Photo Credit: Greg Trowse

9 OPPORTUNITIES AND STRATEGIES FOR BUSINESSES

Businesses that get involved in tidal energy development now will gain experience and skills needed to serve the industry as it grows.

9 - OPPORTUNITIES AND STRATEGIES FOR BUSINESSES

WHAT DOES THIS MODULE COVER?

The natural resources available in Nova Scotia's tides provide an opportunity for businesses to start-up or expand service offerings to a new industry and perhaps relocate near the resource. This module describes the potential commercial opportunities in a new tidal energy industry and what businesses can do to take them up.

This module outlines the opportunities for businesses and strategies for taking advantage of them. Specifically, it covers the following:

• Activities that will be undertaken at each stage of tidal energy project development;

• Product and service suppliers, and the skilled and knowledge workers needed at each stage;

• Business development strategies for harnessing the benefits of tidal energy development; and

• Government and non-government organizations that play an important role in the development of the tidal energy.

This module is for anyone interested in how businesses can get involved in the tidal energy industry as it develops.

9.0 - SECTION 1: SUPPLY CHAIN DEVELOPMENT AND OPPORTUNITIES

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Multiple services, supplies, and expertise are required to support tidal energy projects through each project stage throughout its lifespan. This supply chain includes many different skillsets, tools, and service providers, including marine scientists and engineers, mechanical and electrical technicians, vessels, sensory instruments, divers, steel fabrication, manufacturing, and supporting expertise such as insurance, legal, transportation, and financial services.

The development of a supply chain for the tidal energy industry is important for a number of reasons. First, a robust supply chain will be integral to the growth and success of Nova Scotia's tidal energy industry. Without the expertise and supplies needed to service projects, tidal energy will not be able to progress efficiently. Second, the building of a supply chain presents a new economic opportunity for businesses, communities, and

Nova Scotians. Businesses that get involved in tidal energy development now will gain experience and skills needed to serve the industry as it grows. Lastly, growing a local supply chain for tidal energy in Nova Scotia and the region is important for ensuring that benefits from tidal energy development are experienced by local communities and businesses. Given that the sector is at an early stage throughout the world, there is also a potential opportunity for entities that get involved in tidal energy projects now to service the global market.

FOUNDATIONAL CONCEPT: WHAT IS A SUPPLY CHAIN?

A supply chain encompasses all aspects of how a product is delivered to an end user. It is a network of retailers, distributors, transporters, storage facilities, and suppliers that participate in the production, delivery, and sale of a product to the consumer. The supply chain is typically made up of multiple companies who coordinate activities to set themselves apart from the competition.

A supply chain has three key parts:

- Supply focuses on the raw materials supplied to manufacturing, including how, when, and from what location;
- Manufacturing focuses on converting these raw materials into finished products; and
- Distribution focuses on ensuring these products reach the consumers through an organized network of distributors, warehouses, and retailers.

9.1 - TIDAL ENERGY SUPPLY CHAIN DEVELOPMENT

The tidal energy supply chain is at a very early stage of development in Nova Scotia and globally, which is reflective of the current state of the industry as a whole. To date, tidal energy deployments have consisted primarily of one-off prototype devices that have been experimental in nature, and therefore, a supply chain capable of providing tens or hundreds of devices per year for commercial deployment has yet to be established. While this gap is a challenge to early projects, it can also be recognized as a window of opportunity for businesses that provide skills or services that can contribute to tidal project and industry development.

9.1.1 - CURRENT STATUS AND PROJECTED GROWTH

Tidal energy development in the near-term will be for the advancement of both small-scale (defined as less than 0.5 MW nameplate capacity) and large-scale in-stream tidal devices. In the mid-term, demand for in-stream tidal, as well as offshore wind components and service is projected to increase. Eventually, industrial approaches to support project development will be needed. There are presently gaps in capability and capacity regionally, as well as internationally.

There are few dedicated suppliers worldwide due to the relatively small scale of the industry, but suppliers in related applications may be able to contribute or modify existing products/services to supply the tidal energy sector. Currently, major components such as gearboxes, blades, and hydraulic generators are being manufactured as custom (one-off) units. This increases the cost of the project and expands lead times for prototypes since full design, development, and custom tooling/fabrication is often required. However, it is likely that as projects move into an array stage of development, using multiple devices, costs and time should both be reduced as supply chain capacity and capabilities grow.

As more tidal energy projects are developed and the industry matures, it is likely that volume can be expected to increase, attracting more suppliers, competition, and security of supply. Figure 9 1: Evolution of the Tidal Energy Supply Chain below illustrates an appropriate scenario for the continual development of the tidal energy supply chain.

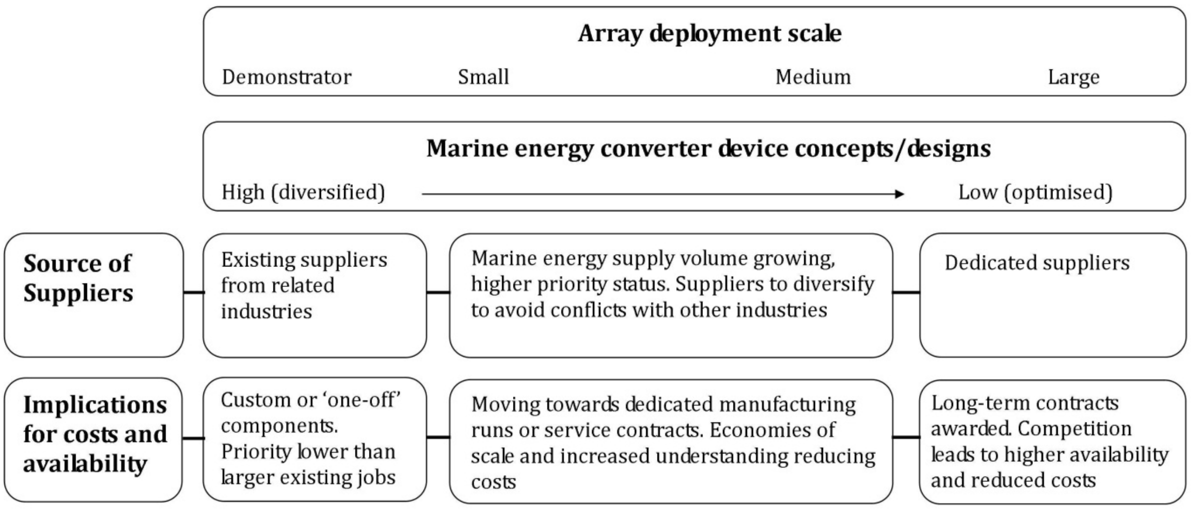

Figure 9-1: Evolution of the Tidal Energy Supply Chain

Source: (EquiMar, 2011)

9.1.2 - GAPS & CHALLENGES

Canada has several key areas where supply chain gaps and challenges have been identified. A 2011 study and report conducted by Natural Resources Canada engaged individuals representing various areas of the industry to provide insight on the status of the marine renewable energy industry and supply chain. The survey identified areas of strengths and perceived weaknesses of the current supply chain.

Table 9-1: MRE Supply Chain Strengths and Weaknesses

STRENGTHS	WEAKNESSES
Deep sea ports	Device manufacturing
Marine construction	Engineering construction
Resource monitoring and analysis	Foundations/anchoring
Environmental assessment	
Marine supplies	
Commercial diving	
Transport	

Source: Marine renewable energy supply chain strength/weaknesses (adapted from Natural Resources Canada, Canmet Energy Report, "The Marine Renewable Energy Sector Early-Stage Supply Chain", 2011)

A Nova Scotia-specific report commissioned by the Nova Scotia Department of Energy in 2011, The Marine Renewable Energy Infrastructure Assessment, identified the availability of appropriate infrastructure in a deep water port with close proximity to the resource, as well as the need for adaptive methods to service and/or deploy devices from shallow dry ports is as gaps that will need to be addressed to enable future development.

9.1.3 - PARTICIPATING IN NOVA SCOTIA'S TIDAL ENERGY SUPPLY CHAIN

The tidal energy supply chain consists of ten key segments. Various companies in Canada are providing services or products in each of these segments.

Table 9-2: Tidal Energy Supply Chain Segments

SUPPLY CHAIN SEGMENT	DESCRIPTION
Technology developers	Marine energy conversion device innovators, designers, and developers.
Manufacturers and suppliers	Manufacturers and component suppliers.
Project developers	Utilities and independent power producers.
Development services	Resource assessment/modelling, mapping, environmental impact assessment, sea floor environmental assessment and related marine safety supply consults, permitting, approvals planning, marine corrosion consulting.
Supporting technology providers	Tidal current resource measurement devices, environmental monitoring devices, buoys, underwater remote vehicle operators/owners, technical resource monitoring, and data collection.
Engineering and construction	Safety management, work platforms, underwater operators, cabling and electrical interconnect for marine operations/facilities, anchoring systems, engineering firms (electrical, civil, mechanical), on-site supervision, and management.
Operations and maintenance	Operational monitoring, transportation, port facilities and marine operators with related experience (including transport vessels and operators and certified diving teams) with the ability to do deployment/removal, emergency repair, mitigation strategies, and asset management.
Research and development	Academia, private, and public research centres and bodies.
Policy and industry support	Government policy development, industry associations, and non-governmental organizations.
Business services	Legal, financial, insurance, business communications, market research, and training activities.

Source: adapted from Natural Resources Canada, CanmetEnergy report, "The Marine Renewable Energy Sector Early-Stage Supply Chain", 2011

Many existing Nova Scotia and regional businesses are part of these segments and will have opportunities to participate in the tidal energy supply chain. Essentially, the gaps and challenges presented are opportunities for businesses to get involved early in project and industry development. Although Nova Scotia does not yet have a mature tidal energy supply chain, the province is well suited to engage in tidal energy development, given its long marine industry tradition—with significant experience in fishing, shipbuilding, and offshore oil and gas industries. Nova Scotia has the highest concentration of ocean technology companies in North America, with more than 200 businesses in operation. These companies have developed specialized expertise in marine environments all over the world and could service the tidal energy industry.

See Section 9.2 Project Stages for a detailed overview of tidal energy project requirements and Nova Scotia sectors with transferrable skills, expertise, and supplies.

DISCUSSION: STRATEGIES FOR SUPPLY CHAIN INVOLVEMENT

There are two potential strategies companies must consider when getting involved in the tidal energy supply chain:

1. Early-mover: Suppliers can put themselves in a position to supply goods and services in advance of demand. If a supplier already has a production capability for the required components, there is likely to be minimal risk or delay in supplying volume.

2. Late-mover: Suppliers can wait for when demand for goods and services are strong enough and move then to supply the industry.

Both routes involve an element of risk for both developers and suppliers. The early-mover can learn from mistakes, have ideas for improvement, and will have built relationships with developers/clients. The late-mover can learn from negative experiences of the early-mover and build their business model and strategies around that (if possible).

9.1.4 - TIDAL ENERGY SUPPLY CHAIN REQUIREMENTS

In order to learn how businesses, communities, and individuals can become involved in tidal energy development, it is important to first get an understanding of the supplies, services, and skills required for a tidal energy project. As noted earlier, at this stage in the tidal energy industry, there have only been a handful of one-off projects consisting of prototype devices. However, from these projects, it is possible to provide a general example and discussion of what service and supply provider requirements are likely to be involved with a single-device project.

This section will provide an overview of an in-stream tidal energy project, including a description of project stages, project activities, and potential supplies and services required.

9.1.4.1 - OVERVIEW OF AN IN-STREAM TIDAL ENERGY PROJECT

An in-stream tidal energy project will progress through a number of stages, each requiring an array of technical as well as supporting and enabling services. Service and supply provider requirements may differ from project to project due to the size of the device, location, and project scope. Device design, number of devices, and site location are some of the factors that may dictate requirements.

The following is a general description of each project stage, sub-stages, associated activities, and corresponding services and supplies required. Some activities and supplies/services required could be addressed by the project developer depending on in-house capability and capacity.

Gathering of data and analysis to inform this section is limited by the fact that all project deployments to date have been experimental in nature and there are few examples of service and supply delivery at each project stage. The following project life cycle inputs description is a compilation of data and analysis from case studies and reports focused on future industry projections, and is not representative of any one particular existing or past project. (NOTE: The identified project activities and inputs may not be exhaustive.)

9.2 - PROJECT STAGES

Similar to other renewable energy resources, like wind and solar, there are several project stages of tidal energy development. This section will provide an overview of each stage to provide an understanding of the development process, associated activities, and supply chain opportunities.

1. RESEARCH AND DEVELOPMENT

The research and development stage (R&D) includes research and testing of tidal energy technologies to test and refine a prototype design that can be developed into a commercial-scale device. Typically, R&D activities are conducted by specialized centers belonging to companies, universities, or government entities.

RESEARCH AND DEVELOPMENT			
ACTIVITIES	SUPPLIERS	EQUIPMENT & INSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
• Energy conversion technology • Energy storage/usage • Prototype testing • Investment	• Universities • Government and industrial labs • Research granting agencies	• Tidal/wave tanks	• Technical expertise (technology choice assessment) • Electrical engineer • Research support • Financial services

Photo Credit: Leigh Melanson

2. SITE SCREENING AND PROJECT FEASIBILITY

The first stage of project development is aimed at identifying potential sites, learning characteristics of the sites, and determining feasibility of a project at those sites. After a potential site has been identified through a site screening, a site resource assessment is completed. The next step is to conduct various feasibility studies that consider the resource identified, resulting in detailed modeling of potential constraints to the project. If a tidal technology has already been selected, potential technical, physical, and environmental constraints influencing the site are assessed in relation to the technology's performance characteristics.

SITE SCREENING AND PROJECT FEASIBILITY			
ACTIVITIES	SUPPLIERS	EQUIPMENT & NSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
• Desktop screening exercise based on available data to identify sites • Early stage resource assessment • Constraints analysis including preliminary identification of First Nations interests, conservation areas, archaeological sites, infrastructure, and other marine environment users such as fishing, commercial transportation, recreational transportation, defence • Analysis of financial feasibility • Identification of high-level site-related health and safety hazards for future assessment and to inform design of Safety Plan • Identification of a suitable grid connection point and determination of availability • Logistics analysis – identification of suitable harbours, associated services, and infrastructure • Identification of marine renewable energy technology that will best fit the project objectives and identified sites	• Engineering and environmental consulting • Financial services • Universities • Government	• Desktop modeling tools • Acoustic Doppler Current Profiler (ADCP)	• Technical expertise (technology choice assessment) • Electrical engineer • Research support • Health & safety expertise • Financial services

3. PLANNING

During the planning stage, tidal energy developers engage in environmental and technical studies and activities to help inform project design and provide details necessary for determining what types of permits, licenses, and authorizations will be required to move forward with the project.

PLANNING			
ACTIVITIES	SUPPLIERS	EQUIPMENT & INSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
Environmental Scoping and Surveys Environmental surveys are used to assess whether a project could have an impact on a species that live in, use, or frequent the marine environment, both in the sea and air. Surveys address benthic species, fish, marine mammals, birds, and onshore species. • Planning for multiple surveys • Operation of vessels for use and management of survey equipment • Aerial surveying where coverage of larger area is required • Collection and evaluation of data to provide information on project development issues • Analysis and interpretation of survey data	• Technical/research consultancy • Universities/researchers • Offshore/marine survey vessel business	• Vessel (range of vessels can be used including local fishing crane, 30m long vessels, and specialist physical surveying vessels for environmental surveying) • Surveying, trawling, and imaging equipment • Aircraft (helicopter) for aerial survey	• Vessel operator •Helicopter/ aircraft operator • Marine biologist, ecologist, environmental scientist, and/or local knowledge from fishers, etc. (should have knowledge of local species)
Physical Surveys Coastal process surveys and seabed surveys are used to examine the subsea environment and potential impact of tidal energy projects, particularly on sedimentation and erosion. Existing bathymetry and seabed geomorphology (geophysical and geotechnical conditions) are investigated to further refine the location and extent of the deployment area, assess the fixing and mooring requirements, and outline a corridor for the cable route. The geomorphology of the seabed can also provide an indication of the likely benthic habitats in the area. Onshore geotechnical conditions should also be assessed in order to identify technical requirements for onshore works and cable installation. These use a mix of desktop studies and on-site investigations. • Planning for multiple surveys • Operation of vessels for installation and management of survey equipment • Collection and evaluation of data to provide information on project development issues	• Offshore/ marine survey vessel business • Technical/ research consultancy •Universities/ researchers	• Specialized vessel • Surveying, trawling, sonar and imaging equipment	• Vessel operator • Knowledge of sediment transfer • Geotechnical engineer

PLANNING			
ACTIVITIES	**SUPPLIERS**	**EQUIPMENT & INSTRUMENTS**	**SKILLED WORKERS & KNOWLEDGE WORKERS**
Meteorological and Resource Assessment/Monitoring Measurement of meteorological and metocean conditions are necessary to enable detailed model of resource characteristics (wave heights, wave periods, tidal speeds, and direction of both waves and tides). Data collected is used alongside historical and modeled outputs to inform project design. The final resource assessment stage is completed once the technology is chosen and serves to determine the exact location of each device. • Planning for the deployment of instruments • Operation of vessels for installation and management of subsea deployment of acoustic profilers (ADCP) • Deployment and collection of ADCP measurements • Collection and analysis of weather patterns in the area • Collection and evaluation of acoustic data to provide information on project development issues	• Technical and research consultancy services to interpret and advise on modeling data (data analysis and resource modeling, site conditions and device suitability analysis)—metocean • Ocean technology supplier (instruments, ADCPs, etc.) • Offshore/ marine survey vessel business • Universities/ researchers	• Meteorological instruments and packaged instruments (ADCPs) • Dynamic positioning vessel • Remotely operated vehicles (ROV)	• Meteorology expertise • Vessel operator • ROV operator • Diver
Electrical Connection The availability of a suitable grid connection with sufficient capacity for the proposed project is integral for moving forward with the project. After identifying suitable grid connection points, a developer must begin discussions with the operator of the electrical grid. • Discussion with System Operator of the electrical grid • Identification of technical and contractual agreements for connection and associated costs	• Technical/ engineering consultancy • Legal services		• Electrical engineer • Technical expertise • Lawyer

4. PROJECT DESIGN & DEVELOPMENT

Tidal energy developers typically progress to the project design and development stage if the outcome of feasibility assessments meets the project objectives. During this stage, a developer typically performs activities necessary for gaining project approvals and permits, and as design progresses, technical information feeds into the regulatory process.

PROJECT DESIGN & DEVELOPMENT			
ACTIVITIES	SUPPLIERS	EQUIPMENT & INSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
Public and Stakeholder Consultation Developers will engage with the local community throughout the life of the project. Extensive consultation with stakeholders, especially those more likely to be affected by the project, is typically undertaken during the preparation of an Environmental Assessment (EA). • Design of a consultation strategy and plan • Identification of potential stakeholders • Ongoing and formal engagement with First Nations • Production of materials for public consumption that provide project details and future development plans • Arrangements for public event/meetings • Collection of stakeholder input and analysis to inform project design, preparation of permit/approval applications, and EA	• Public relations firm/consultant • Consultants with existing EA expertise	• Meeting/conference space (local community centre or hotel)	• Consultant with knowledge of key local stakeholders and their relevant interests in a project may be required • Public Relations expertise
Mi'kmaq Ecological Knowledge Study (MEKS) There are sites in Nova Scotia that have particular cultural significance for the Mi'kmaq of Nova Scotia, who may use them to support traditional or current practices for food, social, or ceremonial purposes. A MEKS should be conducted to identify areas of historical and current use in the project area and to help to ensure that traditional knowledge informs project design and development. • Determine MEKS scope in consideration of project requirements and proposed site	• MEKS services	• Geographic Information Systems (GIS) technology • Geographical Positioning Systems technology.	• Mi'kmaq traditional knowledge experts

PROJECT DESIGN & DEVELOPMENT			
ACTIVITIES	SUPPLIERS	EQUIPMENT & INSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
Environmental Assessment (EA) Although EAs have basic requirements and common elements, they should be project and site specific. They are informed by scoping and surveying conducted during the feasibility stage of project development. The EA considers the impacts of the project through the installation, operation, and decommissioning phases. Parameters assessed include: coastal and sedimentary processes, marine ecology (including benthic ecology and marine mammals), fish resources and commercial fisheries, marine navigation, cultural heritage and archaeology, ornithology, terrestrial ecology, landscape and visual impact, road traffic and access, tourism and recreation, water/sediment/soil quality, noise and air quality, and socio-economics. • Surveys and specialist investigations to provide a description of current environmental features (baselines) • Data gathering according to criteria defined by the previous surveying and scoping • Modeling and specialist studies to predict potential environmental impacts and evaluation, identification mitigation measures, identification of uncertainties, assessment of cumulative effects, and identification of monitoring requirements/plans • Input from stakeholders/consultees from continued dialogue on scope of surveys and studies, likely impacts, and mitigation measures • Design of potential monitoring program	• Consultants with existing EA and related specialist experience	• Physical and biological environmental monitoring and data processing equipment (e.g. ADCPs, hydrophones)	• Environmental/ resource management expertise (background in planning, environmental studies, biology, ecology, etc.)

PROJECT DESIGN & DEVELOPMENT			
ACTIVITIES	SUPPLIERS	EQUIPMENT & INSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
Other Legal, Permitting, and Approval Requirements Project developers will need to prepare applications and documentation for all legal and permitting requirements including: land lease, power purchase agreement, regulatory approvals, financial agreements, and insurance. • Preparation of land lease document, permits/approvals applications • Preparation of application for negotiation of electrical grid connection conditions including modeling of device and array power quality output (if applicable), power project interconnection studies • Design of Safety Plan (addressing operational and occupational health and safety issues) • Determination of financing options and building of a financial team • Clarification of required insurance during the construction and operating phases covered by plant suppliers, construction, and installation contractors	• Detailed experience in the permitting and approval of projects within the marine environment • Legal services • Financial services • Insurance supplier • Health & safety consultant		• Legal expertise • Consulting services (health & safety expertise) • Electrical engineer • Technical expertise • Health & safety expertise • Legal expertise • Financial expertise
Project Design The project design is developed and refined in parallel to the EA. Findings from the environmental surveys and studies should feed back into the design and technical specification. This process should also set the basis for the preparation of suitable procurement and contract strategies. Technical specifications and drawings will assist in the drafting of the contract documents. • Evaluation of design options and outline of selected design using the following pre-set criteria: functionality, flexibility, operability, costs, proven performance, safety issues, environmental and socio-economic impacts, ease of installation, project risks, reliability, maintainability, and survivability. • Techno-economic analysis to determine the expected costs and revenues arising from the project to facilitate eventual financial investment decisions.	• Engineering consultant • Logistical support – marine architect		• Marine architect • Engineer

PROJECT DESIGN & DEVELOPMENT			
ACTIVITIES	SUPPLIERS	EQUIPMENT & INSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
Development of a Procurement Strategy A strategy for the procurement of services and materials to serve project lifecycle needs will be developed. Strategies are designed to select suppliers that provide value for money over the expected life of the project while ensuring supplier competence and quality of service. Design of a strategy typically takes the following factors into consideration: • Analysis of current market status and projected market trends • Research and consideration of rules and procedures for procurement applicable to project development • Analysis of risk between parties involved and development of management techniques for uncertainty • Development of procurement process timescales and integration with overall project program	• Consultant may be required depending on the project developer's procurement and contract management experience.		• Financial, business administration expertise

PROJECT DESIGN & DEVELOPMENT			
ACTIVITIES	SUPPLIERS	EQUIPMENT & INSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
Detailed Design A detailed design of the project will commence once a project receives the necessary approval from regulatory authorities and the predicted technical and commercial performance of the project remains feasible and in line with project objectives. Technical studies will be undertaken to refine project design. • Assessment and detailed design of electrical equipment and cables (subsea and onshore) • Detailed design of Supervisory Control and Data Acquisition (SCADA) System, communications, and control equipment • Detailed design of onshore facilities and auxiliary equipment • Development of generation profiles and quality of generation based on selected technology to inform grid connection studies • Grid connection feasibility study and integration with network • Specification of safety features, navigational marking, and lighting • Detailed review of the selected technology • Marine logistics studies to optimize installation methods, vessel, and port requirements • Failure Modes, Effects, and Criticality Analysis (FMECA) to ensure the integrity and survivability of the project infrastructure and to optimize its reliability, availability, and maintainability. • Review and refinement of cost estimates and program • Update of the design risk register • Preparation of a Quality Plan	• Logistical support (inform on marine safety and standards requirements) • Consultants –Engineering, technical, OHS, planning (deployment) • Financial services • Universities/ researchers		• Marine architect • Marine engineer • Subsea electrical expertise • Health & safety expertise • Technical knowledge in marine renewable energy or parallel sectors including pressurized vessels, marine equipment, and aquaculture. • Electrical engineer • Financial expertise

5. PROJECT FABRICATION

This stage focuses on the implementation of the selected procurement strategy for elements of the project that are to be contracted out. Device, project components, and infrastructure begin to be manufactured according to standards, timescales, and costs agreed to in the contract.

Main structural components

The development of most components needed for the core generating technology will be developed and/or used by the original equipment manufacturer (OEM) and would likely be outside of the local supply chain in Atlantic Canada unless there are developers or manufacturers active in the region. Depending on the rate and scale of development, there may be potential to attract the assembly or some manufacturing. Servicing and maintenance of these components is more likely to be sourced locally.

PROJECT FABRICATION			
ACTIVITIES	SUPPLIERS	EQUIPMENT & INSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
Hydrodynamic System The hydrodynamic system is composed of the blades or hydrofoils and moves directly under the influence of forces applied by water. **Activities**: • Precision fabrication of blades and hydrofoils • Moulding and finishing of composite materials • Casting of metal structures used in providing buoyancy • Assembly of components with fasteners, welding, or other means • Design and production of pressure vessels for marine environment • Provision of coatings and treatments to control corrosion and marine growth • Workshop testing and verification	• Steel fabrication • Composites manufacturing	• Raw materials and parts: steel, composites	• Welders • Engineers

PROJECT FABRICATION			
ACTIVITIES	**SUPPLIERS**	**EQUIPMENT & INSTRUMENTS**	**SKILLED WORKERS & KNOWLEDGE WORKERS**
Reaction System The reaction system keeps the device in position and provides a static reference point for oscillating devices (mooring arrangement, gravity base, foundation, or foundation fixed to sea bed via piles). **Activities:** • Design of dynamic structure in the marine environment under frequent waves • Procurement, fabrication, and handling of large scale steel and concrete structure of up to over 1000 tonnes • Design, manufacturing, and installation of wire ropes, chains, and anchors	• Steel fabrication • Manufacturer • Concrete supplier	• Raw materials: steel, concrete	• Engineers • Procurement specialist • Expertise in corrosion and marine growth prevention • Local knowledge of marine conditions
Power Take-Off System The power take-off system converts the motions of a device's hydrodynamic system into electrical energy. This can be done in two ways – 1) with hydraulic actuators or a linear electrical generator, or 2) constraining movement with speed-up gearboxes or direct drive electric generators. • Production of gearboxes, bearings, and power transmission components	• Engineering/ technical consultancy	• Subsea connectors from device to inter-array cabling with voltage rating of 11kV and above.	• Electrical engineer • Mechanical engineer • Technical expertise
Control System The control system provides both supervisory and closed-loop control. It also includes auxiliary systems. • Design and production for high reliability applications	• Engineering/ technical consultancy	• Specialist sensors and data collection systems related to the marine environment to indicate pressure, movement, electrical characteristics, or environmental conditions. • Hydraulic actuators, valves, or other equipment. • Bearings and actuation components for use in yawing or pitching	• Experience in design and use of supervisory control and data acquisition (SCADA) systems • Engineers

PROJECT FABRICATION			
ACTIVITIES	**SUPPLIERS**	**EQUIPMENT & INSTRUMENTS**	**SKILLED WORKERS & KNOWLEDGE WORKERS**
Subsea Cabling and Connectors An electrical collector system is needed to connect individual devices to a common device interconnection point. There are two types of cables that are necessary for the operation of an in-stream tidal energy project. Array cables are required to connect strings of devices (if the project consists of an array) to an offshore substation and higher voltage cables are necessary to connect the substation to the onshore grid connection point. There is already very high demand for these types of cables from other industries and if manufacturing capacity does not increase, bottlenecks will likely occur. • Advise on selection of cable • Specify protection requirements	• Subsea cable supplier • Cable installer	• Large-scale and high precision cabling extrusion and assembly equipment • Cable armouring products to protect against extreme forces and ensure life of the conductor	• Electrical design knowledge • Mechanical engineer • Expertise in the production of insulation for cables to provide thermal and electrical protection
Electrical Equipment Transformers, switchgear, and other electrical equipment are likely to be based on conventional electrical power engineering products, but adapted to meet the needs of specific applications.	• Offshore electrical manufacturing		• Knowledge and understanding of design requirements of distributed generation and impacts of wave and tidal supply characteristics. • Electrical engineer
Foundations, Anchoring Systems, and Moorings In-stream tidal devices are anchored to the seabed. There are different types of systems for anchoring depending on device design. The following is a generalization of activities and supplies required to design and produce a foundation and anchoring system. • Production of large scale concrete structure • Fabrication of steel frame structure weighing up to over 500 tonnes • Assembly of various components	• Concrete supplier • Steel fabrication • Corrosion and marine growth prevention products	• Concrete • Cranes: lifting of various components into place for assembly and lifting assembly into barge for testing and deployment	• Marine engineer • Expertise in the design of dynamic structures for the marine environment • Technical expertise • Welders • Marine architect
Other Project Stage Service and Supply Requirements: • Insurance: protection of owner from accidental damage to the components during fabrication and assembly • Transportation of component parts to site for final assembly	• Insurance supplier • Transport company	• Trucks	• Truck drivers and machinery operators

6. CONSTRUCTION, INSTALLATION, AND COMMISSIONING

The construction, installation, and commissioning stage starts once all permits and approvals have been received and the device and other components are complete and ready for final assembly. This includes onshore assembly, offshore installation activities, and on-site commissioning. A range of vessels are typically required including specialist, modified, standard, and jack-up vessels. A number of suppliers are required to manage and deliver the safe, timely installation of expensive and relatively delicate technology in tough environmental conditions.

This stage presents an array of opportunities for local suppliers and smaller companies as they have the advantage of local knowledge, understanding of the site conditions, and access to local labour.

CONSTRUCTION, INSTALLATION, AND COMMISSIONING			
ACTIVITIES	SUPPLIERS	EQUIPMENT & INSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
Procurement and Assembly Logistics • Identification of permitting requirements • Movement of materials procured from other jurisdictions	• Marine consultant • Customs broker for importing materials and guidance in obtaining proper permits for temporary use of barge		
Barge Requirements Supply vessels such as jack-up barges and crane barges will be required for lifting heavy loads. • Inspection of barge and associated equipment for compliance with regulations • Towing of barge through test program prior to deployment activities	• Marine consultant • Customs broker		

CONSTRUCTION, INSTALLATION, AND COMMISSIONING			
ACTIVITIES	**SUPPLIERS**	**EQUIPMENT & INSTRUMENTS**	**SKILLED WORKERS & KNOWLEDGE WORKERS**
Deployment and Installation of Device • Preparation of device at port and float-out and install devices using general purpose vessels where possible • Marine logistics planning • Towing of barge and tidal assembly into place for deployment (and recovery) • Monitoring movement of marine life (lobster, fish, mammals, birds) during deployment for indication of change from normal behavior • Explore fish monitoring technologies at the turbine site (2-D and 3-D sonar) and follow fish patterns • Identification of acoustic signatures • Passive monitoring of acoustic noise from marine mammals to determine any effect or risk • View turbine in operation using side scan SONAR and camera on tether • Monitoring and analysis of anticipated wind and sea state during expected deployment/recovery window	• Engineering and environmental consultancy • Universities/ researchers • Diving services	• Fishing boats for transporting additional personnel and emergency response • Personal protective and safety equipment • Radios for communication between all parties involved in deployment • Instrumentation for communication with the assembly during deployment and recording of forces experienced on the assembly and other data to further understand environmental conditions and optimize design • Specialist tooling and ROVs • Marker buoys and navigational lighting	• Marine consultant for review and inspection and knowledge of local conditions and constraints • Electrical Engineer • Mechanical Engineer • System Engineers • Power Engineers • Certified welders (CWB Class 47.1) • Journeyman machinists • Customs broker to provide guidance in obtaining proper permits for temporary use of barge • Tugboat operator • Health and Safety/ Emergency Response preparedness • Marine biologist, ecologist • Divers
Installation of Foundations and Moorings In-stream tidal devices are anchored to the seabed. The method by which it is anchored depends on device design (pin-piled, concrete gravity, multipoint mooring). • Offshore installation and assembly of various components	• Diving services	• Cranes • Specialist tooling • ROV • Support vessels • Specialist vessels (installation) • Drilling and piling operations	• Vessel operators • Divers • Marine drilling • Marine construction • Environmental monitoring • Construction supervision • ROV and tooling operator

CONSTRUCTION, INSTALLATION, AND COMMISSIONING			
ACTIVITIES	SUPPLIERS	EQUIPMENT & INSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
Installation of Offshore Electrical Systems (including Cable Installation) • Grid connection upgrades • Procurement of cabling/electrical contractors and storage/testing of cables • Procurement of bespoke winches and drums for cable • Draw-through and installation of several kilometers of subsea cabling to avoid geohazards • Cable protection and securing using rock dumping (and potentially ROVs for pinning and active positioning around seabed features) • Directionally drilled pipelines from shore out to the location of devices • Installation and connection of the offshore substation and array cabling between devices (if applicable)	• Cabling/electrical contractors • Drilling contractor	• Power conditioning equipment (converters, generators) • Underwater substation pod—(transformers, switchgear) • Bespoke winches and drums for cable • Cable laying vessel • Special drilling equipment (carbon steel pipeline, fabricated-coated-assembled-welded) • ROV (optional)	• Electrical engineer • Technical expertise • LV Dynamic cable and MV Static Cable (with fibre optics) • Geotechnical knowledge • ROV operator • • Subsea cable armouring/burial vessels and skills
Onshore Structures (if needed) Projects will likely include an onshore substation and control building. This could also be built to house some essential operations and maintenance staff. Given the remote location of some of these projects, it is also possible that a road may need to be built to provide for site accessibility. • Construction of building • Preparation of applications for any planning permits or approvals required by regulatory authorities	• Building contractor • Concrete supplier • Electrical contractor • Window installation • Telecommunications • Metalworks • Plumber	• Concrete • Building supplies • Windows • Plumbing supplies • Electrical equipment	• Carpentry • Building design and construction • Electrician • Metal works • Plumbing • Telecommunications
Other Project Stage Service and Supply Requirements: • Insurance: protection of owner from accidental damage to the components during fabrication and assembly • Project certification	• Insurance supplier		• Certification – permitting requirements

7. OPERATIONS AND MAINTENANCE

The project development process will be designed to ensure cost-effective and safe operation throughout the life of the project. Maintenance will be scheduled to enable efficient performance and mitigate environmental impact. This stage will likely require technical support from the installation contractor, equipment supplier, and technology developer at early stages of operation. Some technical developers are anticipating significant service interventions every five years and expect a major overhaul or equipment replacement every 25 years. Since properly chosen marine renewable energy sites are expected to remain in perpetuity, ongoing support of them can be a sustainable business opportunity and source of career employment.

When possible, developers will likely want to carry out operations and maintenance tasks local to each project using port facilities to reduce logistics costs and response times. If port facilities are shared between projects and able to accept complete devices for repair or refurbishment, then the scale of activity could attract a supporting supply chain with a clustering effect.

OPERATIONS & MAINTENANCE (O&M)			
ACTIVITIES	SUPPLIERS	EQUIPMENT & INSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
Operations • Review, monitoring, auditing, and managing environmental performance to ensure compliance with permit/approval conditions • Provision of information on environmental impact to stakeholders and regulatory authorities • Monitoring performance • Inspection of operations and activities • Planning and management of maintenance activities • Administrative activities related to customer, regulatory, and legal requirements	• Diving services • Consultants—engineering, technical, environmental • Administrative services • Port services and facility	• Computing systems • Navigation systems and data	• Dedicated operations staff and control centre • Marine engineer (class 4 or higher) for offshore and onshore maintenance work • Power Engineer (Class 1 and Class 4) • GIS services • Subcontractor support services • Vessels for ongoing environmental monitoring activities and inspection • Ecologists and marine biologists • Mechanical technicians • Electrical technicians • Health & Safety/Emergency Response • Business administration

OPERATIONS & MAINTENANCE (O&M)			
ACTIVITIES	SUPPLIERS	EQUIPMENT & INSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
Maintenance • Planned maintenance including retrievals using tugs and workboats • • Management of unplanned maintenance	• Port facility • Consultants – engineering, technical	• Support vessels including tug boats and workboats • Portside lifting capability to lift the device to shore if needed (crane) • Local workshop facilities to allow for strip-down, refurbishment, re-assembly, and testing of devices. • Storage for replacement parts/ PTO systems	• Dedicated maintenance staff and control centre • Mechanical technicians • Electrical technicians • Marine engineer (class 4 or higher) for offshore and onshore maintenance work • Welding and machining • Health & Safety/Emergency Response

8. DECOMMISSIONING

Once a project reaches the end of its operating life, it will be decommissioned and the associated infrastructure removed in a safe and environmentally sustainable manner and in accordance with regulatory requirements.

Many of the physical activities and supply requirements under decommissioning will be similar to the installation and O&M stages and therefore several steps have not been repeated in this section. Please see stages 6 and 7 for a list of those activities and requirements.

DECOMMISSIONING			
ACTIVITIES	SUPPLIERS	EQUIPMENT & INSTRUMENTS	SKILLED WORKERS & KNOWLEDGE WORKERS
Decommissioning Plan • Prepared as part of the permitting conditions and revised over the life of the project • Consultation with regulatory authorities and stakeholders to determine decommissioning methodology and potential mitigation needs • Consideration of potential environmental impacts • Contains provisions for safe removal of the project infrastructure and disposal of removed equipment • Preparation of a suitable procurement strategy for the elements of the decommissioning work to be outsourced • Site surveys pre- and post-decommissioning	• Engineering and environmental consulting • Government		• Technical expertise • Engineers • Research support • Health & Safety expertise • Financial services
Decommissioning Fund • Fund set aside over life of the project to ensure that decommissioning and other costs will be covered	• Financial services		

CASE STUDY: NOVA SCOTIA POWER AND OPEN HYDRO AT FORCE*

In 2009, Nova Scotia Power and Open Hydro deployed a 1 MW Open Hydro device at FORCE. The following is an account of services, supplies, and activities involved in the project provided by Nova Scotia Power Inc. (NSPI). It is the only information available based upon actual experience of deploying a turbine in the Bay of Fundy.

The types of services, materials and skill sets that were solicited outside of the berth holder (NSPI) and technology developer's (OpenHydro's) organization during the fabrication, deployment, and recovery of the OpenHydro In-Stream Tidal Turbine in the FORCE site in the Bay of Fundy are identified below. The information is divided into three sections: Design, Fabrication, and Deployment and Recovery.

DESIGN

Research Support

- Collection of bathymetry data to aid in selecting the most ideal location for deployment of the device

Deployment

- Collection of Acoustic Doppler Current Profiler (ADCP) measurements at the deployment location so that design of the assembly could be optimized
- Analysis of the weather patterns in the area and the tidal profile so that the design could be optimized
- Collection and evaluation of acoustic data to quantify the acoustic signature of the area before and after deployment

Engineering Consultants

- Assistance in the preparation of applications for funding support
- Assistance in evaluation of possible technologies for deployment

Marine Architect

- Evaluated the subsea base design
- Provided logistical support during final design, testing, and deployment
- Informed on Nova Scotia marine safety and standards requirements

FABRICATION

Steel Fabrication

- Fabrication of the subsea base in Nova Scotia (closer to the deployment location than the technology developer's shop in Ireland)
- Inspection of the subsea base during fabrication

Concrete Supplier

- Ballasting the subsea base for stable deployment in the Bay of Fundy

Cranes

- Lifting the various components into place and allowing for assembly
- Lifting the assembly into the OpenHydro Installer barge (the “barge”) for testing and deployment

Diving Services

- Assistance with removal of subsea base ballast fill pipes

Insurance

- Protection of the owner from accidental damage to the components during fabrication and assembly

Instrumentation

- Provision of communication with the assembly during deployment
- Recording of forces experienced on the assembly and other data to further understand conditions in the Bay of Fundy and optimize the design

Marine Consultant

- Inspection of the barge and associated equipment for compliance with regulations
- Provision of warranty surveyor services and preparation of tow certificate
- Evaluation and summary of available underwater electronic data collection and communication technologies

Research Support

- Assessment of seabed conditions to aid in design of sea trials / testing of assembly

DEPLOYMENT AND RECOVERY

Marine Consultants

- Review and evaluate the OpenHydro Installer barge (the “barge”)
- Assist in identification of permitting requirements

Customs Broker

- Assistance in movement of materials from the UK to Nova Scotia as required
- Guidance in obtaining proper permits for temporary use of the OpenHydro Installer barge

Personal Protective Equipment

- Ensuring personnel involved with deployment and recovery operations had all available precautions in place to ensure their safety

Radios

- Ensuring efficient and effective communication between all parties involved in deployment and recovery operations

Fishing boats

- Accompaniment for the barge and tugboats during deployment and recovery operations to carry additional personnel that could not be on the tugboats

- Providing quick response in case of emergency.

Tugboats

- Towing the OpenHydro Installer barge (the "barge") through a test program prior to initiating deployment activities in the Bay of Fundy

- Towing the barge and tidal assembly into place for deployment, and towing the barge into place for recovery of the assembly.

Research Support

- Monitoring the movement of lobster during deployment for indication of change from normal behaviour

- Viewing the turbine in operation using side scan SONAR

- Viewing the turbine in operation using a camera on a tether

- Studying the anticipated wind and sea state during expected recovery window

- Monitoring biomass (schools of fish) and their movements in the upper Bay of Fundy through echo sounding and netting

- Monitoring bird and mammal behaviour in the area of the turbine for changes

- Passive monitoring of acoustic noise from marine mammals and determining if they are affected or at risk from the turbine.

- Exploring fish monitoring technologies at the turbine site (e.g. 2-D and 3-D sonar), and following fishing patterns at shoreline herring weirs in the area.

- Identifying acoustic signatures to the turbine and determining the effects locally

- Determining deployment effects scour on benthic habitat

Insurance

- Protection of the owner from accidental damage to the components during deployment and recovery operations

Public Relations

- Provision of professional media coverage of milestone events such as assembly and deployment

Cranes

- Lifting for dismantling of the assembly to allow for evaluation of performance

Diving Services

- Observation of the subsea base to evaluate biological growth and overall condition

Looking forward, there are a number of services and technologies that may be valuable for further deployments of in-stream tidal turbines in the Bay of Fundy.

- Dynamic Positioning (DP) Vessel – This type of vessel was not required for the deployment or recovery of the OpenHydro turbine. However, this type of vessel may be valuable for the deployment of other technologies or larger turbines as they approach commercialization. In addition, cable repairs or cable splicing for any reason "on sea" may require a constant position, which may be facilitated by this type of vessel.

- Remote-Operated Vehicle (ROV) – ROVs were not used in the deployment or monitoring of the OpenHydro turbine. However, all technology developers recognize the benefit of using an ROV to monitor deployment, perform visual surveys of the cable or turbine, and complete work under water. It is unknown if ROVs that can be manipulated accurately in the Bay of Fundy are available.

- Core sampling – Core sampling was not performed when evaluating the deployment site for the OpenHydro turbine. Accurate characterization of the floor of the Bay of Fundy, particularly at the deployment site, may be valuable information for technology developers. The ability to do this type of work in a cost effective manner in the Bay of Fundy is unknown.

- Piling etc. – Some technology developers may be planning to anchor their turbines directly to the floor of the Bay of Fundy (vs. the subsea gravity base used by OpenHydro). This may also prove to be a challenge in the Bay of Fundy.

** Please note that information in this case study was solicited by Maritime Tidal Energy Corporation in its preparation of the "Marine Renewable Energy Infrastructure Assessment" and was originally published as part of that assessment.*

Nova Scotia and the Atlantic region have a unique opportunity to capture the benefits of this new sector through the entire supply chain—from research and development through to engineering, manufacturing, installation, operation and maintenance.

9.3 - BUILDING THE TIDAL ENERGY SUPPLY CHAIN

Growth of the tidal energy sector in Nova Scotia and elsewhere will be highly dependent on having a supply chain with the right businesses, skills, and expertise to support project and industry development. Nova Scotia and the Atlantic region have a unique opportunity to capture the benefits of this new sector through the entire supply chain—from research and development through to engineering, manufacturing, installation, operation and maintenance. This would build on Nova Scotia's maritime tradition of the fisheries, shipbuilding, offshore oil and gas, and aquaculture. If Canada and Nova Scotia continue to take a lead in marine renewable energy development, a large part of that supply chain could be based in Canada.

9.3.1 - RELATED SECTORS WITH SUPPLY CHAIN POTENTIAL

Businesses and organizations with a track record in working in the marine environment, perhaps gained from industries such as offshore oil and gas, ocean technology, fishing, or marine aggregates extraction, may be well suited to undertake this work. This embedded workforce can serve to transfer skills across to the developing tidal energy sector, creating a new supply chain.

This section aims to provide an overview of the major ocean-industry related sectors that could feed into the tidal energy supply chain to develop some of the major components needed to support the industry and decrease the costs of project development. It also provides some strategies for supply chain development.

9.3.1.1 - OFFSHORE PETROLEUM

Canada has internationally recognized expertise in extraction equipment, drilling technologies, and maintenance systems for the offshore oil and gas industry—expertise that has already been engaged in some aspect of early tidal energy prototyping. Businesses, technical skills, and resources that are already involved in the offshore petroleum sector can be aligned with tidal energy projects to support the installation, operation, and maintenance of devices.

9.3.1.2 - WIND ENERGY

Similar to offshore oil and gas, the wind energy sector includes some skill sets and expertise that could be transferrable to the tidal energy sector. However, some experts have noted that the transfer of skills between industrial sectors is not seamless and careful planning and effort need to be made to develop knowledge transfer strategies.

9.3.1.3 - OCEAN TECHNOLOGY

Ocean technology is a growing sector in Nova Scotia, generating $5 billion in revenue and employing 14% of the province's workforce. The sector is a mix of primarily small and medium-sized enterprises with a few large multi-national corporations (Government of Nova Scotia, 2011). Local companies have been pioneers in underwater acoustics and imaging, marine communications, navigation, ocean monitoring, a wide variety of enhanced engineering and environmental services, and the production of innovative equipment to operate in harsh marine environments. Many ocean technology firms also have a breadth of experience in the offshore oil and gas industry, having provided much of the engineering, seismic survey, modeling, forecasting, production, and processing underwater intervention support during the Sable Offshore Energy project and Deep Panuke Project.

Key sub-sectors existing in Nova Scotia's ocean technology sector that could become involved with marine renewable energy development include:

- acoustics, sensors, and instrumentation;
- data, information, and communications systems;
- marine geomatics;
- unmanned surface and underwater vehicles; and
- naval architecture.

In close proximity, Newfoundland and Labrador also has more than 50 knowledge-intensive enterprises that develop innovative ocean technology products and services for niche markets in Canada, the United States, Central and South America, Europe, and Asia. A key element of Newfoundland's ocean technology sector is a multi-stakeholder cluster initiative—OceansAdvance—joining companies, institutions, and government agencies to facilitate world-class capability.

With 450 PhDs in ocean-related disciplines and the world's highest concentration of researchers in the sector, Nova Scotia has many knowledge workers that can access opportunities presented by tidal energy development.

9.3.2 - RESEARCH AND ACADEMIC INSTITUTIONS

Tidal energy project development will require access to R&D facilities, skilled workers, and research expertise in a number of disciplines. With 450 PhDs in ocean-related disciplines and the world's highest concentration of researchers in the sector, Nova Scotia has many knowledge workers that can access opportunities presented by tidal energy development. Nova Scotia is home to eleven universities and a community college system, which together have marine, science, engineering, marine geomatics, geological oceanographic studies, technology programs, courses, and potential research activities that have and/or will likely contribute to support tidal energy development. Strategic research initiatives among key organizations can help answer key research questions and gather supporting data.

Research and academic institutions in Nova Scotia include (this list is not exhaustive):

- Acadia University (Acadia Tidal Energy Institute, Acadia Centre of Estuarine Research),
- Fundy Energy Research Network (FERN),
- Bedford institute of Oceanography,
- Geological Survey of Canada,
- National Research Council,
- Defense Research Development Canada,
- Offshore Energy Research Association (formerly OEER/OETR Associations),
- Fundy Ocean Research Center for Energy (FORCE),
- Halifax Marine Research Institute,
- Dalhousie University,
- Saint Mary's University,
- St. Francis Xavier,
- Cape Breton University, and
- Nova Scotia Community College.

Academic institutions could serve to support future training and skills in marine renewable energy development by establishing programs and courses that cater to the needs of the sector. They also may have research facilities, resources, and expertise that could be applied to future project development. Collaborative activities and projects among local research institutions and industry could serve to accelerate marine renewable energy industry development through applied research projects, business incubation, and university placements.

9.3.3 - MARINE STRUCTURE FABRICATION AND MARINE TRANSPORTATION

Nova Scotia and the Atlantic region have expertise in marine structure fabrication for the shipbuilding and offshore oil and gas sectors. This is a growing sector, evidenced by the addition of new players such as Korean company, Daewoo Shipbuilding and Marine Engineering, and the recently announced $33-billion federal shipbuilding contract to Irving Shipbuilding. Many of the companies and skilled workers involved in this sector are also well suited to play a role in tidal energy development. Opportunities include potential manufacturing of some system components, flotation equipment, mooring expertise, marine towing and navigation, and supply and maintenance.

9.3.4 - PORT FACILITIES

Nova Scotia has port facilities and associated infrastructure available to support deployment, operations, maintenance, and recovery activities for marine renewable energy projects. Ports and nearby businesses will have opportunities to support emerging industry needs, from the housing of large vessels to assembly of device structures.

Infrastructure requirements vary according to the type and size of technology used and life cycle stage. The Marine Renewable Energy Infrastructure Assessment (2011) identified that multiple ports in Nova Scotia could support aspects of project development given the broad requirements of developers at this early stage. The assessment concluded that current infrastructure was sufficient in these early stages, but major infrastructure would be required to support the tidal energy industry beyond the capacity of 64 MW at FORCE.

Ports within the region that have been used or have been identified as having future potential and their respective assets are shown in Table 9-3.

Table 9-3: Assets of Nova Scotia Ports Identified for Tidal Energy

ASSETS/DETAILS	PORT
Proximity to the Bay of Fundy (within 150 km of the Minas Passage site)	Digby, Parrsboro, Hantsport, Saint John
Large, deep-water shipping facilities, heavy lift capacity, manufacturing, and access to service providers	Halifax Regional Municipality
Deep ports with heavy lift capacity	Shelburne and Mulgrave/Strait of Canso
Small-scale tidal support	Meteghan, Saulnierville, Weymouth, Freeport, Westport, Tiverton, East Sandy Cove

Source: Marine Renewable Energy Infrastructure Assessment, 2011

9.3.5 - PROFESSIONAL AND SUPPORTING SERVICES

Various support services will also be required by tidal energy projects, including legal, financial, insurance, logistics and management support, consultants (environmental, engineering, technical), planning, transportation, construction (onshore), and communications. These services are readily available in Nova Scotia and the region and as the industry advances, it is likely that there will be greater opportunities for these businesses to participate. It is also likely that many new opportunities could also emerge. For example, the creation of innovative businesses such as a turn-key management service, providing planning and implementation of the installation process, could be attractive to project developers.

CASE STUDY: NEW COMPANIES EMERGING TO SERVICE WAVE AND TIDAL ENERGY

There are several examples of innovative companies and partnerships being established to service marine renewable energy projects—with companies from different sectors bringing expertise to the tidal energy industry.

Recently, Swedish utility, Vattenfall joined forces with the UK's Babcock and Spanish renewables specialist Abengoa, to launch a new engineering services company, Nautimus, which will focus on wave and tidal energy. Nautimus will provide technology-neutral engineering, procurement, and construction (EPC) services for project developers. The partnership was established to address the absence of EPC services players in the marine renewable energy sector capable of handling the wide ranging challenges associated with constructing projects with new technology in the marine environment. If unfilled, this gap would pose a significant problem for the sector in the UK if industrial development proceeds as it is projected.

Nautimus is the world's first engineering firm dedicated to marine renewable energy and signals the momentum and opportunity presented by the sector as it grows towards larger projects and increased industrial activity.

For more information on Nautimus, please visit: http://www.abengoa.es/corp/web/en/noticias_y_publicaciones/noticias/historico/2012/05_mayo/abg_20120507.html for the news release or www.vattenfall.com.

KEY DOCUMENTS

The following documents and links provide further information on tidal energy supply chain development, opportunities in Nova Scotia, and the global status of the tidal energy industry. Data to inform project supply chain requirements at each tidal energy project stage was gathered from the following documents:

- Wave and tidal energy in the Pentland Firth and Orkney waters: How the projects could be built, BVG Associates for The Crown Estate, 2011 http://www.thecrownestate.co.uk/media/71431/pentland_firth_how_the_projects_could_be_built.pdf
- Nova Scotia Tidal Symposium Supply Chain Presentations, July 2011. Government of Nova Scotia www.nsrenewables.ca
- Marine Renewable Energy Infrastructure Assessment Report, Nova Scotia Department of Energy, 2011http://www.gov.ns.ca/energy/resources/EM/renewable/Marine-Renewable-Energy-Infrastructure-Assessment.pdf
- The Marine Renewable Energy Sector Early-Stage Supply Chain, Natural Resources Canada, Canmet Energy, 2011 http://www.oreg.ca/web_documents/marine_renewable_energy_supply_chain_en.pdf
- Guidelines for Project Development in the Marine Energy Industry www.emec.org.uk.

ORGANIZATIONS

SUPPLY CHAIN-SPECIFIC LINKS

- Offshore Renewables Supply Chain Directory (Scotland) http://www.scottish-enterprise.com/your-sector/energy/offshore-wind/CompanySearch.aspx

OTHER ASSOCIATIONS AND ORGANIZATIONS

Nova Scotia

- Ocean Technology Council of Nova Scotia http://otcns.ca/

International

- Scottish Development International http://www.sdi.co.uk
- Marine Renewables Industry Association (Ireland) http://www.mria.ie/links.php
- Aotearoa Wave and Tidal Association (AWATEA) -- established in 2006 to promote the uptake of marine energy in New Zealand www.awatea.org.nz
- RenewableUK -- the trade and professional body for the UK wind and marine renewables industries www.bwea.com
- Scottish Renewables -- Scotland's trade association for renewable energy, including wave and tidal www.scottishrenewables.com/
- European Ocean Energy Association (EU-OEA) -- unites the broad interests of the European ocean energy industry into a single, focused and independent voice www.eu-oea.com

9.4 - SECTION 2: STRATEGIES FOR BUSINESSES

Author: Dr. Shelley MacDougall

There is much work to be done. The challenges and opportunities of sustainably developing tidal energy call for the participation of a wide array of businesses. This section describes the concept of industry clusters and the idea of "cluster thinking" to propel the region to the forefront of technology and process expertise. Advice is given on how businesses can get involved, and the government departments and non-governmental organizations in Nova Scotia that play a role in the development of the industry are identified.

9.4.1 - INDUSTRY CLUSTERS

An industry cluster is a geographic concentration of companies (suppliers of goods and services, their customers, and related companies) and organizations (research labs, universities, industry associations, standards associations) in the same industry. Companies in the cluster share common needs, opportunities, constraints, and obstacles to productivity (Porter, 2000, p. 18). They both compete with one another and cooperate. One of the most famous of industry clusters is Silicon Valley in California. There are many others: the Italian shoe industry, New York City's garment district, banking and theatre industries, the US auto industry, California's film-making and wine industries, the Alberta oil industry, and Boston's Route 128 biotech industry, to name a few.

9.4.1.1 - HOW DOES A CLUSTER FORM?

Researchers have studied many clusters over the years, but it is difficult to generalize about how they form. However, clusters have often formed near a particular resource, such as a natural resource, or skilled or inexpensive labour; near a market, for easier access to customers; near customers and suppliers, for reduced costs of doing business; or near a strategic asset (Seeley, 2007). In the case of Nova Scotia, tidal resources are a draw for businesses, but so too is the developing knowledge of TEC devices, monitoring and communications technologies, processes, practices, and standards. These constitute strategic assets. Clusters also form around a university with breakthrough technologies (such as in Kitchener-Waterloo), and government contracts (such as the Canadian Government's shipbuilding contract, awarded to Irving Shipbuilding). In Nova Scotia, NSPI's renewable energy requirements and the Clean Energy Act lend support to the development of a tidal energy industry.

As an industry develops in an area, other companies are attracted to it to supply products and services, so they locate or start up nearby. This is especially the case in an industry that is new and the products and services are still undefined. Being close to customers and suppliers allows for ease of communication, collaboration, and sharing of tacit knowledge (Seeley, 2007).

FOUNDATIONAL CONCEPT: TACIT AND EXPLICIT KNOWLEDGE

"Knowledge is defined as a fluid mix of experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. Human knowledge exists in different forms that can be articulated explicitly (explicit knowledge) or manifested implicitly (tacit knowledge).

Individuals bring specialized knowledge and expertise into an organization. Once shared or learned, knowledge can be held collectively. The building of collective knowledge eventually contributes to the organization's intellectual capital.

Collective knowledge can be either explicit or tacit. Explicit collective knowledge is present in organizational operating procedures, documentation, information systems, and rules. Some of this knowledge is public domain knowledge shared by many professionals and organizations. Collective tacit knowledge is manifest in such things as habits, skills, and abstract understanding among organization members. It is an overarching and collective form of shared knowledge that is neither readily observed nor easily and quickly learned. Those who gain access to and acquire collective tacit knowledge can leave with it, but it simultaneously remains in the organization" (MacDougall & Hurst, 2007, p. 185).

9.4.1.2 - HOW BIG IS THE GEOGRAPHIC REGION OF A CLUSTER?

The geographic region ranges from a few city blocks to multiple provinces (Alberta, Saskatchewan oil industry) or states (US auto industry). Medicon Valley, a biotech and pharmaceuticals cluster, spans the water between Denmark and Sweden (Lundquist & Power, 2002). Clusters have been described in various configurations, such as district, valley, triangle, route, and region. In Nova Scotia, the tidal energy region is yet to be defined; it could be in one municipality, a county, the province, or a multi-provincial, even international region, such as the Fundy region.

9.4.1.3 - WHAT ARE KEY ELEMENTS IN A CLUSTER?

Key elements in an industry cluster include availability of skilled and knowledge workers, access and engagement of researchers and university labs, support for research and development, and startup financing for developers of technologies.

An industry association is integral to an industry cluster. The industry can be a forum in which otherwise competing companies can collaborate to share non-proprietary knowledge; engage in public education; communicate needs to government (such as what infrastructure is needed); share costs of specialized equipment; promote the industry brand (e.g. Nova Scotia Wines); advise schools, colleges, and universities of the skills and expertise needed by the industry to develop the competence base; host networking events, workshops, and seminars; and collaborate on standards setting.

The Fundy Ocean Research Centre for Energy (FORCE) is an example of the collaborative efforts of companies in the tidal energy industry, regulators, and researchers who have joined together to share costs and knowledge for the advancement of the industry. This test facility for large-scale tidal energy devices is important to the development of an industry cluster. Also important in the development is the existence of business incubators, such as the Acadia Centre for Rural Innovation and research institutes, such as the Acadia Tidal Energy Institute.

9.4.1.4 - WHAT ARE THE ADVANTAGES?

One of the advantages of an industry cluster is strength in numbers. Regional wine industries are a good example: wineries and grape growers are generally small organizations. Individually, they do not have sufficient clout to influence public policy or have commercial bargaining power. Collectively, though, through the formation of a wine and grape growers association, they are able to lobby government; promote the wine region and its wines; share costs of equipment, supplies, and consultancy services; engage with university and government researchers on common problems; and raise money for local initiatives.

Another advantage is the proximity to suppliers and customers, which facilitates the development of new technologies and processes by virtue of the ability to meet regularly, face-to-face. The rate of innovation in clusters tends to be greater than outside clusters, at least during the growth stage. As they mature, this can change. Clusters may become too inward looking and, over time, find themselves no longer competitive globally (Seeley, 2007).

While the construction and deployment of the tidal energy devices in local waters themselves may not become a large economic driver in Nova Scotia, the development of technologies and expertise associated with them will be in demand worldwide.

9.4.1.5 - HOW CAN THIS WORK FOR NOVA SCOTIA TIDAL ENERGY INDUSTRY?

First of all, “cluster thinking” is needed: an orientation toward groups of organizations, rather than individual firms (Courtright, 2006). Many of the pieces are in place for the Nova Scotia tidal energy industry to develop as a cluster. Table 9.5: Key Organizations Supporting Tidal Energy Development for Nova Scotia identifies many of key organizations that are in place. While the construction and deployment of the tidal energy devices in local waters themselves may not become a large economic driver in Nova Scotia, the development of technologies and expertise associated with them will be in demand worldwide. Developing and exporting innovative products and process expertise will generate local economic benefits.

As noted above (Related Sectors with Supply Chain Potential), much of the skill and expertise needed to serve the nascent tidal energy industry is available in Nova Scotia in other maritime industries. As the prospects for tidal energy develop, many of these organizations can make the investment necessary to also serve the tidal energy industry. This will help build an industry cluster.

9.4.1.6 - CAN GOVERNMENT POLICY ENCOURAGE THE DEVELOPMENT OF A TIDAL ENERGY INDUSTRY CLUSTER?

“Most clusters arise without the help of governments and many die despite it” (Seeley, 2007, p. 64). Still, governments can play a role. They can help though promotion of the region as being an area where world-class expertise and tidal resources exist (i.e. The Fundy Standard), maintaining favorable policies toward innovation (i.e. COMFIT and FIT), encouraging entrepreneurship, supporting research and development through funding university, government and private research and laboratories, and a supporting a good education system (Seeley, 2007). It is important for government to not “pick winners” or prop up a failing business; rather, government should let market forces stimulate the drive toward innovation (Craig, 2000). The government can also keep the industry informed, convening cluster members to share information, working with the industry association, and supporting access to capital.

VIGNETTE: MAINE TIDAL ENERGY AS AN INDUSTRY CLUSTER

“Maine has the unique opportunity to create a world-class marine tidal energy cluster that encompasses multiple industries and organizations. This cluster would feature research and development (R&D) excellence at both the University of Maine and Maine Maritime Academy, fostering high-tech manufacturing facilities for marine composite structures, a resurgence of marine services activity at working waterfronts, and enhanced understanding of the Gulf of Maine ecosystem.

This collective approach to sensible development of Maine’s tidal energy resource will have significant economic, educational, and social impacts. Tidal energy development will be as defining to the Maine coast in the 21st century as forest harvesting, fishing, boat building and tourism have been. It has the potential to provide long-term benefits that could positively affect future generations” (Ferland, 2008, p. 111).

VIGNETTE: ORKNEY RENEWABLE ENERGY CLUSTER

“Given that Orkney is rich in renewable energy sources of wind, wave and tide, there is clearly scope for Orkney to be a major renewable energy producer in the future. Developing local natural resources has always been the key pathway to economic development in the islands, enabling the development of industries which export to markets outside the islands, so earning revenues to pay for goods and services imported to the County. Rather than self-sufficiency, the traditional goal has been to maximise production and profit, selling into export markets in the UK and beyond.

Developing Orkney’s renewable energy resources will benefit the islands economically, and indeed the development that has already taken place has brought jobs (OREF calculate of the order of 150), skills and expertise that can be used locally and exported, and income for landowners and for community groups that have an involvement. The European Marine Energy Centre, which tests marine energy devices, and the International Centre for Island Technology (Heriot Watt’s Orkney campus and the base for its postgraduate renewable energy courses), are part of a marine renewables cluster. This cluster also encompasses a number of private sector firms which have developed considerable renewables expertise, and which are attracting funds to Orkney and selling their expertise abroad” (Orkney Islands Council, 2009, p. 4).

FOUNDATIONAL CONCEPT: SEVEN SECRETS OF FAILURE

John Craig summarized the "Seven Secrets of Failure" in developing an industry cluster and provides alternative approaches. Paraphrasing Craig, the alternative approaches are as follows:

1. Rather than focusing on real estate (providing industrial land and enticing companies to locate there), focus on where the organizations with knowledge and skills relevant to the cluster are located.

2. Rather than concentrating on attracting outside investment, build on the "embryo of the industry cluster that already exists. Gather and digest information about the world-wide market and technological opportunities relevant to the cluster. Development of a learning cluster starts as a learning process, rather than an investment process."

3. Rather than politically push for the creation of businesses in the cluster, allow the cluster to grow in response to the pull of the market.

4. Rather than providing strong political leadership, allow companies to respond what customers want. Also, do not allow those with the strongest established positions to control the cluster's development.

5. Do not pick winners – do not provide government assistance where market failures are identified.

6. Do not plan the development of the cluster or provide special government supports. Rather, help make information about opportunities more readily available.

7. Do not be secretive, rather, make information widely available.

Craig, J. (2000) The Seven Secrets of Failure. Centre for Policy and Development Systems, Queensland, Australia. Accessed July 2012 at: http://cpds.apana.org.au/Documents/Cluster/developing_industry_cluster.htm# .

9.5 - CHECKLIST FOR BUSINESSES

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The following is a checklist that will help companies and business owners determine whether they have skills and expertise to service tidal energy projects and identify the appropriate strategy for engaging in the tidal energy industry.

Table 9-4: Checklist for Businesses Interested in Tidal Energy

CHECKLIST FOR BUSINESSES
What skills, services, and/or supplies do you currently offer that could be applied to a tidal energy project? What needs to be brought in?
What is your capacity to serve tidal energy projects (1, 2, or multiple projects and at what activity level)?
Are resources available to make tidal energy a priority and work to be an early-mover?
Have you made connections with any potential business partners or project developers?
Have you considered potential risks involved with working in an emerging sector like tidal energy?

9.5.1 - KEEPING INFORMED OF OPPORTUNITIES

There are several ways for businesses and communities to learn more about tidal energy development and keep informed of associated supply chain opportunities. Many organizations provide information about the industry and projects through websites, organizing and hosting networking events (conferences, workshops, trade missions), and posting supply chain specific opportunities. Networking events and conferences are valuable opportunities to meet project developers and other industry players. Table 9-5 lists links to organizations, key documents, and literature that provide background and up-to-date information on supply chain opportunities.

Marine Renewables Canada (formerly the Ocean Renewable Energy Group (OREG)) provides a list of worldwide events, conferences, and workshops of interest to the marine renewable energy industry: http://www.oreg.ca/index.php?p=1_6_Events.

9.6 - KEY ORGANIZATIONS

There are several organizations in Nova Scotia, regionally and at the national level, that are very involved in tidal energy development and serve as valuable resources for information on current industry progress, new project initiatives, and supply and service opportunities. These are identified in Table 9-5.

Table 9-5: Key Organizations Supporting Tidal Energy Development for Nova Scotia

KEY ORGANIZATIONS			
ORGANIZATION	ABOUT	LINK	SUPPLY CHAIN ACTIVITIES/ SUPPORT
Nova Scotia Department of Energy	Provincial government department leading tidal energy policy and regulatory development.	www.gov.ns.ca/energy	• Notice of new industry development initiatives, projects, and supportive policy/regulations • Hosts workshops and stakeholder consultations
Nova Scotia Department of Economic, Rural Development, & Tourism	Provincial government department leading community and rural development initiatives.	www.novascotia.ca/econ/	• Implementation of the JobsHere plan: http://novascotia.ca/jobshere/
Atlantic Canada Opportunities Agency	Federal department working to create opportunities for economic growth in Atlantic Canada by helping businesses become more competitive, innovative, and productive.	http://www.acoa-apeca.gc.ca/Eng/Pages/Home.aspx	• Oversees and administers business development programs
Fundy Ocean Research Center for Energy	Canada's leading research centre for in-stream tidal energy, located in the Bay of Fundy, Nova Scotia.	www.fundyforce.ca	• Currently has 4 berths for tidal technology project development, with different technologies/project developers • Posts opportunities for contractors, subcontractors, etc. here: http://fundyforce.ca/media-center/opportunities/

KEY ORGANIZATIONS			
ORGANIZATION	ABOUT	LINK	SUPPLY CHAIN ACTIVITIES/ SUPPORT
Offshore Energy Research Association	Funds offshore energy environmental and geoscience research and development.	www.offshoreenergyresearch.ca	• Issues requests for proposals for R&D work • Hosts bi-annual R&D conference and research events/workshops
Marine Renewables Canada (formerly Ocean Renewable Energy Group – OREG)	National marine renewable energy (tidal, wave, in-stream river) industry association supporting the development of the sector	www.marinerenewables.ca	• Hosts networking events, an annual conference, and trade missions • Conferences provide opportunities to learn about industry progress and players involved • Posts opportunities specific to tidal energy development
The Maritimes Energy Association	Industry organization for Eastern Canada's energy industry focused on supporting the maximization of Atlantic Canadian participation in the supply of both goods and services to meet the needs of the energy industry.	http://www.maritimesenergy.com/	• Hosts networking events, an annual conference, and trade missions • Posts opportunities for energy and marine supplies and services
Acadia Tidal Energy Institute	Focused on assessing tidal energy resources and the associated environmental challenges and socio-economic opportunities.	http://tidalenergy.acadiau.ca/	• Conducts multidisciplinary research projects on tidal energy resource assessment, environmental monitoring and impacts, socioeconomic growth, and sustainable communities • Leads development and delivery of tidal energy educational programs and other support materials • Facilitates capacity building and understanding of available tidal energy resources, environmental effects, and socioeconomic opportunities, particularly in local rural communities
Fundy Energy Research Network	Coordinates and fosters research collaborations, capacity-building, and information exchange to understand the environmental, engineering, & socio-economic factors associated with tidal energy development in the Bay of Fundy.	www.fern.acadiau.ca	• Core focus is socio-economic issues (including supply chain development) • Coordinates and supports tidal energy research projects, activities, and events

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