OFFSHORE WIND ENERGY DEVELOPMENT:

Supply chain identification and capacity within Newfoundland and Labrador

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The **Newfoundland and Labrador Environmental Industry Association (NEIA)** is a not-for-profit association of businesses that supports the development of clean technology and the growth of the green economy in Newfoundland and Labrador, Canada. With over 200 members, NEIA is Newfoundland and Labrador’s premier resource for the environmental sector, offering a diverse range of expert knowledge and support services for firms and organizations working to grow economic opportunity while respecting our natural environment. NEIA is the business of the environment.

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**Stapleton Environmental Consulting** serves the Canadian natural gas, electric utility, mining, and renewable energy sectors. Areas of expertise are environmental assessment, regulatory consultation and permitting, and stakeholder engagement. Based in Newfoundland and Labrador, Canada, Principal Erin Stapleton is passionate about supporting the development of Atlantic Canada’s marine renewable energy resources.

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INTRODUCTION

The first offshore wind project was installed off the coast of Denmark in 1991. By 2016, global cumulative installed offshore wind capacity was 14,384 MW.\(^1\) By some estimates, global capacity may reach 60,000 MW over the next ten years, which represents capital and operational expenditure of £210 billion (approximately $CAD 350 billion) over the same timeframe.\(^2\) This presents exciting business opportunities for firms who can provide products and services to this burgeoning sector.

The Newfoundland and Labrador Environmental Industry Association (NEIA) retained Stapleton Environmental Consulting to provide information on the supply chain for the offshore wind energy sector. The objective of this study was to qualitatively assess Newfoundland and Labrador’s capabilities to help inform NEIA’s future business development activities. Specifically, this report identifies the products and services typically required for offshore wind energy development, and indicates which products and services are available in Newfoundland and Labrador.

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SUPPLY CHAIN FOR OFFSHORE WIND ENERGY DEVELOPMENT

PROJECT LIFECYCLE

Supply chain is discussed in the context of project lifecycle. The typical offshore wind energy project lifecycle consists of four main phases: planning; development and construction; operation and maintenance; and decommissioning (Table 1). The lifecycle can exceed 30 years, with the operation and maintenance phase lasting 25 years and constituting 40% of lifetime spend.\(^3\)\(^4\) It is important to note that this typical lifecycle is based on the well-established UK offshore wind energy sector. Project lifecycle may be longer (particularly the planning and development phases) in jurisdictions just starting to develop an offshore wind sector.\(^5\)

Table 1: Typical offshore wind energy project lifecycle and relative expenditure

<table>
<thead>
<tr>
<th>Phase</th>
<th>Summary of Activities</th>
<th>Expenditure (% of lifetime spend)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
<td>Feasibility studies, siting, regulatory processes and approvals, engineering and design.</td>
<td>3</td>
</tr>
<tr>
<td>Development &amp; construction</td>
<td><strong>Manufacturing and assembly of turbine components</strong> – turbine nacelle assembly, blades, castings and forging, drive train, and tower.</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td><strong>Balance of plant</strong> - all major aspects of an offshore wind farm (other than turbines). Includes subsea array cables, subsea export cables, offshore and onshore substations, turbine foundations (e.g., gravity-based structures).</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td><strong>Installation and commissioning</strong> – Mobilizes from ports and requires specialized installation vessels. Includes installation of foundations, turbines and substations, as well as laying of subsea cables.</td>
<td>11</td>
</tr>
<tr>
<td>Operations &amp; maintenance</td>
<td>Day-to-day operations, regular inspections, preventative and unscheduled maintenance of turbines, replacement of equipment, monitoring of conditions.</td>
<td>40</td>
</tr>
<tr>
<td>Decommissioning</td>
<td>Shut-down of operations; removal of turbines, support structures and cables.</td>
<td>4</td>
</tr>
</tbody>
</table>

TYPICAL SUPPLY CHAIN

The typical offshore wind energy supply chain is illustrated in Figure 1.

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Figure 1: Typical offshore wind energy supply chain
Project developer

- Responsible for the overall management of the project and for securing the financial backing.
- May sell the project to an operator following the construction phase, or may retain ownership throughout the life of the project.
- Retains qualified companies and professionals to provide the many products and services required to plan, develop, construct, operate, maintain and decommission the project.

Professional services

- Includes project management, legal, environmental, socio-economic, Aboriginal engagement, public relations, and human resources.
- The project developer may contract a qualified firm to manage the project (e.g., scope, schedule, budget, procurement, staffing, quality management, risk management).
- Legal services required include execution of lease agreements and contracts, regulatory guidance, dispute resolution, and hearing preparation.
- Environmental services required include biophysical studies during the planning phase (e.g., marine mammal surveys), environmental assessments to satisfy provincial and federal regulatory requirements prior to construction (e.g., environmental impact statement, fish habitat assessment), environmental effects monitoring during the operations phase. Environmental permits, management plans and contingency plans are also required.
- Socio-economic studies are required to satisfy provincial and federal regulations, and include assessment of the potential impacts of the project to economy, land use, and health.
- Where Aboriginal interests are identified, firms with experience in Aboriginal engagement are required to gather information important to Aboriginal communities, including Traditional Knowledge and Traditional Land Use.
- Public relations and stakeholder engagement services are required to manage the communication of project information and to gather input from citizens, industry, environmental groups and other interested parties.
- Human resources services are required to attract and retain the workforce for each phase of the project lifecycle.

Engineering services

- Civil engineering services required may include design, construction or modification of any buildings (e.g., expansion of port facility, new manufacturing facility), and infrastructure to support development (e.g., wastewater system, road network).
- Environmental engineering services are required to consider the effects of environmental conditions on the project, including estimating sea ice loads to inform feasibility studies and modelling wind conditions to ensure optimal siting of turbines.
- Electrical engineering services required include design of the array cable configuration for the wind farm itself, as well as the design of the overall offshore-to-onshore electrical system.
- Mechanical engineering services required may include design of turbine foundations, design of assembly machinery, and modifications to marine vessel equipment.
Ocean technology

- Refers to any technology that must be deployed in the ocean environment to contribute to the successful operation of the wind farm.
- Includes sensors to monitor the individual turbines and the collective wind farm, monitoring stations for environmental conditions, and remotely-operated underwater vehicles for inspections.

Software and modelling

- Software is used to design, analyze and optimize wind farm configuration, and is required to manage the volume of data collected throughout all phases of an offshore wind project (e.g., environmental data from surveys, performance data from turbines, repair and maintenance records).
- Modelling of wind and weather conditions is key in siting the turbines, and monitoring current and forecasting future conditions is an important aspect of day-to-day operations and proactively managing for extreme weather events.
- Modelling of various accidents and malfunctions (e.g., spills, mechanical failure) assists with planning response procedures.

Research and education

- Research and development (R&D) of innovative technologies may be required during the planning stage to support project development in unique environments.
- The first wind farm decommissioning occurred in 2016 - the risks, costs, and environmental impacts of the decommissioning phase are not yet thoroughly understood and require further R&D.  
- Universities and technical colleges have a role to play in educating the workforce required throughout the project lifecycle, with support from industry for work-terms, on-the-job training, and mentorship.
- In addition to professional services (page 4), a variety of skilled tradespeople are required to support offshore wind energy development, from the more traditional welders and electricians to the relatively new trade of wind turbine technician.

Certification

- Health and safety certification is required throughout all phases of project development.
- Specialized offshore safety training is required for workers participating in any activities at sea, including sea survival, and helicopter safety and escape.
- Safe operation of equipment, machinery, turbines and vessels must be ensured through ongoing monitoring and maintenance.

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Marine vessels

- Vessels required include survey, supply and maintenance vessels, as well as those designed specifically for cable-lay, heavy-lift, and turbine installation.  
- While it was once customary to improvise with generic offshore construction vessels, the more recent trend is towards using purpose-built vessels for installation.

Geotechnical and geophysical services

- Required during the planning of the wind farm to help inform any aspect of development that will impact the seafloor (e.g., seabed mapping, sediment and bedrock coring).
- On-site expertise is also required during construction and decommissioning when the seabed is disturbed during installation and removal of wind farm components (e.g., laying and removal of cables).

Turbine supplier

- Supply of turbines is the single largest contract placed by the project developer.
- The supplier designs and supplies all the electrical and mechanical components and systems that make up a wind turbine.
- Given their highly-specialized knowledge of the turbine components and systems, the supplier is actively involved in the planning, development and construction of the wind farm.

Manufacturing and fabrication

- Manufacturing of the turbine consists of the integration and assembly of all turbine components to create the final product.
- Required to support the balance of plant phase, including subsea array cables, subsea export cables, offshore and onshore substations, and turbine foundations.

Machinery

- Required to support construction, operations, maintenance and decommissioning of an offshore wind farm.
- Includes cranes for turbine installation, customized deck machinery for operations and maintenance vessels, and dredging equipment for removal of cables during decommissioning.

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8 Ibid.
Electrical system

- Power generated by a wind farm reaches land via an electrical system of subsea cables and offshore and onshore substations.
- Offshore wind farms are different from onshore wind farms in many respects, so specialized services are required to configure the system, install the subsea cables, repair damaged cable, and design and implement the supervisory control and data acquisition (SCADA) system.10

Port facilities

- The ideal port has deep water with a large hinterland to support the manufacturing and storage of turbine components.
- Serves as a supply base and service hub.

Marine trades and operations

- Any aspect of wind farm development occurring in the marine environment (i.e., construction, operations and maintenance, and decommissioning) requires expertise in marine trades and operations.
- Includes vessel pilots, certified commercial divers, and marine medical and emergency service providers.

Accommodations and catering

- Particularly important during the development and construction phase when the workforce is at its peak.
- Includes hotels, motels, temporary camps, restaurants, caterers, and on-site cooks.

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NEWFOUNDLAND AND LABRADOR SUPPLY CHAIN

The products and services available in Newfoundland and Labrador were identified through a review of the Marine Renewables Canada (MRC) supply chain database11 and from the information provided in response to a Request for Information (RFI) issued by NEIA.12 The MRC supply chain database is an online tool that identifies firms throughout Canada with capabilities applicable to marine renewable energy (not specifically offshore wind). Results from the database were filtered and refined to focus on only those firms located in Newfoundland and Labrador, and only on products and services applicable to offshore wind energy development. Results from the database and RFI responses were summarized into 16 categories based on the typical supply chain identified in Figure 1.

LOCAL CAPACITY

Review of the MRC database and RFI responses indicates that Newfoundland and Labrador has the capacity to provide many aspects of the required supply chain for an offshore wind energy sector.

The local firms listed in the MRC database each provide a product or service in at least one of the supply chain categories, except for “port facilities” (no local capacity noted)13, “turbine supplier” (no local capacity noted) and “accommodations & catering” (not considered for MRC database) (Figure 2). Respondents to the RFI indicated capacity to provide a product or service in at least one of the supply chain categories, except for “turbine supplier” (Figure 3).

It is important to note that this study is not a comprehensive assessment of Newfoundland and Labrador’s supply chain readiness; rather, it is a preliminary survey of the existing capacity of local firms to support an offshore wind energy sector.

11 MRC 2017. https://supplychain.marinerenewables.ca/
13 Though local port facilities were not identified in MRC’s database, it is important to note that there are ports in the province that could potentially service a future offshore wind industry, as indicated by RFI respondents in the “port facilities” category. The Port of Esbjerg, located in the City of Esbjerg (current population approximately 72,000), Denmark, is as an example of how a port can successfully transition to serve the offshore wind energy sector. The Port of Esbjerg is an historical fishing port, then became the hub for the Danish offshore oil and gas sector, and is now the leading shipping port in Europe for the offshore wind energy sector. From 2003 to 2014, the Port of Esbjerg invested approximately one billion Danish Krone to meet the demands of the offshore industry and to facilitate future growth. Investments in infrastructure would be required for ports in Newfoundland and Labrador to service the offshore wind energy sector. Port of Esbjerg 2017. http://portesbjerg.dk/en/about/history
Figure 2: Newfoundland and Labrador Supply Chain Capacity – MRC Database

Figure 3: Newfoundland and Labrador Supply Chain Capacity – RFI Responses

Local firms = 70
Source: MRC 2017

RFI respondents = 21
OUR STRENGTH - SYNERGY WITH OFFSHORE OIL AND GAS

That Newfoundland and Labrador has the capacity in many aspects of the required supply chain was expected given the synergy between the offshore oil and gas and offshore wind sectors. The transferability of products and services between the two sectors is well-demonstrated in the United Kingdom (UK). At 5,156 MW, the UK has the largest amount of installed offshore wind capacity in the world. Scotland has become an offshore wind energy sector hub in the UK. It has 197 MW of operational offshore wind and another 4 GW that has been given planning consent. Over £190 million has been invested in offshore wind in Scotland by developers, and the sector currently supports over 1,800 jobs. Scotland’s success in offshore wind is in part credited to its 40-year history of offshore oil and gas development. Many of the elements required to develop an offshore wind project have already been developed by the oil and gas sector. Numerous UK firms participating in the oil and gas sector have successfully diversified into the offshore wind energy sector.

Scottish Enterprise (2016) has identified nine areas of the offshore wind supply chain that present the greatest opportunities for companies in the oil and gas sector:

1. **Project management** - Oil and gas companies have the experience in managing complex projects in the offshore environment.

2. **Array cables** - Manufacturing array cables for offshore wind requires similar skills and equipment to oil and gas umbilical manufacture.

3. **Substation structures** - These are typically one-off designs, similar in scale to oil and gas platforms.

4. **Turbine foundations** - The fabrication skills used in oil and gas can be harnessed to produce serially manufactured structures.

5. **Secondary steelwork** - An accessible market for companies without the capacity for foundation manufacture and entry may not require new coastal facilities.

6. **Cable installation** - Most contractors in this market have oil and gas experience and have learned to adapt to the significant new challenges that the complexity of offshore wind contracts presents.

7. **Installation equipment** - A considerable number of companies have diversified from oil and gas into areas like cable handling equipment and trenching and burial tools.

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8. **Installation support services** - Many oil and gas companies have experience of working offshore which can bring real benefits to the offshore wind industry in subsea services (e.g., diving and ROV services) and onshore activities (e.g., marine consultancy).

9. **Maintenance and inspection services** - Oil and gas experience in offshore logistics can shape evolving strategies in offshore wind.

While Newfoundland and Labrador’s expertise in offshore oil and gas positions us to be leading suppliers to an offshore wind energy sector, the distinct differences between the two sectors must be acknowledged. Newfoundland and Labrador can learn from the UK experience and focus supply chain development in key areas where the greatest synergies have been documented. Additionally, there will be a “learning curve” as skills, processes and technologies are adapted for application to the offshore wind energy sector. Strategic partnerships with firms that are experienced in offshore wind energy and involved in supply chain development, particularly in Europe and the along the US Atlantic coast, will be integral to preparing our supply chain. 24,25,26

**REALISTIC EXPECTATIONS FOR LOCAL CAPACITY**

There are two major elements of the supply chain that are unavailable locally and are highly unlikely to ever be sourced locally - a wind turbine supplier and the vessels required to install turbines.

Given the history of offshore wind energy development in Europe, it is no surprise that the German company Siemens dominates the global wind turbine supply market. 27 In 2016, 98% of the turbines connected to the UK grid were supplied by Siemens Wind Power, while the remaining 2% were supplied by MHI Vestas Offshore Wind. 28 Siemens opened a turbine production plant in China in 2010 to serve that country’s growing market. 29 Siemens also has a blade-manufacturing plant in Ontario, though it currently produces only onshore wind turbine blades. 30 The technical requirements of turbine manufacturing make new entry into this market difficult; however, if an offshore wind industry develops in Atlantic Canada or continues to grow in the U.S, existing turbine manufacturers may modify or establish plants in North America to feed these markets. 31

The turbine installation vessels (TIVs) used in the offshore wind energy industry are highly specialized. It was once commonplace to improvise with generic offshore construction vessels used mainly in port, bridge, or oil and gas projects. However, by 2011, most new installation vessels were purpose-built TIVs, and this trend is expected to continue. 32 Currently, only 12 vessels are fully-adapted for work in the

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offshore wind industry and there is a global shortage. Several ship builders in Florida and Louisiana have built vessels for the US and European markets. Market demand will dictate future opportunities for supply of TIVs.

CONCLUSION
The emergence of an offshore wind energy sector in the northeastern Atlantic presents a considerable economic opportunity for Newfoundland and Labrador. With our 30-year history in offshore oil and gas, our province has a solid foundation from which we can build a supply chain to the offshore wind energy sector. Critical to our success will be a supply chain development strategy that focuses on leveraging our offshore oil and gas expertise, and a willingness to ready our supply chain in advance of demand. By proactively engaging partners experienced in the offshore wind sector, we can begin the transfer of knowledge now to ensure we are prepared when opportunity arises. These strategic partnerships, combined with local innovation, corporate investment and government support, will help position Newfoundland and Labrador as a hub for the Atlantic offshore wind energy sector.