The Community and Business Toolkit for Tidal Energy Development

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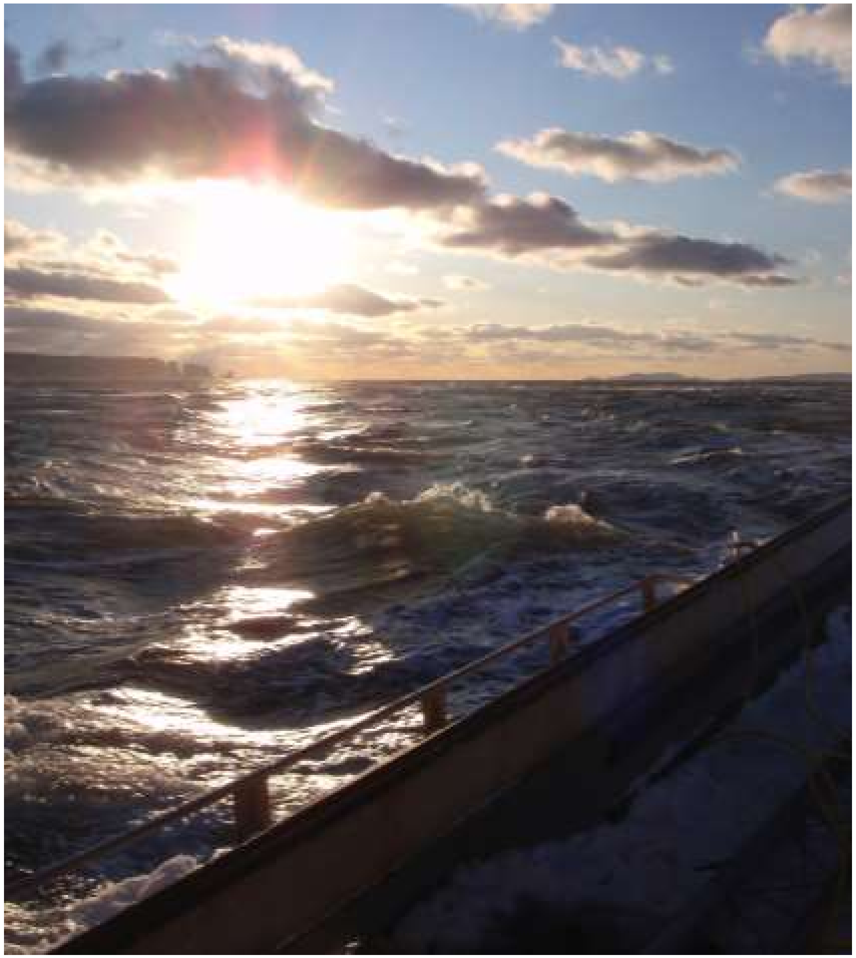
ACADIA
Tidal Energy
INSTITUTE
Research. Education. Outreach.

Purpose



- Practical transfer of knowledge from researchers to industry, governments, NGOs and communities.
- Empowerment of rural and coastal communities in developing renewable energy opportunities.
- Facilitation of community infrastructure and supply chain development to support a tidal energy project.

Audience

Curious or Concerned Citizen/Interest Group

Potential Tidal Energy Developer/ Investor

Business or Community interested in tidal energy opportunities

"I will be glad when the toolkit is done, so when people in my community ask me questions, I don't have to spend a half-day preparing an answer for them. I can direct them to the toolkit" (May, 2012).

ACADIA Tidal Energy INSTITUTE

Want to know about tidal energy?

What is Tidal Energy?

Dr. Graham Daborn

FOUNDATIONAL CONCEPT: ENVIRONMENTAL ISSUES OF BARRAGE-BASED TIDAL POWER STATIONS

Building a barrage or dam across an estuary can produce major changes to the ecosystem, with significance for other inhabitants (e.g. marine mammals, birds, fish, and their food supplies) or for other uses of the estuary (e.g. shipping, fishing, or recreation). The dam itself may limit access by migrating fish to spawning or feeding grounds in the upper estuary or the rivers that feed into it, and if they do pass through the dam, they may suffer injury or death because of contact with moving parts of the turbine or changes in pressure, etc. The dam also restricts water flows and so may modify the tidal movements on both the sea and landward sides of the barrage. Changes to intertidal zones may include a reduction in the area exposed at low tide and major changes to sediment distributions, which in turn may affect fish, birds, and other animals that live in or depend on the intertidal zone. In the case of the Bay of Fundy, some of the larger barrage proposals considered in the 1970s would have modified the tidal range throughout the Bay and the Gulf of Maine, with significant changes that could affect fisheries and shoreline properties.

1.2.1 - CURRENT APPROACHES TO TIDAL ENERGY

The present considerations for tidal electricity generation are primarily based upon new designs for tidal energy converters (TEC) devices that convert the kinetic energy of the flowing water. TEC devices have a long history at the concept level, including in Canada. Clarkson, in 1915, developed a mechanical pump driven by tidal flows that could pump seawater up to a considerable height, from where it could be used to drive a conventional turbine, and the National Research Council assisted in the development of the Davis vertical axis turbine (based on the Savonius rotor) more than 30 years ago. Most of the more mature TEC technologies are either horizontal or vertical axis designs (Figures 1-3 and 1-4). Converting the kinetic energy of flowing tidal water using TEC devices is the major focus of tidal power investigations in Canada, Europe, and the U.S.A. at the present time and the subject of this toolkit.

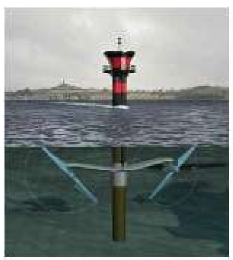


Figure 1-3: Horizontal axis turbine - Marine Current Turbines -SeaGen

Source: SeaGen turbine: http://www.alternative-energy-news.info/seagen-tidal-power-installation/

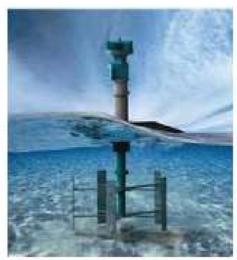


Figure 1-4: Vertical Axis Turbine, New Energy Corporation

Source: New Energy Corporation, http://newenergycorp.ca/Default.aspx

1.3 - WHY TIDAL POWER?

The tide, like the wind, is a renewable energy source that does not consume any fossil fuels (after construction at least!) and generates neither greenhouse gases nor waste heat. Unlike the wind, however, the flow of the tides is very predictable. It is possible to forecast the state of the tide and the velocity of the water reasonably accurately for any given place and time, years into the future. This predictability makes it easier to integrate tidal energy into an existing electrical grid system than other intermittent renewable resources such as wind, wave, or solar power. Around Canada and some other parts of the world, there are many loca-

Natural Resources Canada identified more than 190 sites on the three ocean coasts of Canada (see Figure 1-9) as having potential to generate more than 1 MW of power from tidal currents

1.5 - TIDAL POWER OPPORTUNITIES IN CANADA

Natural Resources Canada identified more than 190 sites on the three ocean coasts of Canada (see Figure 1-9) as having potential to generate more than 1 MW of power from tidal currents (NRCan 2006). The total tidal energy available in the country was estimated at more than 42,000 MW. Most of the resource is found in Nunavut, particularly in the vicinity of Hudson Strait and Foxe Channel, and thus relatively remote from major areas of electricity demand. However, TEC devices could be used effectively to provide consistent, predictable, renewable energy suitable for support of local communities that are presently dependent on imported fossil fuel. Most other sites having more than 1 MW potential were found in British Columbia, whereas on the Atlantic coast, a few sites with high potential were identified in the Bay of Fundy and Cape Breton.

In Nova Scotia, there are a number of locations where electricity could be obtained from tidal waters, either using tidal range or tidal stream approaches. If one were to accept the consequences of building barrages, lagoons, or other tidal range structures, it would be possible to generate several gigawatts of power—far more than the current total energy demand in Nova Scotia, which is about 2200 MW (or about 2.2 GW). With tidal stream approaches, however, the potential is much lower because TEC devices can capture only a smaller portion (up to 30%) of the kinetic energy in the water. An early study in 2006 suggested that about 1,000 MW could be generated by arrays of TEC devices in the various portions of the Bay of Fundy (Bedard et al. 2006). More recent work, outlined in Module 2 of this Toolkit, suggests that this may be a considerable underestimate. Many of the narrow passages in the Bay of Fundy or around the Bras D'Or lakes in Cape Breton have the potential for producing only a few MW.

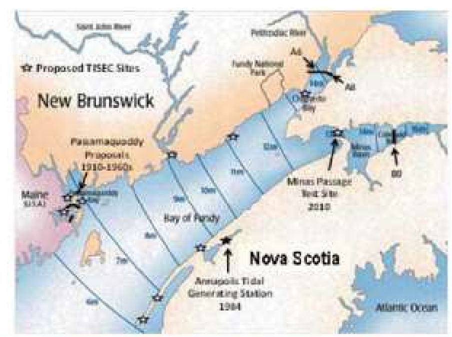


Figure 1-8: Locations of proposed and current tidal power developments in the Bay of Fundy, 1910-2010.

Sites A6, A8, and B9 were sites considered for barrage style tidal power developments in the 1970s. Lines drawn across the Bay of Fundy represent the approximate maximum tidal range (m).

Want to know about tidal energy resources in Nova Scotia?

Measuring and Accessing the Tidal Resource

Dr. Richard Karsten

A critical aspect of tidal power development is an accurate assessment of the power resource.

DEFINITION: TYPES OF RESOURCE

Theoretical Resource is the power contained in the entire resource.

Technical Resource is the proportion of the theoretical resource that can be captured using existing technology.

Practical Resource is the proportion of the technical resource that is available after consideration of external constraints – for example, environmental impacts.

Economic resource is the proportion of the practical resource that can be economically captured.

(adapted from a number of sources)

2.- MEASURING AND ASSESSING THE TIDAL RESOURCE

Dr. Richard Karsten

WHAT DOES THIS MODULE COVER?

The following module describes the tidal resource in Nova Scotia. It contains:

- Maps of Nova Scotia showing the locations of the largest in-stream tidal resources.
- Calculated extractable power at each location.
- Calculated potential installed capacity of the turbine array that could be deployed at each location.
- A discussion of site assessment.
- A detailed analysis of Minas Channel including bathymetry, tidal flow, and the impact of extracting power.

IS THIS MODULE FOR YOU?

This module is for anyone interested in the size of the potential in-stream tidal resource in Nova Scotia as a whole and at specific locations. It is also for anyone interested in the method of assessing the total resource and the resource at a specific site. It will be of interest to anyone wanting to learn the terminology of tidal resources.

2.0 - INTRODUCTION: NOVA SCOTIA TIDAL RESOURCE

Nova Scotia has significant tidal energy resources. The Bay of Fundy has the world's highest tides, routinely reaching over 16 m in range in the Minas Basin. Several passages along the coast of the Bay of Fundy have strong tidal currents that are suitable for the deployment of Tidal Energy Converters (TEC) that extract energy from the fast moving currents. A critical aspect of tidal power development is an accurate assessment of the power resource. The following two sections summarize the in-stream tidal resource as described in Karsten (2012).

Using the energy of the tides is a very old human activity. The power in flowing tidal waters has been used for about two thousand years: the Egyptians, Greeks, and Romans used tidally-driven water wheels to grind grain, and remains of a tidal mill dating to 620 AD have been found at a monastery in Northern Ireland. Even the famous London Bridge contained four tidal wheels that drove pumps providing water to the city in the 17th century. In Canada, Champlain built a tidal mill at Port Royal (Nova Scotia) in the early 17th century and other mills existed in New England and Passamaquoddy Bay (New Brunswick) in the 1800s. These

DEFINITION: INSTALLED CAPACITY

Installed Capacity is the maximum power generation capacity of a given turbine array. For example, an array of 10 turbines rated to produce 1.2 MW would have an installed capacity of 12 MW.

Figure 2 1: Estimated Maximum Extractable Power from Tidal Passages in Nova Scotia

2.0.2 INSTALLED CAPACITY

The size of turbines and turbine arrays are usually discussed in terms of the installed capacity - the maximum power the turbine array can produce. The map in Figure 2-2: Estimated Maximum Installed Capacity for Tidal Passages in Nova Scotia gives the Karsten (2012) estimate of the maximum installed capacity that each passage could support. The installed capacity at a given site is only a fraction of the extractable power – for the sites examined here the installed capacity ranged from 15% to 40% of the extractable power.

The estimates of the installed capacity for the passages give a rough idea of the size of the turbine array that might be deployed at each site. Current TEC technology has focused on turbines with a capacity of roughly 1 MW. As such, Minas Channel could support an array of roughly 1000 turbines, Digby Gut around 50 turbines, Petit and Grand Passages 5 to 10 turbines each, and the Cape Breton passages(Great Bras d'Or, Barra Strait) 1 large or maybe 2-3 smaller turbines. Although these are rough estimates, they do give a first idea of the size of industry that might develop around each site.

Want to know about the regulatory environment in Nova Scotia?

The Regulatory Regime for Tidal Energy

Elisa Oberman

FOUNDATIONAL CONCEPTS: WHAT IS A FEED-IN TARIFF (FIT)?

A "feed-in tariff" (FIT) is a rate per kilowatt hour that small-scale energy producers are guaranteed for a fixed period of time. This provides them with enough economic certainty to invest in renewable energy projects. "Feed-in" means that energy produced by these projects will be fed in to the province's electricity grid.

As of early 2012, FITs have been implemented in at least 65 jurisdictions and 27 states,* notably in Spain, Germany, Vermont, and Ontario to accomplish specific policy objectives including renewable electricity acceleration, employment creation, and industry building.

*"Renewables 2012 Global Status Report", Renewable Energy Policy Network for the 21st Century

http://www.ren21.net/Portals/0/documents/activities/gsr/GSR2012_low%20res_FINAL.pdf

4.2.4 - ENHANCED NET-METERING

Net-metering is a utility-led program by Nova Scotia Power that allows a consumer to meet his or her annual electricity needs with a low impact renewable electricity generation facility of up to 1 MW capacity. The facility must be connected to the distribution grid through a meter that measures electricity flows in two directions. Tidal energy is considered a low impact renewable resource that qualifies for this program.

More information about the enhanced net-metering program can be found in the following documents and websites:

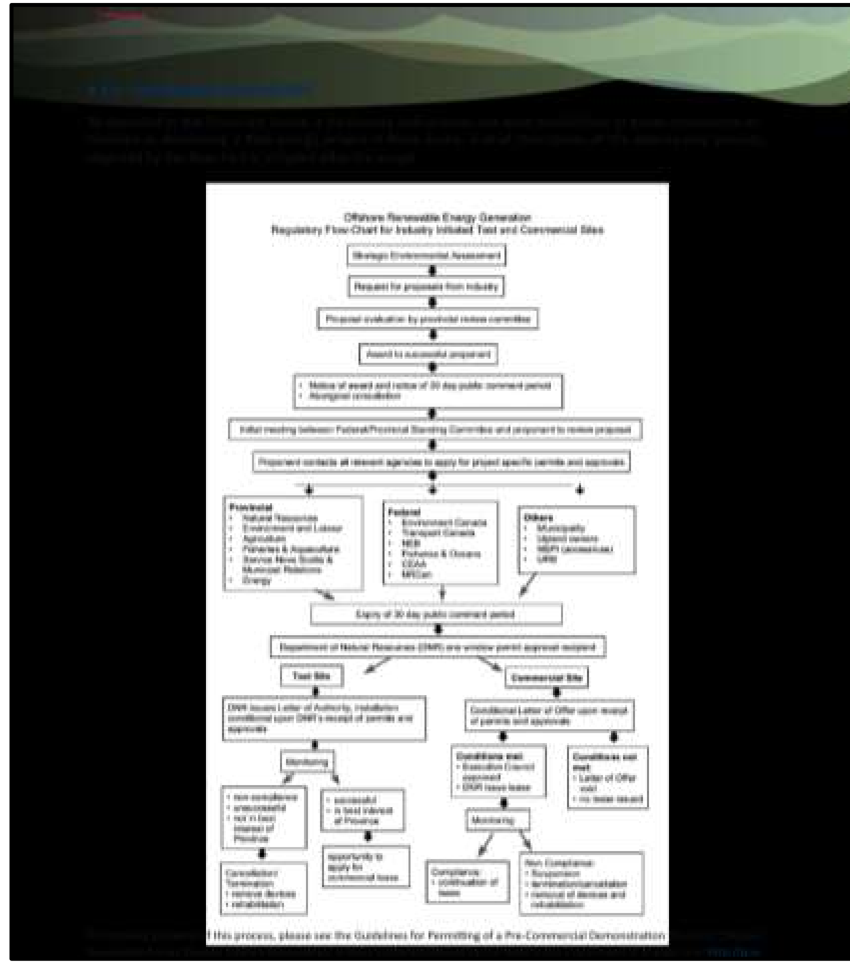
- Nova Scotia Power website: http://www.nspower.ca/en/home/environment/renewableenergy/enhanced/default.aspx
- Bill 64--Amended Electricity Act
- Regulation 3.6 Net Metering Service
- Interconnection Guidelines (Customer Generation with Capacity up to 100 kW)
- Net Metering Interconnection Agreement.

4.2.5 - COMMUNITY-BASED FEED-IN TARIFF (COMFIT) PROGRAM

The COMFIT program was created to encourage and support smaller-scale renewable energy projects that are developed and owned by community-based groups such as municipalities, First Nations, co-operatives, and not-for-profit groups. The focus on community-based projects is designed to ensure that projects are rooted in the community and investment returns remain there.

Projects will be connected to the grid at the distribution level. The province's current distribution capacity is roughly 200 MW, but changes as new customers are added or deleted. Some of that capacity is located in areas that are not well suited for development. Therefore, the Province is expecting roughly half that capacity may be used, or about 100 MW. Each distribution connection has its own capacity that is set by the size of the electricity demand or load that it serves.

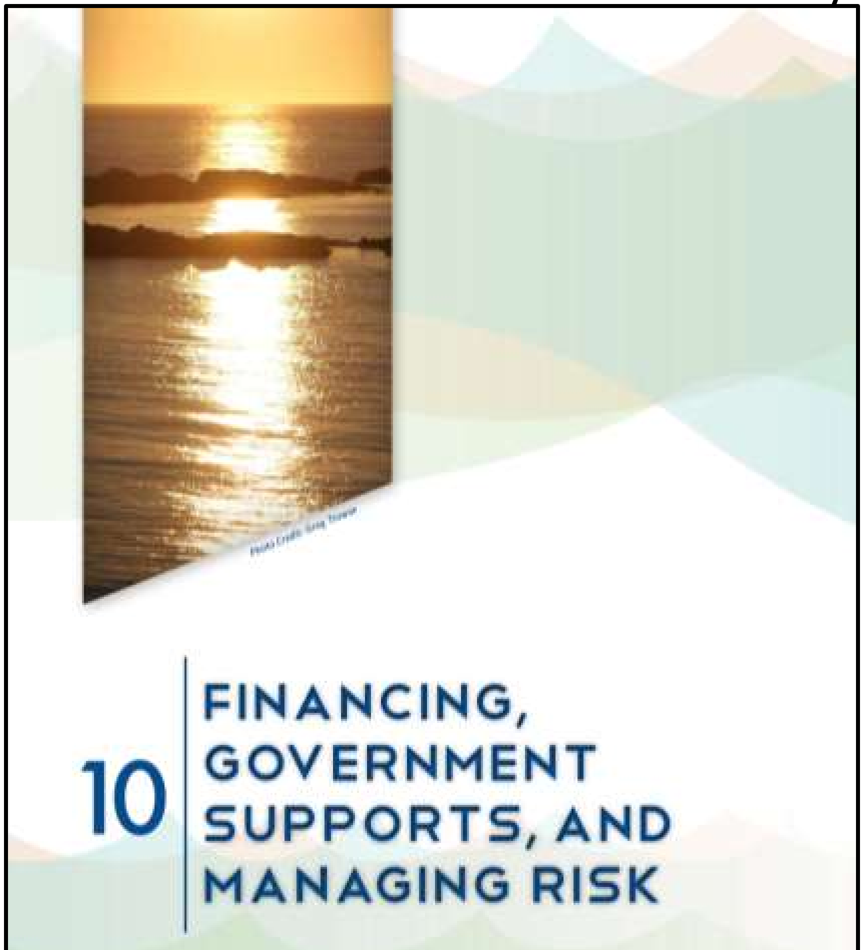
Tidal energy is a qualifying renewable resource under the COMFIT program. Devices that are 0.5 MW or less and connected at the distribution level can receive a small-scale tidal COMFIT rate of 65.2 cents/kWh. This rate was set during a hearing process led by the Nova Scotia Utility and Review Board (UARB), as directed by Nova Scotia's Renewable Electricity Regulations. For more information on the setting of the COMFIT rate and to read the UARB's formal decision concerning the first set of COMFIT rates established in July 2011, review the final decision document here: http://www.nsuarb.ca/images/stories/pdf/Decisions/11Sep/comfit%20order%20with%20tariffs.pdf



Want a better understanding of tidal energy financing and managing risk?

Financing, Government Supports, and Managing Risks

Dr. Shelley MacDougall



10.2.12.3 - ACCELERATED CAPITAL COST ALLOWANCE FOR CLEAN ENERGY GENERATION

Capital investment expenditures made in tidal power equipment are eligible for accelerated capital cost allowance, or amortization for tax purposes. The CCA rate for this class of equipment (Class 43.2) is 50% per year, on a declining balance basis. This has the effect of deferring taxes to later in the project's life.

In addition, "certain intangible project start-up expenses (for example, engineering and design work and feasibility studies) are treated as Canadian Renewable and Conservation Expenses. These expenses may be deducted in full in the year incurred, carried forward indefinitely for use in future years, or transferred to investors using flow-through shares" http://www.budget.gc.ca/2010/plan/anx5-eng.html#a27.

10.3 - RISK AND RISK MITIGATION

Authors: Melissa Beattie and Dr. Shelley Macdougall

There are numerous risks associated with tidal energy projects. The risks vary by the stage of the project and affect its financial viability. Although complete removal of all of the risks is unachievable, mitigation measures can be taken to reduce exposure to the risks to an acceptable level. The appropriate mitigation methods will vary according to the stage of the project and type of risk.

Throughout a tidal energy project, decisions are made that expose the project developer and its investors to risk. The higher the risk associated with a project, the more hesitant investors are about financing it. Since tidal energy is at an early stage of development, the level of risk is a considerable barrier to obtaining financing. Financers want to have answers to questions such as: what can go wrong, what kind of additional costs and delays would result, and who takes the risk (Hamilton, 2006)? To increase investors' confidence, it is important to identify risks and attempt to mitigate and reduce them as much as possible (Drake & Howell, 2011). This section will describe the risks inherent in building, installing, and operating tidal energy devices and ways to mitigate or manage these risks.

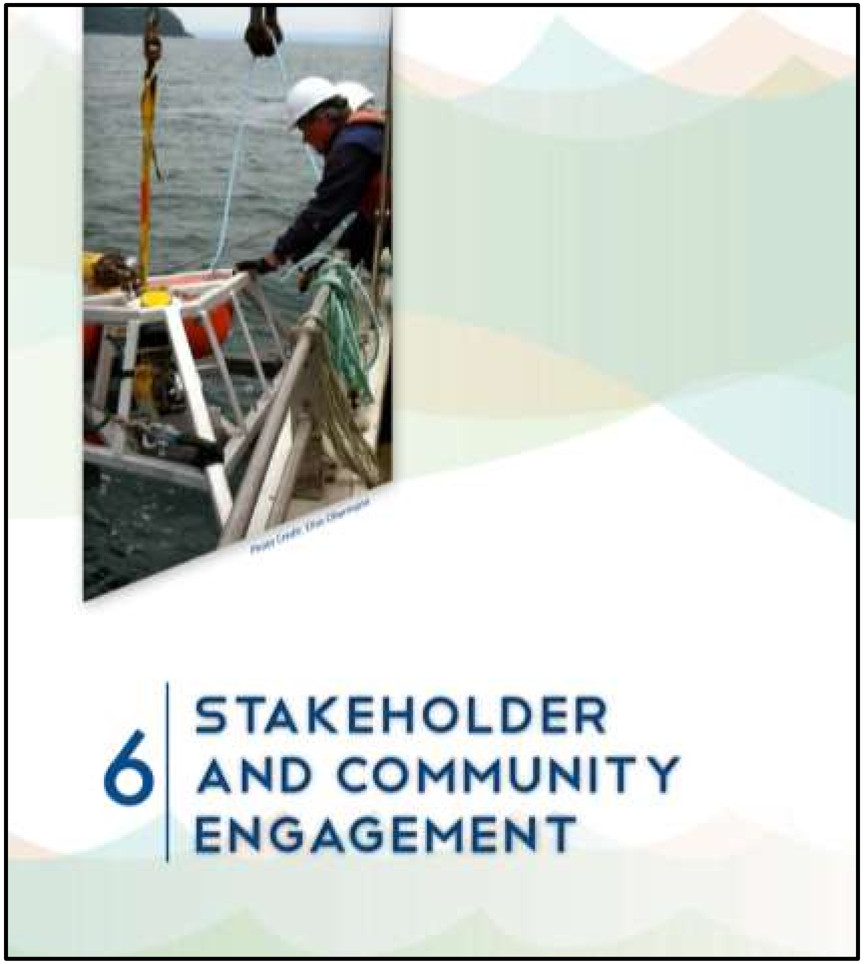
10.4 - TYPES OF RISKS

To analyze and mitigate the risks inherent in tidal energy, they must first be identified. Some are related to the technology itself (design), others depend on the maturity of the supply chain (equipment accessibility, cost overruns, damage to property, availability of a capable operator), while still other external risks are beyond the control of the project developer (weather, market risk, political/regulatory risk). Furthermore, there is risk of damage to the environment and risk of damage to the equipment by the elements in the environment.

The various types of risks noted are discussed in this section. Once the specific risks of the project are identified, the appropriate risk mitigation methods can be explored to manage and minimize negative outcomes.

Want to know about stakeholder concerns and methods for stakeholder engagement?

Dr. John Colton



IN NOVA SCOTIA: ENGAGING THE MI'KMAQ

Aboriginal community engagement is important in Nova Scotia. In the early stages of development, it is important to communicate with local Mi'kmaq communities and the Atlantic Chiefs Policy Congress and the Confederation of Mainland Mi'kmaq. It may also be important to partner with local Mi'kmaq communities to conduct cultural/archaeological site assessments to determine if potential sites for tidal development are located adjacent to these significant cultural areas.

For more information on protocols for engagement with Mi'kmaq, refer to the Proponent's Guide: Engagement with Mi'kmaq of Nova Scotia.

http://www.gov.ns.ca/abor/docs/Proponants-Guide.pdf

IN NOVA SCOTIA: MI'KMAQ ECOLOGICAL STUDIES

Mi'kmaq Ecological Study (MEKS): The MEKS Study Protocol was ratified in November 2007. The purpose of the MEKS is to capture Mi'kmaq traditional knowledge from elders and other knowledge holders. When conducting a MEKS, ecological information regarding Mi'kmaq/Aboriginal use of specific lands, waters, and their resources are identified and documented by the project team. MEKS I was for the Bay of Fundy in relation to the development of the FORCE project. MEKS II is focused on the outer Bay of Fundy, Digby

square kilometers, including both terrestrial and marine ecosystems. The Crown or government has the legal authority to consult with First Nation communities, but it is incumbent on tidal energy developers to play a role as well.

Key steps in your planning process should include:

- Approaching Chief and Council and their economic development officer. Work to understand their points of view and discuss ways to develop meaningful stakeholder relationships.
- Approaching Elders. Seek their perspectives on the project and, where appropriate, offer gifts (this is common practice for many Aboriginal communities and demonstrates respect to the Elders and their knowledge).
- Being prepared to offer financial assistance to the First Nation community to participate in the consultation process.

Be prepared for prolonged engagement; as a result, it is important to start early. Learn as much as you can about the community, their history, identify the informal leaders in the community, and communicate effectively. It is critical that you provide information to Chief and Council prior to making public announcements. This is true in all cases of community/municipal engagement.

6.4 - OUTLINING THE ENGAGEMENT STRATEGY

It is important to outline an engagement strategy and to share this with stakeholders. Examples from wind energy development in the United Kingdom and Canada provide insight into the development of engagement strategies associated with tidal energy development.

6.4.1 - STAGE 1: STARTING THE CONSULTATION PROCESS

The first task is to select who will lead the consultation process (usually the developer or government) and maintain contact with stakeholders throughout the process. The steps are to:

- Identify the stakeholders and do a preliminary scoping of issues.
- Plan and design the consultation process, outline objectives and outputs, techniques, key events, timing, resourcing (including budgets), and coordinate with other statutory and non-statutory processes.
- Draft invitations when meetings are required, and indicate with whom the stakeholders can liaise. Who sends the invitations and 'hosts' the events may vary (e.g. the developer, local councils, coastal partnerships, or an independent body such as a local college).
- Prepare presentations and documents for distribution before

Series of Modules

- Overview of Tidal Energy
  - Dr. Graham Daborn
- Measuring and Accessing Tidal Resource
  - Dr. Richard Karsten
- Tidal Power Extraction Devices
  - Sue Molloy & James Taylor
- Regulatory Environment for Tidal Energy
  - Elisa Oberman
- Environmental Risk Assessment
  - Lisa Issacman
- Stakeholder and Community Engagement
  - Dr. John Colton

- Financial Evaluation and Cost of Energy
  - Dr. Shelley MacDougall
- Opportunities and Strategies for Communities
  - Alan Howell & Dr. John Colton
- Opportunities and Strategies for Businesses
  - Elisa Oberman
- Financing, Government Supports, and Managing Risk
  - Dr. Shelley MacDougall
- Assessing the Potential Economic impacts of a Five Megawatt Tidal Energy Development in the Digby Area
  - Dr. Brian van Blarcom

THE COMMUNITY & BUSINESS TOOLKIT FOR TIDAL ENERGY DEVELOPMENT

In June 2011, the Nova Scotia Utility and Review Board (UARB) announced Community Feed-In Tariffs (COMFIT) for va renewable energy developments, including small-scale tidal energy. This innovative government policy gives communities/developers a long-term, guaranteed price for electricity generated from renewable resources. The UARB als announced that feed-in tariffs for large-scale tidal energy would be forthcoming.

However, many question remain around how communities and businesses in Nova Scotia can benefit from tidal energy development. To address some of these questions the **Acadia Tidal Energy Institute,** with support from municipal, provincial and federal partners, has developed the **Community and Business Toolkit for Tidal Energy Developme** The **Community and Business Toolkit for Tidal Energy Development** will assist communities and businesses in be understanding the opportunities stemming from tidal energy while encouraging responsible harvesting of the tidal energ resource.

The **Community and Business Toolkit for Tidal Energy Development** contains a series of modules that describe opportunties and strategies for communities and businesses to become involved in tidal enegy development. The modu also provide relevant advice, checklists and links.

Individual modules can be downloaded from the links below.

It is recommended that all files be downloaded for viewing rather than viewed in the web browser as some elements ma display properly in all versions of Adobe Reader - several files are large so it may take a few minutes to download.

Entire Toolkit (11MB)

Individual Modules

- Executive Summary
- Introduction
- Module 1: Overview of Tidal Energy
- Module 2: Measuring and Assessing the Tidal Resource
- Module 3: Tidal Power Extraction Devices
- Module 4: The Regulatory Regime for Tidal Energy
- Module 5: Environmental Risk Assessment
- Module 6: Stakeholder and Community Engagement
- Module 7: Financial Evaluation and Cost of Energy
- Module 8: Opportunities and Strategies for Communities
- Module 9: Opportunities and Strategies for Businesses
- Module 10: Financing, Government Supports, and Managing Risk
- Module 11: Assessing the Potential Economic Impacts of a Five Megawatt Tidal Energy Development in the Digh

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OERA Offshore Energy Research Association of Nova Scotia

NOVA SCOTIA

JASCO RESEARCH

NortekUSA

VEMCO A division of AMIRIX

FORCE Fundy Ocean Research Center for Energy

Fundy Tidal Inc. ~ current thinking.

Emera

CREDA CUMBERLAND REGIONAL ECONOMIC DEVELOPMENT ASSOCIATION

AECOM

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Thanks!

Toolkit:

http://tidalenergy.acadiau.ca/community-business-toolkit-.html

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