" that would provide reduced energy costs to Bay of Fundy communities
- how community economic development and small business development could be supported through a system of royalties or incentives
- financial structures to allow local communities to invest in marine renewables
- Aboriginal title as it relates to energy development
- how private corporate ownership of Nova Scotia's electrical grid affects all of the above recommendations.

OEER has no projections of potential revenue flows that may be expected from tidal energy development, and understands that these will depend on the interaction over time between increasing costs of non-renewable energy and decreasing costs of tidal technology and its deployment. OEER understands that, in the short-term, there is unlikely to be a large pot of money derived from tidal energy that can be shared between the developers, the Province and local communities. However,

14 Bay of Fundy Marine Resource Centre. 2008. Sustainable Energy and Rural Development: Options and Alternatives: A Discussion Paper by Bay of Fundy Marine Resource Centre

assuming that all technical and environmental issues can be addressed and overcome, the profitability of tidal energy will undoubtedly increase. Therefore revenue sharing principles and structures must be flexible.

OEER believes that the Province should approach the development of marine renewables with a strategy that builds on the uniqueness of the Fundy tidal resource and has clear objectives to maximize Nova Scotia benefits from the outset. OEER is recommending that developers should be required to enter into a benefits agreement but that the requirements of this agreement should be adjusted to the scale of the development

Recommendation 22
Marine Renewable Energy Benefits Strategy

> **OEER recommends that Nova Scotia develop a Nova Scotia Marine Renewable Energy Benefits Strategy to ensure that the people of Nova Scotia benefit substantively from the development of these technologies. The Strategy should include (a) a flexible system of economic rents linked to profitability, (b) mandatory developer benefits agreements with requirements for Nova Scotia content, and (c) programs or incentives to promote the development of Nova Scotia owned and developed technology and expertise.**

OEER supports the principle of ensuring that guaranteed (rather than incidental) benefits accrue to coastal communities around the Bay of Fundy. These draw part of their livelihood from the Bay, including direct fishing and aquaculture activities, recreation activities, and tourism. As one stakeholder pointed out, tourism in this region also depends on the fisheries as an essential part of the landscape, culture, and regional character. OEER believes that these communities should (a) have opportunities to participate in the development of tidal and other marine renewable resources in their own backyard, and (b) because they will have an involuntary share in any environmental impacts associated with tidal developments, should also share in the benefits that accrue to the Province in the form of lease payments or royalties.

OEER is not able to specify at this stage exactly how community participation and benefits should be ensured; this will take further research and consultation. However, OEER believes strongly that this should form an integral part of Nova Scotia's overall approach to marine renewable energy development. The socioeconomic background study proposed in Recommendation 6 will play an important role in determining how best to structure opportunities for participation and benefits.

OEER believes that the concept of providing lower cost electricity to local communities would be difficult to justify in the early years when the cost of tidal energy will likely be high compared to non-renewable energy but may have merit if and when renewables become the cheaper alternative. However, consideration of this idea would also need to address the conservation implications of providing lower cost energy.

Recommendation 23
Community Participation and Benefits

OEER recommends that the Province of Nova Scotia, in consultation with municipalities, community development organizations, and other stakeholders, develop a Marine Renewable Energy Community Participation and Benefits Strategy to ensure the delivery of lasting socioeconomic benefits in the Fundy Region. The Strategy should be completed well in advance of any commercial projects receiving approval. The Strategy should address measures such as:

- **mechanisms to ensure access to the tidal resource by municipally or community owned entities or investment funds, either independently or in partnership with other tidal developers, in order to participate in and benefit from tidal development;**
- **allocating a portion of economic rents to adjacent municipalities; and**
- **local access to and participation in related business and employment opportunities.**

CHAPTER TEN
Other Marine Renewables

As specified in OEER's commission from Nova Scotia Energy, the SEA has focused on TISEC technology. The Background Report provides limited information on wave, offshore wind, and other tidal technologies, and certainly not enough to scope out the full range of possible technology/environment interactions.

Wave energy conversion technology is at a similar stage of development as TISEC technology, with a number of devices in the pilot or demonstration phase. Construction of a commercial scale project off the coast of Portugal has also begun. The complex nature of waves has resulted in a range of designs and it is possible that a number of different types of wave technology will evolve to fit various niches. The Background Report points out that all floating and offshore wave technologies will require to be anchored on the seafloor in a way that allows a certain amount of movement which *"may prove challenging in an area with a large tidal range, such as the Bay of Fundy"* [BR 3-10]. The Report also notes that the Bay does not provide *"a regular or reliable high energy wave environment".* However, OEER notes that smaller scale wave energy devices might play a useful role in decentralized generation, or to serve dedicated end uses at a community scale.

Unlike TISEC technology, wave energy devices would be deployed at the surface and would therefore present a somewhat different set of challenges particularly around required exclusion zones.

Offshore wind is a much more mature industry with numerous large commercial applications. Wind farms in other parts of the world are currently being installed in 20-30 meters of water. The Background Report concludes *"The requirement to be surface-piercing puts offshore wind parks at a distinct disadvantage from a constructability and engineering standpoint in an area with significant tidal variations and ice"* [BR 3-1], which, of course, describes the Bay of Fundy. Offshore wind farms would again involve exclusion zones, and would raise issues around visual impacts and effects on birds and bats.

© GE Wind Energy

As far as OEER is aware, there are currently no proponents seeking to demonstrate either wave or offshore wind devices in the Bay of Fundy. There is, however, a proponent seeking to develop an alternative form of tidal technology in the area. The tidal lagoon concept would use conventional low-head generators that have been proven, from the point of view of technical feasibility, in conventional tidal barrage structures such as the Annapolis Royal Generating Station. The tidal lagoon, instead of damming off a bay or estuary, would instead create a complete rubblemound impoundment in a shallow area. Tidal flows would move in and out of the impoundment but would also move around it. There are as yet no commercial applications of the tidal lagoon technology.

As identified in the Background Report some of the features of the tidal lagoon concept include the following:

- Construction technology is conventional, with large initial costs;
- Energy output is predictable with the possibility of extending generation time by creating compartments within the lagoon structure;
- Because the transmission cable can be enclosed within the rubblemound structure, this reduces the length of subsurface cable required;
- The lagoon has *"a relatively large 'footprint' within the marine environment, potentially causing important changes to local hydrodynamics, and potential alteration to the movement of migratory and transient marine life as the habitat becomes lost to them";* [BR 3-6]
- *"Tidal lagoons may result in important changes to local and far-field hydrodynamics";* [BR 3-12]
- Impounding water will likely affect ice formation. It is not known yet whether this would represent anything more than an operating challenge;
- The lagoon would likely close the impounded area to fishing activity; however the structure itself might create new habitat;
- Tidal lagoon development would take place in shallower areas where marine mammal interactions would be limited to porpoises and seals, and not whales;
- As a large construction project, a lagoon would create a large number of short-term jobs; and
- A lagoon extracts tidal energy more efficiently than in-stream turbines, and would generate a significant amount of electricity from one project.

OEER also notes that (1) tidal lagoons cannot be implemented incrementally, and that (2) it is unlikely that implementation of a tidal lagoon project could be reversed, and certainly not to the same extent as the other marine renewable energy technologies under consideration. Therefore there would be no demonstration phase involved, and an adaptive management regime would involve only mitigation and not removability.

There was very limited stakeholder discussion about alternative marine renewable energy technologies. The tidal lagoon proponent was represented on the Roundtable and put forward a request that the SEA support the concept of the Province awarding a conditional seafloor lease, dependant on all environmental assessment requirements being met.

OEER is recommending that a basic set of sustainability principles be applied to all types of marine renewable technology in the Bay of Fundy. Tidal lagoon technology clearly differs significantly from wave, wind and TISEC applications. The proposed Sustainability Principle 1.5 would present a challenge.

> **Until near and far-field effects of marine renewable energy are well understood and deemed to be acceptable, development should take place by modest increments supported by an effective and transparent research and monitoring program, installations should be removable, and clear thresholds should be established to indicate when removal would be required.**

Tidal lagoon development is an all-or-nothing proposition. It cannot be developed incrementally and could not be easily removed. Therefore OEER believes that, any proposed project should receive rigorous scrutiny, and at very least should undergo a full federal-provincial panel review.

Recommendation 24
Offshore Wind, Wave and Tidal Lagoon Technology

OEER recommends that the Province of Nova Scotia should apply the Sustainability Principles in Recommendation 1 to consideration of all types of marine renewable energy technology. Because tidal lagoon technology is not proven from an environmental perspective for use in the Bay of Fundy context and because it is not amenable to either incremental implementation or removability, the Province of Nova Scotia should support a full Federal-Provincial panel review for any proposed tidal lagoon project.

CHAPTER ELEVEN
Integrated Management for the Bay of Fundy and Stakeholder Involvement

The introduction of tidal in-stream devices into the Bay of Fundy, especially at a commercial scale, has the potential to interact with many aspects of the biophysical and socioeconomic systems in the Fundy region. These multiple interactions are documented in the Background Report. Far-field effects could be experienced at considerable distances, over long periods of time, and in other jurisdictions — clearly a complex situation requiring a comparable response.

The Background Report concludes that

> *"Any energy extraction development in the Bay of Fundy needs to be in conformity with an established and comprehensive coastal zone management policy in each province. (In this connection, the contemporary view is that the coastal zone extends landward beyond the high water mark to include estuaries and the rivers that empty directly into the marine environment. This view underlies both Canada's Oceans Act and the former Coastal 2000 policy in Nova Scotia). Where such a policy is lacking or incomplete, completion and implementation should be a high priority in order that a policy vacuum does not impede progress"* BR 8-6

Stakeholders told OEER that:

- management of developments and activities in the Bay of Fundy should involve a significant level of collaboration between Nova Scotia, New Brunswick, the Government of Canada and the State of Maine;
- that we need a shared vision for the Bay of Fundy and a shared space management plan;
- that an Integrated Coastal Zone Management (ICZM) plan or policy is required to make good decisions about the necessary trade-offs that will be involved (balancing environmental and economic interests);
- consideration should be given to lobbying the federal government to designate the Bay of Fundy as a Large Ocean Management Area (LOMA)[15]; and
- there were also concerns that federally driven processes such as the Eastern Scotian Shelf Integrated Ocean Management Plan (ESSIM) are very slow.

Ecology Action Centre prepared a report, funded by a Participation Support grant, that reviewed the learnings from past integrated management initiatives in the Bay. The report described the characteristics of ICZM as:

- seeking a balance between the objectives of stakeholders;
- involving as many stakeholders and as many issues as possible in the decision process and in formation of policies for equitable distribution of space and resources in the coastal environment;
- empowering local resource users to take the lead, leading to democratic decision making and better resource management;

15 "LOMAs provide a large-scale geographical and ecological basis for the application of ecosystem and human use objectives. They also define the geographical context for the establishment of collaborative planning systems to support integrated ocean management." Eastern Scotian Shelf Integrated Ocean Management Plan (2006-2011)

- incorporating science and sound management principles to provide a guiding framework around resource management decision making; and
- involving a holistic vision of the ecological, economic, cultural and social well being of a particular ecosystem.

EAC's investigation involved six case studies:

- the Bay of Fundy Fisheries Council, 1997-2000;
- Clean Annapolis River Project (CARP);
- Bay of Fundy Ecosystem Partnership (BoFEP);
- Upper Bay of Fundy Fisheries Management Project;
- Annapolis Watershed Resource Committee; and
- Sustainable Communities Initiative.

The participants in these six management initiatives, three of which are still active, agreed that integrated management needs to be community-based but with active government participation, should respond to the particularity of location, be adequately resourced, and able to draw on sound research. The report concludes that tidal development should be embedded in ICZM, rather than the other way around, that communities must be involved, and that there is need to establish an adaptive management body probably under a federal-provincial agreement.

OEER notes that in 2007, the Joint Panel reviewing the White's Point Quarry proposal recommended that Nova Scotia develop an ICZM policy or plan, and that the Nova Scotia Department of Environment has accepted the Panel's recommendations.

DFO defines (ICZM) as:

> *"a continuous planning process in which stakeholders and regulators reach general agreement on the best mix of conservation, sustainable resource use and economic development for coastal areas. Goals to be achieved through an ICZM process include:*
>
> - ***conservation,*** *based on an ecosystem approach, for the purposes of maintaining biological diversity and productivity of coastal environments and preserving ecosystem health;*
> - ***sustainable use*** *of coastal resources; and*
> - ***economic diversification*** *and the generation of wealth for the benefit of all Canadians, but in particular, coastal communities[16]".*

OEER understands that ICZM is often held up as an ideal but sometimes seen as too complex and too lengthy a process to undertake. Nonetheless, OEER believes that ICZM is an appropriate response to the challenges of ensuring sustainability in the Bay of Fundy region and that the Province and stakeholders will be able to develop a cautious but pragmatic approach that will deliver timely guidance.

16 DFO. A Guide to Integrated Coastal Zone Management in Canada Brochure

Recommendation 25
Integrated Coastal Zone Management

> **OEER recommends that the Province of Nova Scotia develop an Integrated Coastal Zone Management Policy for the Bay of Fundy before large scale commercial marine renewable energy developments are allowed to proceed. The Province should involve communities and stakeholders in the development of the policy and the Province should undertake to resource that involvement.**

OEER suggests that the Province of Nova Scotia, in collaboration with New Brunswick and in consultation with stakeholders, should provide siting guidance to potential demonstration and commercial proponents through the development of geo-referenced tools that will indicate opportunities for possible development of marine renewable energy technologies, and potential constraints with respect to environmental sensitivities or risks and potential resource use conflicts. These tools should be a "living" system that can add new layers of information as they became available through the ongoing research and monitoring program.

Recommendation 26
Geo-Referenced Tools to Indicate Opportunities and Constraints

> **OEER recommends that Nova Scotia, New Brunswick and Canada collaborate to prepare and maintain geo-referenced tools to indicate opportunities and constraints for the full range of marine renewable energy technologies, to support the allocation of marine renewable resources within the context of an Integrated Coastal Zone Management Policy.**

The Bay of Fundy Marine Resource Centre prepared a second report for the SEA process with a Participation Support grant[17]. This report addresses options for improving citizen engagement in resource and energy developments and recommends that:

- development of tidal power in the Bay of Fundy include an engagement strategy with Bay of Fundy coastal communities that is inclusive, ongoing, dialogic and transparent;
- meaningful consultation be established by supporting community-based organizations and agencies facilitate necessary dialogue, public education, outreach and research; and
- further research be conducted into successful models for citizen engagement in resource projects.

Recognizing the valuable contribution made to this SEA process by the members of the SEA Stakeholder Roundtable, and through other forms of stakeholder input, OEER agrees that the Province should continue to engage communities and stakeholders in a dialogue about marine renewable energy development and about integrated management of resources in the Bay of Fundy. OEER has made a number of recommendations to this effect:

17 Bay of Fundy Marine Resource Centre. 2007. Public Engagement and Renewable Energy Development. Options and Alternatives for Tidal Energy Development in the Bay of Fundy.

Inclusion of stakeholders in the development of a marine renewable energy research program. (Recommendation 4)

Creation of a Stakeholder Advisory Board as part of a Marine Renewable Energy Demonstration Program. (Recommendation 8)

Mandatory consultation with fishers when locating potential sites for demonstration projects. (Recommendation 9)

"Ample Involvement" of communities and stakeholders in the environmental assessment of the proposed demonstration facility. (Recommendation 10)

Liaison between the Fundy Tidal Energy Research Committee and the Stakeholder Advisory Board to ensure that research questions are relevant to stakeholders. (Recommendation 11)

Creation of a commercial development framework for marine renewable energy, either through an expansion of the existing SEA process, or through a new process that includes stakeholder involvement. (Recommendation 12)

Proponent engagement with aboriginal communities at an early stage of project development to address issues and concerns. (Recommendation 20)

Development of a fisheries consultation and involvement protocol for use by future tidal energy developers. (Recommendation 21).

Develop a Marine Renewable Energy Community Participation and Benefits Strategy in consultation with municipalities, community development organizations, and other stakeholders. (Recommendation 23).

Involvement, with resources, of communities and stakeholders in the development of Integrated Coastal Zone Management Policy for the Bay of Fundy. (Recommendation 25).

Involvement of municipalities by the Province and proponents at every stage of the development process. (Recommendation 27)

A strategy for public education and awareness developed by the Province together with marine renewable energy proponents, research institutions and environmental and community organizations involved in sustainability education. (Recommendation 28)

OEER also heard that municipalities — the level of government closest to communities and residents – needs to be closely involved with the development of tidal energy, by being consulted as early as possible and by being kept informed at every step. Municipalities also need to play an active role in incorporating marine renewable energy options into their municipal sustainability plan.

Recommendation 27
Municipal Involvement

> **OEER recommends that the Province of Nova Scotia consult with the Union of Nova Scotia Municipalities to develop procedures and protocols to ensure that municipalities are informed and consulted at every stage of tidal development, both by the Province and by proponents.**

OEER believes that sustainability of new technological developments that have both environmental and socio-economic implications depends upon acceptability to the public at large. This requires that the public be sufficiently knowledgeable about the technologies, their implications, and costs and benefits. This can only be assured by ready access to relevant information. Since potentially applicable technologies are rapidly developing, it should be a part of the strategic plan for public development to provide a) an updatable source of information about these technologies, and b) a database of information sources that would enable members of the public to enhance their knowledge of the environmental and socioeconomic implications of marine renewable energy developments in Nova Scotia.

Recommendation 28
Public education and awareness

> **OEER recommends that the Province of Nova Scotia work with marine renewable energy proponents, research institutions and environmental and community organizations involved in sustainability education, to develop a strategy for public education and awareness about marine renewable energy technologies. The strategy should enable the public to access and contribute to a database of up-to-date information.**

Ultimately, in order to make ICZM a reality in the Bay of Fundy Region, a new management body will be needed, bringing together New Brunswick, Nova Scotia and the Government of Canada and coastal communities around the entire Bay. In addition, the Gulf of Maine Council provides both a potential model and a vehicle for international collaboration. It is beyond OEER's capability at this stage to entirely envisage how such a body would be constituted, its exact role, and how it would operate. There is undoubtedly much to be learned from other jurisdictions and examples.

Recommendation 29
Long-term Integrated Management in the Bay of Fundy

> **OEER recommends that the Province of Nova Scotia, partnering if possible with New Brunswick, Canada, and the Gulf of Maine Council, study ICZM requirements, approaches and experiences, to provide the background for a major workshop to be held in 2009 to examine integrated management issues and organizational options.**

APPENDIX A
Recommendations Summary

CHAPTER FOUR
Sustainability Principles and Overall Recommendations

Recommendation 1
Sustainability Principles

OEER recommends that the Province of Nova Scotia adopt the following ten sustainability principles to guide marine renewable energy development in the Bay of Fundy. These principles should be incorporated as appropriate into:

- provincial policy on marine renewable energy development or coastal zone management;
- any new legislation regarding marine renewable energy development;
- guidelines for all environmental assessments of marine renewable energy proposals;
- terms of reference for future phases of the SEA; and
- terms of reference for any ongoing research, integrated management, or stakeholder involvement body or process.

1.1 The marine renewable energy resource in the Bay of Fundy should remain under public control and management.

1.2 Marine renewable energy developments should be planned, approved and managed within a strategic context that will ensure net reductions of Nova Scotia's greenhouse gas emissions.

1.3 Nova Scotia, New Brunswick and the Government of Canada should collaborate in the management of the marine renewable energy resource to ensure protection of the entire Bay of Fundy ecosystem.

1.4 Commercial application of marine renewable energy developments should go ahead only when a proponent can demonstrate that there will be no significant adverse effects on the fundamental hydrodynamic processes of the Bay of Fundy tidal regime (energy flow, erosion, sediment transportation and deposition) or on biological processes and resources.

1.5 Until near and far-field effects of marine renewable energy are well understood and deemed to be acceptable, development should take place incrementally, supported by an effective and transparent research and monitoring program, installations should be removable, and clear thresholds should be established to indicate when removal would be required.

1.6 Adverse effects on the fishery or on aquaculture by energy developments should be avoided, or should be minimized. If displacement takes place, or if adverse environmental effects occur, compensation must be addressed.

1.7 Development of marine renewable energy should be planned and managed to ensure lasting stewardship of the resource in order to deliver durable socioeconomic benefits to present and future generations in Nova Scotia.

1.8 Nova Scotia's marine renewable energy development strategy should strengthen local community development capacity, through measures such as access to the resource, encouragement of community-scale technology developments and uses, or revenue sharing.

1.9 Marine renewable energy development should be part of an Integrated Coastal Zone Management approach for the Bay of Fundy, including the informed participation and cooperation of all stakeholders in order to balance environmental, economic, social, cultural and recreational objectives, within the limits set by ecosystem dynamics.

1.10 Research, monitoring and decision making related to marine renewable energy should be carried out in an open and transparent manner. The public should have access to all environmental information. The public should have access to resource assessment information, respecting the need to keep certain commercial information confidential. Requests by proponents to keep information confidential should undergo stringent review.

Recommendation 2
Allowing the Demonstration of TISEC Technologies

OEER recommends that the Province of Nova Scotia give the necessary approvals, contingent on satisfactory completion of a project-specific environmental assessment, to allow demonstration of a range of TISEC technologies in the Bay of Fundy.

The purpose of demonstration projects should be to determine (a) operational feasibility, (b) the extent of environmental impacts, and (c) the effectiveness of mitigation approaches. Demonstration projects and facilities should be subject to conditions specified in this Report.

Recommendation 3
Marine Renewable Energy Legislation

OEER recommends that, before large-scale commercial development proceeds, the Province of Nova Scotia enact legislation respecting the renewable energy resources in the Bay of Fundy. The legislation should incorporate the Sustainability Principles in Recommendation 1 and provide a framework for the testing and development of offshore renewable energy that will, among other things:

- Encourage the development of marine renewable energy resources in a safe and environmentally sound manner;
- Require interested parties to obtain licenses for the rights to develop. Such licenses should be conditional on undertaking activity that will promote timely development;
- Provide for immediate disclosure of all environmental information and, after appropriate confidentiality periods, disclosure of technical information related to the resource;
- Provide for the Province to receive revenues from the licensing and/or development of the resource;
- Provide opportunities for affected communities to benefit from the development; and
- Provide incentives for the net reductions of greenhouse gases in the Province.

CHAPTER FIVE
Information Gaps and Research Requirements

Recommendation 4
Research Program

OEER recommends that the Province of Nova Scotia facilitate the development of a collaborative research program for marine renewable energy development in the Bay of Fundy. The research agenda would address:

- immediate needs related to demonstration projects;
- longer term requirements relating to the development of an integrated management approach to the commercial development of marine energy renewables;
- consideration of non-TISEC technologies;
- the understanding, prediction, mitigation and monitoring of far-field and cumulative effects; and
- the eventual determination of ecosystem carrying capacity limits.

The design of the research program should include all levels of government, Aboriginal peoples, research institutions, and stakeholders. The program should determine research priorities, timing, and responsibilities.

Recommendation 5
Mi'kmaq Ecological Knowledge Study

OEER recommends that the Province of Nova Scotia ensure that a Mi'kmaq Ecological Knowledge Study is carried out before marine renewable energy projects proceed in the Bay of Fundy, either as part of the research program identified in Recommendation 4 or as a requirement for project-specific environmental assessment.

Recommendation 6
Provincial Standard for Ecological Data

OEER recommends that the Province of Nova Scotia require all marine renewable energy proponents and their consultants to ensure that ecological data is geo-referenced and metadata compiled in accordance with the relevant provincial standard. This should be completed in consultation with the Nova Scotia Geomatics Centre and other provincial centers, where relevant.

Recommendation 7
Bay of Fundy Socioeconomic Background Study

OEER recommends that the Province of Nova Scotia undertake a socioeconomic background study, as soon as possible to describe fully the communities, economies and cultures of the Bay of Fundy region and Mi'kmaq communities with fishing interests in the Bay; to address in more detail how development of marine energy renewables would interact with the socioeconomic environment; and to identify opportunities, constraints and risks. The study process should engage communities and stakeholders.

CHAPTER SIX
Implementing an Incremental Approach

Recommendation 8
Marine Renewable Energy Demonstration Program

OEER recommends that the Province of Nova Scotia establish a Marine Renewable Energy Demonstration Program to (a) encourage the development of a range of tidal energy and other marine renewable technologies, applicable at different scales of application and in different operating environments, (b) gather knowledge about environmental and socioeconomic impacts and benefits, and (c) initiate longer term research needed to predict cumulative and far-field effects in the commercial phase. The Development Program should establish a Stakeholder Advisory Board to review proposed demonstration projects, advise on research and monitoring required, review monitoring results, and address requirements for the transition to commercial projects. Demonstration projects will include, but not be limited to, the proposed demonstration facility. The Demonstration Program will be guided by the Sustainability Principles outlined in Recommendation 1 and will provide provincial (and possibly federal) assistance in an equitable manner to a range of projects that meet appropriate criteria. The Program should also ensure that demonstration projects are assessed, implemented, and monitored in an environmentally and socially acceptable manner and that an appropriate compensation process is in place.

Recommendation 9
Siting Demonstration Projects

OEER recommends that the Province require proponents to consult with local fishers, other marine resource users including marine transportation stakeholders, and adjacent communities in the selection of sites for demonstration projects and to avoid or compensate the displacement of productive fishing activity. In addition, the Province of Nova Scotia and proponents should consult broadly with science advisors, including DFO, and fishers on the issue of interference with migration patterns and consider this advice in (a) selecting a location that will have a low risk of impact, (b) developing mitigation measures including determining time periods when construction should not take place, (c) designing a monitoring program for this issue, and (d) determining a threshold effect level that would require devices to be removed from the water.

Recommendation 10
Environmental Assessment of the Demonstration Facility

OEER recommends that the Province of Nova Scotia amend the provincial Environmental Assessment Regulations to designate tidal energy projects that produce 2 megawatts or more of energy as Class I undertakings. In the case of the proposed demonstration facility OEER recommends that the provincial Minister of Energy require a provincial project-specific environmental impact assessment (EIA), including the production of an environmental-assessment report. The EIA should provide ample opportunity for adjacent communities and stakeholders to be informed and to express their views, concerns and suggestions, through a process involving early consultation and community meetings. Stakeholder perspectives should also be obtained through the involvement of the Stakeholder Advisory Board (see Recommendation 8).

Recommendation 11
Fundy Tidal Energy Research Committee

OEER recommends that the Province of Nova Scotia initiate the formation of a federal-provincial Fundy Tidal Energy Research Committee, also involving the Province of New Brunswick, if interested, to determine baseline research requirements and to develop research and monitoring requirements for demonstration and future commercial projects. This Committee should have a close relationship with the Stakeholder Advisory Board, to help identify research questions relevant to stakeholders. Non-government participants from other institutions, or agencies carrying out relevant research, should also participate as appropriate. The Research Committee should also play an active role in helping to determine the broader research program (see Recommendation 4).

Recommendation 12
Commercial Development Framework

Recognizing that the Bay of Fundy is one resource shared by two provinces, OEER recommends that the Province of Nova Scotia work with New Brunswick and the Government of Canada to develop a commercial development framework for marine renewable energy, either through an expansion of the existing SEA process, or through a new process that includes stakeholder involvement. The commercial development framework should be guided by the sustainability principles included in Recommendation 1, and should address the transition from demonstration to commercial, scales of development, research and modelling needs, and the capacity of the Bay of Fundy marine ecosystem to absorb different energy extraction levels without significant cumulative environmental effects, taking the Precautionary Principle into consideration.

Recommendation 13
Incremental Development and Removability

OEER recommends that larger commercial developments be required to develop incrementally in stages with an appropriate effects monitoring program; that all installations be designed in such a way that the machines, their footings and all cables can be completely removed if necessary and the site remediated to close to its former condition; and that effect thresholds be established at which the proponent would be required to remove some or all of the machines from the water if unacceptable adverse effects are observed.

CHAPTER SEVEN
Integration of Marine Renewables and End Uses

Recommendation 14
Nova Scotia Energy Priorities

OEER recommends, in accordance with Sustainability Principle 1.2, that the Province of Nova Scotia takes steps to maximize the benefits of commercial marine renewable energy projects to Nova Scotia. The Province's first priorities should be to (a) satisfy provincial, national and international greenhouse gas reduction commitments and (b) improve provincial energy security. Projects that are proposed primarily to export electricity should not be considered until these priorities have been met. Proposed export projects should be required to go through a public consultation process, and to guarantee significant benefits to Nova Scotia.

Recommendation 15
Conservation, Efficiency and Carbon Credits

OEER recommends that the Nova Scotia Renewed Energy Strategy and Climate Change Action Plan (a) place high priority on conservation and efficiency measures, and (b) implement a carbon credit trading scheme, or comparable measures, to strengthen the economic viability of the tidal energy industry.

Recommendation 16
Grid Capacity

OEER recommends that the Province of Nova Scotia study (a) the advantages and disadvantages of developing more decentralized generation, (b) the current capacity of the grid to support additional renewable energy developments, and (c) required upgrades and how these should be financed.

Recommendation 17
End Uses

OEER recommends that the Province of Nova Scotia study alternate uses of marine renewable power generation to maximize benefits. The study should address small-scale applications, on and off-grid, new energy applications such as hydrogen, storage methods, and how the current regulation of electricity contributes to both opportunities and constraints.

CHAPTER EIGHT
Interactions with the Fisheries and other Marine Resource Uses

Recommendation 18
Fisheries Database

OEER recommends that the Province of Nova Scotia (a) assist DFO to develop and maintain a geo-referenced database of fisheries resources and activities to be used to determine where tidal energy development would have least impact on the fishery and other marine resource uses, and (b) develop a detailed study of potential tidal energy exclusion zone requirements by type of activity (including different types of gear use), potential impacts and possible mitigative strategies.

Recommendation 19
Compensation and Liability

OEER recommends that the Province of Nova Scotia facilitate the development of a preliminary mitigation process to address compensation for fisheries displacement, damage to gear, and other environmental impacts, and limits to liability before any demonstration project proceeds. Before any commercial scale development proceeds, this process should be evaluated, and adjusted if necessary for application to future commercial developments. The mitigation process should ensure that compensation, if required, goes to resource users who have a demonstrated dependency on and investment in the area in question. The mitigation process should also address the potential for impacts in other areas if fishing activity is relocated.

Recommendation 20
Aboriginal Fisheries

OEER recommends that the Province of Nova Scotia require marine renewable energy proponents to engage with aboriginal communities at an early stage of project development to address issues and concerns, and facilitate discussion and information sharing. This engagement would be in addition to, and would not replace, the Province's duty to consult with First Nations.

Recommendation 21
Fisheries Consultation and Involvement Protocol

OEER recommends that the Province of Nova Scotia work with marine renewable energy proponents, local fishers and other fisheries interests to develop procedures and protocols to ensure that fishers and fisheries stakeholders are informed and consulted at every stage of tidal development, both by the Province and by proponents.

CHAPTER NINE
Maximizing Regional and Community Benefits

Recommendation 22
Marine Renewable Energy Benefits Strategy

OEER recommends that Nova Scotia develop a Nova Scotia Marine Renewable Energy Benefits Strategy to ensure that the people of Nova Scotia benefit substantively from the development of these technologies. The Strategy should include (a) a flexible system of economic rents linked to profitability, (b) mandatory developer benefits agreements with requirements for Nova Scotia content, and (c) programs or incentives to promote the development of Nova Scotia owned and developed technology and expertise.

Recommendation 23
Community Participation and Benefits

OEER recommends that the Province of Nova Scotia, in consultation with municipalities, community development organizations, and other stakeholders, develop a Marine Renewable Energy Community Participation and Benefits Strategy to ensure the delivery of lasting socioeconomic benefits in the Fundy Region. The Strategy should be completed well in advance of any commercial projects receiving approval. The Strategy should address measures such as:

- mechanisms to ensure access to the tidal resource by municipally or community owned entities or investment funds, either independently or in partnership with other tidal developers, in order to participate in and benefit from tidal development;
- allocating a portion of economic rents to adjacent municipalities;
- local access to and participation in related business and employment opportunities; and
- encouragement of eco-tourism opportunities related to marine renewable energy development.

CHAPTER TEN
Other Marine Renewables

Recommendation 24
Offshore Wind, Wave and Tidal Lagoon Technology

OEER recommends that the Province of Nova Scotia should apply the Sustainability Principles in Recommendation 1 to consideration of all types of marine renewable energy technology. Because tidal lagoon technology is not proven from an environmental perspective for use in the Bay of Fundy context and because it is not amenable to either incremental implementation or removability, the Province of Nova Scotia should support a full Federal-Provincial panel review for any proposed tidal lagoon project.

CHAPTER ELEVEN
Integrated Management for the Bay of Fundy and Stakeholder Involvement

Recommendation 25
Integrated Coastal Zone Management

OEER recommends that the Province of Nova Scotia develop an Integrated Coastal Zone Management Policy for the Bay of Fundy before large scale commercial marine renewable energy developments are allowed to proceed. The Province should involve communities and stakeholders in the development of the policy and the Province should undertake to resource that involvement.

Recommendation 26
Geo-Referenced Tools to Indicate Opportunities and Constraints

OEER recommends that Nova Scotia, New Brunswick and Canada collaborate to prepare and maintain geo-referenced tools to indicate opportunities and constraints for the full range of marine renewable energy technologies, to support the allocation of marine renewable resources within the context of an Integrated Coastal Zone Management Policy.

Recommendation 27
Municipal Involvement

OEER recommends that the Province of Nova Scotia consult with the Union of Nova Scotia Municipalities to develop procedures and protocols to ensure that municipalities are informed and consulted at every stage of tidal development, both by the Province and by proponents.

Recommendation 28
Public education and awareness

OEER recommends that the Province of Nova Scotia work with marine renewable energy proponents, research institutions and environmental and community organizations involved in sustainability education, to develop a strategy for public education and awareness about marine renewable energy technologies. The strategy should enable the public to access and contribute to a database of up-to-date information.

Recommendation 29
Long-term Integrated Management in the Bay of Fundy

OEER recommends that the Province of Nova Scotia, partnering if possible with New Brunswick, Canada, and the Gulf of Maine Council, study ICZM requirements, approaches and experiences, to provide the background for a major workshop to be held in 2009 to examine integrated management issues and organizational options.

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Final Report