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Marine Renewable Energy Supply Chain Development
Ocean Technology Sector

Engagement and Strategy Report

May 16, 2013
SLR Project No.: 210.05859.00000

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MARINE RENEWABLE ENERGY SUPPLIER DEVELOPMENT

ENGAGEMENT AND STRATEGY REPORT

SLR Project No.: 210.05859.00000

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EXECUTIVE SUMMARY

On behalf of the Nova Scotia Department of Energy, SLR Consulting (Canada) Ltd., with our partners Glas Ocean Engineering Consulting, Steve De Belie and the Halifax Marine Research Institute, engaged the Ocean Technology sector in a discussion of the challenges facing the development of commercially-viable tidal energy in Nova Scotia. The primary goals of this assignment were to initiate discussions and relationships that could lead to Nova Scotia Ocean Technology companies' involvement in the resolution of these technical challenges, and to identify opportunities for the public sector to support sustainable competitiveness in the tidal energy supply chain. Longer-term goals include export potential for locally-developed products and services as the tidal industry grows worldwide, and uses for those products and services in other sectors.

Five technical challenge areas were identified:

- Sensors and instrumentation – assessing the resource, monitoring the devices, and monitoring environmental effects
- Deployment and recovery – for the initial installations of devices and cables as well as regular maintenance
- Subsea electrical grid – to transmit and condition the electricity generated by the devices
- Turbines/moorings – the devices and equipment that generate the electricity and maintain the position of that equipment and related infrastructure
- Cabling and connectors – between the land-based infrastructure and the subsea grid, both for electricity and communications

Following an analysis of the technical issues facing tidal energy and a review of Nova Scotia's ocean technology companies and capabilities, a workshop was designed and executed which brought together international tidal experts and representatives of over 60 ocean technology companies. In all over 100 people attended the workshop held at the NRC in Halifax, Nova Scotia on March 5, 2013.

Output was drawn from the workshop in three ways: panel discussions of the business case and technical challenges, breakout sessions to discuss specific technical challenges, and a detailed questionnaire distributed to all participants.

- Output from the workshop indicates that there is a combination of curiosity and caution from the Ocean Technology community. Specific technical interests lie in the environmental and oceanographic sectors, as well as the development of a universal platform that could be manufactured locally. Interest in developing the turbines themselves was limited. Workshop participants in general shared similar views on several key points:

- While there is significant general interest in tidal energy in the Ocean Technology community, respondents felt that uncertainty regarding the business case. Setting the Feed-In Tariff will create a stronger business case.

- The high-flow marine environments need to be properly and completely described so the resource and engineering operating environment can be properly evaluated and understood. Local Ocean Technology companies can play a significant role if there is a positive business case for doing so.

- Cost reduction is critical to make the business case for tidal energy. This can be accomplished through collaboration between technology and methodology developers to reduce the costs of data collection and analysis, and that of RD&D expenditures for universal issues, and standardization of equipment to achieve economies of scale through global standardization, which in turn requires collaboration with other development regions.

- An alternative funding method is required such as a publicly-funded investment. The business case needs to include the value of MRE to Canada overall in order to engage the interest of the federal government in further funding RD&D.
- To have a viable industry a turbine of some kind needs to be installed in Nova Scotia. It is not necessarily important that all installations be in very high flow; a moderate site would help stage sensor, instrumentation and turbine research.
- Many organizations are currently involved in the development of Nova Scotia's tidal energy resources, each with a similar yet different mandate. Organizations approaching the tidal industry often find this situation perplexing and are unsure where the focal point for collaboration locally and with other organizations worldwide.

Several suggestions are put forward to facilitation the Ocean Technology sector's involvement in tidal energy development:

- Continue to collaborate with other tidal development jurisdictions to facilitate local industry access to global markets.
- Re-validate the premise that the supply chain for the turbine itself is full (i.e., that the turbine-fixing-deployment chain is inextricably linked and presents no opportunity for Nova Scotia's ocean technology sector.
- Construct, publish and distribute to workshop registrants a map of public and non-profit organizations working to further tidal energy development in Nova Scotia.
- Consider maintaining the momentum generated by the Tidal Opportunities Workshop through means such as regular electronic and social media updates and continue discussions through focused meetings. Initiatives associated with Oceans Week and other communications issued by ADIANS should also be considered.
- Examine the potential for an existing public sector entity or independent third party to facilitate incentives such as a contract for tidal development work; funding assistance programs; cost sharing initiatives and collaboration.
- Once the Feed-In Tariff rate is set, consider a review or re-survey of workshop participants to evaluate changes in perceptions and plans.
- Support the Nova Scotia ocean technology value chain in developing export markets related to high potential areas such as the characterization and monitoring of the turbine operating environment. A suggested approach is to issue a Request for Proposals through OERA to solicit development proposals to bring relevant capabilities to bear.
- Longer-term goals such as the export potential for locally-developed tidal-related products and services and uses for those products and services in other sectors will only occur after the Ocean Technology Sector is engaged in tidal energy development projects. The above suggestions related to communication and business case improvement is a move toward those goals.

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1.0 INTRODUCTION

SLR Consulting (Canada) Ltd., with our partners Glas Ocean Engineering Consulting, Steve De Belie and the Halifax Marine Research Institute, was contracted by the Nova Scotia Department of Energy (DOE) to engage the Ocean Technology sector in the resolution of challenges facing the development of commercially-viable tidal energy, and identify opportunities for the public sector to support sustainable competitiveness in the tidal energy supply chain.

Beyond the primary goals, the target companies, being made aware of the technical challenges and opportunities, may realize export potential for products and services as the tidal industry grows worldwide, or uses in other sectors for technologies developed for the tidal industry.

The following tasks were identified as the basis of the assignment:

- Review materials and consult with key stakeholders to identify tidal energy technical challenges along the tidal energy supply chain in cooperation with the Project Steering Committee
- Rank and categorize capabilities within the Nova Scotia Ocean Technology Sector and identify ways that the public sector can promote a sustainable competitive advantage within the tidal sector for five key technology areas in partnership with the Project Steering Committee
- Identify Ocean Technology companies with the innovation and R&D capacity to engage in the five key technology areas
- Develop and host a workshop for the identified Nova Scotia Ocean Technology companies to increase awareness of the technical challenges facing the deployment of tidal devices and site characterization
- Prepare a formal report and presentation for the Project Steering Committee detailing the results of the work and providing strategy recommendations.

The report documents the approach taken for each of the above tasks and details the output derived from the workshop itself. This includes a summary of the Panel Discussions, documentation of the Breakout Session discussions, and an analysis of the Questionnaire responses.

Based on the evaluation of the workshop output, key opportunities and priorities are identified and public sector strategy actions are suggested.

2.0 IDENTIFICATION OF SUPPLY CHAIN CHALLENGES

To lay the groundwork for workshop planning activities an extensive review of existing materials, as well as interviews with selected key individuals, was conducted to provide a broad view of the types of technical challenges facing tidal energy development, as well as their relative significance in terms of effect on cost and overall viability. The following sections summarize the activities that led to the selection of priority challenges.

2.1 Research and Evaluation

The supply chain challenges were determined through review of a number of sources, the first being the original Statement of Work from the DOE that states “Nova Scotia will only fully harness the electrical generating power of the Fundy tides when significant technical challenges are overcome in key areas of the supply chain including:

- Sensors and instrumentation
- Tidal device monitoring and data collection
- Mooring attachments
- Tidal array deployment and retrieval
- Engineering design
- Subsea electronics and connectors”

The next source was the global value chain analysis, “Nova Scotia’s Ocean Technologies” by Gereffi et al. of the Duke University Center of Globalization Governance and Competitiveness found that Nova Scotia was “well positioned across value chains” for underwater sensors and instrumentation, AUVs & ROVs, and inshore and extreme climate vessels. The report also clearly states that the market in Ocean Technology has:

- Demand for less expensive, more versatile products capable of remote or autonomous operation
- Demand for products suitable for use in tough, physical environments
- Importance of integrating multiple systems into a simple user-interface, and
- Customization for the end-user.

The tidal environments identified in Nova Scotia for energy exploitation offer a unique opportunity to companies wanting to develop technologies for high flow, high noise, tough, physical environments. The FORCE site is potentially the most extreme site in the world and could be used as a laboratory for local product development. Table 1 provides general conditions at the site.

Table 1: FORCE Site Conditions

Constraint	Details
Slack Tide	20mins-1 hour, time with flow 1-2m/s
Average Flow	4-6m/s
Max Flow	Greater than 6m/s
Geotech	Varies across site, some areas require significant drilling, some areas will crumble

Lower energy but significant sites at Digby and the Bras D’or Lakes provide valuable intermediate intensity ‘labs’.

FORCE is currently developing a project that will provide a cabled platform for instrumentation and sensor installation. This will present opportunities to build capacity in this field. The Bay of Fundy Monitoring Workshop, held in support of this project in January 2012, identified the following priority areas for monitoring environmental changes in the Bay of Fundy after the installation of turbines including monitoring area, turbulence, currents, animal monitoring and detection, noise, and sedimentation.

Additionally, FORCE has identified three areas of challenge and risk in the installation of the platform:

- Operations associated with deployment and servicing
- Stability once deployed (including impact tolerance)
- Cable survival (either direct to shore or to the power cable abandonment termination).

Significant overlap exists between the different areas listed above. This presents an opportunity to brief the wider ocean technology industry on Marine Renewable Energy opportunities and to clearly illustrate the overlap and need for collaboration and cooperation among industries to solve the immediate challenges of the industry.

2.2 Priority Challenges

The identified technical challenge areas have been grouped into the following:

Sensors and instrumentation - includes sensors, equipment and platform for site assessment and monitoring tidal energy systems, as well as data collection. Challenges related to this area include: survivability and measurement validity in the high current, design to facilitate easy deployment and recovery, easy maintenance.

Deployment and recovery - the methodology and equipment to launch and deploy all aspects of the tidal energy system: cabling, subsea grid, turbines, mooring systems, monitoring instrumentation. Includes initial deployment and recovery for repairs and regular maintenance.

Subsea electrical grid - includes electrical/electronic equipment, cabling and connectors associated with individual cables or subsea electricity conditioning equipment. Challenges include design survivability in the high current environment, deployment, accessing for repair and maintenance and packaging of components for subsea use, and connection methods to turbines.

Turbines/moorings - the in-stream devices that convert tidal flow into electricity. Challenges include the high current flow, turbulence, in-flow debris, cost, deployment, recovery for repair and maintenance.

Cabling and connectors - cabling between shore facility and the subsea electrical grid. Includes hardware and methodology to connect to the grid. Challenges include survivability in the high current environment, deployment, how to connect/disconnect.

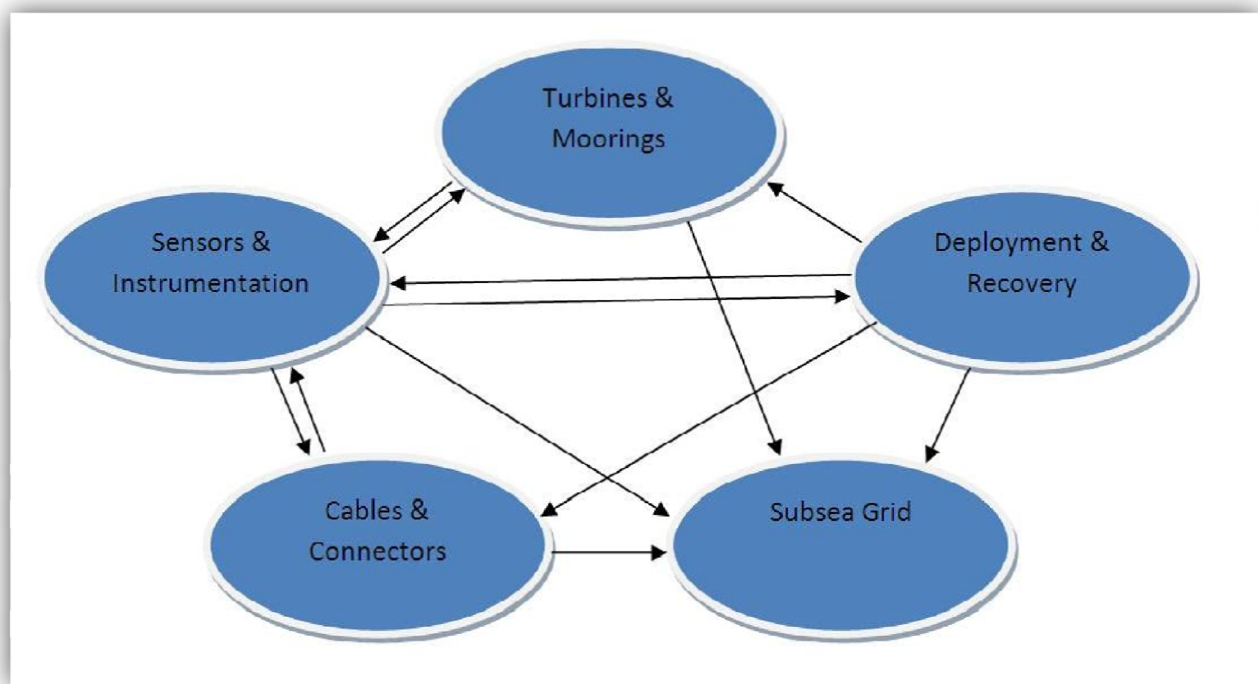
The technical challenge areas are summarized in Table 2, and their overlap and interdependency is illustrated in Figure 1.

Table 2: Technical Challenge Areas

Challenge Area	Challenge Details	Overlap with other challenge areas
Sensors and Instrumentation	Noise, debris, high flow Survivability Deployment, access for maintenance and repair	Moorings Deployment and recovery Cable and connectors
Deployment and recovery	Understanding physical environment	Sensors/Instrumentation
Subsea electrical grid	Survivability Deployment, access for maintenance/repair Packaging for the environment Connection to turbines	Sensors/Instrumentation Deployment and recovery Moorings Cables and connectors
Turbines and moorings	High current flow In-flow debris, Deployment, access for maintenance/repair	Sensors/Instrumentation Deployment and recovery Subsea electrical grid
Cabling and connectors	Survivability Deployment, access for maintenance/repair connecting	Sensors/Instrumentation Deployment and recovery

Figure 1: Technical Challenges Overlap and Interdependency

Based on the information derived during the preceding research and discussions, a factored



rating system was developed in order to rank the identified technical challenges and allow priorities to be established for the subsequent set of activities. The ranking system and results are summarized in Table 3.

Table 3: Technical Challenge Rating

Techical Challenge Area	Project Cost Impact		Project Timeline Impact		NS Company Participation		Critical Path		Implement-ation Cost		Total
	Score (1-5)	Rated Score	Score (1-5)	Rated Score	Score (1-5)	Rated Score	Score (1-5)	Rated Score	Score (1-5)	Rated Score	
Sensors & Instrumentation	4	4	3	3	4	4	5	5	3.5	3.5	**19.5**
Deployment & Recovery	5	5	4	4	2.5	2.5	4	4	2	2	**17.5**
Subsea Electrical Grid	2	2	3	3	3.5	3.5	2	2	1	1	**11.5**
Turbines & Moorings	4	4	3	3	1	1	3	3	1	1	**12**
Cabling & Connectors	3	3	3	3	1	1	3	3	2	2	**12**

Criteria Weighting (1-2, higher=more important)	
Project cost impact	1
Project timeline impact	1
NS company participation	1
Critical path	1
Implementation cost	1

3.0 OCEAN TECHNOLOGY SECTOR ATTRACTION STRATEGY

The choice of companies to invite to the workshop began with a list of ocean technology companies in Nova Scotia provided by the Department of Energy. The listed companies were far ranging, from aquaculture and nutritional supplements, to marine equipment, shipbuilding and instrumentation. Other company names were added, from sources such as:

- "Nova Scotia's Ocean Technologies" report, prepared by the Duke Center on Globalization, Governance and Competitiveness
- "Environmental Monitoring Tools and System Technical Experts Workshop - Summary and Notes," the results of a workshop conducted by FORCE in January 2012

Academic and research organizations and government agencies were also identified, with input from the OREG "Business Opportunities from Marine Renewable Energy Development and Project Life Cycle Needs" report.

The SLR team provided further company and organization names to the list, drawing from experience in the Nova Scotia industry, academic, and government agency areas. Consideration was given to companies that offered technology and expertise that could address the technical challenge areas, even though they were not directly involved in the marine or tidal energy fields. These include companies that provide engineering, procurement and construction services to the oil and gas industry, and companies involved in other renewable energy technologies.

There were some organizations whose technology, and therefore interest, would not likely be applicable to tidal energy. However they were included in the invitation list as they may have known of others who might be interested in the workshop topics.

The workshop was aimed at an audience that could understand both the technical challenges facing tidal energy, as well as the business case and opportunities available. Identifying the correct people to contact within the organizations was key to getting the right people to attend. The focus was to identify company leaders, involved in both business development and technology development. Again, the team relied on past experience and networking contacts to identify these individuals. Others were identified through companies' websites and industry directories. The resulting invitee list contained over 230 names.

As time was short, an email invitation was prepared that focused on catching the attention of an organization's decision makers, with an up-front statement emphasizing why they should attend (to learn of business opportunities to apply your company's skill and expertise in solving challenges related to tidal energy development in Nova Scotia). The email also offered the following information:

- Key speakers Martin Wright and Peter Fraenkel, co-founders of Marine Current Turbines
- Presentations and panel discussions on the tidal energy business case and local, national and international opportunities
- Presentations and panel discussions on tidal energy technical challenges
- Breakout group discussions on technical challenges:
    - sensors, instruments and monitoring
    - deployment and recovery
    - subsea electrical grids
    - turbines/moorings
    - cabling and connector

Subsequent follow-up emails to invitees provided more details and encouragement to attend. As well, targeted invitees were contacted by phone.

4.0 DEVELOPMENT AND PRESENTATION OF WORKSHOP

The DOE's request for proposal requested "the design and host of a knowledge-sharing workshop to encourage, facilitate and promote tidal-related R&D and collaboration among Nova Scotia's ocean technologies cluster to address tidal energy technological challenges."

Specific objectives were outlined for the workshop:

a) to increase awareness among ocean technology companies regarding technical challenges influencing the development of the tidal sector in NS
b) to encourage and support participants to work together in the future to address these challenges
c) to encourage the research and development community to be able to respond to research calls in the province, nationally and or internationally.

4.1 Workshop Logistics

The Workshop date was an immediate consideration, given the short time frame to work within, and the need to provide as much notice to invitees and presenters as possible to allow for travel scheduling. In order to maximizing the attendance at the workshop, the following were considered with respect to the event's date:

- Limit the workshop to a one-day event; it was felt that industry people would be unlikely to commit to a two-day event.
- The scheduling of other industry events, to avoid conflicts.
- Timing of university and public school breaks.
- The scheduling of complimentary events, to maximize the benefit for participants travelling from out of town.

After much discussion with the Steering Committee, March 5 was selected as the workshop date.

The length of the workshop was also well discussed, balancing the desire to present as much information as possible, obtain feedback, provide networking opportunities and keep the attention of participants so that they would stay for the whole day. Events of this type, if not of sufficient interest, could see participants leaving part-way through. The final result saw the schedule begin at 9am, with the final wrap-up at 5 pm.

The workshop was held at the National Research Council building, located on the Dalhousie University campus in Halifax. Numerous convention and meeting venues were considered throughout Halifax, including local hotels, research facilities and local club facilities. After considering costs, the tight organizing timeline resulting in short notice, and the availability of potential venues, the NRC facility was selected for the event.

This venue offered a theatre style presentation room, numerous adjoining rooms and work areas for the break-out sessions, and the networking lunch and breaks. The venue proved the perfect size for the group, providing a close setting that encouraged discussion.

Because DOE was seeking input from industry, the workshop needed to provide opportunities for participants to ask questions, and provide the desired input. Two methods were employed to obtain input: panel discussions with question and answers from the audience, and break-out groups to allow group discussion on technology challenges.

The workshop's morning session was focused on the business case for tidal energy, while the afternoon session focused on the technical challenges in tidal energy development. In each session, presentations were followed by panel discussions, with questions and comments from the presenters, panellists and the audience. The afternoon session included a breakout session where groups discussed specific areas of technical challenges.

Jim Hanlon, CEO of the Halifax Marine Research Institute, was selected as the event's moderator. Jim applied a balance of extensive business and technical background in ocean technology to moderate the panel discussions and keep the event moving along throughout the day.

The workshop was aimed at a group size of 50-100 participants, with ideally 80-100 people, and a mix of roughly 70% industry, and 30% from academic, institutional and government organizations.

The invitation process resulted in over 100 attendees, with approximately 65 from commercial organizations, 17 from government and institutional organizations and 15 from the academic organizations, plus the workshop organizers. Workshop registrants are listed in **Appendix A**, and the workshop agenda is provided in **Appendix B**.

4.2 Speakers and Topics

While the objective of the workshop was to identify sources of technological innovation to address the challenges with tidal energy, the organizers felt that the business case for tidal energy would need to be presented, so that companies could understand the market potential for tidal energy technologies. This was seen as a main strategy to entice ocean technology companies to apply their technologies to the challenges. Topics chosen to support the business case included:

- The potential opportunities for tidal development in Nova Scotia, in Canada, and worldwide
- Insight into the costs, and major cost drivers involved in tidal projects
- The political, economic, regulatory, environmental, social and technical challenges involved
- Involvement of government agencies in tidal energy development

Topics on the technical side of tidal energy development included:

- Technical challenges encountered in local and overseas development projects
- Experiences of the FORCE berth holders
- The FORCE test platform
- Species at risk

The selection of speakers and panellists was based on their involvement in, and knowledge of, the field of tidal energy development, both locally and globally, and from Industry and government organizations. Organizers were fortunate that the majority of the speakers suggested by the organizers and DOE steering committee were available on the event's date. Complimentary events assisted in providing the impetus for people from outside the area to travel to the event, as well as aiding in funding their expenses.

Peter Fraenkel and Martin Wright from Fraenkel Wright Consulting were the founders of Marine Current Turbines, developers of the first and currently only commercially-operating Tidal Turbine in the world. The group had an opportunity to invite Fraenkel and Wright, with some sponsorship from Minas Basin Energy, to speak at the workshop and give the wider industry the benefit of their experience and knowledge. This meant that a credible company with hard numbers and facts was able to answer the questions and concerns of the workshop participants and identify unmet challenges. To maximize the value of Fraenkel and Wright's time and the expense in bringing in speakers from Europe it was proposed that the wider ocean tech community be invited to the entire workshop and in the future smaller more focused meetings could be held to help companies explore ideas in depth.

The decision was made to keep the wider group together for the bulk of the day and have moderated panel discussions and the in the later afternoon break out into groups according to a subset of the topics listed in **Error! Reference source not found.** (Section 2.0). This influenced the determination of challenge areas to be addressed in this workshop.

The following list of speakers (in order of appearance) addressed the main topic areas:

Jim Hanlon, CEO, Halifax Marine Research Institute (HMRI)
Jim acted as master of ceremonies and moderator of the panel discussions.

Michael Johnson, Executive Director, Business Development and Corporate Services, Nova Scotia Department of Energy
Michael delivered an introduction and welcome to the workshop participants

Marc Charbonneau, VISTA Program Manager, Lockheed Martin Canada
Marc spoke briefly about the recent funding announcement for the Atlantis /Lockheed Martin berth holder project at the FORCE test site.

The morning session on the Tidal Energy Financial Case began with presentations by:

Martin Wright, Partner, Fraenkel Wright
Martin is a former co-founder of Marine Current Turbines, who have successfully installed a 1.2 MW turbine system in the UK. Martin addressed the business model and challenges of tidal development in the UK and globally.

Elisa Obermann, Atlantic Director, Marine Renewables Canada
Elisa spoke to the Canadian and international roadmaps for tidal energy, and the Canadian financial perspective.

Sandra Farwell, Director of Sustainable and Renewable Energy, Nova Scotia Department of Energy
Sandra spoke about DOE's and the province's involvement in tidal energy.

Tracey Kutney, Senior Research Engineer, Natural Resources Canada (NRCan)
Tracy spoke about NRCan's programs and involvement relating to tidal energy.

Muktha Tumkur, Program Manager, Renewable Energy, CSA Group
Muktha spoke about the benefits of applying standardization to tidal energy development.

Once presentations were completed, and following a short networking and coffee break, a panel discussion on the Tidal Energy Financial Case was held, moderated by Jim Hanlon of HMRI. Panelists were:

- *Martin Wright*
- *Elisa Obermann*
- *Sandra Farwell*
- *Tracey Kutney*
- *Muktha Tumkur*

Two more presentations were made just before the networking lunch break:

Stephen Dempsey, Executive Director, Offshore Energy Research Association of Nova Scotia (OERA)
Stephen spoke about OERA's involvement, and funding programs.

Sue Molloy, Glas Ocean Engineering and Science Officer, Fundy Ocean Research Centre for Energy (FORCE)
Sue discussed a cost estimate spreadsheet produced by FERN, identifying key cost drivers in tidal development.

After the lunch break, the afternoon session began with presentations on Technical Challenges and Opportunities:

Peter Fraenkel, Partner, Fraenkel-Wright
A co-founder of Marine Current Turbines, Peter discussed technical challenges he encountered in developing MCT's 1.2 MW tidal development in the UK, and by others.

Tony Wright, Marine Operations Manager, Fundy Ocean Research Centre for Energy (FORCE)
Tony Discussed FORCE's test platform and involvement in the Bay of Fundy

Anna Redden, Director of the Acadia Tidal Energy Institute and the Acadia Centre for Estuarine Research
Anna discussed species at risk in tidal development in the Bay of Fundy.

Dana Morin, Director of Business Development, Fundy Tidal Inc.
Dana discussed Fundy Tidal's experiences as a berth holder in the FORCE test site.

John Woods, Vice President of Energy Development, Minas Basin Pulp and Power
John discussed his company's experiences as a berth holder in the FORCE test site.

All of the FORCE berth holders were invited to present their experiences, however only Fundy Tidal and Minas Basin Pulp and Power chose to present.

Once the presentations were complete, a panel discussion on the Technical Challenges and Opportunities was held, again moderated by Jim Hanlon of HMRI. Panelists were:

- *Peter Fraenkel*
- *Anna Redden*
- *Sue Molloy*
- *Mo El-Hawary, Professor of Electrical Engineering, Dalhousie University*
- *Brian Polagye, Research Assistant Professor, Mechanical Engineering University of Washington, and Co-Director, Northwest National Marine Renewable Energy Center*
- *Eric Bibeau, Associate Professor, University of Manitoba, Manitoba Hydro/NSERC Alternative Energy Chair*

More information about the speakers and panelists can be found in **Appendix C**.

The combination of speakers and topics, the panel discussions and subsequent workgroups, presented a compelling discussion on tidal energy. This was evidenced by the significant number of participants who remained for the whole duration of the event.

4.3 Complimentary Events and Networking Opportunities

With the mix of attendees from business, government, academic and institutional organizations, the workshop would be an ideal place to network. Opportunities were provided during a 45 minute lunch, and mid-morning and mid-afternoon nutrition breaks. A networking reception was planned for the evening after the workshop, however, feeling this would make for a very long day for workshop participants (and therefore prone to light attendance) this event was moved to the evening before the workshop, and open to all workshop attendees.

Attendees to the workshop were able to take part in complimentary events. This allowed out-of town visitors to make the most of their time in Halifax, and provided added incentive to attend the workshop. These events included:

- A public lecture on tidal energy was held on the Monday evening before the workshop, presented by Martin Wright and Peter Fraenkel, of Fraenkel-Wright, who offered their experiences on tidal energy development, on both the business and technical side.
- A reception held immediately after the public presentation for the workshop participants. This event was well attended and offered a relaxed environment for networking.

Dalhousie University's engineering school offered a two-day course on tidal turbines, presented by Peter Fraenkel, held on the Wednesday and Thursday following the workshop. Many workshop participants attended this course.

5.0 WORKSHOP OUTPUT

The business case and technical panel discussions resulted in the following concerns and paths to solutions. Overall, it was clear that the industry must fully describe the resource and make the business case in order to attract investment from government. To attract business investment there must be a concerted effort in de-risking the industry. Again, this can be done through data gathering.

5.1 Panel Discussion Output

Panel discussions featured international and Canadian experts in tidal energy, both from the private and public sectors. The morning panel session focused on the business case for tidal energy while the afternoon session discussed technical challenges.

The workshop panel discussions covered many points. A major theme that emerged is the business case for tidal energy. Investors are presented with a long timescale for payback on investment, given the costs involved with developing tidal energy projects, and the current market rate for power. Combined with the risks associated with the severe physical environment, investors are shy in exploring tidal projects. The business case for tidal energy must see beyond the costs and financial payback; the potential for a sustainable green energy supply, and the potential to build-up a local industry of tidal technology must also be considered in the true value of tidal energy for Nova Scotia.

Cost reduction is seen as a component of a more attractive business case. Suggested measures include:

- Standardization of components and interfaces (such as turbine mounting, cable connections and grid compliance) to reduce costs and provide economies of scale.
- Collaboration on the R&D will also reduce costs, allowing the best use of available investment dollars, and eliminate redundant parallel development. Collaboration should be considered between countries, organizations such as FORCE and EMEC, among companies and among research institutes.
- Utilizing existing effective technologies to address challenges, instead of re-inventing solutions. This will also contribute to reducing risk.
- Sharing of expensive resources, such as those needed for deployment of turbines, cables and instrumentation. Sharing the costs for these resources among the project developers around the world could provide for the development of specialized equipment that can deal with the extreme tidal currents, resulting in safe and cost effective resources that could not be realized if the costs were born by individual developers acting in isolation.
- Risk reduction will allow insurance costs to reduce as the risk is reduced. Reducing the risk is possible by better understanding the physical environments the in-stream tidal turbines will work in.

The source of funding for projects was discussed. If investors are not lining up because the return on investment window is too far out, then we should look to how other energy technologies evolved. Existing energy technologies were very heavily subsidized in their early days of development, to meet military and government needs. Additionally, it was pointed out that commercial tidal rates should be expected to drop in a manner similar to wind power, not hydro.

Considering the involvement of Nova Scotia SMEs in tidal energy development, it was suggested that government needs to set and support a vision to enable NS SMEs to get involved. Funding is available when technology is proven to work, however, companies are asking for funding to develop the proven technology. It was suggested that the Canadian government set up an agency similar to the Carbon Trust in Britain that could evaluate return on investment.

The concept of social license was raised and discussed. Social license is acceptance by the populace of many factors such as environmental and habitat impact, social economic impact on the region (such as jobs created, and industries impacted) and agreement with ratepayers and taxpayers bearing some or all of the development costs. Social acceptance is needed to move a development project forward.

Describing the tidal energy resource is seen as a concern, one that touches on many of the challenges facing development. Efforts to fully understand the energy potential, and the parameters of the physical environment, are required and will lead to risk reduction and cost savings. Instrumentation and monitoring are key technology areas to address the understanding of the tidal resource, and will contribute to the survivability of equipment in the harsh environment, maximizing the energy realized, and further the understanding of the environmental impacts. Understanding will also aid the government in determining investment priorities.

Concerns were raised related to effects of ice on the turbines, and on the cabling on the seafloor. Further research is required to determine the danger of sediment laden ice.

Installation is another area that can benefit from a better understanding of the tidal environment. As a major cost driver in tidal developments, maximizing the installation window during tidal cycles will reduce costs. As mentioned previously, collaboration and sharing of resources will aid cost reduction in this area. Base support structures were discussed, monopile versus multipile, and factors such as ground structure factor into deciding the best approach. Again, understanding the physical environment will play a key role in addressing these challenges.

5.2 Breakout Session Output

The breakout groups and facilitators are shown in Table 4:

Table 4: Breakout Sessions Topics and Facilitators

Group	Topic	Facilitator
1	Sensors & Instrumentation - Physical	Len Zedel, MUN
2	Sensors & Instrumentation – Marine Life	Bruce Hatcher, CBU
3	Deployment and Recovery	Eric Bibeau, U of Manitoba
4	Turbines/Moorings	Brian Polagye, U of Washington
5	Turbines/Moorings II	Sheila Paterson, DOE
6	Subsea Communications	Sandra Farwell, DOE
7	Cabling/Grid	Stephen Dempsey, OERA

The practical goal of the workshop was to determine how to support SMEs and institutions in NS in the development of technologies that would support the Marine Renewable Energy industry that could also become export products. After much deliberation it was determined that if the NS government had answers to some practical questions then they could follow up with specific groups after the workshop to discuss support mechanisms. The questions were chosen to identify priority areas among the group and to build on their knowledge of their own industries. The participants were assigned to breakout groups but free to switch to a different group if they felt they were miss-assigned. The breakout groups went to separate rooms to discuss the questions in Table 6 and were asked to return to the larger group to present answers to those questions.

Table 5: Group Questions

Question	Intent
What areas can be addressed?	What technical challenges could be addressed? The groups were advised to use the cost estimate spreadsheet (in **Appendix D**) as a starting point for discussion; to look at the percentages of overall cost and determine which percentages could be moved and which are simply the cost of the work and unavoidable.
Who can address it?	Should this be a university or institution project or led by the private sector? Which companies or institutions would be appropriate and who at those companies and institutions should be contacted?
What collaborations are possible?	Is a consortium of private partnerships needed or is there a need to bring in academic or government researchers? If it is an academic or institutional project would private sector be interested in supporting the work?
What resources are needed?	What infrastructure is needed? Is equipment needed? Who has this type of equipment? Can it be bought and used as part of a group resource?
What financing is necessary?	Who can apply? What kinds of amounts are needed? Are academic-private partnerships necessary to access funding? How can funds be leveraged?

The following tables (6 through 11) include the responses of the groups to the questions in Table 6. Each group interpreted the questions and gave responses. Some have more broad industry wide comments and some have very detailed responses and name existing companies and organisations.

Table 6: Deployment

Question	Response
What areas can be addressed?	Costs can be reduced through standardization. Areas to consider for both research and standardisation are: connection to grid, foundations, forces on foundations, loads on vessels, types of vessels and anchor options
What collaborations are possible?	Collaboration is important to speed up the rate of development, We can use past projects as examples and make the effort to learn from existing work
What financing is necessary?	Sharing of expensive resources should be facilitated Reduced risk = reduced costs A role of Gov't could be to underwrite the initial charter of

	deployment vessels
General Comments	Important Note – this is the biggest component of overall MRE development and it touches on many other aspects (cable, turbines, instrumentation, operation and maintenance, grid)

Table 7: Physical and environmental sensors

Question	Acoustic Sensing	Seabed Stability
What areas can be addressed?	Important to investigate acoustics and understand because of the high noise in tidal races Need to visualise and qualify debris such as underwater ice, sediment The quality of data from ADCPs will be impacted by high noise environments This research is applicable to other areas with ice debris	No penetrative tests have been done on the seabed To date it's not known how to do these in such a high flow environment Vessels that can accomplish penetrative testing must be deployable in Bay of Fundy
Who can address it?		A large civil engineering company possibly can do this, could be done as research project or combined research –industry project
What collaborations are possible?	Collaboration between industry, academic	
What resources are needed?	Need a carrot for industry to get going, some financial incentive should be clear	
What financing is necessary?		$2m
General Comments	A smaller platform should precede FORCE's larger 10-ton platform and be deployed in a less energetic environment Immediate priority is seafloor characterization and debris identification Tide measurement is also necessary – looking at actual vs. predicted - $25k/yr Need to develop plug and play standardized monitoring packages Need gov't to seed development with funding or RFPs Collaboration - industry/academic/gov't	

Table 8: Turbines, moorings

Question	Response
What areas can be addressed?	Turbines are a converging technology: within 3 years only a handful of companies will remain, large players are unlikely to be interested in additional single device testing. Europe has a clear lead in core turbine technology development and testing No compelling opportunities to produce large-scale turbines in NS. Few financially compelling opportunities exist for small scale turbines but unique challenges still in off-grid markets. All elements of a turbine and its mooring need not be supplied by a single source. Deployment is critical – we need low cost, reliable methods. Crossover research and development work with seabed characterization. Best opportunities for product development is in anchors and foundations, multi turbine platforms or a universal seabed mount. Nova Scotia must move to arrays over single device testing, support ways to optimize and integrate turbines to the power base and standardize the turbine to platform to installation process. There is a chance for NS to leapfrog Europe on turbine array development
Who can address it?	NS can take advantage of local shipbuilding and engineering capabilities Focus on critical infrastructure that is exportable to any MRE site, application to offshore wind. There is extensive regional expertise (including Newfoundland).
What collaborations are possible?	This is a good opportunity to engage local industry and research Gov't should support the creation of a technology pipeline Seed transformative/disruptive concepts Pick a near-term winner to enable array development to go forward
What financing is necessary?	$100m required, needs Canadian involvement not just NS. NS is not big enough to do this alone; this is an opportunity for all of Canada so it needs federal support. The case needs to be made at the Federal level.
General Comments	Opportunities: Large array demonstration in the Minas Passage Attract converged technology to Canada through arrays and the FIT. Clear major benefit to most elements of the local ocean tech supply chain – fabrication, operations, research Strengthen the relationships with large technology developers through focusing on arrays. Multi-rotor platform development R&D – this may be tied to specific turbine technology or NS could support the development of a universal platform Investigate opportunities in mass production and modularity – *will be tied to specific turbine technology*

Table 9: Communications

Question	Response
What areas can be addressed?	How can we communicate remotely? – we use Acoustic, Optical, RF and Electromagnetic methods Turbulence and noise are the main issues impacting the ability to communicate subsea in tidal races Acoustic – ambient noise is high, difficult to read the signal Optical – turbulence and sediments affect the clarity of the signal Electromagnetic – low bandwidth so less data transfer RF – short range high bandwidth so need equipment to not move from installation location The Bay of Fundy offers a unique environment and could be a lab to develop products for the Tidal In-Stream Energy Converters market as well as for the Cdn Navy (subsea communication while underway) and possibly more.
Who can address it?	Lots of local expertise available to address, there are existing funding routes in this area. Acoustic communication is a core regional expertise Could be addressed by local companies and institutions.
What collaborations are possible?	Recommend a focused questionnaire be sent to the companies and institutions mentioned above to determine areas what local collaborations can be facilitated. Publish research or technical questions for interested parties to respond Hold workshop specific to identified problems
What resources are needed?	There is limited IP bandwidth in Parrsboro, this needs to be addressed to allow the potential for data use and data visualisation to be realised.
What financing is necessary?	Depends on the technology, highly variable Possible research funding – IRAP, NSERC
General Comments	Public outreach is a high priority to assist social acceptance of work in the Bay of Fundy and other high flow sites. It is valuable to make data available/consumable by public through the FORCE centre, Discovery Centre, museums etc. Engage existing public research groups such as FERN

Table 10: Cabling/Grid

Question	Response
What areas can be addressed?	Grid compliance is essential to take advantage of existing technology and reduce risks Routing is an issue and we need more site characterization right now it is high risk and unproven. It is not clear if cable laying should be accomplished through direct drilling or seabed surface laying in that environment. Modelling of cable dynamics could reduce costs and increase survivability of the cable through the laying process if using seabed surface laying. Need to plan cable grids for future growth Can investigate and develop sensors for monitoring the cable Develop redundancy through looped systems Currently the major costs are found in mobilization for deployment
Who can address it?	There are no Canadian cable installation companies right now. UK Companies and US companies There are local companies that can supply components, cable manufacturers, research institutes and universities
What collaborations are possible?	Can/UK collaborations, research orgs/academic/ gov't will help w/ standardization UK cable companies as partners Take advantage of Clean Energy agreement and UK joint memorandum Use collaboration as a means to reduce risk and cost Common specifications on cabling are necessary, can be supported through standardisation agencies.
What resources are needed?	Support of standardization Focus on using mature technologies e.g. cables can be bought off the shelf Summary of resources needed: FIT, standards, research funding, workforce development
What financing is necessary?	$30M Share the risk to reduce costs and make more financeable. Need collaborative approach between government and industry
General Comments	Develop new technologies needed for deployment and connecting of cables. Consider the complete picture: design deployment, operations, maintenance. Research existing technologies/methods globally to determine what's already been done, find gaps for new opportunities

Table 11: Sensors/Marine life

Question	Response
What areas can be addressed?	A baseline data of existing species is needed especially ones covered as commercially important under Fisheries Act and at risk or endangered under Species at Risk Act. Check existing databases and determine what gov't supported research is needed for appropriate environmental monitoring. Consider plans to collect additional data in key areas Need to identify tools and methods to portray impact of the tidal turbine installation and the ecosystem around a near field area via maps and movies. It's important to cover the full timescales of organism life. To have a social licence we must develop tools and technology to demonstrate no harm (although, from examples from the workshop, need to temper this absolute no harm with reality and perspective e.g. 50,000 Danish birds are killed annually by offshore wind turbines, 1million Danish birds killed annually by cats, must be clear on species and populations being impacted) Require: $3M over 5 years for research centre Require: new sensing and monitoring methods, technologies and software to address turbulent environment where visibility is low. Nova Scotia presents challenges today due to strong currents and sediment in the Bay of Fundy, but global opportunities exist as well due to increased turbulence from interaction of multiple arrays. Workshop participants suggested a staged approach of a small investment in assessing quality of existing data to determine which technologies/software development approaches might achieve the most significant gains in information. A $50k public sector investment in first stage was thought to be required to complete the first stage. Subsequent development could range between $1 to $2 million with private sector investment as well as public.
Who can address it?	Private companies with expertise in sensing and monitoring. Universities and gov't institutions in collaboration with industry
What collaborations are possible?	Multidisciplinary teams of researchers and companies
What resources are needed?	Access to the locations where turbines will be deployed. Deployment vessels for instrumentation
What financing is necessary?	Deployment and instrumentation costs
General Comments	Sensors must be suitable for the tidal race environment Use a portion of the $1.6M funding allocated for environmental development Collaboration and focus on research that has been done to find the research gaps - focus on those gaps. Make use of federal program in defence innovation and clean technology support and of OERA programs

5.3 Questionnaire Output

A detailed Questionnaire was prepared by Nightsail Marine Energy Research on behalf of SLR in order to draw specific information from the workshop participants in relation to skills, resources, perceived opportunities and barriers, and the conditions or mechanisms that would help the company overcome those barriers. Twenty responses were received out of approximately 60 ocean technology companies present at the workshop. The Survey Report is provided in **Appendix E**.

As the Survey Report concludes, there was significant interest in tidal energy from most respondents, with a strong presence in the environmental and oceanographic sectors. The survey reflected little interest in the actual development of machinery (e.g., turbines), but several respondents were interested in the development of a universal platform that could be manufactured locally.

Respondents suggested that the investment horizon was significantly longer than those required for private investment sources, and an alternative funding method was required, such as a publicly-funded investment trust.

6.0 CONCLUSIONS

Nova Scotia's tidal energy resources have the potential to provide a predictable, renewable source of electricity for Nova Scotia consumers. Addressing the following technical challenges can move the technical and economic feasibility of commercially viable tidal energy exploitation in Nova Scotia forward.

- Sensors and instrumentation – assessing the resource, monitoring the devices, and monitoring environmental effects
- Deployment and recovery – for the initial installations of devices and cables as well as regular maintenance
- Subsea electrical grid – to transmit and condition the electricity generated by the devices
- Turbines/moorings – the devices and equipment that generate the electricity and maintain the position of that equipment and related infrastructure
- Cabling and connectors – between the land-based infrastructure and the subsea grid, both for electricity and communications

Solving these challenges can provide significant local and international opportunities for Ocean Technology. The overlap and interdependency of these technical issues requires a multi-disciplinary approach to their resolution. Government can play an important role facilitating the building of these relationships.

Feedback from the Tidal Opportunities Workshop indicates that there is a combination of curiosity and caution from the Ocean Technology community. Specific technical interests lies in the environmental and oceanographic sectors, with additional respondents interested in the development of a universal platform that could be manufactured locally. The expertise for developing energy converters (turbines) was limited in this room and while there is opportunity in the modelling, testing and optimizing of turbines, there are no Nova Scotia-based turbine designers at this point.

Workshop participants in general shared similar views on several key points:

- While there is significant general interest in tidal energy in the Ocean Technology community, respondents felt that uncertainty in the business case suggested an investment horizon that is significantly longer than those required for industry to participate using their own financial resources or other private investment sources. Most companies are SMEs and cannot take the financial risks necessary to move the industry forward. Setting the Feed-In Tariff will create a stronger business case.
- The high-flow marine environments need to be properly and completely described so the resource and engineering operating environment can be properly evaluated and understood. Local Ocean Technology companies can play a significant role if there is a positive business case for doing so.
- Cost reduction is critical to make the business case for tidal energy. This can be accomplished through collaboration between technology and methodology developers to reduce the costs of data collection and analysis, and that of RD&D expenditures for universal issues, and standardization of equipment to achieve economies of scale through global standardization, which in turn requires collaboration with other development regions.
- An alternative funding method is required such as a publicly-funded investment. The business case needs to include the value of MRE to Canada overall in order to engage the interest of the federal government in further funding RD&D in MRE and thereby give the industry the opportunity to flourish.
- To have a viable industry a turbine of some kind needs to be installed in Nova Scotia. It is not necessarily important that all installations be in very high flow; a moderate site would help stage sensor, instrumentation and turbine research.
- Many organizations are currently involved in the development of Nova Scotia's tidal energy resources, each with a similar yet different mandate. Organizations approaching the tidal industry often find this situation perplexing and are unsure where the focal point for collaboration locally and with other organizations worldwide.

Drawing on the research and interviews discussed in Section 2.0, and the various output from the Tidal Opportunities Workshop presented in Section 5.0, several suggestions are put forward related to public involvement for facilitating the Ocean Technology sector's involvement in tidal energy development:

1. Continue to collaborate with other tidal development jurisdictions to facilitate local industry access to global markets.

2. Re-validate the premise that the turbine supply chain is full (i.e., that the turbine-fixing-deployment chain is inextricably linked and presents no opportunity for Nova Scotia's ocean technology sector. This could be accomplished through focused meetings with selected organizations.

3. Construct, publish and distribute to the workshop registrants a map of public and non-profit organizations working to further the goal of commercial tidal energy development in Nova Scotia. For each organization, consider including roles, responsibilities and a single point of contact. This will aid organizations, including Nova Scotia ocean technology SMEs, in navigating the various organizations operating in the sector.

4. Consider maintaining the momentum generated by the Tidal Opportunities Workshop and keep the registrants and other interested parties within the ocean technology sector informed and engaged through means such as regular email updates, postings on nsrenewables.ca and @NS_MRE and continue discussions with high-potential subsectors through such means as focused meetings. Initiatives associated with Oceans Week and other communications issued by ADIANS should also be considered.

5. The local Ocean Technology sector will engage with tidal energy when a perceivable potential for future revenue exists through mechanisms such as a contract for development work; funding assistance programs; cost sharing and collaboration. Maintaining communication and engagement with the OT sector will help to crystallize interest and foster the development of the above mechanisms. Examine the potential for an existing public sector entity or independent third party to facilitate this collaboration.

6. Once the Feed-In Tariff rate is set, consider a review or re-survey of workshop participants to evaluate changes in perceptions and plans.

7. Support the Nova Scotia ocean technology value chain in developing export markets related to high potential areas such as the characterization and monitoring of the turbine operating environment. A suggested approach is to issue a Request for Proposals through OERA to solicit development proposals to bring relevant capabilities to bear.

8. Longer-term goals such as the export potential for locally-developed tidal-related products and services and uses for those products and services in other sectors are subsequent to the short-term goal of engaging the Ocean Technology Sector in local tidal energy development projects. The communication and networking provided by the workshop has contributed to these longer-term goals and the above suggestions related to communication and business case improvement is a move toward those goals.

7.0 CLOSING

This report has been prepared by SLR Consulting (Canada) Ltd. with all reasonable skill, care and diligence, and taking account of the resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

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APPENDIX A
List of Workshop Registrants

MRE Supplier Development
Nova Scotia Department of Energy
Engagement and Strategy Report
SLR Project No.: 210.05859.00000

Tidal Opportunities Workshop
List of Registrants

Organization	Contact
Acadia University	Anna Redden
Acadia University	Joel Culina
Acadia University	Mitchell O'Flaherty-Sproul
Cape Breton University	Bruce G. Hatcher
Dalhousie University	Alex Hay
Dalhousie University	Lukas Swan
Dalhousie University	Meinhard Doelle
Dalhousie University	Mo El Hawary
Dalhousie University	Nina Stark
Fundy Energy Research Network	Lisa Isaacman
Memorial University	Len Zedel
Ocean Tracking Network, Dalhousie University	Fred Whoriskey
Oceans Networks Canada	Scot MacLean
University of Manitoba	Eric Bibeau
University of Washington	Brian Polagye
DFO	Phillip Macaulay
Municipality of the District of Digby	Terry Thibodeau
Nova Scotia Department of Economic and Rural Development and Tourism	Lorraine Glendenning
Nova Scotia Department of Energy	Bruce Cameron
Nova Scotia Department of Energy	Greg Decker
Nova Scotia Department of Energy	John Kean
Nova Scotia Department of Energy	Mana Wareham
Nova Scotia Department of Energy	Melissa Oldreive
Nova Scotia Department of Energy	Michael Johnson
Nova Scotia Department of Energy	Sandra Farwell
Nova Scotia Department of Energy	Sheila Paterson
Nova Scotia Department of Energy	Toby Balch
NRCan	Tracy Kutney
Offshore Energy Research Association	Jennifer Pinks
CBCL Engineering	Randy Thorpe
Fraenkel Wright Ltd	Martin Wright
Fraenkel Wright Ltd	Peter Fraenkel
Grantec Engineering Consultants Inc.	Rick Grant
Hammurabi Marine Consulting	Jack Gallagher
Harbinger Energy Consulting	Andrew Henry
Huntsman Marine Science Centre	Pat Fitzgerald
London Offshore Consultants (Canada) Ltd	Andrew Lund
Maritime Tidal Energy Inc.	Evan Cervelli
Maritime Tidal Energy Inc.	Kay Crinean
Maritime Tidal Energy Inc.	Ron Scott
Nightsail Marine Energy Research	Jamie Ross
SolutionSmith Engineering Inc.	Corey Smith
Stantec Consulting Ltd.	Alan Cyr
Stantec Consulting Ltd.	Dan McQuinn
Stantec Consulting Ltd.	Sam Salley
Andritz Hydro Canada	Keith Pomeroy
Emera	Nicholas Fyffe
FORCE	Doug Keefe

Organization	Contact
FORCE	Tony Wright
Fundy Tidal Inc.	Dana Morin
Fundy Tidal Inc.	Greg Trowse
Minas Basin	Aaron Long
Minas Basin	Amanda Burden
Minas Basin	John Woods
AMG Claims	Andy Williams
CSA Group	Muktha Tumkur
Marine Renewables Canada	Elisa Oberman
Maritimes Energy Association	Barbara Pike
Waterford Energy Services Inc.	Blair MacDougall
Akoostix Inc.	Joe Hood
Allendale Electronics Limited	Cyril Meagher
Canadian Seabed Research Ltd.	Colin Toole
Dynamic Systems Analysis Ltd. (DSA)	Dean Steinke
EMO Marine Technologies Ltd.	Tom Knox
Focal Technologies/Moog Components Group	Roger Connolly
GeoSpectrum Technologies Inc.	Arnold Furlong
Hawboldt Industries Ltd.	John Millett
Hawboldt Industries Ltd.	John Huxtable
Irving Equipment	Rod Malcolm
Kongsberg Maritime Canada	John Gillis
Kongsberg Maritime Canada	Nick Burchill
Marener Industries	Michael Hebb
Martec Limited	Claude DesRochers
McDermott Canada Ltd.	Sean Griffiths
McKeil Marine Limited	Dan MacPherson
Ocean Sonics	Desiree Stockermans
Ocean Sonics	Mark Wood
OceanMoor Technical Services	Murray Scotney
Oceans Ltd	Simon Melrose
Omnitech Inc.	Duane B Watson
Omnitech Inc.	Steve Locke
Precise Design Engineering Solutions Ltd. (Division of Advanced Precision Ltd	Bruce Stover
Romor Atlantic Ltd.	Darrin Verge
Seaforth Energy	Mike Morris
Trihedral Engineering	Balir Sooley
Trihedral Engineering	Patrick Cooke
Vemco Ltd. (Amirix Systems Inc.)	Denise King
AMEC Marine Services	Bruce Batstone
Atlantic Energy Claim Service Inc.	Bob Hutchins
Fleetway Inc. (Part of JD Irving Limited Group of Companies)	Jim Pope
IT International Telecom	Paul Kravis
Lengkeek Vessel Engineering	Marius Lengkeek
McGregor GeoScience Ltd	Grace MacIntyre
Xeos Technologies Inc.	Derek Inglis

APPENDIX B
Workshop Agenda

MRE Supplier Development
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Agenda - Tidal Energy Opportunities Workshop

NRC, 1411 Oxford Street, Halifax, NS
March 5, 2013

8:30 - 9:00 Registration and Refreshments

9:00 - 9:15 Introduction
Introduction of Michael Johnson, *Jim Hanlon*
Welcoming Remarks, *Michael Johnson*
Announcement and Introduction to Workshop, *Jim Hanlon*

9:15 - 10:10 Panel Discussion: Tidal Energy Financial Case (Part 1)
Panelists: Martin Wright, Elisa Obermann, Sandra Farwell, Tracey Kutney, Muktha Tumkur
Presentations by panelists

10:10 - 10:30 Nutrition Break and Networking

10:30 - 11:50 Panel Discussion: Tidal Energy Financial Case (Part 2)
10:30 - 11:30 Open Q&A moderated by Jim Hanlon
11:30 - 11:50 Summary and follow-up Q&A

11:50 - 11:55 Funding Opportunities
Stephen Dempsey

11:55 - 12:00 Estimated costs: Review of Fundy Energy Research Network (FERN) spreadsheet and opinions on the sensitivity of specific items (i.e., how much the costs could be moved)
Sue Molloy

12:00 - 12:45 Networking Lunch

12:45 - 2:15 Panel Discussion: Technical Challenges and Opportunities
Presenters: Peter Fraenkel, Tony Wright, Dana Morin, Anna Redden, John Woods
Panelists: Peter Fraenkel, Mo El-Hawary, Brian Polagye, Eric Bibeau, Anna Redden, Sue Molloy
Presentations and discussion of technical challenges

2:15 – 2:20 Preparation for Breakout Groups (including schematic of basic layout, clear descriptions of technical topics, clear direction of goals)

2:20 - 3:20 Group discussions on Technical Challenge topics

3:20 - 3:35 Nutrition Break and Networking

3:35 - 4:35 Presentations by breakout groups

4:35 - 4:45 Summary, final input from participants, closing

Please see reverse for affiliations of presenters and panelists.

Presenters and Panelists

Michael Johnson
Executive Director, Business Development and Corporate Services, Nova Scotia Department of Energy

Jim Hanlon
CEO, Halifax Marine Research Institute (HMRI)

Martin Wright
Partner, Fraenkel-Wright

Elisa Obermann
Atlantic Director, Marine Renewables Canada

Sandra Farwell
Director of Sustainable and Renewable Energy, Nova Scotia Department of Energy

Tracey Kutney
Senior Research Engineer, Natural Resources Canada (NRCan)

Muktha Tumkur
Program manager, Renewable Energy, CSA Group

Stephen Dempsey
Executive Director, Offshore Energy Research Association of Nova Scotia (OERA)

Sue Molloy
Glas Ocean Engineering
Science Officer, Fundy Ocean Research Centre for Energy (FORCE)

Peter Fraenkel
Partner, Fraenkel-Wright

Tony Wright
Marine Operations Manager, Fundy Ocean Research Centre for Energy (FORCE)

Brian Polagye
Research Assistant Professor, Mechanical Engineering University of Washington
Co-Director, Northwest National Marine Renewable Energy Center

Eric Bibeau
Associate Professor, University of Manitoba
Manitoba Hydro/NSERC Alternative Energy Chair

Anna Redden
Director, Acadia Tidal Energy Institute
Director, Acadia Centre for Estuarine Research

John Woods
Vice President of Energy Development, Minas Basin Pulp & Power

Mo El-Hawary
Professor of Electrical Engineering, Dalhousie University

Dana Morin
Director of Business Development, Fundy Tidal Inc.

APPENDIX C
Speaker and Panelist Information

MRE Supplier Development
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Presenters and Panelists Biographies

Martin Wright
Partner, Fraenkel-Wright
Martin Wright is the Managing Director of Aurora Ventures Limited, Chairman of Mojo Maritime Limited and the Renewable Energy Association and a past Chairman of the Ocean Energy Group. Currently, Martin is also involved in two new ventures, Gravitricity, an Energy Storage company, which has secured initial grant funding, and Fraenkel Wright, where together with Peter Fraenkel, he is doing consultancy specialising in Energy Policy, Energy Technology as well as pursuing a number of new ideas related to Renewable Energy.

Sandra Farwell
Director of Sustainable and Renewable Energy, Nova Scotia Department of Energy
Sandra Farwell is the Director of Sustainable and Renewable Energy with the Nova Scotia Department of Energy. Much of her work with the Department has been related to implementing the Province's Cleaner Energy Plan which included the development of the Nova Scotia's Marine Renewable Energy Strategy and Renewable Electricity Plan.

Sandra has worked with the Nova Scotia Department of Energy for the past 8 years in the area of policy and regulatory development and stakeholder engagement. She led the creation of the Province's regulatory framework for marine renewable energy and serves as the provincial government member on the Board of FORCE -Fundy Ocean Research Centre for Energy- Canada's leading research centre for in-stream tidal energy.

Prior to joining government, Sandra worked for several years in the field of fisheries and marine management where she focused on policy and regulatory affairs. Sandra holds a B.Sc. in Biology, a BA in Sociology and a Masters in Public Administration (MPA), from Dalhousie University.

Tracey Kutney
Senior Research Engineer, Natural Resources Canada (NRCan)
Tracey Kutney is the Senior Research Engineer for the Marine Energy Technology team for Natural Resources Canada's CanmetENERGY in Ottawa and has been leading the team since 2011. Ms. Kutney is the Canadian representative on the IEA OES Executive Committee, contributes to IEC TC114 standards development, has acted as the government lead on the Canadian Marine Renewable Energy Technology Roadmap, and has led a number of marine energy research projects. Prior to joining NRCan, Ms. Kutney worked at Garrad Hassan and coordinated its Canadian marine energy consulting services. In 2008 she was voted Executive Treasurer of the Marine Renewables Canada (then OREG) Board of Directors. Also while at Garrad Hassan she performed wind resource analyses, annual energy production estimates, led environmental impact due-diligence reviews, taught courses on wind farm design, and managed multiple environmental assessments. She holds a B.A.Sc Honours in Mechanical Engineering from the University of Waterloo and is a licensed Professional Engineer.

Muktha Tumkur
Program manager, Renewable Energy, CSA Group
Muktha Tumkur is Program Manager, Renewable Energy with CSA Group. The renewable portfolio of standards at CSA Group includes wind, photovoltaic, marine along with geothermal ground source heat pumps, solar thermal hot water heating. CSA Group has also developed standards related to smart grid, biomass and is developing a committee that will focus on energy storage.

Stephen Dempsey
Executive Director, Offshore Energy Research Association of Nova Scotia (OERA)
Stephen is the Executive Director for the Offshore Energy Research Association of Nova Scotia, and is focused on providing leading edge research to enable the responsible development of Nova Scotia's offshore energy resources. Prior to this, Stephen was employed as CEO of the Greater Halifax Partnership, the economic development organization for Halifax.

Stephen supports his community in several ways serving or having served on the boards in the Halifax region including the Halifax International Airport Authority, and the Partners for Care Association of Capital Health.

Stephen is a 7th generation native of Halifax and received his B.Comm from Saint Mary's University, and his MBA from the University of Ottawa. Stephen and his wife Linda reside in Ketch Harbour, Nova Scotia and have two adult children, Lauren, and Jonathan.

Peter Fraenkel
Partner, Fraenkel-Wright
Peter Fraenkel was co-founder of Marine Current Turbines Ltd., a UK company that has pioneered the development of turbines for extracting energy from tidal currents and which has the most advanced technology in this field. The company was recently acquired by Siemens AG. He is at present a partner in Fraenkel-Wright Ltd, an energy engineering consultancy and has also formed a company called Gravitricity Ltd to develop a novel mechanical grid-scale electrical energy storage system. He is a UK Chartered Mechanical Engineer, a Fellow of the Institution of Mechanical Engineers, a Fellow of the Energy Institute and he is also a Visiting Professor at the University of Edinburgh.

Brian Polagye
Research Assistant Professor, Mechanical Engineering University of Washington
Co-Director, Northwest National Marine Renewable Energy Center
Dr. Brian Polagye is the co-Director of the Northwest National Marine Renewable Energy Center, leading marine renewable energy research, development, and testing at the University of Washington. His research areas include several aspects of tidal current power generation, such as resource characterization, identification and mitigation of environmental impacts, and integrating energy harvesting with oceanographic instrumentation. He also participates in the development of international standards for resource assessment and power performance of tidal current converters. Dr. Polagye holds a BSME (2000) from Princeton University and MSME (2005) and PhD (2009) from the University of Washington.

APPENDIX D
TISEC Cost Spreadsheet

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	TISEC (1 MW nominal) Item	LOW $ 8,200,000	HIGH $ 24,350,000	MEDIAN $ 16,375,000	% of Total Cost
A.	Preliminary Engineering	$ 800,000	$ 5,350,000	$ 3,075,000	19%
	Site Selection	$ 50,000	$ 250,000	$ 150,000	1%
	Resource Assessment	$ 400,000	$ 1,000,000	$ 700,000	4%
	Environmental Permitting	$ 300,000	$ 2,000,000	$ 1,150,000	7%
	Device Selection	$ 50,000	$ 100,000	$ 75,000	0%
	Land Control	$ -	$ 2,000,000	$ 1,000,000	6%
B.	Procurement	$ 3,900,000	$ 9,400,000	$ 6,650,000	41%
	IP		$ 1,500,000	$ 1,500,000	9%
	Detailed Engineering	$ 800,000	$ 1,200,000	$ 1,000,000	6%
	Turbine/Generator	$ 400,000	$ 1,000,000	$ 700,000	4%
	Gravity Base	$ 500,000	$ 1,000,000	$ 750,000	5%
	Instrumentation/Data Management	$ 200,000	$ 600,000	$ 400,000	2%
	Cabling-Power/Communication	$ 1,000,000	$ 3,000,000	$ 2,000,000	12%
	On shore	$ 800,000	$ 2,000,000	$ 1,400,000	9%
	Power Conversion/Power Quality	$ 200,000	$ 600,000	$ 400,000	2%
C.	Construction	$ 2,300,000	$ 7,000,000	$ 4,650,000	28%
	Deployment	$ 800,000	$ 2,000,000	$ 1,400,000	9%
	Subsea Cable	$ 1,000,000	$ 3,000,000	$ 2,000,000	12%
	On Shore Electrical	$ 500,000	$ 2,000,000	$ 1,250,000	8%
D.	Annual Operation, Maintenance	$ 1,200,000	$ 2,600,000	$ 2,000,000	12%
	Environmental Monitoring/Reporting	$ 300,000	$ 1,000,000	$ 650,000	4%
	Annualized Overhauls (4 year freq.)	$ 500,000	$ 1,000,000	$ 750,000	5%
	Lease/Insurance/Compensation	$ 200,000	$ 600,000	$ 400,000	2%
	General	$ 200,000		$ 200,000	1%
X.	Other Non-Cost Cosiderations				
	Life				
	TISEC				20 to 30 yrs
	Subsea Cable				25 to 40 yrs
	On shore				40 to 70 yrs
	Capacity Factor*				35 to 65%

APPENDIX E
Nightsail Energy Research Survey Report

MRE Supplier Development
Nova Scotia Department of Energy
Engagement and Strategy Report
SLR Project No.: 210.05859.00000

Survey Report on the
Tidal Energy Opportunities Workshop

NRC, 1411 Oxford Street, Halifax, NS
March 5, 2013

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1.0 Introduction

There is a potential tidal energy market of approximately 330 MW in Nova Scotia with a additional 90 MW capacity in New Brunswick. In order to assess what the business potential is for Nova Scotia companies to encourage their participation, it is worthwhile to look at the potential market for goods and services. We have an initial assessment of development costs based on work done in Minas Passage by Nova Scotia Power and while this is preliminary, it provides a starting point. The project costs are broken by phase in Chart 1 with Procurement and Construction dominating expenses at a total of 69%.

Project development and deployment would typically take about 5 years with Preliminary Engineering lasting about 2 years while O&M will be required for the operational life of the project, typically 20 years.

Assuming 330 MW of power and then using high, median and low cost estimates of $24.4M, $1.3M and $8.2M/MW, this allows an estimate of relative market potential for goods and services.

Chart 1

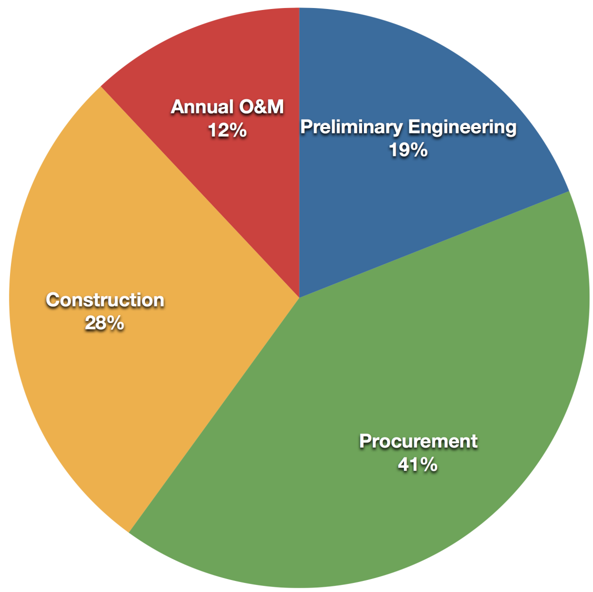

Table 1. Preliminary Cost Estimates for Tidal Development

		LOW	HIGH	MEDIAN	% of total cost
	TISEC (1 MW nominal) Item	$ 8,200,000	$ 24,350,000	$ 16,375,000	
A.	Preliminary Engineering	$ 800,000	$ 5,350,000	$ 3,075,000	19%
	Site Selection	$ 50,000	$ 250,000	$ 150,000	1%
	Resource Assessment	$ 400,000	$ 1,000,000	$ 700,000	4%
	Environmental Permitting	$ 300,000	$ 2,000,000	$ 1,150,000	7%
	Device Selection	$ 50,000	$ 100,000	$ 75,000	0%
	Land Control	$ 0	$ 2,000,000	$ 1,000,000	6%
B.	Procurement	$ 3,900,000	$ 9,400,000	$ 6,650,000	41%
	IP		$ 1,500,000	$ 1,500,000	9%
	Detailed Engineering	$ 800,000	$ 1,200,000	$ 1,000,000	6%
	Turbine/Generator	$ 400,000	$ 1,000,000	$ 700,000	4%

	Gravity Base	$	500,000	$	1,000,000	$	750,000	5%
	Instrumentation/Data Management	$	200,000	$	600,000	$	400,000	2%
	Cabling-Power/ Communication	$	1,000,000	$	3,000,000	$	2,000,000	12%
	On shore	$	800,000	$	2,000,000	$	1,400,000	9%
	Power Conversion/Power Quality	$	200,000	$	600,000	$	400,000	2%
C.	Construction	$	2,300,000	$	7,000,000	$	4,650,000	28%
	Deployment	$	800,000	$	2,000,000	$	1,400,000	9%
	Subsea Cable	$	1,000,000	$	3,000,000	$	2,000,000	12%
	On Shore Electrical	$	500,000	$	2,000,000	$	1,250,000	8%
D.	Annual Operation, Maintenance	$	1,200,000	$	2,600,000	$	2,000,000	12%
	Environmental Monitoring/Reporting	$	300,000	$	1,000,000	$	650,000	4%
	Annualized Overhauls (4 year freq.)	$	500,000	$	1,000,000	$	750,000	5%
	Lease/Insurance/ Compensation	$	200,000	$	600,000	$	400,000	2%
	General	$	200,000			$	200,000	1%

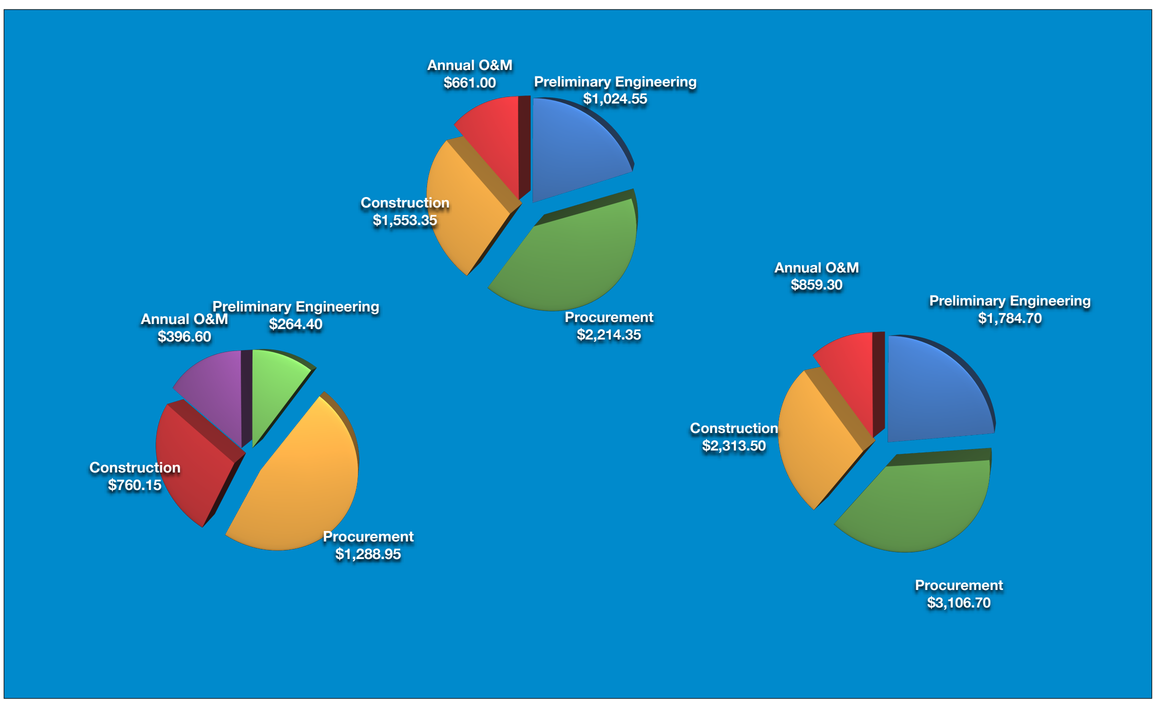

Figure 1: Market Estimates ($M) by Phase (Low, Median, High)

2.0 Workshop Survey Results

We provided a survey to determine what development areas were of interest to the participant and the level of readiness to participate. We also asked about what support they felt was needed and in what form and what kind of obstacles they felt they faced.

We asked each participant to rate each sector according to their current company offerings and potential offerings and score as follows:
1= no interest,
4 = possible with support/incentives,
6= current products/services could be adapted,
9 = current available products/services

Current Goods and Services Offerings

The results for companies who felt they had currently available products or services is shown in Figure 2. Dark colours indicate higher number of companies responding.

Preliminary (19%)			Procurement (41%)		Construction (28%)	O/M (12%)	
Research and Development	Feasibility Assessment	Planning	Design	Manufacturing	Installation	Operation	Decommissioning
Energy Conversion Technology (1)	Geophysical (1)	Project Planning (2)	Project Detailed Design (3)	Moorings (2)	On-shore Assembly	Integrity Management (1)	Offshore Disassembly
Energy Storage/ Usage (1)	Oceanographic (4)	Permits	Offshore Design (2)	Energy Coupling System (1)	Cabling Laying	Power System Management	Transportation
Turbine Technology Development (2)	Heritage	Insurance	Mechanical Design (3)	Power Generation Equipment (1)	Transportation (2)	Fault Detection and Reliability Management	Recycling / Waste Disposal
Risk Analysis (2)	Environmental (3)	Financing/ Investment	Hydrodynamic Design (1)	Power Transmission Equipment	Offshore Construction (2)	Recover and Repair	Refurbishment
Systems Lifecycle Analysis	Competing Use	Legal	Power/Electrical System Design	Navigation/ Common Equipment (2)	Off-shore Deployment (Barge)	Logistics Management	Environmental Compliance (1)
Grid Integration (1)	Financial/Economic	Power Purchase Agreement/FIT	Civil (Onshore) Design (1)	SCADA/Control Equipment (2)	Civil (Onshore) Engineering	Structural Monitoring	
Universal Platform (1)		Transportation Analysis (1)	SCADA/Control Systems Design (1)	Energy Storage System	Environmental Monitoring (3)	Environmental Monitoring (2)	
Socio-Economic Research (1)			Environmental Monitoring System Design (4)	Onshore Structures Construction			
Fish Tracking Sensors (1)				Resource Assessment Equipment			
				Marine Deployment Vessels (1)			
				Component Testing			
				Component Verification			

Figure 2: Current Goods and Services Offerings

The results indicate that the most capability exists in the environmental and oceangraphic sectors with additional responses in offshore/marine, mechanical engineering and electronics. A signifcant result is the lack of participation in heavy equipment engineering, manufacturing and installation which is a significant cost in the projects. There is capability to support R&D activities. There were no responses in the financial/investment sectors which reflects a lack of workshop participation. As lack of investment capital was identified as a major obstacle, a future workshop could focus on these areas.

Goods and Services Offerings Adaptable to Tidal Energy

The next level response from the participants was whether they had products or services which they felt could be adapted to the tidal energy projects.

Preliminary (19%)			Procurement (41%)		Construction (28%)	O/M (12%)	
Research and Development	Feasibility Assessment	Planning	Design	Manufacturing	Installation	Operation	Decommissioning
Energy Conversion Technology	Geophysical (3)	Project Planning	Project Detailed Design (2)	Moorings	On-shore Assembly	Integrity Management (1)	Offshore Disassembly (1)
Energy Storage/ Usage	Oceanographic (3)	Permits (2)	Offshore Design	Energy Coupling System	Cabling Laying	Power System Management	Transportation
Turbine Technology Development	Heritage	Insurance	Mechanical Design (1)	Power Generation Equipment	Transportation	Fault Detection and Reliability Management (2)	Recycling / Waste Disposal
Risk Analysis (2)	Environmental (3)	Financing/ Investment	Hydrodynamic Design (2)	Power Transmission Equipment	Offshore Construction	Recover and Repair	Refurbishment
Systems Lifecycle Analysis	Competing Use	Legal	Power/Electrical System Design	Navigation/ Common Equipment (1)	Off-shore Deployment (Barge)	Logistics Management	Environmental Compliance (2)
Grid Integration	Financial/Economic	Power Purchase Agreement/FIT	Civil (Onshore) Design (1)	SCADA/Control Equipment	Civil (Onshore) Engineering	Structural Monitoring (3)	
Universal Platform		Transportation Analysis	SCADA/Control Systems Design (1)	Energy Storage System (1)	Environmental Monitoring (5)	Environmental Monitoring (4)	
Socio-Economic Research			Environmental Monitoring System Design (3)	Onshore Structures Construction			
Fish Tracking Sensors (1)			Universal Platform Design	Resource Assessment Equipment (2)			
				Marine Deployment Vessels (1)			
				Component Testing (1)			
				Component Verification (1)			

Figure 3: Goods and Services Offerings Adaptable to Tidal Energy

The results from this response are consistent with the previous capabilities. The strongest capabilities are in the environmental sector with some design and analysis capabilities.

The identification of interest in areas such as fault detection, compliance and risk analysis as well as integrity managment suggests that there is near-term potential for local participation in critical areas for long term tidal systems operation.

Goods and Services Which Could Be Developed With Support

The last result was which sectors could potentially be developed with support.

Preliminary (19%)			Procurement (41%)		Construction (28%)	O/M (12%)	
Research and Development	Feasibility Assessment	Planning	Design	Manufacturing	Installation	Operation	Decommissioning
Energy Conversion Technology	Geophysical (1)	Project Planning (1)	Project Detailed Design (4)	Moorings (1)	On-shore Assembly (1)	Integrity Management (1)	Offshore Disassembly
Energy Storage/ Usage	Oceanographic (1)	Permits (1)	Offshore Design (3)	Energy Coupling System	Cabling Laying (1)	Power System Management (1)	Transportation
Turbine Technology Development	Heritage (1)	Insurance	Mechanical Design (2)	Power Generation Equipment	Transportation	Fault Detection and Reliability Management (2)	Recycling / Waste Disposal
Risk Analysis	Environmental (1)	Financing/ Investment	Hydrodynamic Design	Power Transmission Equipment	Offshore Construction	Recover and Repair (1)	Refurbishment
Systems Lifecycle Analysis	Competing Use (1)	Legal	Power/Electrical System Design (1)	Navigation/ Common Equipment	Off-shore Deployment (Barge)	Logistics Management	Environmental Compliance (1)
Grid Integration (1)	Financial/Economic	Power Purchase Agreement/FIT	Civil (Onshore) Design (1)	SCADA/Control Equipment (2)	Civil (Onshore) Engineering	Structural Monitoring (1)	
Universal Platform (1)		Transportation Analysis	SCADA/Control Systems Design	Energy Storage System	Environmental Monitoring (1)	Environmental Monitoring (3)	
Socio-Economic Research			Environmental Monitoring System Design	Onshore Structures Construction			
Fish Tracking Sensors			Universal Platform Design (1)	Resource Assessment Equipment			
				Marine Deployment Vessels			
				Component Testing (2)			
				Component Verification (1)			

Figure 4: Goods and Services Which Could Be Developed With Support

Respondents expressed interest in moving into many areas in the tidal energy supply chain, significantly in the high value phases of procurement and construction. There was also high interest in O&M sectors which is important for long term operations supported from a local base of suppliers.

The interest in these areas was conditional on some type of support to enable these companies to engage in development and production activities.

Total Interest

The total interest results provide a scoring which combines current and potential product and services offerings. The objective is to determine possible focal areas for development and associated policy and monetary support.

Preliminary (19%)			Procurement (41%)		Construction (28%)	O/M (12%)	
Research and Development	Feasibility Assessment	Planning	Design	Manufacturing	Installation	Operation	Decommissioning
Energy Conversion Technology	Geophysical	Project Planning	Project Detailed Design	Moorings	On-shore Assembly	Integrity Management	Offshore Disassembly
Energy Storage/ Usage	Oceanographic	Permits	Offshore Design	Energy Coupling System	Cabling Laying	Power System Management	Transportation
Turbine Technology Development	Heritage	Insurance	Mechanical Design	Power Generation Equipment	Transportation	Fault Detection and Reliability Management	Recycling / Waste Disposal
Risk Analysis	Environmental	Financing/ Investment	Hydrodynamic Design	Power Transmission Equipment	Offshore Construction	Recover and Repair	Refurbishment
Systems Lifecycle Analysis	Competing Use	Legal	Power/Electrical System Design	Navigation/ Common Equipment	Off-shore Deployment (Barge)	Logistics Management	Environmental Compliance
Grid Integration	Financial/Economic	Power Purchase Agreement/FIT	Civil (Onshore) Design	SCADA/Control Equipment	Civil (Onshore) Engineering	Structural Monitoring	
Universal Platform		Transportation Analysis	SCADA/Control Systems Design	Energy Storage System	Environmental Monitoring	Environmental Monitoring	
Socio-Economic Research			Environmental Monitoring System Design	Onshore Structures Construction			
Fish Tracking Sensors			Universal Platform Design	Resource Assessment Equipment		Total Scores 46-61	
				Marine Deployment Vessels		31-45	
				Component Testing		16-30	
				Component Verification		1-15	

Figure 5: Total Interest

Respondents indicated interest in a wide range of sectors in the supply chain with highest strengths in the oceanographic and environmental sectors. These is also significant interest in engineering sectors while participation in energy systems requires support to establish a strong local presence.

Types of Support and Obstacles

The second part of the survey assessed what types of support would help companies participate in the sectors they had identified as well as what obstacles they saw.

	This would not affect our decision	This would allow us to seriously consider participation	This would definitely allow us to participate
Accelerated Tax Write-Downs	5	5	2
Feed-In-Tariffs	4	4	2
Publicly Funded Development Contracts		5	8
Guaranteed Purchase Agreements	1	5	9
Research and Development Tax Credits	2	8	4
Low Interest Pubic Investment Loans	8	1	2
Licensing of Government Technology	5	1	3
Other: (write in)			3

Figure 6: FInancial Support Effects on Participation

The results indicate the widest support for development contracts and guaranteed purchase agreements. This is consistent with the uncertainty associated with the tidal industry. Three write-in suggestions were

1. Development of collaborative teams
2. Information to understand market potential
3. Need a contract to provide services

	Not an obstacle	Medium obstacle	Major obstacle
Lack of investment capital	2	1	11
Uncertainty of the tidal energy market	3	3	9
Competition from alternate energy systems	5	4	2
Lack of resources (staff, equipment etc)	7	5	2
Immaturity of the technology	6	5	2
Risk associated with the marine tidal environment	4	6	3
Competition from established foreign suppliers	3	8	3
Other: (write in)			

Figure 7: Obstacles to Participation

The results here are clear that lack of investment capital and the uncertainty of the tidal market are major inhibitors to participation by many companies.

Discussion

The workshop provided a forum to educate potential suppliers to the nature and challenges of tidal energy power systems in Nova Scotia. The participants reflected a diverse community of private industry, academic and government organizations.

Key speakers were Martin Wright and Peter Fraenkel who were principals in developing Marine Current Turbines, since aquired by Siemens. As they have extensive experience operating tidal turbines (since 2008), their perspectives were well recieved.

Martin's key point was that Canada was too late to the game to develop its own turbines in the general commercial class and should focus on universal mounting platform technology as well as collaborating on deployment ships. Current dynamic positioning (DP) vessels developed for the offshore oil and gas industry do not have the positioning capability to handle the high currents, severely restricting the availability. The current size of the DP vessels also restricts their capability to operate in Minas Passage specifically, as well as the other passages. Martin felt that collaboration on a design which they had underway would provide Canada with unique capabilities which could support tidal development on the Atlantic and Pacific coasts as well as potentially Artic operations.

As the survey reflected, there was insufficient participation by the financial community, especially noted as lack of investment capital being a major obstacle for many companies. It was pointed out that the 15-20 year investment horizon needed for many tidal projects was incompatible with the 3-5 year horizon of most private investment sources. A publicly funded investment trust was suggested as an example of alternate funding methods, allowing the returns from FIT to flow back into the public.

The responses from the survey reflected the strong presence in environmental and oceangraphic sectors, but there was siginificant interest in most sectors. While there was little interest in heavy machinery development (turbines primarily), there was interest in the universal platform development which could be manufactured in the region.

Overall, the consensus was that support was required to facilitate development of the tidal energy sector, especially to support development of DP vessels and platform infrastructure which could be a Canadian discriminator. This would need more active involvement at a national level, which would require a more compelling reason to invest, given the current status of Canada as a net energy exporter. It was suggested that development of tidal energy platforms for national operations along the Northwest Passage as well as northern communities, might replace costly and vulnerable diesel supplies.

Overall, most participants felt the workshop was useful, but indicated that the current uncertainty of tidal energy development and the corresponding lack of investment capital remain major obstacles to participation.

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