net-zero atlantic

Assessment of Atlantic Canadian Ports to Support Offshore Wind Development

Final Report

August 2025

ACKNOWLEDGEMENTS

This project is led and managed by Net Zero Atlantic with major funding provided by Canada's Ocean Supercluster, Nova East Wind, Simply Blue Group, and Northland Power.

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Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the parties, Canada's Ocean Supercluster or its members, Nova East Wind, Simply Blue Group, Northland Power, PF Collins International Trade Solutions, the Cape Breton Partnership, BlueFloat Energy, or any of their affiliates.

Letter from Net Zero Atlantic

Net Zero Atlantic is pleased to present the findings from the Assessment of Atlantic Canadian Ports to Support Offshore Wind Development. This study represents an important step in understanding the readiness of Atlantic Canadian ports to participate in the growing offshore wind industry and to capitalize on domestic and U.S. market opportunities.

The project set out to identify willing ports in Atlantic Canada capable of supporting primary offshore wind activities and to outline the infrastructure upgrades required to meet industry needs. The final report provides an assessment of ten shortlisted ports and highlights the investments and planning necessary to position the region as a competitive player in the global offshore wind supply chain.

We would like to thank our major project funders – Nova East Wind, Simply Blue Group, Northland Power, and Canada's Ocean Supercluster – for their support of this work. We also acknowledge PF Collins, the Cape Breton Partnership, and BlueFloat Energy for their additional contributions. Special thanks go to our consultants Moffatt & Nichol, with contributions from Xodus, Angler Solutions Inc., Envigour Policy Consulting Inc., and Caron Hawco Group, whose expertise and collaboration were essential to delivering this report.

We also extend our appreciation to the many stakeholders who participated in interviews, port outreach, and the public information session. Their input enriched the findings and demonstrated the region's growing commitment to offshore wind.

The results of this study provide a foundation for next steps, including detailed technical assessments, investment planning, and continued stakeholder engagement. Net Zero Atlantic looks forward to building on these findings to support Atlantic Canada's energy transition and the development of a strong offshore wind industry.

Thank you for your interest in this work. For more information, please visit our website to explore related research or to contact us with any questions.

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Table of Contents

List of Figures

List of Tables

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List of Acronyms and Abbreviations

AACE	Association for the Advancement of Cost Engineering
ABP	Associated British Ports
avg	Average
BF	Brownfield
CNLOER	Canada-Newfoundland and Labrador Offshore Energy Board
CNSOER	Canada-Nova Scotia Offshore Energy Board
COD	Commercial Operation Date
CLV	Cable Lay Vessel
CTV	Crew Transfer Vessel
DGA	Dense Graded Aggregate
FIV	Foundation Installation Vessel
Fixed	Fixed-bottom Marshalling
FLOW	Floating Offshore Wind
FOU	Foundation
ft	Feet
GBS	Gravity Based Structure
GF	Greenfield
GW	Gigawatt
ha	Hectare (= 10,000 m^2)
HTV	Heavy Transport Vessel
HVAC	High-Voltage Alternate Current
HVDC	High-Voltage Direct Current
LOA	Length Overall
m	Meter
m^2	Square Meters
m/s	Meters per second
mCD	Meters Chart Datum
MOU	Memorandum of Understanding
MRC	Marine Renewables Canada
MW	Megawatt
NB	New Brunswick
NL	Newfoundland and Labrador

NREL	National Renewable Energy Laboratory
NS	Nova Scotia
NZA	Net Zero Atlantic
OEM	Original Equipment Manufacturer
O&M	Operations & Maintenance
OSW	Offshore Wind
PEI	Prince Edward Island
PIANC	World Association for Waterborne Transport Infrastructure (Permanent International Association of Navigation Congresses)
RAG	Red, Amber, Green
RPS	Renewable Portfolio Standards
SPMT	Self-propelled modular transporters
SSB	Semi-Submersible Barges
SOV	Service Operation Vessel
S&I	Staging & Integration
TLP	Tension Leg Platform
t/m^2	Tonnes per square meter
Tonnes	Metric Tonnes
US	United States
WEA	Wind Energy Area
WTG	Wind Turbine Generator
WTIV	Wind Turbine Installation Vessel

Executive Summary

Background

This study was initiated by Net Zero Atlantic (NZA), a leading independent energy research organization advancing Atlantic Canada's transition to a low-carbon future by encouraging growth of a sustainable energy sector through identifying knowledge gaps, connecting experts to projects, and leading applied research. NZA, in partnership with offshore wind (OSW) developers Northland Power, Simply Blue Group, and Nova East Wind Inc, acknowledges the essential need for port locations to support the Canadian offshore wind market and commissioned this study to identify potential primary port locations in Atlantic Canada. To complete this assessment, leading offshore wind and port consultants, Moffatt & Nichol, were selected along with partners Xodus, Angler Solutions Inc, Envigour Policy Consulting Inc and Caron Hawco Group.

Scope

The purpose of this study was to conduct a comprehensive assessment of primary offshore wind port capabilities in Atlantic Canada (covering the provinces of New Brunswick (NB), Newfoundland and Labrador (NL), Nova Scotia (NS) and Prince Edward Island (PEI)) and the necessary infrastructure upgrades required to serve the emerging OSW industry. This report provides infrastructure investors, developers, federal and provincial policymakers, port owners and operators, and other stakeholders and right holders with valuable insights into the current state of port infrastructure in the region.

The main objectives of this study can be broken down into the following:

- Provide an overview of the OSW industry and market conditions in Atlantic Canada, with anticipated timescales for project development and the forecasted demand for port services.
- Establish port infrastructure requirements to enable fixed-bottom and floating OSW projects to be developed in Atlantic Canada.
- Assess the current infrastructure at identified ports in the context of supporting primary OSW activities, identify any service requirement gaps for both fixed-bottom and floating OSW projects, and estimate the investment required to close these gaps.
- Provide actionable recommendations based on the study's findings to enhance Atlantic Canada's ability to support the growing OSW industry and ensure the region is well positioned as a global leader in clean energy.

Market findings and opportunities

In addition to assessing primary port locations, the study assesses the current and future demand of the OSW market in both Atlantic Canada and the US. The market analysis, conducted by Xodus in collaboration with local partners took an in-depth look at current offshore wind port demand and provided projections of future demand based on development scenarios for both markets.

The US market currently has 1.9 gigawatt (GW) of OSW capacity either operational or under construction. Many US states have published targets for OSW procurement. Based on these targets, the study found that demand for wind turbine generating components will peak in 2050, and that there is a strong likelihood that Atlantic Canadian ports will continue to support OSW marshalling for the US market through this date. The Atlantic Canadian market currently supports wind turbine generator (WTG) and foundation (FOU) marshalling for projects in the Northeastern United States, a trend which is expected to continue for the foreseeable future. While Atlantic Canada does not have a history supporting array and export cable activities, given regional experience, this is seen as a future opportunity.

Although Atlantic Canada has no operational OSW projects, it offers an ideal location for both fixed-bottom and floating OSW projects with consistent wind speeds and favourable bathymetric conditions. Several provinces have conducted regional assessments, and in particular, Nova Scotia has proposed five Wind Energy Areas (WEA) for commercial development. Based on an assumed installation capacity of 500 megawatt (MW) per marshalling port and one operation & maintenance (O&M) facility per project, three Atlantic Canada OSW development scenarios were established:

- Low Scenario: 2.5 GW installed capacity by 2050, requiring one marshalling port and four O&M ports.
- Medium Scenario: 7.5 GW installed capacity by 2050, requiring two marshalling ports and nine O&M ports.
- High Scenario: 11.5 GW installed capacity by 2050, requiring three marshalling ports and 12 O&M ports.

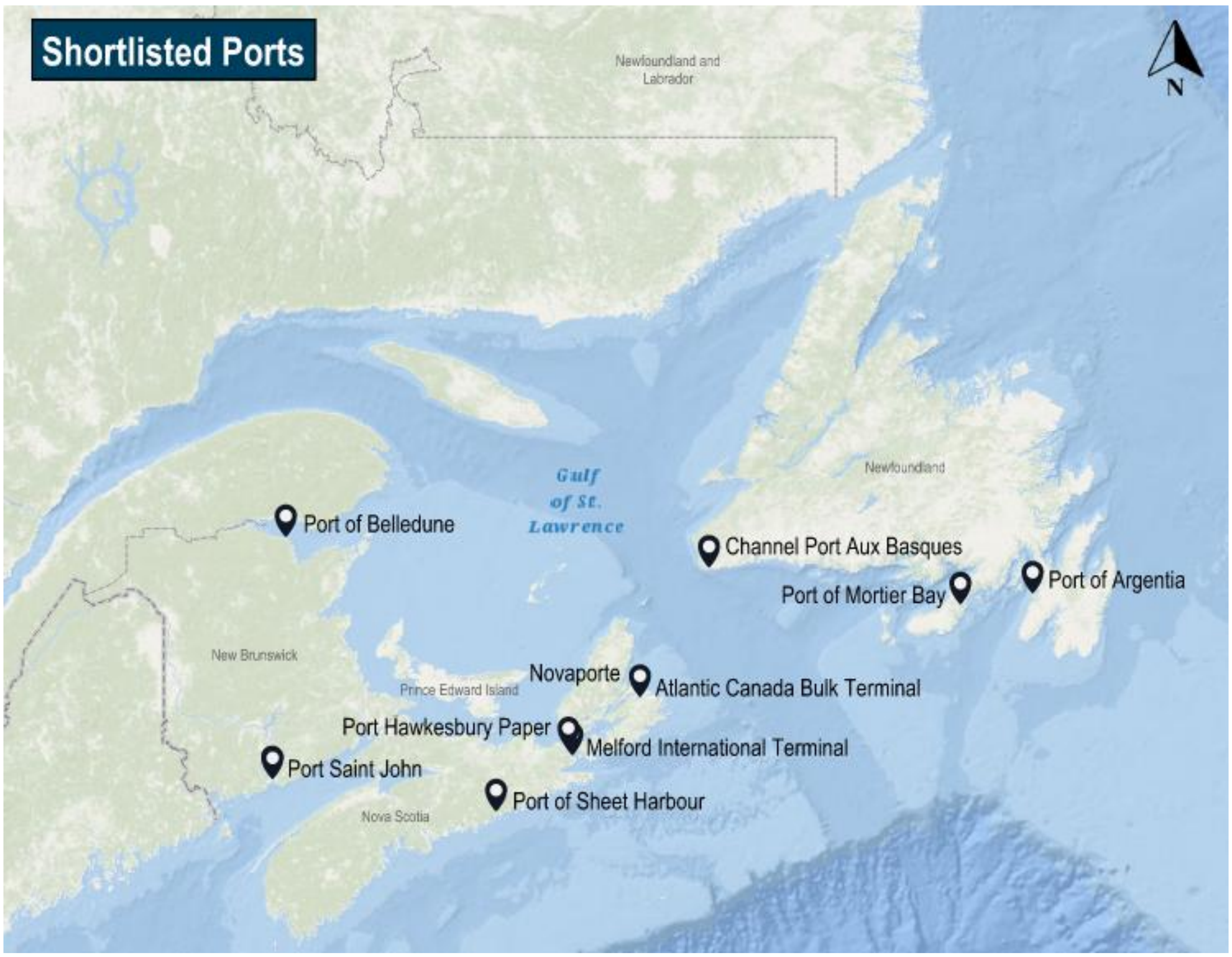
Port assessment process

This assessment began by establishing minimum criteria for each of the three primary offshore wind port categories: fixed-bottom marshalling (referred to as fixed marshalling), floating offshore wind (FLOW) foundation assembly, and FLOW staging & integration. The established criteria focused on critical characteristics: (waterfrontage, upland area, air draft restrictions and navigational characteristics). Simultaneously, a port inventory was developed for all four Atlantic Canadian provinces, with a total of 77 sites identified and documented.

A red flag analysis using established minimum criteria was then used to screen the 77 identified port locations for suitability as a primary offshore wind port. This red flag analysis narrowed the port inventory to 26 sites. Further screening and evaluation was conducted by direct outreach with port representatives and input provided following a public information session. The public information session was held on February 19th 2025 and included 163 attendees. The attendees consisted of members from private industry (64 attendees), academic institutions (5 attendees), indigenous groups (3 attendees), and both governmental and non-governmental organizations (36 attendees).

Based on the screening criteria and information gathered from engagement, a shortlist of ports that were deemed suitable for primary offshore wind port activities was identified. The final selection of ports are those that met the screening criteria and agreed to participate in the study.

SHORTLISTED PORTS



Source: Moffatt & Nichol on ArcGIS

The table below identifies the 10 shortlisted ports that agreed to participate in the study and met the required criteria as well as the suitability of each site to support various primary OSW activities. It should be noted that for the purpose of this study, a 1 GW project with a one-year installation timeline for fixed-bottom projects and the completion of one integrated unit per week for floating projects was considered. Moffatt & Nichol understands this FLOW output may be aggressive and is highly dependant on weather thresholds, however, this is in line with the current industry expectations. It is acknowledged that some OSW developers may require less infrastructure to install a smaller project over a longer timeline. Ports that were included in the shortlist but not nominated for a particular activity may in fact be able to service this activity on a smaller scale.

SHORTLIST OF OSW PORTS AND RESPECTIVE OSW ACTIVITIES

Port Name	Region	Fixed Marshalling	FLOW Staging & Integration	FLOW Foundation Assembly	FLOW Combined
Port of Belledune	New Brunswick	Y	N	N	N
Port Saint John	New Brunswick	Y	Y	N	N
Channel Port aux Basques	Newfoundland & Labrador	Y	N	N	N
Port of Argentia	Newfoundland & Labrador	Y	Y	Y	Y
Port of Mortier Bay	Newfoundland & Labrador	Y	Y	Y	Y
Atlantic Canada Bulk Terminal	Nova Scotia	Y	Y	Y	Y
Melford International Terminal	Nova Scotia	Y	Y	Y	Y
Novaporte	Nova Scotia	Y	Y	Y	Y
Port of Sheet Harbour	Nova Scotia	Y	Y	Y	Y
Port Hawkesbury Paper	Nova Scotia	Y	Y	N	N

Source: Moffatt & Nichol

The 10 ports deemed suitable for primary OSW activities were further analyzed in a qualitative assessment to identify required upgrades. When considering required upgrades, only the waterfront and upland area verified by direct engagement with each site was considered available. The significant weight and size of OSW components requires bearing capacities considerably higher than most traditional port uses, driving the need for wharf and upland improvements at many of the sites considered. Required infrastructure upgrades focused on:

- Wharf Upgrades
  - Increase in length
  - Increase of bearing capacity
  - Use of concrete caisson construction
- Reclamation/Infill
  - Expansion of infill area
  - Grading and compaction of soils adjacent to wharf
- Uplands Upgrades
  - Grading and compaction of upland soils
  - Expansion of usable port area from identified available areas
- Berth Pocket Dredging
  - Assumption of 30% contaminated soils and 70% clean soils

This secondary analysis also included the development of port layouts, AACE 18R-97 Class 5 cost estimates, and project permitting and construction timelines based on the OSW activities that each site was deemed suitable for. Analysis was conducted based on meeting the minimum criteria established as part of this study. Any permits reported as completed by a particular port were considered in the permitting timeframe. Potential layouts for each site can be found in Appendix A.

SUMMARY OF CONSTRUCTION COST ESTIMATES AND PROJECT TIMELINES

Port	Province	Project Development Timeline	Fixed Marshalling, FLOW Staging & Integration	FLOW Foundation Assembly	FLOW Combined
Port of Belledune*	NB	45 – 63 Months	$ 177,900,000	-	-
Port Saint John	NB	45 – 63 Months	$ 256,500,000	-	-
Channel Port aux Basques*	NL	69 – 93 Months	$ 324,300,000	-	-
Port of Argentia	NL	21 – 36 Months	$ 8,800,000	$ 230,100,000	$ 230,100,000
Port of Mortier Bay	NL	69 – 109 Months	$ 469,600,000	$ 660,500,000	$ 964,700,000
Atlantic Canada Bulk Terminal	NS	27 – 51 Months	$ 135,200,000	$ 158,600,000	$ 230,000,000
Melford International Terminal	NS	48 – 63 Months	$260,300,000	$ 305,500,000	$ 441,500,000
Novaporte	NS	48 – 63 Months	$ 346,300,000	$ 434,600,000	$ 653,900,000
Port of Sheet Harbour	NS	52 – 80 Months	$ 246,900,000	$ 261,700,000	$ 490,400,000
Port Hawkesbury Paper	NS	45 – 63 Months	$ 357,500,000	-	-

*Port's navigational channel is constrained and unable to support FLOW activities.

Source: Moffatt & Nichol

Conclusion and recommendations

Conclusions drawn from this study, which focused on identifying potential primary offshore wind ports in Atlantic Canada, are as follows: There is demand for ports in Atlantic Canada that are willing and capable to support the OSW industry as primary ports for both fixed-bottom and floating OSW.

- The identified sites are situated in locations that can support both the Canadian and US OSW industries.
- Several Atlantic Canadian ports (Argentia, Atlantic Canada Bulk Terminal and Sheet Harbor) have already supported offshore wind projects on the East Coast of the US and have reported interest in continuing this activity. The need for this support will be highly dependant on the current and future US administrations policies on renewable energy.
- Based on the demand analysis performed, at least one primary port, with potential demand for three, will be required to meet Atlantic Canadian OSW targets.

In addition, further assessment is recommended in the following areas.

- Study of potential funding opportunities to support the development of primary offshore wind ports. This should consider both provincial and federal level government funding as well as private equity.
- Further, in depth, study of individual sites and their capabilities and challenges in completing the required infrastructure upgrades necessary to support primary OSW activities.
- Although the study focuses on primary ports for delivering OSW projects, many of the ports identified in initial screening can be considered for secondary activities. As it is predicted that there are significant demand for these ports in the future, a separate study, focused on assessing ports capable of secondary offshore wind activities is recommended.

1. Introduction and Background

1.1. Background

Net Zero Atlantic (NZA) is an independent leading energy research organization advancing Atlantic Canada's transition to a low-carbon future by encouraging growth of a sustainable energy sector through identifying knowledge gaps, connecting experts to projects, and leading applied research. NZA is dedicated to an inclusive and successful clean energy transition in Atlantic Canada using credible and unbiased research that will best prepare policymakers, industry leaders and workers, and sector investors to work together on pathways to decarbonize the region's economy, mitigate climate change impacts, and move Atlantic Canada toward net-zero emissions.

NZA acknowledges the important role ports play in maintaining and growing our economies. Each port is as unique as the communities it serves. Similarly, NZA recognize Atlantic Canadian ports as being essential components of the specific infrastructure required to complete the energy transition underway now. Ports and suitable port infrastructure are key to the successful delivery of offshore wind (OSW) projects, with turbine components and foundations transported through these gateways. Port locations serve as a link between marine and landside activities and often become a hub for supply chain activity. While it is well recognized that ports perform several critical functions within the OSW industry, there is a significant lack of information on port infrastructure capabilities in relation to anticipated industry needs for Atlantic Canada.

NZA, in partnership with three offshore wind developers (Northland Power, Simply Blue Group, and Nova East Wind Inc) has commissioned this assessment of Atlantic Canadian Ports to be conducted by Moffatt & Nichol and partners: Xodus, Angler Solutions Inc, Envigour Policy Consulting Inc, and Caron Hawco Group.

1.2. Objective

The purpose of this study is to conduct a comprehensive assessment of the port infrastructure in Atlantic Canada and the necessary infrastructure upgrades required to serve the emerging OSW industry. This report intends to provide infrastructure investors, developers, federal and provincial policymakers, port owners and operators, and other stakeholders and right holders with valuable insights into the current state of port infrastructure in the region.

The main objectives of this study can be broken down into the following:

- Provide an informative overview of the OSW industry and market conditions in Atlantic Canada, with anticipated timescales for project development and the forecasted demand for port services.
- Establish port infrastructure requirements to enable fixed-bottom and floating OSW projects to be developed in Atlantic Canada.
- Assess the current infrastructure at identified ports in the context of supporting primary OSW activities, identify any service requirement gaps for both fixed-bottom and floating OSW projects, and estimate the investment required to meet these gaps.
- Provide actionable recommendations based on the study's findings to enhance Atlantic Canadian ports' ability to support the growing OSW industry and ensure the region is well positioned as a global leader in clean energy.

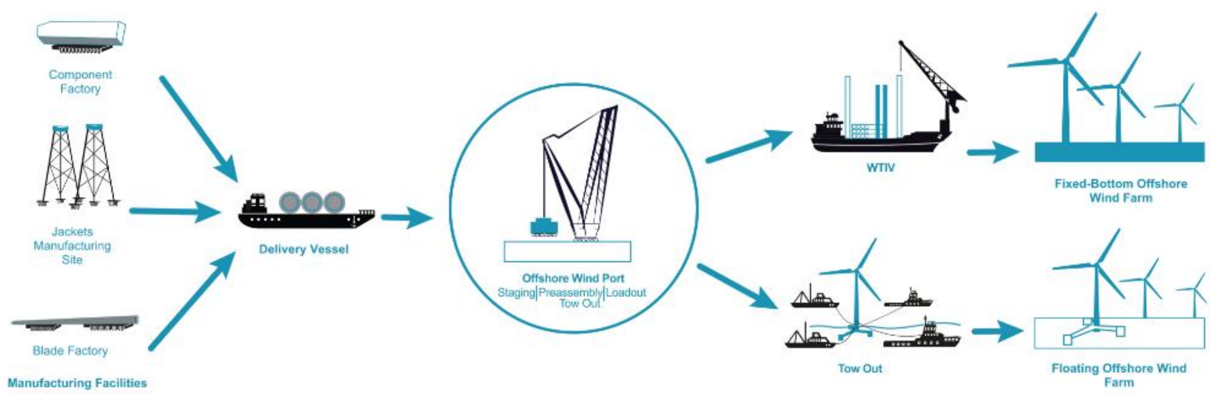
The focus of this study is a high-level assessment of facilities that are identified as suitable for supporting the OSW market. Two categories of offshore wind ports are needed, primary and secondary, which will be described in further detail within this report. This study focuses on primary port activities including fixed marshalling, floating offshore wind (FLOW) staging & integration, FLOW foundation assembly and a FLOW combined foundation assembly and staging & integration port. This study does not assess but does provide discussion of secondary ports such as operations & maintenance (O&M), cable storage and loadout facilities, mooring chain/rope and anchor handling facilities, and manufacturing facilities. Suitable ports were identified using a selection process that is detailed further in Section 4.2 of this report. It should be noted that detailed engineering was not performed as part of this study.

2. Offshore Wind Overview

Ports serve a critical function in the offshore wind (OSW) supply chain, acting as logistical hubs for project build-out. The installation efficiency for OSW projects is directly influenced by the logistical and operational capabilities of the utilized port infrastructure. Fixed-bottom and floating OSW projects each have distinct port requirements. Fixed-bottom OSW projects primarily rely on marshalling ports for component delivery, staging, preassembly and install vessel loadout, while floating offshore wind (FLOW) projects necessitate additional port functions such as foundation assembly, turbine integration, and turbine pre-commissioning. Secondary ports are also required for the development and long-term maintenance of both types of offshore wind projects.

The figure below highlights the importance of ports within the OSW development supply chain.

FIGURE 2.1: PORTS IN THE OSW SUPPLY CHAIN



Source: Moffatt & Nichol

Key characteristics of offshore wind ports related to this study are described below.

TABLE 2.1: DEFINITION OF OFFSHORE WIND PORT CHARACTERISTICS

Term	Definition
Navigation Channel	A dredged or naturally occurring waterway designated for vessel traffic which provides a corridor for safe passage, often through areas of shallow water or obstacles.
Berth	A designated location where a vessel can dock, usually along a wharf.
Wharf	A level shoreside area where a vessel can be tied up and docked. Wharfs are often comprised of multiple berths.
Upland	Any area adjacent to the wharf or waterfront of a particular site. Typically for OSW, the upland area is where components are stored and must be free of obstacles.
Sinking Basin	An area of naturally occurring or dredged deep water suitable for unloading semi- submersible vessels.
Wet Storage	Area used for the storage of floating foundations, both pre- and post-integration, before tow-out to a final installation site.
Preassembly area	Dedicated quayside area to stage wind turbine generator (WTG) components and preassemble towers in a controlled environment before loading onto an installation vessel.

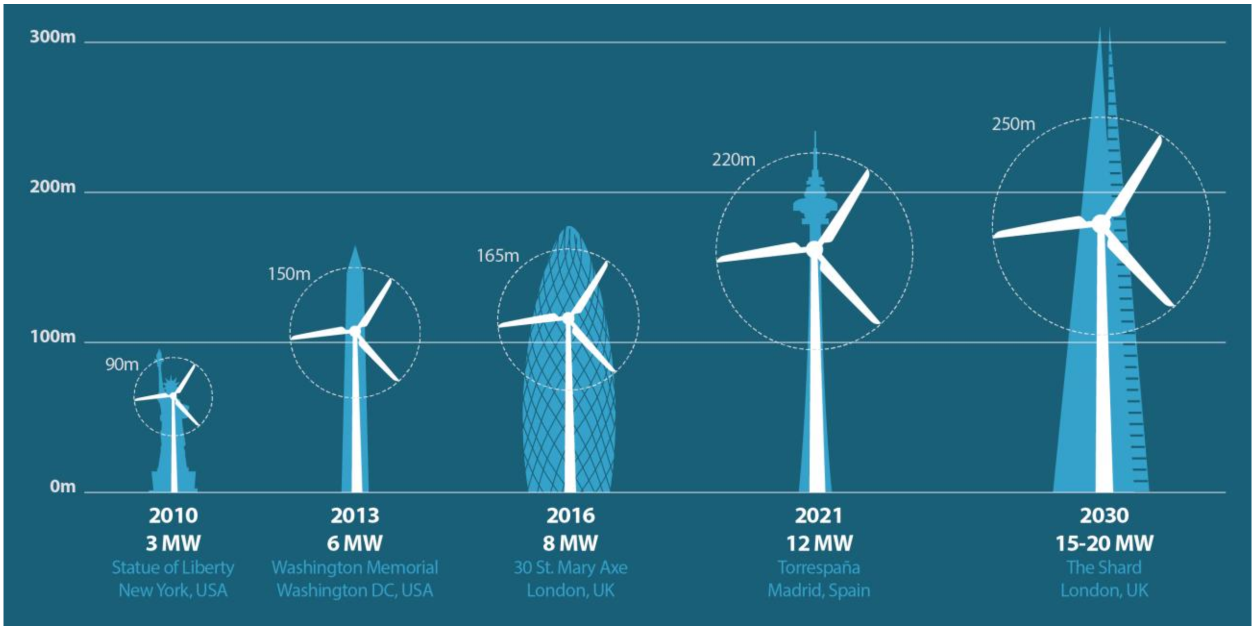
Source: Moffatt & Nichol

2.1. Fixed-bottom and Floating Offshore Wind Components

2.1.1. Wind Turbine Generation (WTG)

The size and weight of OSW components is the driving factor behind minimum criteria for a primary offshore wind port. Over the past 25 years, commercial WTG sizes have increased from 3 megawatt (MW) to the 12-15 MW units being installed today. While turbines of up to 15 MW are currently commercially available, the anticipated size of turbine systems to be installed in the near future is expected to range from 18 to 22 MW. This study aims to futureproof the port infrastructure required to support the OSW industry. As such, the base case for this assessment is a turbine size of 18-22 MW turbine, with its approximate dimensions provided in Table 2.2.

FIGURE 2.2: INCREASE IN TURBINE SIZES OVER THE YEARS



Source: Moffatt & Nichol

The values outlined in the table below are those recommended for planning a major port terminal on a 50-year time horizon to meet the anticipated needs of the continuously developing OSW industry. Values are approximate as these technologies are still in development.

TABLE 2.2: WTG COMPONENTS DIMENSIONS (18-22 MW)

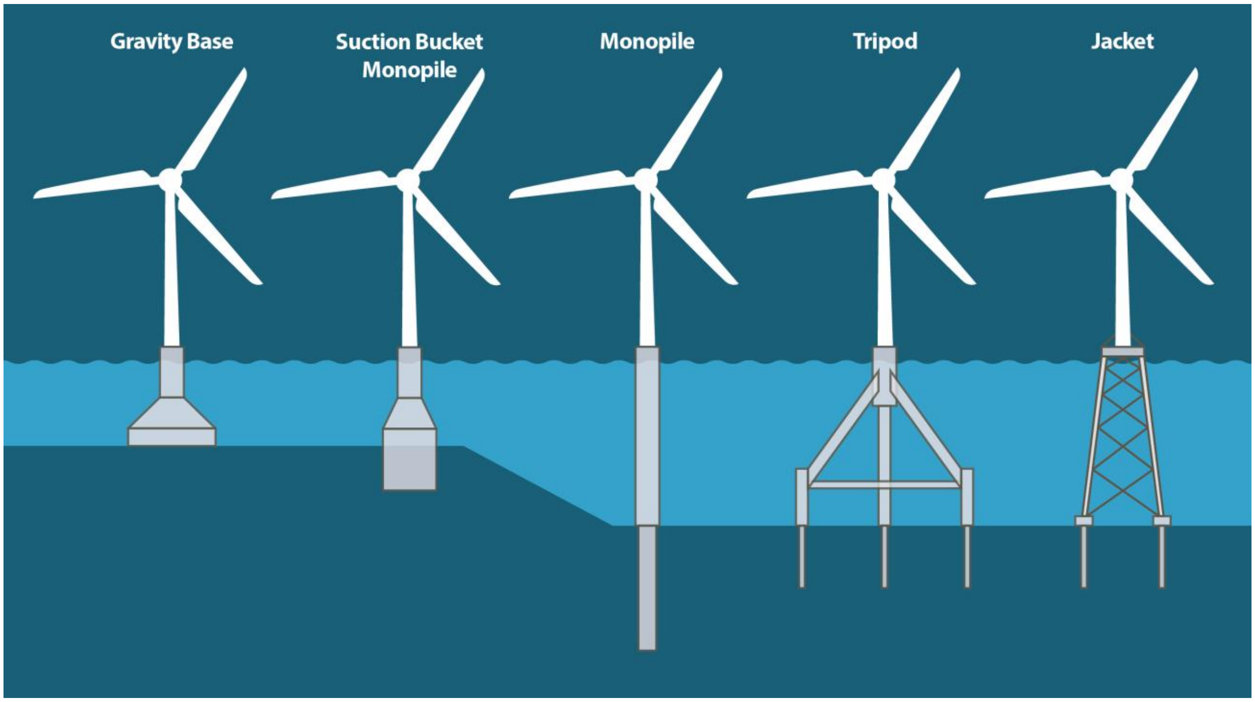
WTG Component	Approximate Dimension (m)	Approximate Weight (tonnes)
Nacelle	26 m L x 13 m W x 13 m H	1,200 tonnes
Tower Section (avg)	9.5 m diameter x 40 m L	340 tonnes
Blade	140 m L x 6 m diametre at root	110 tonnes

Source: Moffatt & Nichol

2.1.2. Fixed-bottom Foundation (FOU)

The most common fixed-bottom foundations utilized in the OSW industry are monopiles and jackets. While other fixed-bottom foundation types exist, any offshore wind port facility should be able to accommodate monopiles and jackets at a minimum.

FIGURE 2.3: TYPES OF FIXED-BOTTOM FOUNDATIONS



Source: Moffatt & Nichol

2.1.2.1. Monopiles

Monopiles are the most used foundation type for fixed-bottom OSW projects and can be installed in water depths up to approximately 60 m. Monopiles consist of a single large steel pile on which a WTG tower is mounted. The exact dimensions of a monopile are specific to each installation site and may vary based on factors such as water depth, geotechnical conditions, and metocean conditions. Between the monopile and WTG tower, a transition piece is sometimes used for connection and access. Transition pieces also vary in size and need to be marshalled similarly to the foundations themselves.

2.1.2.2. Jackets

Jackets are often used when monopiles are no longer economically viable or when ground conditions are unsuitable for monopile installation. They are typically used in water depths of up to approximately 75 m. Jackets are three or four-legged steel lattice structures consisting of tubular beams and braces. They are often secured to the seabed using pin piles or suction buckets. Pin piles are typically installed separately from jackets whereas suction buckets are directly attached to the bottom of the jackets and installed simultaneously.

2.1.2.3. Gravity Based Structure (GBS)

Gravity based foundations are precast concrete structures ballasted with gravel, sand or stones that are typically used in depths up to approximately 30–35 m. Gravity base foundations are often used in sites where soil composition makes pile driving impractical. These foundations are technologically proven in the oil and gas industry. However, the foundation has a large install footprint, requires a specific seabed condition (high bearing capacity) and seabed preparations.

2.1.2.4. Suction Bucket Monopile

A suction bucket monopile foundation is shaped as an upside-down cylinder that's pressed into the soil. The suction bucket is an existing offshore technology and operated by penetrating the seabed partly by self-weight and partly by applied suction. This type of foundation is utilized in water depths up to 60 m and has the advantage of producing less vibration during installation and having a shorter construction period. A disadvantage is that the suction bucket is highly subjected to soil characteristics.

2.1.2.5. Hybrid Monopile

A hybrid foundation is new type of support that aims to reduce the length and increase the lateral stiffness of a standard monopile. The foundation is typically composed of a vertical pile and an additional element such as a horizontal bearing plate or tripod legs extending from the monopile. These types of foundations have been proposed in waters up to approximately 100m deep.

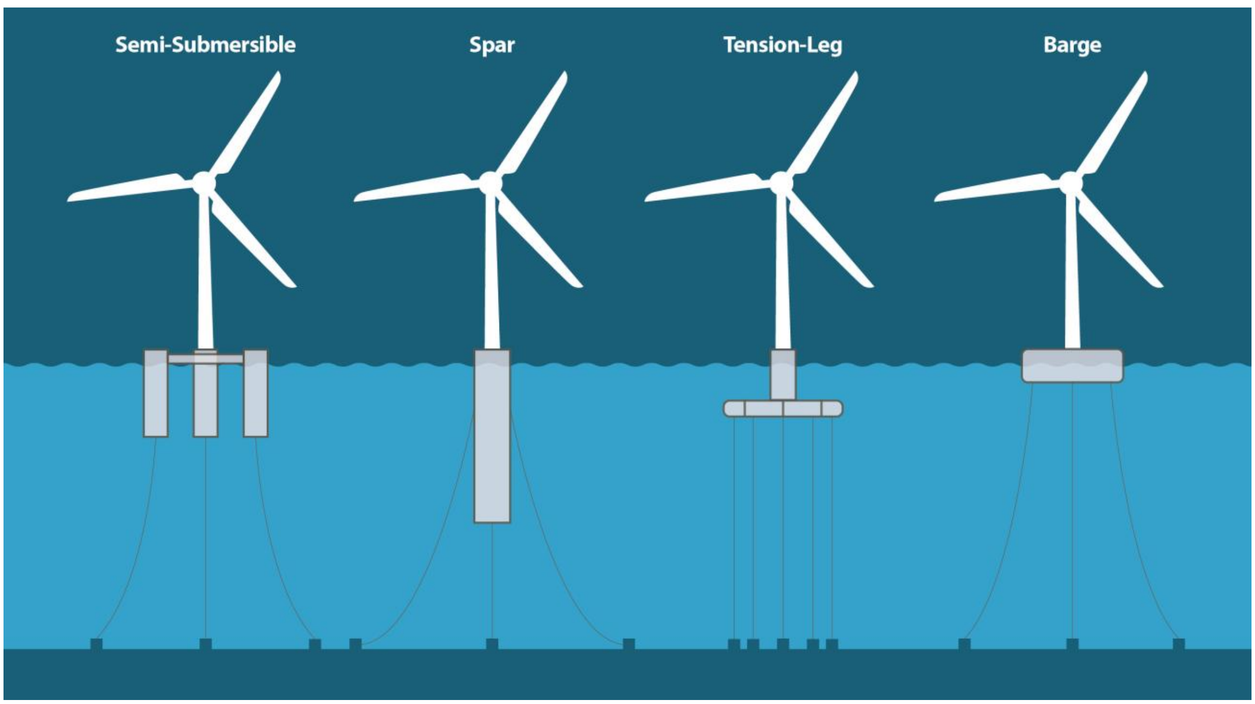
2.1.3. Floating Foundation

Floating foundations are used when water depths, typically greater than approximately 75 m, make the use of traditional fixed-bottom foundations impractical or uneconomical. These types of foundations support WTG systems on a floating platform which is held in place by a mooring and anchoring system. A key distinction in shoreside activities for floating offshore wind (FLOW) development is that floating foundations are integrated with WTG components at the port before being towed to an installation site. Foundations can either be constructed at a facility adjacent to the staging and integration site or imported. Foundations are typically constructed of steel or concrete:

- Concrete foundations are cast at the port using aggregates and other raw materials before being launched and integrated.
- Steel foundations are typically assembled from prefabricated steel sections transported to the port before being launched and integrated.

While the specifics of floating foundation design vary greatly, four major categories are typically defined. They are tension leg, barge, semi-submersible, and spar type platforms. Images of each are shown in Figure 2.4. Although the ultimate type of foundation and design will be based on project specific constraints and preferences, the characteristics to define the differing foundation categories are expanded upon in the following subsections. Typical foundation dimensions are shown below in Table 2.3.

FIGURE 2.4: MAIN TYPES OF FLOATING FOUNDATIONS



Source: Moffatt & Nichol

TABLE 2.3: FLOATING FOUNDATION AND INTEGRATED TURBINE DIMENSIONS (18–22 MW)

Floating Foundation Only	Approximate Dimension (m)
Foundation Beam / Width	Up to 130 m x 130 m
Foundation Weight (steel)	3,600 - 8,100 mt
Foundation Weight (concrete)	15,400 - 22,700 mt
Draft (Before Integration)	4.5 – 7.5 m
Integrated Floating Offshore Wind Turbine (WTG and FOU)	**Approximate Dimension (m)**
Draft (After Integration)	8 – 15 m
Hub/Nacelle Height (from Water Level)	Up to 183 m
Blade Tip Height (from Water Level)	Up to 305 m
Rotor Diameter	Up to 280 m

Source: NREL

2.1.3.1. Tension Leg Platforms

Tension leg platforms (TLP) utilize a taut mooring system to achieve stability of the platform and the installed turbine. These foundations are often smaller in size compared to other platform types. TLP's provide decreased motion based loading due to their smaller waterplane area. Their taught mooring systems also have a smaller benthic footprint. The disadvantages of a taut mooring system include the need for specific seabed conditions to handle specialized, vertically loaded, anchors. These foundations may also encounter stability issues or require supplemental lift units while at the wharf.

2.1.3.2. Barge Platforms

Barge platforms rely primarily on increased waterplane area for stability. Mooring systems for barge platforms typically are catenary. Barge platforms are easy to install, but generally have higher motion based loads than other floating foundations.

2.1.3.3. Semi-submersible Platforms

Semi-submersible platforms consist of a system of interconnected buoyancy modules designed to maximize stability while minimizing waterplane area and motion induced loading. These platforms can be moored by a variety of mooring systems such as catenary, taut, and semi-taut designs. The size and weight of semi-submersible foundations can cause challenges in assembly and loadout.

2.1.3.4. Spar Platforms

Spar foundations consist of a single, vertical, monopile like structure. The minimized waterplane area reduces motion induced loading. The depth required for the integration of spar type foundations limits their application to areas with very deep water ports.

2.2. Primary Offshore Wind Ports

There are four primary offshore wind port types:

- Fixed marshalling
- FLOW combined assembly and staging & integration
- FLOW staging & integration
- FLOW foundation assembly

2.2.1. Fixed-bottom Offshore Wind Marshalling Ports

For fixed-bottom OSW, marshalling ports serve as the central hub for project logistics. Activities include receiving and storing WTG and foundation components from original equipment manufacturer's (OEM's), preassembly of components, and load-out onto installation vessels. To limit travel time and transportation costs, marshalling ports are ideally located in close proximity to OSW lease areas and must be capable of accommodating a range of vessels.

Marshalling ports are comprised of flat, open uplands, typically greater than 14 ha, and a straight wharf to allow for simultaneous delivery and load out operations. Operations include:

- Delivery and storage of WTG and foundations components
- Preassembly of components
- Loading of installation vessels

- Serving as the project's operational headquarters for construction and initial maintenance activities

WTG components and foundations are delivered to marshalling ports by large cargo, heavy lift transport vessels and barges. For a 1 gigawatt (GW) OSW project of 20 MW WTG components, deliveries generally occur on a 10- to 14-day cycle for eastern North American projects, with one to two vessels being unloaded per week. Unloading operations utilize various methods depending on component size and port infrastructure, including roll-on/roll-off (RoRo), vessel-mounted cranes, or shore-based cranes.

Onshore, port operations include component storage and preassembly of WTG components before loading onto the installation vessels. Towers are typically preassembled at the installation berth prior to being loaded onto the installation vessel. This is done to minimize the crane assembly activities at the offshore installation site. Depending on vessel deck capacity, transit times and installation schedules, installation vessels return to port approximately every 7 to 10 days for reloading.

2.2.2. Floating Foundation Assembly and Staging & Integration Port

FLOW introduces additional port infrastructure requirements and activities beyond those of fixed-bottom OSW projects. These activities include:

- Assembly/casting of floating foundations
- Integration of WTG components with floating foundations
- Pre-commissioning of fully integrated turbines

These activities require significant additional uplands area and wharf length.

The most significant additional requirement for a port that will support floating OSW is the assembly/casting and launch of foundations. These foundations can be steel or concrete.

Steel foundation sections will be manufactured offsite and transited to the port. Once on site the foundation components will be stored in the designated uplands area. The components will then be assembled in the uplands yard. Assembly consists of framework and bracing, bolted or welded connections and coating. Finished foundations will be moved to the face of the wharf for launching.

Concrete foundations will be cast in the uplands area. Raw materials such as aggregate, cement and sand will be delivered to the port via truck or barge. These materials will then be moved and stored near the on-site concrete batch plant. The concrete foundations can be cast in modules and then assembled or using mass pours. Assembling the formwork and installation of reinforcing steel are also a significant activity. Finished foundations will be moved to the face of the wharf for launching.

Launching options for floating foundations include a semi-submersible barge, direct crane lift, ship lift elevator systems, and ramps. For commercial scale operations, this activity will require a dedicated berth at the wharf. For the purposes of this study a semi-submersible barge methodology was assumed.

Once the foundation is completed and launched, it will have the WTG components integrated at the port. This differs from fixed-bottom OSW where the WTG components are integrated onto the foundation at the offshore assembly site. This port integration method enhances installation efficiency by making use of a stable working environment within the port, eliminating the need for specialized offshore installation vessels, and reducing exposure to adverse marine conditions.

Following integration, pre-commissioning is conducted in port to verify mechanical and electrical systems before the turbine is deployed. Once pre-commissioned, completed units are towed off the wharf to either the installation site or a wet storage area to await final tow-out. Fully integrated units can be towed to the installation site only when wave and wind conditions are under set thresholds. If the weather thresholds are exceeded the units must be stored in wet storage while waiting for an acceptable weather window.

Given the additional port operations, delivery vessel frequency is expected to be higher than for fixed-bottom OSW, with two to three vessels arriving per week to supply both foundation materials and turbine components.

While a combined foundation assembly and S&I port is most efficient, identifying a site capable of both operations may be difficult. In such cases, a multi-port strategy may be employed, conducting foundation assembly at one site and S&I activities at another.

2.2.3. Floating Offshore Wind Staging & Integration Port

When a multi-port strategy is followed, there is a need for a dedicated S&I port. S&I ports accommodate component marshalling, integration of WTG components onto the floating foundation, and pre-commissioning activities. WTG components are delivered and stored on-site. Fully assembled floating foundations are delivered to the site either by heavy transport vessel (HTV) or towed from an alternative port location. The delivered foundations will likely be stored in wet storage and then moved to the integration berth at the wharf where the WTG components will be integrated onto the foundation.

Following integration, pre-commissioning is conducted in port to verify mechanical and electrical systems before the turbine is deployed. Once pre-commissioned, completed units are towed off the wharf to either the installation site or a wet storage area to await final tow-out. This location is weather dependant. Fully integrated units can be towed to the installation site only when wave and wind conditions are under set thresholds. If the weather thresholds are exceeded to the units must be stored in wet storage while waiting for an acceptable weather window.

2.2.4. Floating Foundation Assembly Port

At floating foundation assembly ports, foundation components are delivered, stored and assembled on-site. Once the foundation is fully assembled, it is launched into the water by a variety of methods. To date, the launching of FLOW foundations from the wharf deck to the water, has not been commercialized. Various methodologies including semi-submersible barge, direct crane lift, ship lift elevator system, graving dock, and ramps are being considered. Once launched, foundations are placed in wet storage or towed to the staging and integration port. Fully assembled floating foundations can be towed to the installation site only when wave and wind conditions are under set thresholds. If the weather thresholds are exceeded to the units must be stored in wet storage while waiting for an acceptable weather window.

2.3. Secondary / Auxiliary Offshore Wind Ports

Secondary ports play an important supporting role in the development of OSW projects. Numerous activities outside of those completed at primary ports are required for successful project development and the maintenance of installed projects. These auxiliary activities include but are not limited to:

- Operations and Maintenance
- Cable storage and loadout
- Mooring chain/rope and anchor handling
- Manufacturing

2.3.1. Operation and Maintenance Facilities

Operations and Maintenance (O&M) ports serve a critical function in supporting long-term OSW maintenance. These smaller ports provide berthing and supply points for vessels responsible for servicing OSW turbines. Unlike marshalling ports, O&M ports can be developed from a wider selection of existing port facilities, as they are subject to fewer constraints related to air draft, navigation, and upland area. These ports typically support crew transfer vessels (CTV) and service operations vessels (SOV).

2.3.2. Subsea Cable Storage Facilities

There are currently no manufacturers of electrical subsea cables in the region. As such, subsea cables will be imported and a waterfront facility will be needed to store and stage inter-array and export cables before being loaded onto a Cable Laying Vessel (CLV).

At this type of facility, subsea cables are imported by a delivery vessel and stored in tanks or turntables in the uplands. The quantity of cable required is variable by project and depends on factors such as water depth, cable depth, and distance to installation site. At a minimum, a cable handling facility should be able to support 10 turntables or baskets, each weighing between 3,000 and 6,000 tons when fully loaded. CLV's then berth at the port and spool cable from the baskets and turntables onto their own onboard storage, a process that may take several days

2.3.3. Anchor Handling Facilities

FLOW turbines will require large and complex mooring systems consisting of a combination of chain, synthetic or wire rope, and a variety of anchor types. Waterfront facilities will be needed to store and stage these materials as well as load them onto anchor handling vessels. Requirements for shoreside facilities to support anchor handling vary by anchor type and water depth.

2.3.4. Manufacturing Facilities

The size of OSW components often dictates that component manufacturing facilities be located on a navigable waterway. These facilities receive raw materials, create components, and store and export them to marshalling yards.

2.4. Terminal Equipment

A variety of specialized shoreside equipment is required at offshore wind ports. The heights and loads of the lifts that occur in offshore wind ports are extreme, requiring some of the largest lifting equipment in the world and driving the need for significant bearing capacity (between 15–30 tonnes per square meter). This equipment includes several types of cranes and self-propelled modular transporters (SPMT).

2.4.1. Cranes

Cranes are required for delivery vessel offloading, WTG preassembly and integration, floating foundation assembly, and install vessel load-out.

Ring cranes are commonly used for both preassembly of tower sections and WTG integration. These are large luffing jib cranes with their slewing pivot in the form of a ring-shaped track. Examples of ring cranes designed for offshore wind port logistics include the Mammoet SK-6000, the Sarens SGC 250, and the BMS/Huisman ring crane. The key advantage of ring cranes is their high lifting capacities and their ability to distribute loads efficiently, in such a way that ground bearing capacities are manageable.

Crawler cranes are typically used at the delivery berths to unload vessels or as an alternative to ring cranes at the S&I berth. These cranes can also be employed at floating foundation assembly sites for the assembly of foundation components. Examples of crawler cranes used in offshore wind port logistics include the Liebherr 11000 and 13000. Crawler cranes are more readily available than ring cranes and require less assembly but have limitations in terms of height and load capacity. The use of two crawler cranes (also known as dual lift) is common in OSW operations, particularly for lifting long components such as blades and foundations.

FIGURE 2.5: EXAMPLES OF RING CRANE (MAMMOET SK-6000) AND CRAWLER CRANE (LIEBHERR 13000)

Source: Mammoet (SK6,000 crane is launched | Mammoet news) (left) and Liebherr (Liebherr LR 13000 crawler crane modernises Mexican oil refinery - Liebherr) (right)

2.4.2. Self-Propelled Modular Transporters (SPMTs)

Self-Propelled Modular Transporters (SPMT) are specialized vehicles used to transport large components. These vehicles are favored in OSW due to their ability to lift extreme heavy loads, and distribute it into the uplands bearing surface at a reasonable magnitude. They consist of a lifting platform on top of several axels of independent wheels. The platform can be lowered or raised to pickup loads. SPMT's are used to transport both foundation and WTG components throughout a terminal. Multiple SPMT's can be used in tandem to increase the load lifting capacity and/or increase load spreading.

FIGURE 2.6: A 6-AXEL SPMT AND A NACELLE BEING TRANSPORTED BY SPMTS

Source: TII Group (SPMT) (left) and Vestas (right)

2.5. Typical Vessels

2.5.1. Delivery Vessels

Foundation and WTG components are too large for road or rail transport and will arrive at the terminal by vessel, often directly from an OEM manufacturing facility. Delivery vessels are typically large cargo carriers or heavy transport vessels. These vessels can be either geared, having their own cargo cranes, or ungeared, requiring shoreside cranes for offloading.

The design characteristics of geared and ungeared delivery vessels, shown in Table 2.4, are selected to reflect and capture the range of characteristics of typical delivery vessels in the OSW industry.

TABLE 2.4: DESIGN DELIVERY VESSEL CHARACTERISTICS

Vessel Characteristic	Large Cargo Carrier	Heavy Transport Vessel
Length Overall (LOA)	185 m	230 m
Beam	25 m	34 m
Summer Draft	11 m	12 m
Deadweight	23,660 tonnes	82,209 tonnes
Displacement	43,500 tonnes	88,200 tonnes

Source: Moffatt & Nichol in reference to delivery vessels Rotra Futura, BBC Denmark, Cosco XYK

2.5.2. Installation Vessels (Fixed-bottom)

For fixed-bottom OSW, two primary installation campaigns exist: foundation installation and turbine installation. For foundation campaigns, specialized crane vessels are often employed called foundation installation vessels (FIV). For WTG integration, specialized wind turbine installation vessels (WTIV) are used. These vessels have jack-up capabilities and use legs to lift themselves out of the water providing a stable platform for loadout of WTG components at the marshalling port and integration of WTG components at the installation site. The general design characteristics for each of these vessel types can be found in the tables below.

TABLE 2.5: DESIGN FOUNDATION INSTALLATION VESSEL (FIV)

Vessel Characteristic	Foundation Installation Vessel
Length Overall (LOA)	216 m
Beam	49 m
Summer Draft	11 m

Source: DEME Orion

TABLE 2.6: DESIGN WIND TURBINE INSTALLATION VESSEL (WITV)

Vessel Characteristic	Jack-Up Vessel
Length Overall (LOA)	175 m
Beam	63 m
Summer Draft	8.5 m

Source: Van Oord Boreas

2.5.3. Semi-Submersible Barge (FLOW)

For FLOW projects, there must be a method of launching foundations from the assembly site wharf deck into the water. A commonly discussed method that does not involve modifications at the port (such as addition of dry dock or launching ramp) is the use of Semi-Submersible Barges (SSB). Assembled foundations are moved onto the deck of a SSB, via SPMT or rial system. Onces the foundation is on the SSB, it is ballasted down to allow the foundation to float off. Float off may occur away from the launching berth in an area of deeper water. The suitability of existing SSB's to launch floating foundations is situationally dependent and may vary between foundation designs and metocean conditions at a specific assembly site.

Approximate characteristics of a suitable SSB are shown in Table 2.7

TABLE 2.7: PURPOSE-BUILT SEMI-SUBMERSIBLE BARGE

Vessel Characteristic	Purpose-Built Semi-Submersible
Length Overall (LOA)	150 m
Beam	102 m
Summer Draft	5-8 m

Source: Moffatt & Nichol

2.5.4. Tugs

Tug boats play an important role in the offshore wind industry for both fixed-bottom and floating OSW projects. Two major types of tug boats may be used, harbor tugs and anchor handling tugs. Harbor tugs are used to assist in the transit and berthing of vessels calling the port and may also assist anchor handling tugs in towing floating foundations. Anchor handling tugs will be primarily responsible for towing foundations and integrated units. Typical vessels sizes for both harbor tugs and anchor handling tugs are listed below:

TABLE 2.8: TYPICAL HARBOR AND ANCHOR HANDLING TUG

Vessel Characteristic	Harbor Tug	Anchor Handling Tug
Length Overall (LOA)	25 m	95 m
Beam	11 m	23 m
Summer Draft	5-6 m	8 m

Source: Crowley

2.5.5. O&M Vessels

The two major vessels conducting O&M activities are SOV and CTV. These vessels are responsible for transporting workers and equipment to the project site for final commissioning, operations, and maintenance activities. SOV's are larger than CTV's and typically stay at sea for days or weeks at a time, providing hotel services to O&M workers. CTV's are smaller and typically visit a project site and return to port daily.

TABLE 2.9: TYPICAL SOV AND CTV

Vessel Characteristic	Service Operation Vessel	Crew Transfer Vessel
Length Overall (LOA)	80 m	27 m
Beam	18.5 m	9 m
Summer Draft	6.8 m	1.5 m

Source: M/V Eco Edison and Windserve Genesis

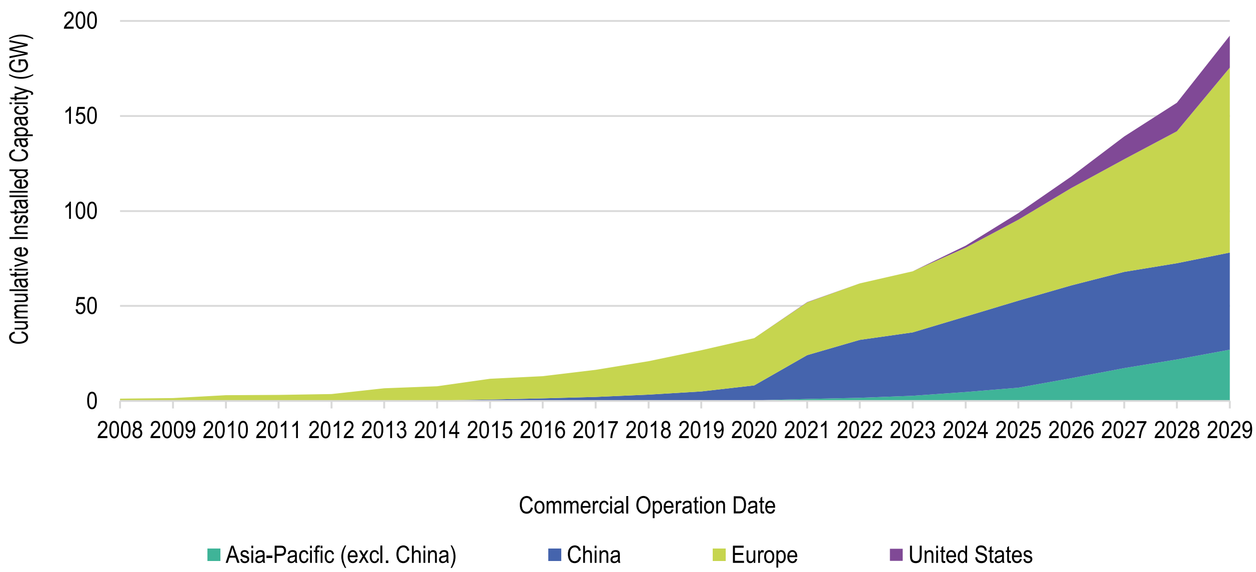
3. Industry and Market Overview

To provide context for the port assessment, this section provides contextual market information on the global offshore wind (OSW) industry. Offshore wind is truly a global industry, with components being shipped all over the world to support a rapid increase in installed capacity. As such, Atlantic Canadian ports have the opportunity to support not only domestic OSW development, but to serve global needs, particularly those of the neighbouring US. The development of these ports are typically financed by Government funding or Private Equity. Private Equity can provide flexibility in development and has proved successful in the UK including Ardersier and the Forth Ports group. These require full technical, cost and permitting plans to be presented to investors and demand a high investment return rate. Government funding in the form of grants from varying levels of government, agencies or public bodies has no requirement to be repaid. This often demands higher scrutiny and more fixed development plans often with requirements and opportunity to enhance the local community. Strategic government investment models have also been used to target specific ports that can serve a wide area and accelerate offshore wind projects. This section includes a special focus on US OSW development and resulting component and port demand, as several Atlantic Canadian ports have served as storage yards for OSW components for US-based projects, to date. While the Canadian OSW industry is in its infancy, details of developments to date are presented along with Low, Medium and High development scenarios out to 2050 to provide an idea of the demand for components and ports that will be required as the industry develops. This is necessary to make key decisions about how many ports will need to be made OSW-ready, and when.

3.1. Global

The global OSW industry continues to expand, driven by ambitious targets set by countries around the world to meet decarbonization goals for 2050. Currently there are nearly 100 gigawatt (GW) of installed OSW capacity, with projections of over 190 GW to be installed globally by the end of the decade, as shown in Figure 3.1. Europe and the Asia-Pacific region are leading the way, with already-established and mature supply chains, competitive players, and significant investments in infrastructure. With such a strong development pipeline, bottlenecks will occur with respect to component, port and vessel demand.

FIGURE 3.1: GLOBAL CUMULATIVE INSTALLED CAPACITY OUT TO 2029



Source: Xodus, derived from NREL Offshore Wind Market Report - 2024 Edition

The European OSW industry's market leaders include the UK, Germany, Denmark, the Netherlands, for OSW, while other European nations such as Italy, Portugal, Sweden, Norway and Poland are emerging as key future markets. Europe played a major role in the development of early OSW and floating offshore wind (FLOW) technology. Europe is also home to a substantial portion of the global OSW supply chain.

The Port of Esbjerg in Denmark is considered the world's largest offshore wind port, with manufacturing, construction, and operation of offshore wind projects. Since 2001, 23.6 GW of offshore wind turbines have been shipped from the port. Green Port Hull, located in the UK, is another major offshore wind port. Turbine original equipment and manufacturer (OEM) Siemens Gamesa has established a significant presence there with its offshore wind turbine blade manufacturing, assembly, and servicing facilities. The port has seen substantial investments, including a £500 million collaboration between ABP and Siemens Gamesa, creating thousands of jobs in the region, contributing significantly to the local economy. The Humber Offshore Wind Cluster, located at Hull, aims to deliver at least 13.8 GW of clean energy by 2030, representing 35% of the UK's total energy production.

China dominates the Asia-Pacific region with regards to OSW development, followed by Taiwan, Japan, South Korea, and Australia, although other Asian countries are pursuing OSW development as well, including Vietnam and the Philippines. Local content and supply chain development feature heavily across these markets. While China is by far the market leader, they do not export large quantities of finished major components due to internal demand, quality and energy security concerns in external markets. They do provide a major share of subcomponents, including steel structure and foundations supply, with most major global suppliers utilizing the Chinese supply chain.

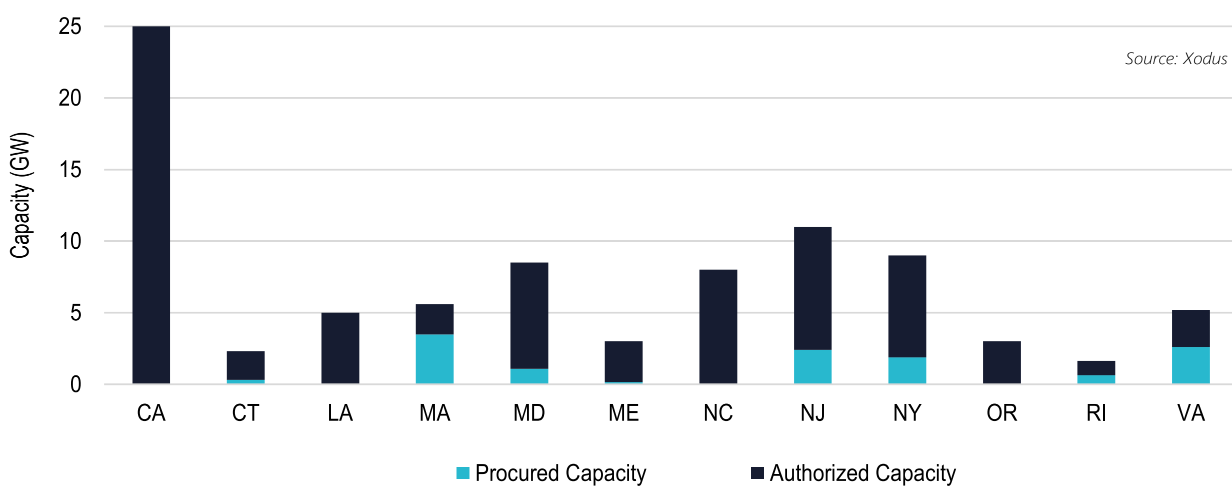
3.2. United States

The United States currently has 174 megawatt (MW) of operational fixed-bottom OSW capacity, with 1.7 GW under construction. The Northeast and Mid-Atlantic coasts are the regions where development is currently underway, with notable projects like Massachusetts' Vineyard Wind I (804 MW), Coastal Virginia Offshore Wind (2,587 MW), and the South Fork project (132 MW) either completed or nearing completion, with others under construction like Revolution Wind project (704 MW). While most OSW developments in the US to-date are fixed-bottom projects, the West Coast, Gulf of Mexico, Hawaii, and Maine will host FLOW developments. Given the geographic proximity of the US, its limited available quayside space, and vessel challenges with respect to the Jones Act, Atlantic Canadian ports stand to provide additional support for future US build out.

The previous Biden-Harris administration set a target of 30 GW by 2030 and 110 GW by 2050, with several states setting individual procurement targets, as shown in Figure 3.2, boosting the nation's commitment to renewable energy. These ambitious national and state-level goals formed the foundation of the industry's expansion. Many states have tied OSW targets to Renewable Portfolio Standards (RPS), which require utilities to source a specified portion of their energy from renewable resources.

Recent policy developments in the US have resulted in a temporary pause on OSW lease activity. An executive action from the current administration has halted all new lease issuance. The length of time this executive action will remain in place and its effect on the rate of US OSW installation is unknown. While some progress continues to be made, the US OSW industry faces significant additional hurdles, including inflation and global supply chain disruptions. Notably, the Jones Act —which mandates that goods transported between US points be carried by US-flagged vessels—has created logistical challenges, as developers have had to navigate these restrictions using feeder barges, and by using ports in Canada that are in appropriate proximity to US OSW sites (e.g., Nova Scotia (NS) and Newfoundland and Labrador (NL)). Atlantic Canadian ports were able to respond rapidly to storage needs from US OSW projects given their extensive laydown space, and available workforce.

FIGURE 3.2: PROCURED AGAINST TARGET OSW CAPACITY FOR US STATES



Source: Xodus

Developers that are either currently pursuing US OSW opportunities to some degree or are currently maintaining a presence in the US include the following:

- Avangrid
- bp
- Duke Energy
- Equinor
- Invenergy
- Ocean Winds
- SBM Offshore
- Ørsted
- RWE
- TotalEnergies
- US Wind
- Vineyard Offshore
- Dominion Energy

The OSW industry in North America is still in the early phases of development in comparison to European and Asia-Pacific counterparts. Driven by a combination of decarbonization goals and the need for renewable energy solutions to meet energy demands in dense population centers, the OSW sector has garnered increasing attention. The growing demand for green hydrogen in the context of energy transition strategies is also emerging as a driving force for OSW development, in addition to OSW for power production, particularly in Canada.

While Mexico currently has no operational OSW capacity and has made no public commitments to future projects, Canada and the US are both pursuing OSW, presenting an opportunity for cross-border collaboration. The proximity of these two nations, and the existing trade relationships between them, makes them important partners in addressing gaps in the OSW supply chain, including the use of ports.

FLOW technology holds the promise of unlocking new offshore wind resources in deeper water that would otherwise be unsuitable for fixed-bottom turbines. While both fixed-bottom and floating OSW projects face similar challenges in terms of infrastructure, regulatory approval, and supply chain development, FLOW requires more specialized vessels, port specifications, different components, and infrastructure for installation.

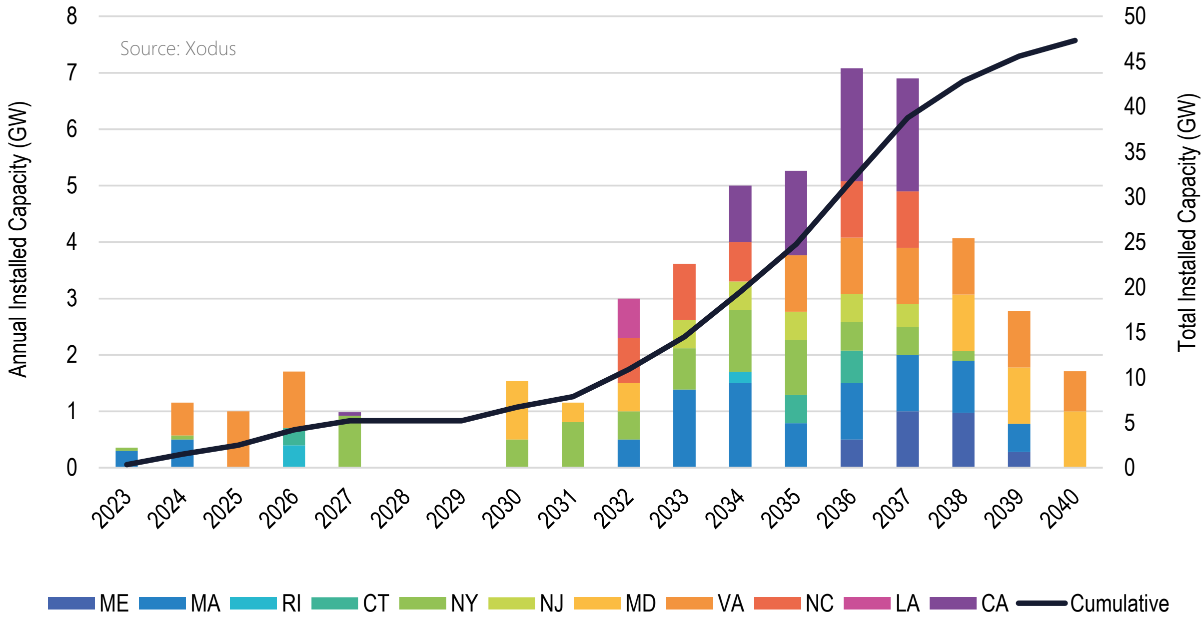
The current OSW market trajectory in the US is unknown given the current political climate and overall challenges mentioned. The following sections were initially developed using years of data predicting significant growth in this emerging industry as per global trends. A preliminary revision has been undertaken assuming a slow down in market conditions in the coming years that would then pick back up to show still favourable demand in the long term. However, it is currently considered impossible to predict the exact US demand, so this report and its recommendations are primarily based around predicted demand in Canada with the US market representing an opportunity for OSW and/or clean electricity export.

3.2.1. US Demand

As shown in Figure 3.2, several states have already begun their pursuit of OSW, and will continue to develop projects with awarded offtake agreements and permits despite the federal pause on leasing. Figure 3.3 shows the projected buildout of both fixed-bottom and floating OSW projects by state out to 2040, taking into considerations the delays resulting from the current administration's orders and assuming that the next administration will be more supportive of OSW development. Projects with stated commercial operation dates (CODs) that were to occur before 2029 that have not been fully permitted are assumed to be delayed by at least five years. Projects with COD's past 2035 are assumed to face minimal delays.

To date, Atlantic Canadian ports have supported US OSW projects based in Rhode Island, Virginia, Massachusetts, and New York. The region has the ability to support activities across the entire eastern seaboard and into the Gulf of Mexico, however New England states as well as New York and New Jersey provide the greatest opportunity for Atlantic Canada given proximity and their limited available quayside space. Note that Atlantic Canada has no ability to support OSW development on the US West Coast, thus all projects in California may be excluded. Based on the above, there is going to be minimal new demand for Atlantic Canadian ports until the early 2030's.

FIGURE 3.3: US FIXED-BOTTOM AND FLOATING OSW FORECAST



Source: Xodus

3.2.1.1. Supply Chain Demand

Based on these projections it was possible to estimate major component demand for the US OSW industry out to 2040, noting there is still a great deal of uncertainty around how the industry will progress following the next US election. Where project information was unavailable, the assumptions that were considered in obtaining estimated values are summarized in Table 3.1. It is assumed that wind turbine and foundation components will be required one year before installation, while cables and substations will be required two years prior.

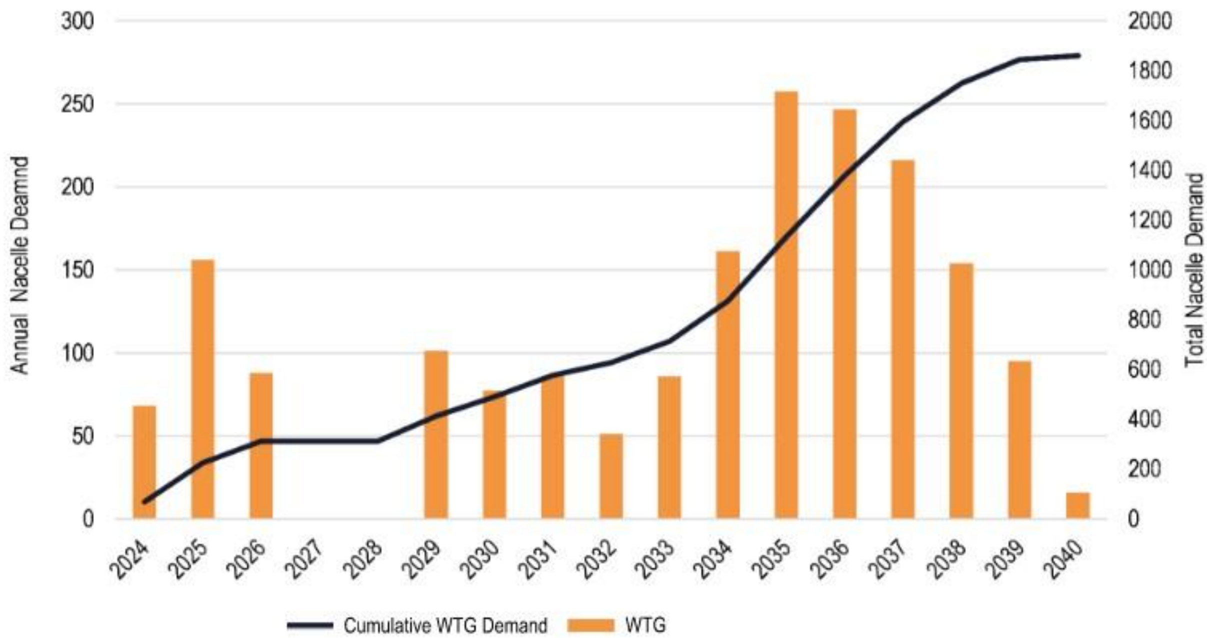
TABLE 3.1: ASSUMPTIONS FOR US MAJOR COMPONENT DEMAND

MAJOR COMPONENT	ASSUMPTION
Wind Turbine Generators	18-22 MW
Monopile Foundation Type	0–60 m – average water depth
Jacket Foundation Type	55–75 m - average water depth
Floating Foundation	75 m or greater average water depth
Export Cable	3 cables per substation (HVAC)
	2 cables per substation (HVDC)
	HVAC length 75km
	HVDC length 175km
	150 km per substation

MAJOR COMPONENT	ASSUMPTION
Array Cable	200 km per 1500 MW (Fixed-bottom)
	200 km per 1000 MW (Shallow floating 100 m)
	250 km per 1000 MW (Deep water 1000 m)
Offshore Substation	1 per 800 MW

Figure 3.4 provides the estimated demand for wind turbines, noting that for each turbine there are three blades, a nacelle, and a tower. Based on these projections, the demand for wind turbines will peak at about 250 per year (750 blades), and a total of just over 1,800 (7,200 blades) will be required by 2040. Atlantic Canadian provinces are currently storing wind turbine generator (WTG) components, where demand is currently equal to or lesser than that projected from 2034 to 2039. While ports continue to be built out in the US, there is a strong likelihood that Atlantic Canadian ports will continue to support WTG component marshalling as installation capacity picks back up.

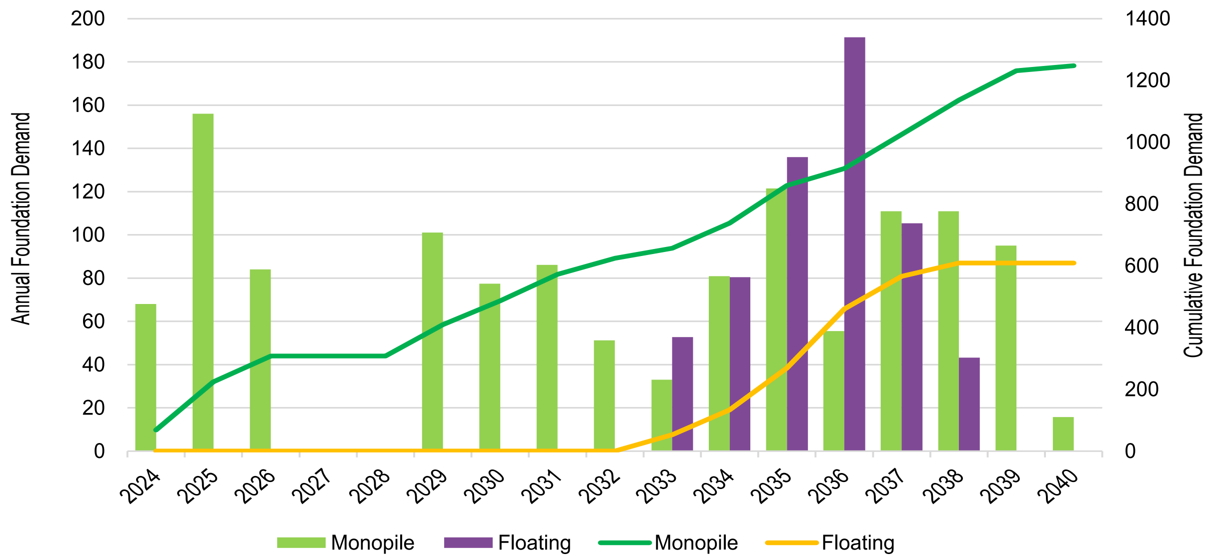
FIGURE 3.4: ESTIMATED US WIND TURBINE DEMAND



Source: Xodus

Based on stated project plans and the assumptions given in Table 3.1, estimates for monopile, jacket and floating substructure foundation demand are given in Figure 3.5. As can be seen there is a strong demand for monopile foundations, with nearly 1,200 being required by 2040. Peak demand for monopile foundations in the US is currently occurring in 2025, with multiple Atlantic Canadian ports marshalling monopiles at time of writing. There are very few jacket foundations anticipated in the US as many of the projects that had been considering using jackets have been either paused or cancelled. Over 600 floating substructures will be required by 2040, based on current projections, with a peak of about 190 anticipated for 2036. Floating substructures are typically assembled at their installation port and towed to the project site following wind turbine vertical integration (i.e. complete assembly) where they are then towed to site. This may limit the ability of Atlantic Canada to support floating substructure marshalling in support of US projects given the challenges of towing a completed wind turbine structure long distances. Changes in installation methods may result in greater reliance on Atlantic Canadian ports—this is yet to be seen as FLOW is not anticipated in the US until 2033.

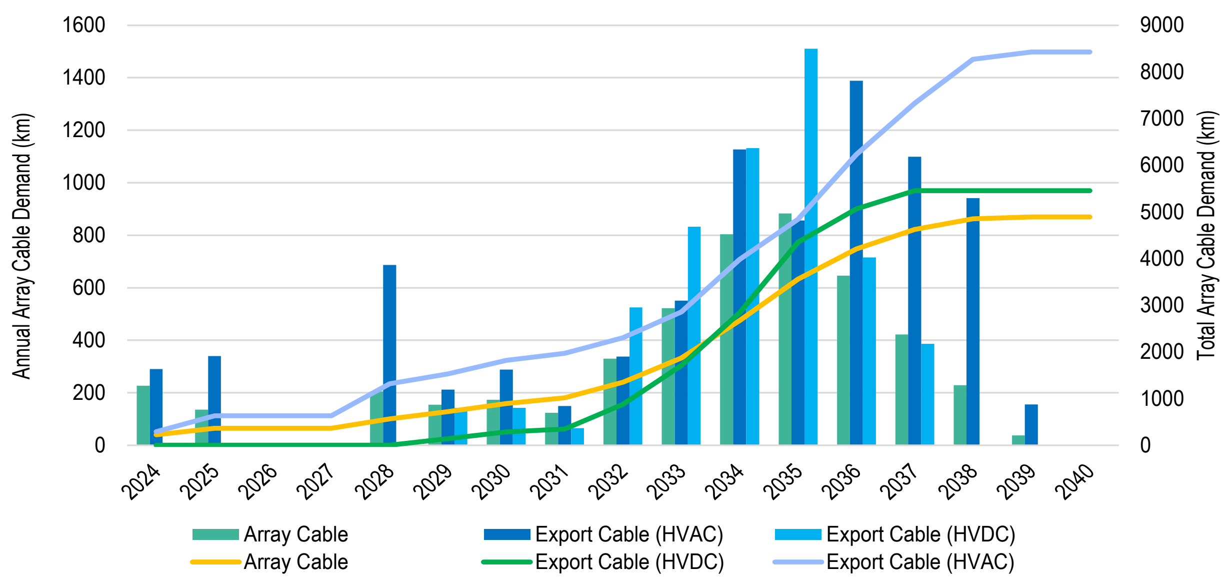
FIGURE 3.5: ESTIMATED US FOUNDATION DEMAND



Source: Xodus

The assumptions given in Table 3.1 are employed in estimating cable demand. Figure 3.6 gives the projected demand for export (HVAC and HVDC) cables and array cables, with nearly 8,500 km of HVAC export cable, and approximately 5,500 km of HVDC and array cables being required by 2040. There is no track record of Atlantic Canadian ports storing or facilitating transport of cables for US OSW projects to date, but given the history of umbilical installation for the offshore oil and gas industry in the region, it could be possible that additional support will be sought in the future.

FIGURE 3.6: US CABLE DEMAND

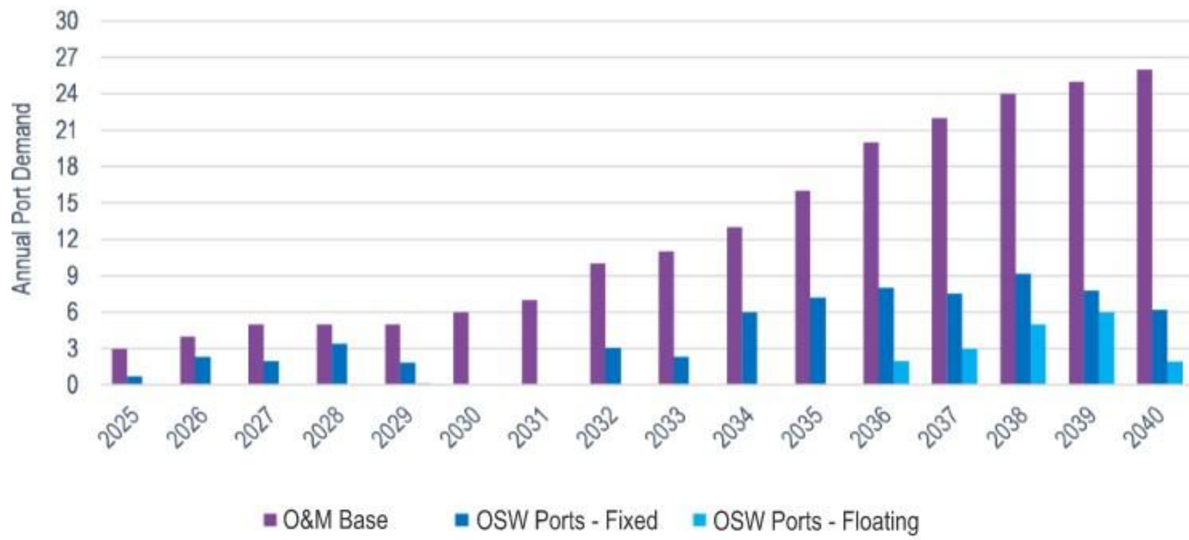


Source: Xodus

3.2.1.2. Port Demand

US port demand was estimated out to 2040 for both fixed-bottom and floating OSW, and for operation and maintenance (O&M) bases. This exercise assumed that one OSW port would be required per year for each 500 MW of installation, and that each project would require an O&M port. In reality it is possible that multiple projects by the same developer may use the same O&M port if the projects are in close proximity, or even that developers may share O&M ports to create efficiencies, however this has not been considered in this analysis given it is difficult to predict based on the case-by-case nature of these decisions and the need to consult with developers to ascertain this information. The resultant estimated US port demand is given in Figure 3.7.

FIGURE 3.7: ESTIMATED US PORT DEMAND



Source: Xodus

Considering the downturn in the US OSW industry, demand for fixed-bottom offshore wind ports peaks at an estimated 9 in 2038, with the majority of this demand being located in the US Northeast, as shown in Figure 3.3. There are currently several offshore wind ports available in the US Northeast that are likely to meet demand out to the early 2030's, however many of these ports have limited quayside space and may continue to seek support for laydown and storage from Atlantic Canadian ports. While it less likely that eastern states further down the coast like Virginia, North Carolina, and Louisiana will utilize Atlantic Canadian ports due to the increased distance, the Coastal Virginia Offshore Wind (CVOW) pilot project in 2020 used the Port of Halifax for major component storage prior to installation. As installation activity ramps up in 2032 there will likely be increased demand for Atlantic Canadian ports for component storage and marshalling.

Based on current projections, the first FLOW ports will be required in 2036 in California and Maine. While Atlantic Canadian ports will not be able to serve the US West Coast, the proximity of Maine paired with the high level of existing collaboration and trade between the state and Canada, and Atlantic Canada's planned FLOW developments, create a strong potential for Atlantic Canadian support being sought for installation campaigns. Other northeastern states will be developing FLOW in the future as projects move into deeper waters, again signaling a potential for Atlantic Canadian port demand.

While O&M bases are typically required to be close to a project installation site, the projected demand — at 26 O&M ports as of 2040 — may also provide opportunities for Atlantic Canadian support. In particular, there may be opportunities for Atlantic Canadian ports to store major components ahead of replacement campaigns.

3.3. Canada

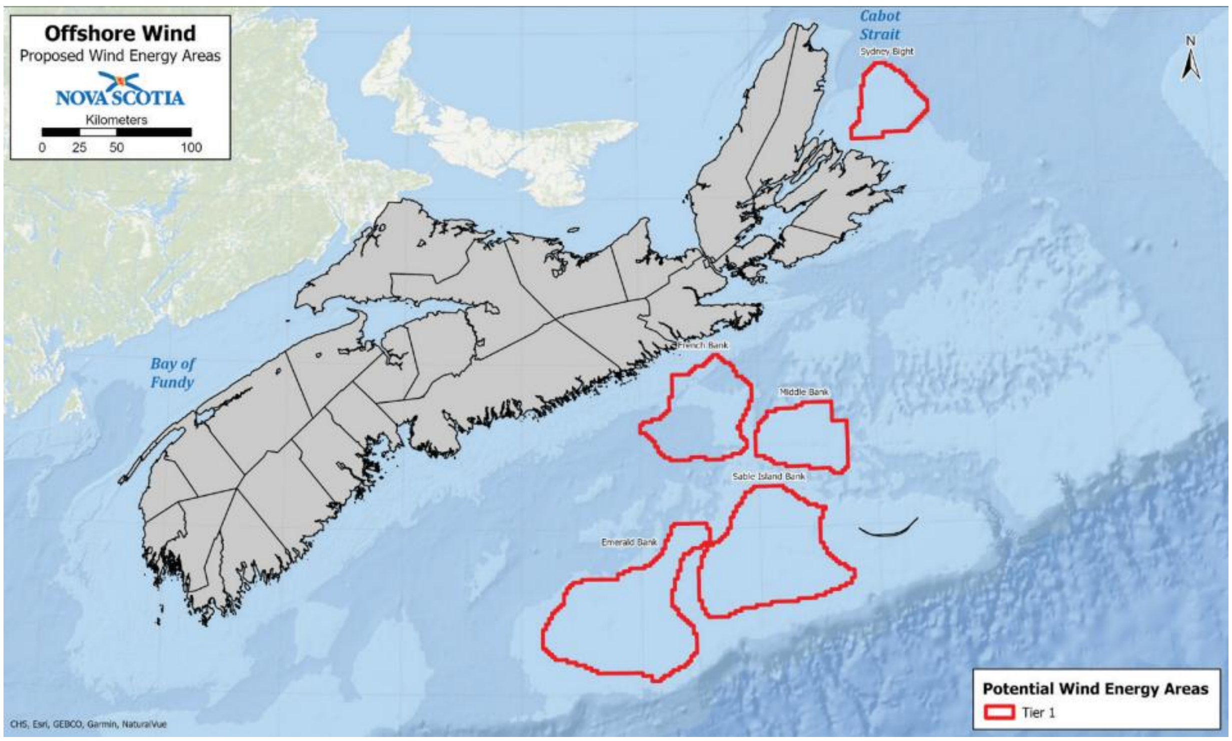
Atlantic Canada in particular, offers world-class conditions for OSW with its average annual wind speeds of up to 11 m/s and bathymetric conditions make the area ideal. Beyond electricity generation, OSW in this region also holds the potential to position Canada as a global supplier of clean hydrogen, responding to the international demand. While Canada does not have a national OSW target, NS has set a goal of leasing (referred to as "licensing" in Canada) 5 GW of capacity of developable seabed by 2030. No other province has announced a stated target for OSW development, to date. Ontario, which previously explored OSW in the Great Lakes, remains in a state of moratorium, having suspended projects in 2011.

Both NL and NS have had Regional Assessments for OSW carried out, establishing future OSW development areas, and making recommendations to provincial authorities on key industry considerations. In March 2025 the Province of NS launched an engagement process for the following five proposed Wind Energy Areas (WEAs) for OSW development:

- French Bank
- Middle Bank
- Sable Island Bank
- Sydney Bight
- Western/Emerald Bank

These areas (see Figure 3.8) were informed by Potential Development Areas identified in the *"Regional Assessment of Offshore Wind Development in Nova Scotia"* in its final report and were subject to further review by the Nova Scotia Department of Energy and Natural Resources Canada.

FIGURE 3.8: PROPOSED WIND ENERGY AREAS FOR NOVA SCOTIA OSW DEVELOPMENT

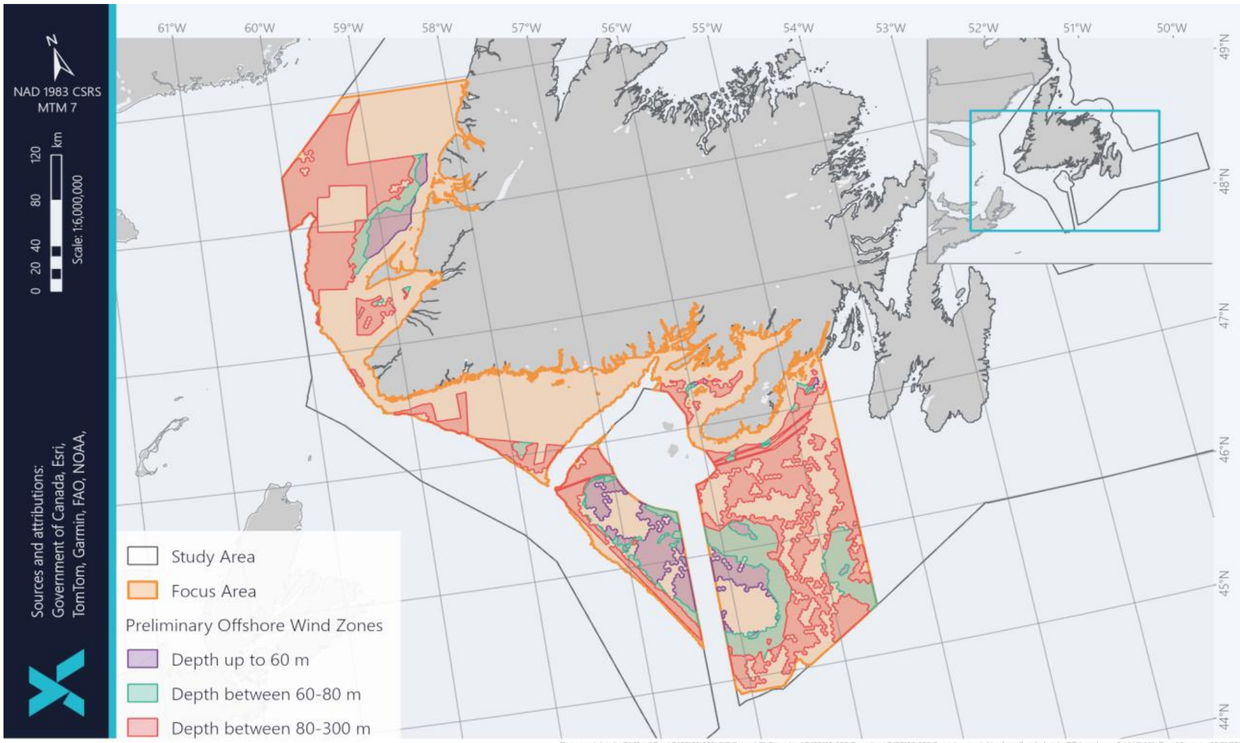


Source: Natural Resources Canada, Nova Scotia Department of Energy (https://novascotia.ca/offshore-wind-energy-areas-engagement/docs/offshore-wind-energy-areas-discussion-paper.pdf)

The *"Regional Assessment of Offshore Wind Development in Newfoundland and Labrador"* identified future potential development areas in its final report, released in January 2025 (see Figure 3.9). Both NS and NL OSW developments will be regulated by the Canada-Nova Scotia Offshore Energy Board (CNSOER) and the Canada-Newfoundland and Labrador Offshore Energy Board (CNLOER), respectively. These entities were established under the federal Atlantic Accord Acts, governing joint federal-provincial management of offshore petroleum development. The passage of recent legislation, Bill C-49, expanded their mandates to include the regulation of offshore renewable energy development.

As an exemption to joint federal-provincial regulation, the Province of NL and the federal government entered a Memorandum of Understanding (MOU) regarding OSW development in December 2023. This established that NL has sole authority over the approval of offshore renewable energy projects within 16 designated bays, such that in these bays, joint federal-provincial management is not required. It outlines a process whereby the province can administer leases and regulate projects, including the revenue for projects developed. There are currently no regulatory bodies present in either New Brunswick (NB) or Prince Edward Island (PEI) that are responsible for OSW development.

FIGURE 3.9: POTENTIAL FUTURE DEVELOPMENT SITES FOR NEWFOUNDLAND AND LABRADOR



Source: Xodus, derived from information from the Government of Canada, Esri, TomTom, Garmin, FAO and NOAA

With regards to manufacturing, Gaspé, Quebec is home to a major wind turbine blade facility operated by LM Wind Power and has produced thousands of blades for projects worldwide. There are currently no major component manufacturing facilities located in Atlantic Canada, however the region possesses a rich history in offshore oil and gas, shipbuilding, ocean technology, maritime industries, and fisheries sectors, offering infrastructure and transferable skills that can be leveraged to support OSW projects. As previously mentioned, Atlantic Canada has existing port infrastructure that has already served the US OSW industry through component storage and marshalling for US projects. These ports include the following:

- Atlantic Canada Bulk Terminal, Sydney, NS
- Port of Argentia, NL
- Port of Halifax, NS (Woodside Multi-Purpose Marine Facility)
- Port of Sheet Harbour, NS

3.3.1. Canadian Demand

While only NS has stated OSW development goals, development scenarios have been created for Atlantic Canada to estimate the demand for major components, ports, and workforce. Low, Medium, and High development scenarios have been built out as a function of offtake pathways, informed by existing projects, public announcements, provincial roadmaps, IRPs, energy tables, and stakeholder engagement. Development scenarios established consider time periods extending from 2030 to 2050 in five-year increments. The timeline considered for Canada is longer than that considered for the US given the OSW industry development lags that of the US. The scenarios are based on incremental market pathway options with increasing capacity development, as follows:

- **Low scenario** – Domestic Use only
- **Medium scenario** – Domestic Use + Electricity Export
- **High scenario** – Domestic Use + Electricity Export + Green Hydrogen Production

For "Electricity Export" it is assumed that electricity generated by wind will be exported to the Northeast US, in particular New England and New York where there is a strong demand for clean energy. Assumptions on the amount of electricity that may be exported and the associated timelines for export are given in Table 3.2 The magnitude of export shown in this table is cumulative. The total export amount from 2035 to 2050 is assumed to be 6,000 MW.

TABLE 3.2: ASSUMED ELECTRICITY EXPORT AMOUNTS, BY PROVINCE

PROVINCE	2035	2040	2045	2050
NS	1,000	500	0	500
NL	0	1,000	0	1,000
NB	750	500	0	500
PEI	250	0	0	0
TOTAL MW (Cumulative)	2,000	4,000	4,000	6,000

While real-world plans are built into the development scenarios, insufficient data exists to accurately predict wind energy buildout for each province out to 2050. Details of the assumptions that have been made to fill information gaps are detailed in the following sections. Note that as projections extend to 2050, capacity numbers exceed those stated by provinces to date as current deployment plans for wind energy do not look this far into the future. It also assumes that any required transmission upgrades will be completed to allow for these capacity levels, and that the necessary export conditions (e.g. regulatory frameworks, export infrastructure, etc.) are met to support the amount of electricity and green hydrogen to be exported.

The stated goal of 5 GW of leased seabed capacity by 2030 in NS has been considered in this analysis including the Nova East floating wind project. The Nova East project is planning for a maximum of 400 MW to be commissioned by 2030 however considering the global commercial floating wind market is moving to the right, all development scenarios assume that Nova East Wind will achieve a 2033 COD. Given the absence of planning information beyond 2030, the development scenarios implemented by this project team are aligned with provincial planning documentation and informed by other regional studies being carried out in the region, including the Marine Renewables Canada (MRC), "*Atlantic Wind Energy Supply Chain Assessment & Pathways for Supply Chain Development*" and the Net Zero Atlantic (NZA) phase one report *"Market Opportunities for Offshore Wind in Atlantic Canada" (June 2025)* produced by E3 and Stantec.

In Table *3.3,* assumptions on OSW capacity buildout by province and by scenario are provided. Note that each subsequent development scenario contains the capacity amounts from the previous scenario and are cumulative across timelines. As project capacities are not available, it was assumed that total capacities are built out in 1 GW "projects", with 500 MW installed per project, per year.

NS was allocated all the "Domestic Only" OSW capacity given it has demand for clean energy domestically, and it has a stated goal of integrating OSW. Electricity export values reference Table 3.2, allocating values to NB and NS ahead of NL given their comparative proximity to export markets. Offshore wind developed for green H2 production relates to the NZA phase one report "Base H2" scenario but shifts timelines out to account for the development times required for future projects. It is assumed that neither NB or PEI develop OSW for green H2 production.

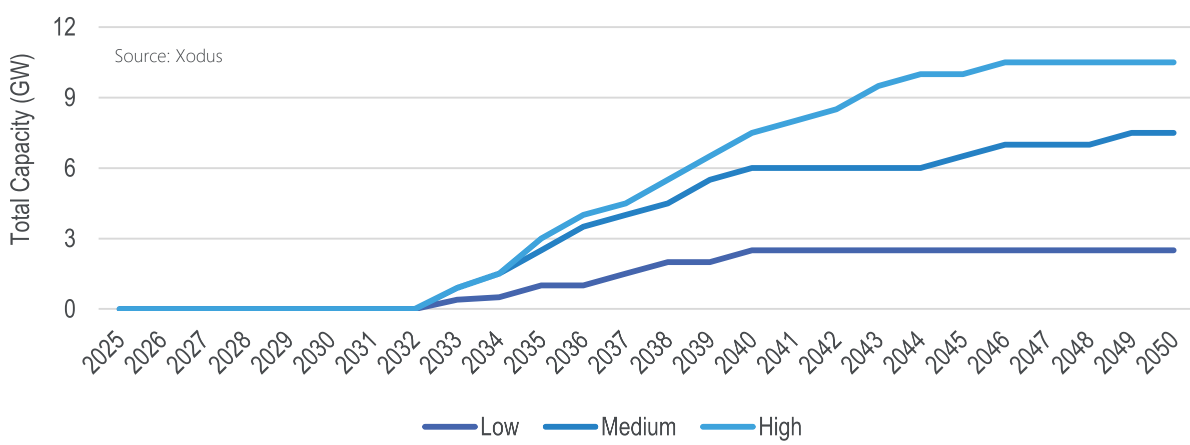
TABLE 3.3: OSW DEVELOPMENT SCENARIOS, VALUES AND ASSUMPTIONS

PROVINCES	ASSUMPTIONS	NB [GW]	PEI [GW]	NS [GW]	NL [GW]	TOTAL [GW]	
Low (Domestic)	Assumes 0.4 GW for potential OSW project (2033 COD) plus 0.6 GW added to NS grid to get to total of 1 GW of OSW for domestic use by 2035.	0	0	1	0	1.0	2035
	Assumes the full capacity of OSW serving the Atlantic provinces in the E3 "Domestic-only" case is allocated to NS.	0	0	2.5	0	2.5	2040
		0	0	2.5	0	2.5	2045
		0	0	2.5	0	**2.5**	2050

PROVINCES	ASSUMPTIONS	NB [GW]	PEI [GW]	NS [GW]	NL [GW]	TOTAL [GW]	
Medium (Domestic + Electricity Export)	Additional 1 GW of OSW capacity added in NS for electricity export by 2035.	0	0	2	0	2.0	2035
	Additional 2 GW of OSW capacity added in NS for electricity export by 2040. NL and NB each assumed to have 1 GW OSW capacity for electricity export by 2040.	1	0	4	1	6.0	2040
	No additional OSW capacity for electricity export out to 2045.	1	0	4	1	6.0	2045
	Assumes an additional 0.5 GW of OSW capacity is added for NB and 1 GW for NS by 2050.	1.5	0	5	1	**7.5**	2050
High (Domestic+ Electricity Export + H2)	No OSW capacity is added for green H2 production by 2035.	0	0	2	0	2.0	2035
	Assumes 1 GW of OSW capacity is added for green H2 production in NS by 2040.	1	0	5	1	7.0	2040
	Assumes an additional 1 GW and 2 GW of OSW capacity for green H2 production is added in in NS and NL, respectively, by 2045.	1	0	6	3	10.0	2045
	Assumes no additional OSW capacity is added for green H2 production by 2050.	1.5	0	7	3	**11.5**	2050

Figure 3.10 illustrates cumulative OSW development over time in the Low, Medium, and High scenarios. In the Low scenario, OSW development begins in 2032 and rises steadily until plateauing at 2.5 GW in 2040. The Medium and High scenarios see OSW development rising more rapidly, plateauing at 7.5 GW and 11.5 GW, respectively, by 2050.

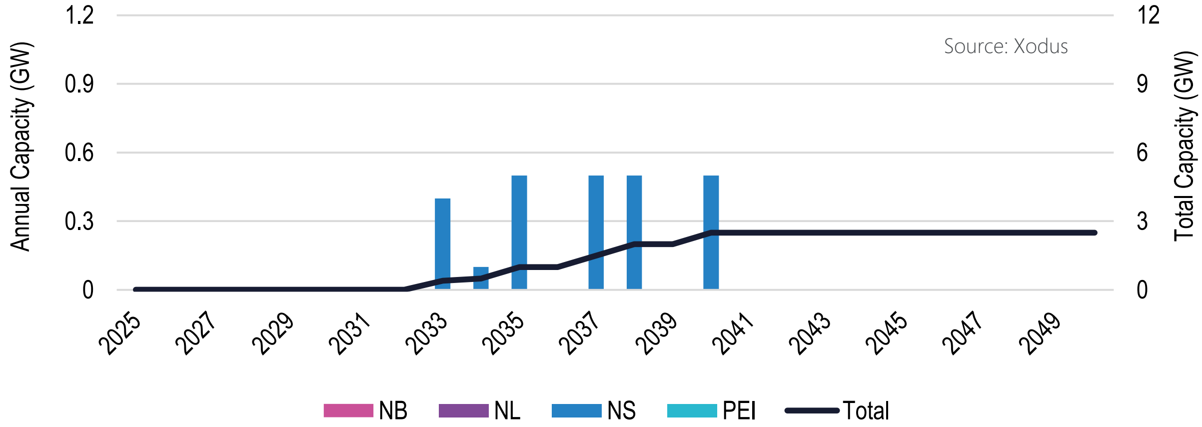
FIGURE 3.10: TOTAL OSW CAPACITY OVER TIME IN THE LOW, MEDIUM, AND HIGH SCENARIOS



Source: Xodus

Low Scenario: Low domestic demand constrains OSW development to NS (Figure 3.11). In this scenario the goal of 5 GW of OSW is not achieved due to demand and grid constraints. NB, NL, and PEI do not develop any OSW due to their existing renewable generation capacity and targets and lack of OSW targets.

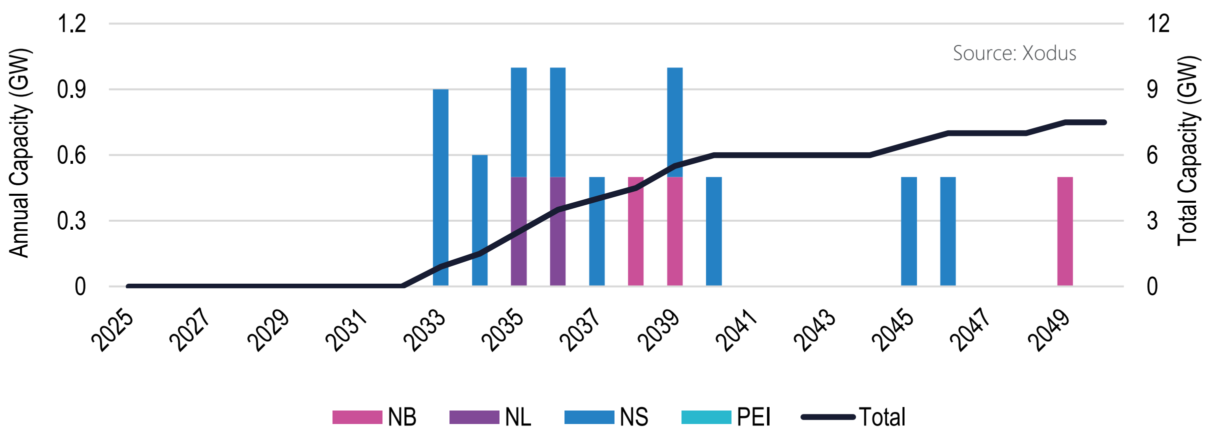
FIGURE 3.11: ANNUAL AND TOTAL OSW CAPACITY OVER TIME IN THE LOW SCENARIO



Source: Xodus

Medium Scenario: Electricity export opportunities drive increased OSW capacity development in NS, NB, and NL (Figure 3.12). NS leads these two provinces due to the established domestic demand, as shown in Figure 3.11. Half of this capacity and all the capacity from NL and NB are exported to the Northeast US in states like Maine, Massachusetts, and New York, where there is high demand for clean electricity imports due to legally binding RPSs and high electricity demand. It must be noted that the impacts of the energy policies of the new federal administration may impact the availability of these markets. It is assumed that PEI does not develop any OSW for electricity export given it has no stated intention of developing OSW.

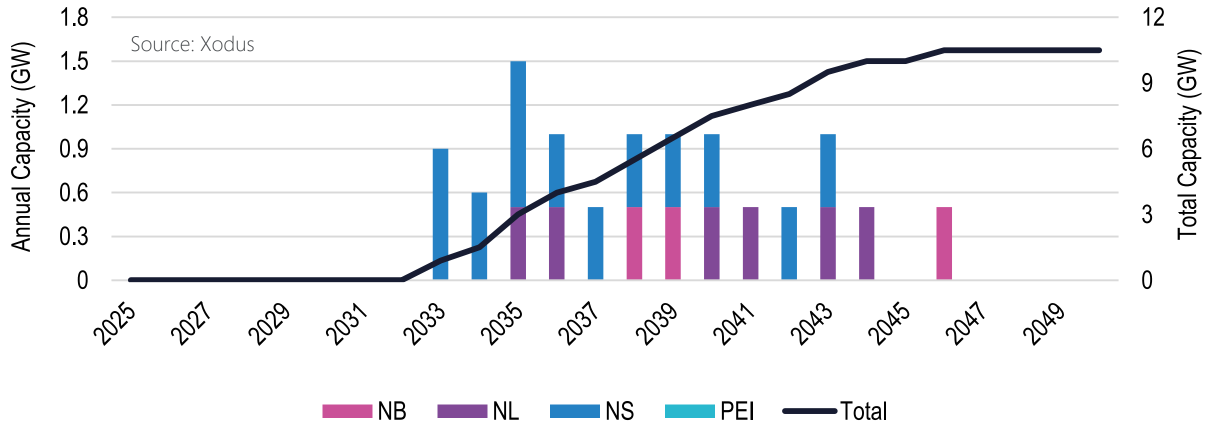
FIGURE 3.12: ANNUAL AND TOTAL OSW CAPACITY OVER TIME IN THE MEDIUM SCENARIO



Source: Xodus

High Scenario: OSW development is driven by green hydrogen demand in NS, NL, and NB (Figure 3.13). More than half of the added capacity in NS and all remaining capacity is allocated for hydrogen production, assuming there is sufficient demand in domestic and international markets. Again, it is assumed that PEI does not develop any OSW for H2 production given it has no stated intention of developing OSW.

FIGURE 3.13: ANNUAL AND TOTAL OSW CAPACITY OVER TIME IN THE HIGH SCENARIO



Source: Xodus

3.3.1.1. Supply Chain Demand

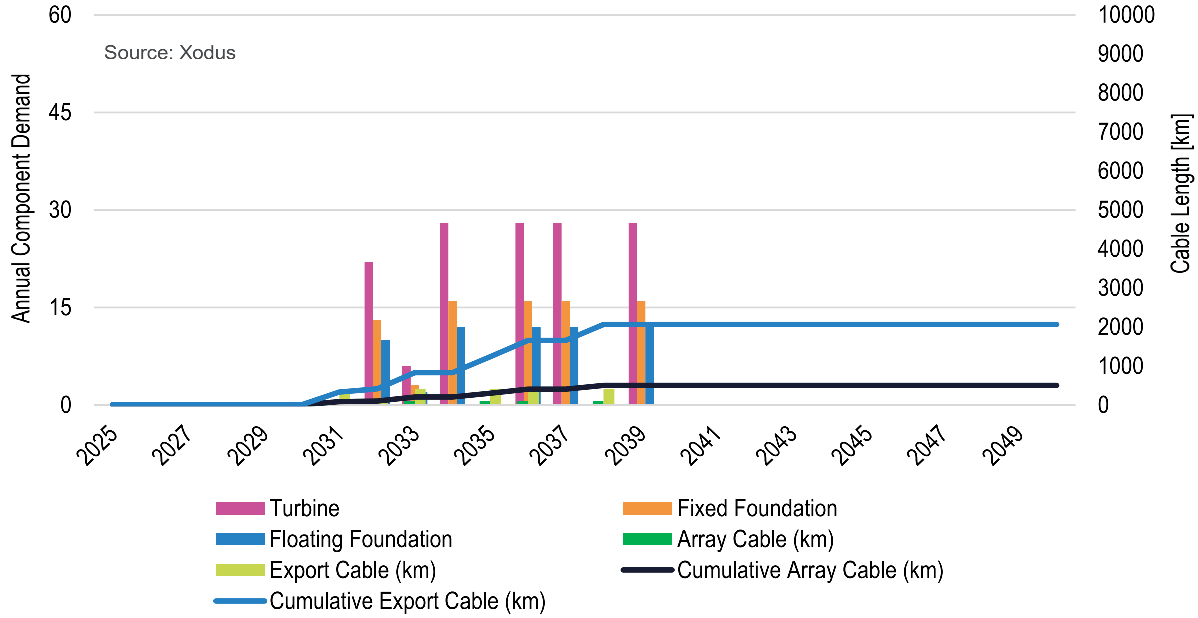
Demand for major components was calculated based on Low, Medium, and High development scenarios. As there is limited information about project buildout, the assumptions listed in Table 3.4 were utilized. Note that these assumptions are simplified from those applied in Section 3.2.1.1 as less information is available regarding foundation type (i.e. fixed-bottom vs. floating).

TABLE 3.4: MAJOR COMPONENT DEMAND ASSUMPTIONS

MAJOR COMPONENT	ASSUMPTION
Wind Turbine Generators	18-22 MW
Fixed-bottom Foundation	4 of 7 sites fixed-bottom
Floating Foundation	3 of 7 sites floating
Export Cable	2.75 cables per substation
	150 km per substation
Array Cable	200 km per 1,000 MW
Offshore Substation	1 per 500 MW

Low Scenario: Component demand for the Low scenario, shown in Figure 3.14, is unlikely to strain the global supply chain. A total of approximately 140 turbines are required out to 2050, corresponding to about 500 km of array cable and just over 2,000 km of export cable. There are estimated to be approximately 80 fixed-bottom foundations (either monopile, jacket or gravity-based) and 60 floating substructures, based on the stated assumptions.

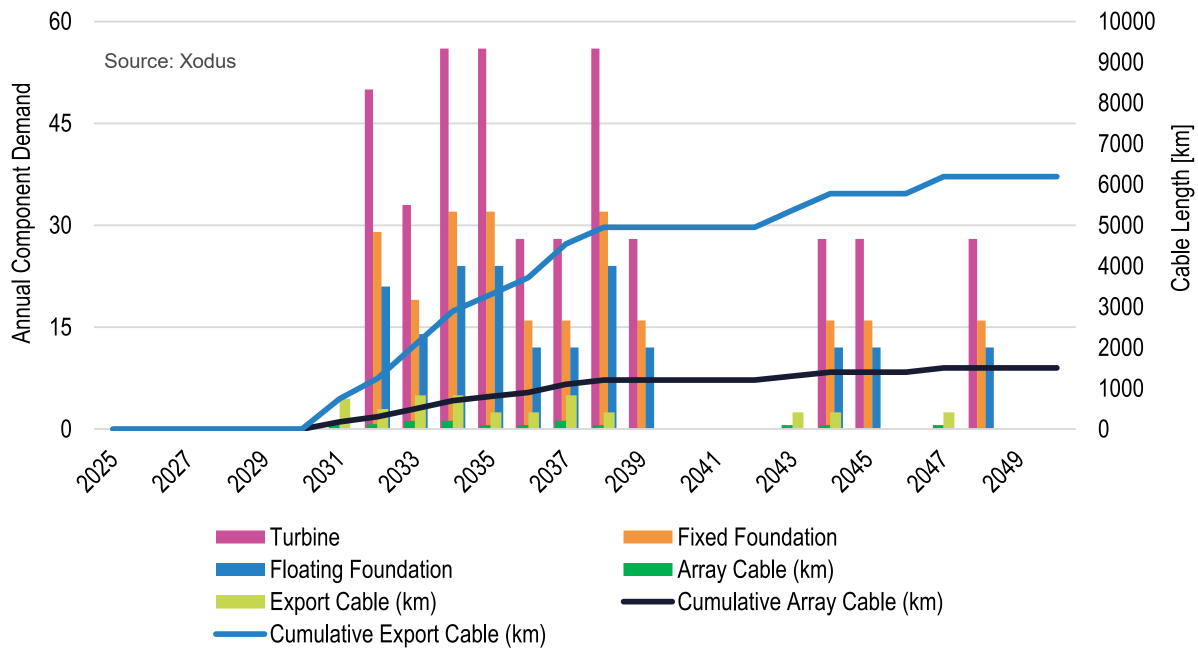
FIGURE 3.14: MAJOR OSW COMPONENT DEMAND FOR LOW SCENARIO



Source: Xodus

Medium Scenario: Component demand for the Medium scenario, shown in Figure 3.15, results in a more consistent component demand over time. Over 400 turbines are required out to 2050, corresponding to about 1,500 km of array cable and just over 6,000 km of export cable. There are estimated to be approximately 240 fixed-bottom foundations (either monopile, jacket or gravity-based) and 180 floating substructures, based on the stated assumptions.

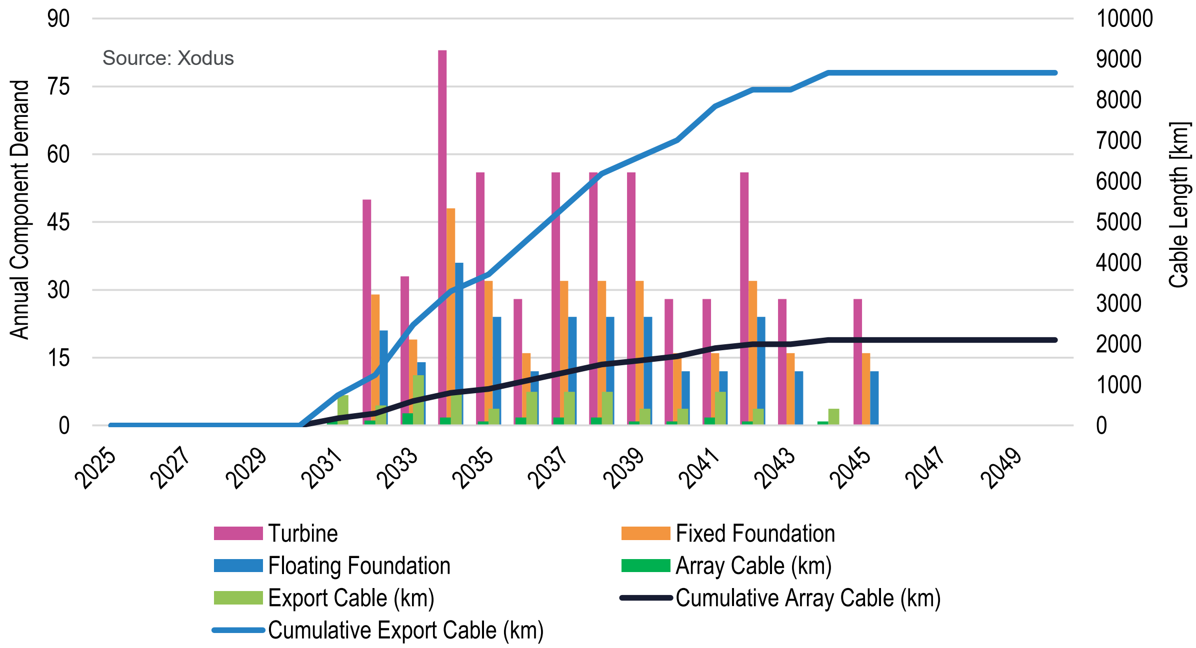
FIGURE 3.15: MAJOR OSW COMPONENT DEMAND FOR MEDIUM SCENARIO



Source: Xodus

High Scenario: Component demand for the High scenario, shown in Figure 3.16, results in a consistently high component demand over time. In this scenario nearly 600 turbines are required out to 2050, corresponding to over 2,000 km of array cable and nearly 9,000 km of export cable. There are estimated to be approximately 340 fixed-bottom foundations (either monopile, jacket or gravity-based) and around 250 floating substructures, based on the stated assumptions. This level of demand requires careful planning to avoid supply chain bottlenecks, and may even justify manufacturing at local ports to meet demand.

FIGURE 3.16: MAJOR OSW COMPONENT DEMAND FOR HIGH SCENARIO



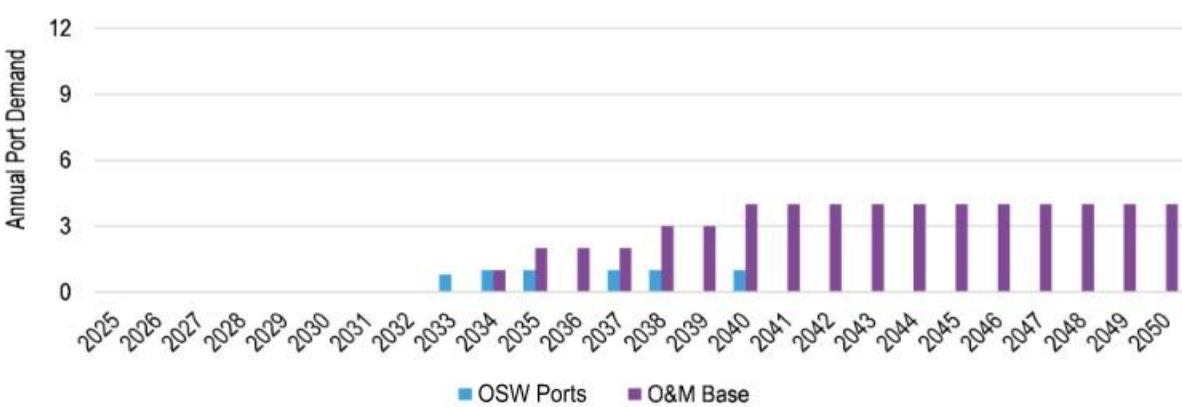
Source: Xodus

3.3.1.2. Port Demand

Atlantic Canada port demand was estimated out to 2050 for both fixed-bottom and floating offshore wind ports, and for O&M bases. This exercise assumed that one offshore wind port would be required per year for each 500 MW of installation, and that each "project" would require an O&M port. The estimated port demand for each of the three scenarios are shown in the sections below.

Low Scenario: Estimated port demand for the Low scenario is given in Figure 3.17. In this scenario no more than one offshore wind port is required at a time, and a maximum of four O&M ports are required. This limits the need for more than one offshore wind port to be developed in the region for a domestic-only demand.

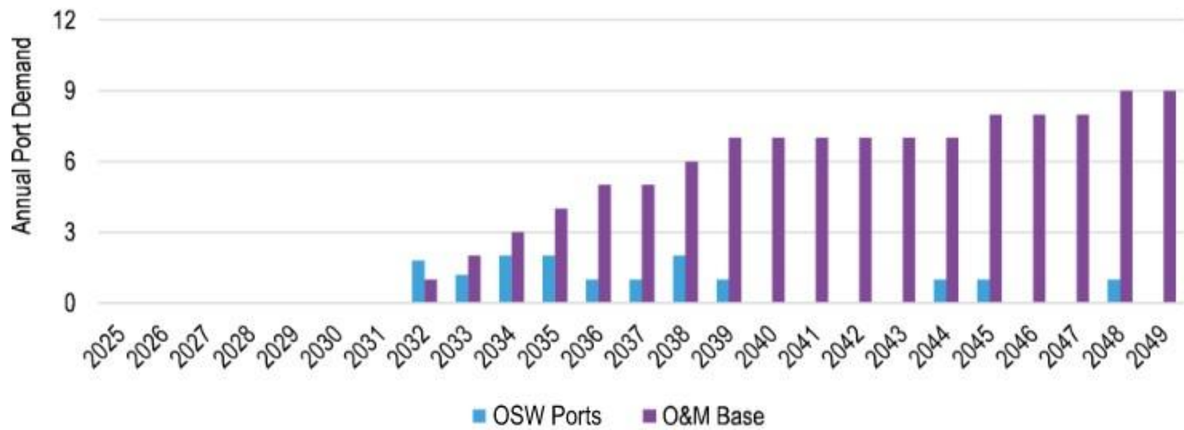
FIGURE 3.17: ANNUAL PORT DEMAND OVER TIME IN THE LOW SCENARIO



Source: Xodus

Medium Scenario: In the Medium scenario (Figure 3.18) the demand for offshore wind ports increases to two in 2032, 2034, and 2035. It is arguable whether it is justifiable to build a second offshore wind port under these demand conditions or simply shifting demand out by a couple years to save on port development costs. It may be worthwhile to develop the second offshore wind port if the US market requires additional capacity, which may well be the case given the demand for offshore wind ports in the US reaches a maximum of nine in 2038. By 2039 there is consistent demand for 7 O&M ports, reaching a maximum of 9 by 2048.

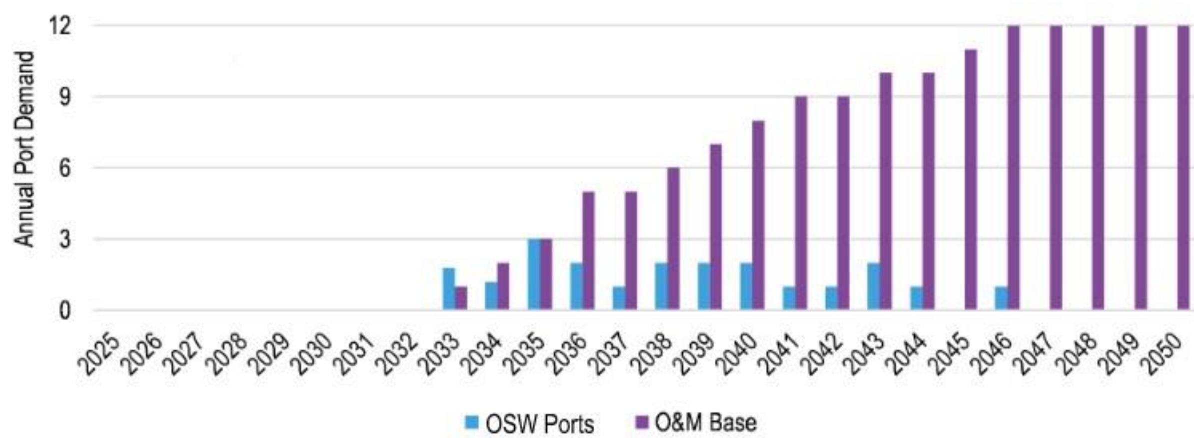
FIGURE 3.18: ANNUAL PORT DEMAND OVER TIME IN THE MEDIUM SCENARIO



Source: Xodus

High Scenario: In the High scenario (Figure 3.19) there is generally consistent demand for one to two offshore wind ports from 2033 to 2043. Given this consistent demand, it is justifiable to build a second offshore wind port in Atlantic Canada. Given project locations and the demand for support from the US, it may even make sense to build a third offshore wind port. At least five O&M ports are required from 2036 onwards, with a peak of 12 being required as of 2046.

FIGURE 3.19: ANNUAL PORT DEMAND OVER TIME IN THE HIGH SCENARIO



Source: Xodus

4. Port Assessment

The primary goal of this assessment is to identify ports in Atlantic Canada with suitable characteristics to play a role in the emerging offshore wind (OSW) industry. Whereas the OSW industry in Atlantic Canada is very early in development, it was important for this screening to be as wide ranging and inclusive as possible with care being taken not to exclude any potential development sites. Knowledge of the OSW industry and port infrastructure requirements in the region may be limited, as such, this screening and assessment are meant to be as transparent as possible. As the OSW industry in Canada is not expected to enter the development stage until the late 2020's or 2030's, it was also important to ensure that criteria were established such that identified facilities can handle the next generation of wind turbine generator (WTG) and foundation components. This section describes the primary focus of this study, the assessment methodology, and the screening process.

4.1. Assessment Focus

To enable OSW development in a new region, port infrastructure is essential. Port facilities are the critical logistical and operational hubs for both fixed-bottom and floating OSW projects. There are numerous categories of port facilities associated with OSW development, however three are the most critical. Offshore wind projects cannot be developed for fixed-bottom projects without a suitable marshalling port. Floating offshore wind (FLOW) projects cannot be developed without a staging & integration (S&I) facility and benefit greatly from a local floating foundation assembly facility. All three of these facilities must be capable of handling a wide range of components of different sizes, weights, and origin. Some of the requirements for the capabilities of these facilities are among the most stringent in the global port industry. Generally, suitable sites for these operations are difficult to come by and are expensive to develop. As such, the assessment primarily focuses on sites suitable for marshalling, staging and integration, and foundation assembly (primary ports, see Section 2.2).

As noted in Section 2.3, there are numerous other shoreside facilities required for the development and operation of OSW projects, secondary or auxiliary ports. While these facilities are also of great importance, they do not have the same stringent requirements as primary ports. Specifically, secondary ports do not have the same requirements for large amounts of upland storage area and ground bearing capacity. Typically, it is easier to find a site suitable for secondary port activities than it is for primary ports. Often secondary activities can take place at existing port facilities with minimal improvements and investment. This assessment does not aim to identify specific facilities for secondary activities but may comment on specific areas which are best suited for secondary ports.

4.2. Assessment Methodology

The "*Assessment of Atlantic Canadian Ports to Support Offshore Wind Development"* was conducted in a manner intended to be inclusive and transparent with care being taken to ensure that no potential sites were missed or excluded from the study. Engagement with identified facilities was paramount to ensure data accuracy, learn about offshore wind related planning, and educate relevant stakeholders of the purpose of this study. The final shortlist of ports was limited to ports that consented to participate in the study. Although extensive measures have been made to identify all suitable sites, it is possible that other suitable sites exist or sites requested to be excluded from this assessment.

The assessment began by establishing assumptions for future component sizes which allowed for the development of minimum criteria for inclusion in the study. Minimum criteria were established for all three primary port categories. Simultaneously, a port inventory was developed for all four Atlantic provinces. A red flag analysis was conducted to preliminarily identify ports meeting key criteria. Outreach was conducted with the port facilities identified and a public information session was conducted on February 19th, 2025. Participants in the information session were encouraged to provide data regarding their sites and to confirm interest in participating in this assessment. The information gathered from these participants was used to verify red flag analysis before a qualitative evaluation could begin for ports wishing to participate in the study. The following sections describe the assessment methodology.

4.2.1. Screening Criteria

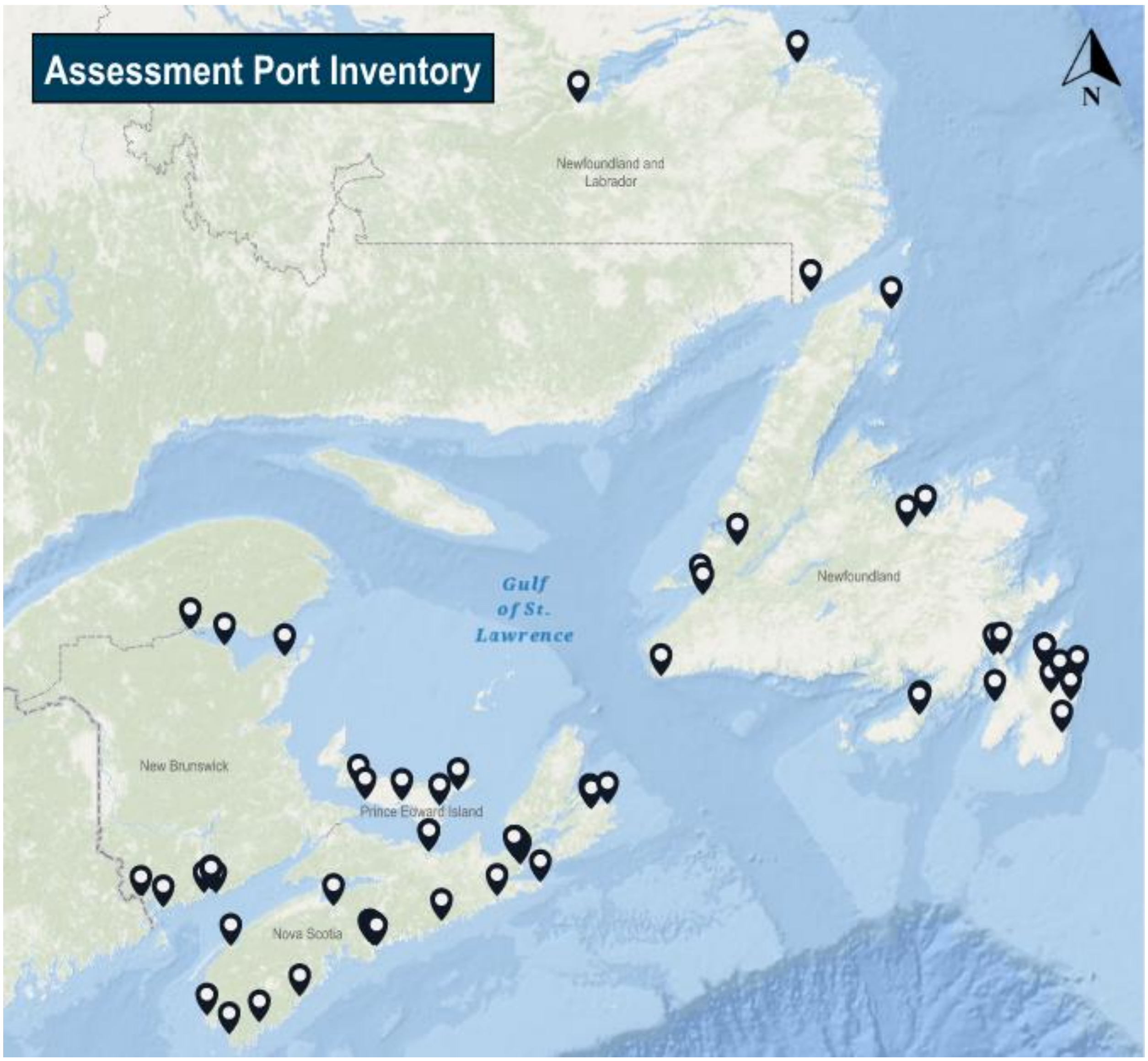
To begin the assessment, a set of minimum criteria for inclusion needed to be established. Screening criteria were developed based on industry trends, conversations with developers and manufacturers, and prior project experience. All criteria were reviewed and approved by industry professionals and were intended to ensure facilities would be screened against future developments rather than current standards. The development of screening criteria is described in detail in Section 4.2.5.

4.2.2. Port Inventory

As screening criteria were established, a port inventory was simultaneously developed. The port inventory was intended to be all encompassing and inclusive of all active, brownfield, and greenfield port facilities in Atlantic Canada (see Figure 4.1). Sites were identified through a desktop study and industry outreach with stakeholders and port associations. At this time, as much public data about each site was gathered as possible for initial red flag analysis described in the next section. Data was input into an inventory database and each site was mapped to the extent possible prior to engagement.

The characteristics of larger ports were often readily available while smaller and more rural facilities required further research and intake of information from engagement. During the development of this inventory, ports which appeared to be unsuitable were still included as it was important to verify any potential expansion or development plans before removal from the assessment. Seventy-seven (77) sites were initially identified through this process.

FIGURE 4.1: ASSESSMENT PORT INVENTORY



Source: Moffatt & Nichol on ArcGIS

4.2.3. Initial Screening: Red Flag Analysis

Certain key criteria are of the utmost importance for the development of primary offshore wind ports. These criteria include:

- Air draft restrictions
- Upland area
- Water frontage
- Navigational restrictions

Meeting the set criteria for the four categories mentioned above is crucial for any site to serve as a primary offshore wind port. Any facility not meeting these four key criteria were preliminarily identified for removal from the assessment pending the appearance of any contrary data. This red flag analysis also provided an early look as to which primary activities each site was best suited for. The port inventory of 77 sites was narrowed down to 26 viable sites through the red flag analysis.

4.2.4. Second Screening: Port Outreach

An information session was held on February 19th, 2025 to educate relevant parties about this assessment and encourage participation where appropriate. Invitations for the session were sent to all contacts from the port inventory as well as contacts from Net Zero Atlantic (NZA) and other stakeholders to increase the likelihood that any site that may have been overlooked could be identified. Registration for the session asked participants to identify the type of organization they represented and contact information for future outreach.

Numerous types of organizations attended the session with a total of 163 attendees. Of these attendees, 31 self-identified as representing a port or site on the port inventory list. One participant identified as representing a facility which was not on the initial port inventory. A breakdown of participant categories is shown below. Please note that not all port representatives self-identified as port authorities as some sites are owned by private industry and governmental agencies.

TABLE 4.1: SUMMARY OF INFORMATION SESSION ATTENDEES

Category	Attendee
Academic/Research Institution	5
Indigenous Group	3
Municipal Government	7
Non-Governmental Organization	11
Port Authority	17
Private Industry	64
Provincial Government	18
Other	38

Source: Moffatt & Nichol

During the information session, attendees were presented with information about this study, a background of the OSW industry and market conditions, and an overview of the role ports play in the OSW industry before discussing the screening process. Ports were presented with information such as upland area required, waterfrontage, air draft restrictions, and other key considerations. This introduction allowed for some ports to 'self-screen' themselves out of the study.

Following the information session, a questionnaire was distributed to all attendees and port contacts to indicate further interest in participating in the assessment. Those who chose to participate were directed to a questionnaire requesting more information such as:

- Existing wharfage
- Existing uplands and potential for expansion
- Berth depth
- Distance from main navigation channel
- Wharf and upland bearing capacity
- Site grading
- Air draft restrictions
- Tidal range
- Icing conditions

Respondents were also asked for relevant contact information and were provided with an opportunity to present any other considerations for the assessment. A visual file showing the available site boundaries for verification purposes was requested. The information gathered was used to verify and update the port inventory and red flag analysis. Twenty-one (21) ports responded to the questionnaire, however only seven of the 21 had passed the red flag analysis. Outreach was conducted to the remaining 19 ports that passed the red flag analysis but did not respond to the questionnaire to encourage participation with mixed results. Facilities that did not indicate an interest in participation were not evaluated further. Several developed sites which did pass red flag criteria indicated that they were already engaged in other activities such as container shipping, bulk cargo, and liquid bulk cargo. These sites noted that they were content with their current business models and were not interested in expanding into the OSW market at this time. The final shortlist consisted of 10 ports, seven from the initial questionnaire response and three identified through further outreach.

Sites which indicated interest in participating and passed red flag analysis moved onto the next round of screening, qualitative assessment. Sites which indicated interest and did not pass red flag analysis were notified that they would not be part of the qualitative analysis and were provided with the criteria which they did not meet as well as any suitable secondary activities they may wish to investigate further.

4.2.5. Qualitative Assessment

Participating sites which passed red flag analysis moved on to a qualitative assessment. In this portion of the assessment, facilities were evaluated based on non quantitative characteristics. Participating sites were given the opportunity during port outreach to provide any additional information about their site such as master planning, existing wind related activities, etc.

Site availability is a major portion of the qualitative assessment. The qualitative analysis revealed areas that were not available for development and/or limited by current tenants or activities. These areas are not considered viable as part of the site.

The geographical location of a site was also considered in the qualitative assessment. It is desirable for any OSW terminal to be located as close as possible to intended project sites to reduce cost and downtime. Several facilities passed red flag analysis but were considered to be highly remote. While this did not exclude the inclusion of these sites, these factors are noted in the port profiles in Section 5. To date, only Nova Scotia (NS) has begun establishing leasing areas. Proximity to these areas are noted in the port profiles. Additional geographical considerations such as flight paths, and military bases located in the vicinity of the port was factored into the assessment.

Similarly, accessibility of a site was considered and noted. WTG and foundation components are too large to be transported over land. For this reason, heavy transport roads and rail links were not considered. However, the port must have suitable road access for construction or improvement of the site as well as port supply services and workforce access. Remoteness is also correlated to the available workforce. Extreme remote areas are unlikely to have an appropriate labor pool to construct and operate these facilities. Conversely, it would also be problematic to develop a port facility in a densely populated area. While the workforce may be readily available, it can be problematic to develop a large port facility adjacent to residential and community use properties due to the visual, audial, and environmental impacts of such a project. A preferred site would be readily accessible while maintaining distance from residential areas.

Existing topographical conditions of a site did not prevent participation but could present challenges. Sites must be developed at an appropriate elevation to be resilient against major storms and sea level rise. Any potential site must also be graded to less than two percent slope with a preference for less than one percent. Grading must be continuous and allow for adequate drainage. Cut and fill to achieve adequate elevation and grading can be a significant driver of cost in developing an offshore wind port. Sites with steep slopes from the waterfront to uplands will require extensive cut and fill which not only drives cost up, but also environmental impacts.

Geotechnical conditions are a major factor in this sense. If a site requires regrading or dredging, exposed bedrock can require substantial blasting creating permitting, environmental, scheduling, and cost challenges. Geotechnical conditions with compressible soils may require significant ground improvements such as soil mixing and/or surcharge. These are problematic in that improvements like pile driving and ground compression may be required to achieve minimum bearing criteria.

Specifically in Atlantic Canada, sea ice conditions can also be of concern. Any sites which are heavily iced during portions of the year could present issues with deliveries and loadout of components. This item did not prevent participation but was considered in the assessment.

Other factors regarding the navigational channel including existing vessel traffic, metocean conditions and navigational hazards were not considered in the assessment. It is acknowledged that these factors are important for the operation and logistics at the ports and follow up detailed studies are recommended to be performed on an induvial port basis.

4.3. Port Infrastructure Criteria

The development of port infrastructure criteria was a key component of this assessment and was the basis for all screening. Minimum criteria were established for each of the three primary port types through collaboration with industry experts, past project experience, and analysis of emerging technologies. The minimum criteria are intended to represent a facility capable of meeting current and future project needs. Key assumptions include WTG component sizing, vessel sizing, and marshalling capacity. For this assessment, a 18-22 megawatt (MW) turbine is considered with a minimum upland marshalling capacity of 20% for a 1 gigawatt (GW) project for all four types of ports.

From these assumptions, minimum criteria could be established for the following categories:

- Upland area
- Upland bearing capacity
- Wharf length
- Wharf bearing capacity
- Water depth at berth
- Channel width
- Channel depth
- Air draft restrictions
- Turning basin sizing
- Vessel/berthing needs

To develop a project efficiently, developers will begin importing components to a marshalling or S&I site before construction begins to build up an inventory, derisking any delays in delivery or installation. An industry standard of 20-30% (of the full project) component marshalling has been established. In the context of this study, this means that upland area would need to accommodate between 10-15 sets of WTG components, or foundations/foundation components. A WTG set is considered a nacelle, three blades and a full tower (4 tower sections were used in this analysis).

Upland areas need to be capable of supporting the significant loading from large components. These loadings include:

- Transport of WTG components and foundations on self-propelled modular transporters (SPMTs)
- Crawler crane tread loading during lifting
- Ring crane track loading during lifting
- Tower assembly prior to wind turbine installation vessel (WTIV) loadout

For the purpose of this study, it is assumed that a large ring crane will be used for preassembly of components at a marshalling site and for integration at S&I sites. Integration of WTG components with floating foundations requires lifting a nacelle which could weigh as much as 1,200 tonnes to heights as great as 200 m. Ring crane manufacturers have indicated a required ground bearing capacity of between 25-30 tonnes per square meter, which are some of the highest in the world. By comparison a typical container terminal should be able to accommodate five tonnes per square meter. Similarly, crawler crane manufacturers have specified a required ground bearing capacity between 25-30 tonnes per square meter to accommodate the required load spreading when lifting OSW components.

Sufficient wharf length or developable water frontage is also crucial to establishing a primary offshore wind port. It is critical that multiple activities can be conducted simultaneously so not to delay or disrupt a project. Required wharf length was established by evaluating the largest existing and planned wind turbine installation vessels, foundation installation vessels, delivery vessels, floating foundations, and foundation launching methods. Specific berthing requirements for each type of primary port are described below. Similarly, water depth, channel width, turning basin radius, and air draft restrictions were established from the same assumptions. Navigational criteria described below was informed by PIANC guidelines applied to the selected design vessels and foundations. It should be noted that PIANC guidelines are not definitive guidance and that a focused navigation study could allow for reduced criteria. Design vessels are described in Section 2.

4.3.1. Fixed Marshalling Port

Fixed WTG marshalling ports are used for component storage, staging, and preassembly as well as the load out of components onto specialized installation vessels. Berthing must be available such that delivery and loadout of components may occur simultaneously. A minimum of one delivery and one installation vessel berth must be available and independently accessible.

Minimum navigational criteria assume one way traffic of the typical vessels as well as a 10% under keel clearance for depth. WTIVs will transport fully assembled tower sections vertically when leaving a marshalling port, as such air draft clearance is a key criterion. Minimum criteria for fixed marshalling ports are shown below in Table 4.2.

TABLE 4.2: MINIMUM CRITERIA FOR FIXED MARSHALLING

Offshore Wind Port Criteria	Metric
Upland area	> 14 ha (ideally > 20 ha)
Upland bearing capacity	15 t/m^2
Wharf length	395 m
Wharf bearing capacity	25 to 30 t/m^2
Water depth at berth	11 m
Channel width	115 m (ideally > 225m)
Channel depth	11 m
Air restrictions (bridges or other overhead obstructions)	160 m
Turning basin	367 m
Vessel/berth needs	1 for delivery vessel 1 for installation vessel

Source: Moffatt & Nichol

4.3.2. FLOW Staging & Integration Port

Whereas fixed-bottom projects involve nacelles and blades being integrated with a pre-installed foundation offshore, FLOW projects require integration of all components in port. S&I sites must also marshal WTG components in the same manner as a fixed-bottom marshalling port. The ability to receive component delivery while integration is underway is crucial. At a minimum, one berth for integration and one berth for deliveries is required. A third, commissioning berth is preferred but not required. A commissioning berth would allow integration of another unit to begin while the previously integrated unit undergoes final pre-commissioning prior to tow-out and installation. Due to the significant height of the integrated turbines, with blade tips expected to be greater than 300 m for 18-22 MW turbines, there must not be any air draft restrictions on the route to the installation site. Minimum criteria for S&I ports are shown below in Table 4.3.

TABLE 4.3: MINIMUM CRITERIA FOR FLOW STAGING & INTEGRATION

Offshore Wind Port Criteria	Metric
Upland area	> 14 ha (ideally > 20 ha)
Upland bearing capacity	15 t/m^2
Wharf length	395 m
Wharf bearing capacity	25 to 30 t/m^2
Water depth at berth	11 m
Channel width	150 m (ideally > 200m)
Channel depth	11 m
Air restrictions (bridges or other overhead obstructions)	unrestricted
Turning basin	367 m
Vessel/berth needs	1 for delivery vessel 1 for WTG integration

Source: Moffatt & Nichol

The availability of wet storage for foundations is also an important factor in locating an S&I port. Wet storage is required to derisk a project from any delivery, installation or weather-related delays and essentially acts as a marshalling area for both integrated and unintegrated units. Siting of wet storage were beyond the scope of this work.

4.3.3. FLOW Foundation Assembly Port

Floating foundation assembly sites will either receive deliveries of preassembled foundation components or cast those components onsite. The required upland area represents a minimum of 20% component marshalling or the ability to support a concrete fabrication facility.

Foundation components will likely arrive via heavy transport vessels (HTV). These vessels are typically larger than WTG cargo carrier delivery vessels. Foundation launching must also be considered. While there are numerous proposals for foundation launching methods, a semi-submersible barge has been the most common launch method to date and was therefore considered in this analysis. These factors drive the need for a longer wharf. A minimum of one delivery berth and one launching berth must be accommodated. Minimum criteria for foundation assembly ports are shown in Table 4.4.

TABLE 4.4: MINIMUM CRITERIA FOR FLOW FOUNDATION ASSEMBLY

Offshore Wind Port Criteria	Metric
Upland area	> 19 ha (ideally > 30 ha)
Upland bearing capacity	15 t/m^2
Wharf length	425 m
Wharf bearing capacity	25 to 30 t/m^2
Water depth at berth	11 m
Channel width	150 m (ideally > 200m)
Channel depth	11 m
Air restrictions (bridges or other overhead obstructions)	100 m
Vessel/berth needs	1 for delivery vessel 1 for foundation launching

Source: Moffatt & Nichol

The availability of wet storage for foundations is also an important factor in locating foundation assembly port. Wet storage is required to derisk a project from any delivery, installation, or weather related delays and essentially acts as a marshalling area for both integrated and unintegrated units. A sinking basin will also be required should a semi-submersible launching method be employed. A sinking basin is an area of sheltered water, deep enough to allow foundation float-off. Siting of wet storage and a sinking basin were beyond the scope of this work.

4.3.4. FLOW Combined Foundation Assembly and Staging & Integration Port

While it is possible for S&I and foundation assembly activities to occur at different sites the co-location of these activities at a singular port provides the highest operational efficiencies. Conducting these activities in close proximity derisks a project from weather and towing related delays and allows for some shared infrastructure. For a combined foundation assembly and staging & integration site, a minimum of three berths are required, one for delivery, one for foundation launching, and one for integration. An additional pre-commissioning berth is preferred but not required. Additionally, both foundation and WTG marshalling must be accommodated in the uplands.

TABLE 4.5: MINIMUM CRITERIA FOR FLOW COMBINED FOUNDATION ASSEMBLY AND STAGING & INTEGRATION

Offshore Wind Port Criteria	Metric
Upland area	>30 ha (ideally > 55 ha)
Upland bearing capacity	15 t/m^2
Wharf length	600 m
Wharf bearing capacity	25 to 30 t/m^2
Water depth at berth	11 m
Channel width	150 m (ideally > 200m)
Channel depth	11 m
Air restrictions (bridges or other overhead obstructions)	unrestricted
Turning basin	367 m
Vessel/berth needs	1 for delivery vessel 1 for WTG Integration 1 for foundation launching

Source: Moffatt & Nichol

5. Port Profiles

A port profile has been created for each of the shortlisted sites to give an overview of the current state of the port's infrastructure and capabilities. Depending on the characteristics of the ports, they were considered for different offshore wind (OSW) applications based on the activity specific criteria in Section 4.3. The sites that were identified as suitable for OSW development in Atlantic Canada and agreed to participate in the assessment are shown in Figure 5.1.

Several sites passed red flag analysis but were ultimately not included in this assessment because of conflicting use cases, non responsiveness to outreach attempts or indication from representatives that there was no interest at this point in entering the OSW industry.

FIGURE 5.1: SHORTLISTED PORTS

Source: Moffatt & Nichol on ArcGIS

TABLE 5.1: SHORTLISTED PORTS

Port	Location (Province)
Port of Belledune	New Brunswick
Port Saint John (Long wharf terminal & Lower cove terminal)	New Brunswick
Channel Port aux Basques	Newfoundland and Labrador
Port of Argentia	Newfoundland and Labrador
Port of Mortier Bay	Newfoundland and Labrador
Atlantic Canada Bulk Terminal	Nova Scotia
Melford International Terminal	Nova Scotia
Novaporte	Nova Scotia
Port of Sheet Harbour	Nova Scotia
Port Hawkesbury Paper	Nova Scotia

Source: Moffatt & Nichol

PORT DETAILS

Port Name	Port of Belledune
Ownership	Belledune Port Authority
Operator	Belledune Port Authority
Location	Belledune, New Brunswick (47.54, 65.50)
Data Source	Port Questionnaire, Port Website
Port Readiness	Operating Port with development plans

CURRENT CHARACTERISTICS / INFRASTRUCTURE

Upland area	6.5 ha
Upland bearing capacity	15.3 t/m^2
Wharf length	738 m
Wharf bearing capacity	5.1 t/m^2
Water frontage	3,240 m
Water depth at berth / shoreline	- 8.9 to - 11.0 mCD
Minimum access channel depth and width	Unconfirmed
Distance to main navigation channel	On main navigation channel
Vertical clearance limitations	No airdraft restriction
Tidal range at wharf	2 m
Ice-in conditions	Ice Free
Distance to nearest offshore wind lease areas	287 Nautical Miles

POTENTIAL FOR FUTURE DEVELOPMENTS

Construction Estimate*	$178 million CAD
Project Timeline**	45 – 63 months

PORT PLAN

Figure 1: Belledune, NB

Figure 2: Port of Belledune proposed OSW area (Source: Moffatt & Nichol on Google Earth)

PORT OVERVIEW AND CURRENT OPERATIONS

Port of Belledune is a breakbulk and bulk port located in northern New Brunswick. The Port is developing a masterplan aimed at diversifying operations into future business. These will be centered around liquid & dry bulk, maritime dependent industry, light manufacturing, green hub and high-visibility commercial operations.

The facility has 4 terminals, with terminals 3 and 4 available for offshore wind activity. The port currently offers 6.5-ha of storage capacity, with an additional 500-ha of undeveloped upland.

The Belledune Port Authority has a protocol agreement with local First Nations communities including Oinpegitoig First Nation (Pabineau), Ugpi'ganjig First Nation (Eel River Bar) and Mi'gmawe'l Tplu'taqnn Inc (Mi'gmawe'l Tplu'taqnn).

POTENTIAL FOR EXPANSION AND FUTURE DEVELOPMENTS

Port of Belledune has 2,500 m of waterfront available for expansion of the current quay or construction of a new quay, along with 32.5 ha of developable uplands adjacent to existing infrastructure.

OSW DEVELOPMENT USE-CASE

The Port can support fixed-bottom offshore wind (OSW) marshalling operations with targeted infrastructure upgrades and given an access corridor from the quay to the upland is made available. The facility is not suitable for floating OSW activities without significant development.

LIMITATIONS AND RESTRICTIONS

The Port benefits from no air draft, channel width, or navigational restrictions. The waterfront distance between Terminals 1 and 2 on the north side of the site and Terminals 3 and 4 to the south is insufficient to allow the transit of floating foundations, limiting its suitability to fixed-bottom OSW. The existing bearing capacity of the wharf is below the study threshold and would require significant improvements.

** AACE 18R-97 Class 5 (-30%, +50%). Range depends on selected activities the port will service. Values includes construction contingency, for further detail on cost estimate refer to section 6.3 of the report.*

*** Level 1 Schedule. Range covers design, permitting and construction activities depending on selected activities the port will service and permitting requirements. For further detail, refer to section 6.3 of the report.*

PORT SAINT JOHN - PORT PROFILE

PORT DETAILS

Port Name	Port Saint John (Long Wharf and Lower Cove Terminals)
Ownership	Saint John Port Authority
Operator	Saint John Port Authority
Location	Saint John, New Brunswick, (45°15'55.71"N, 66° 3'30.06"W)
Data Source	Port Questionnaire, Port Official Website
Port Readiness	Operating Port with development plans

CURRENT CHARACTERISTICS / INFRASTRUCTURE

Upland area	14 ha
Upland bearing capacity	9.7 t/m^2
Wharf length	510 m, 225 m (Lower Cove) + 285 m (Long Wharf)
Wharf bearing capacity	4.9 t/m^2
Water frontage	925 m, 225 m (Lower Cove) + 700 m (Long Wharf)
Water depth at berth / shoreline	-10.7 mCD
Minimum access channel depth and width	-9.5 mCD x 150 m
Distance to main navigation channel	600 m
Vertical clearance limitations	No airdraft restriction
Tidal range at wharf	8 m
Ice-in conditions	Ice Free
Distance to nearest offshore wind lease areas	330 nautical miles

POTENTIAL FOR FUTURE DEVELOPMENTS

Construction Estimate*	$257 million CAD
Project Timeline**	45 – 63 months

PORT PLAN

Figure 1: Port Saint John, NB

Figure 2: Port Saint John Long Wharf and Lower Cover Terminal (Source: Moffatt & Nichol on Google Earth)

PORT OVERVIEW AND CURRENT OPERATIONS

The Port Saint John is a multipurpose marine facility and part of the critical infrastructure supporting the economies of Canada and New Brunswick. The Port comprises a diverse range of facilities and operations on behalf of the federal government or private owners, serving industries including marine transportation, import and export of cargo, potash, containers, cruise and local tourism and fisheries. The Port is regularly used by Greater Saint John and surrounding areas.

The Port engages with several indigenous communities, including Wolastoqey Nation in New Brunswick, Mi'gmawe'l Tplu'taqnn Inc, Kopit Lodge, and the Joint Economic Development Initiative (JEDI).

Several land parcels are currently available for leasing, and the Port has identifies the Long Wharf and Lower Cover terminals as potential sites for offshore wind (OSW) activities. The Port has prior experience supporting local onshore wind and stated as having an appetite for supporting OSW projects in the Northeast US through the storage of blades, nacelles, towers, monopiles and transitional pieces. Future support to the OSW industry would involve clustering of both terminals to meet infrastructure and operational requirements.

POTENTIAL FOR EXPANSION AND FUTURE DEVELOPMENTS

At this time, no expansion areas or future development opportunities have been identified at Port Saint John.

OSW DEVELOPMENT USE-CASE

The Long Wharf and Lower Cove terminals could support fixed-bottom OSW marshalling and floating OSW staging and integration operations. The two sites would have to operate with a feedering system, with Lower Cove serving as a supporting laydown area and Long Wharf as the main delivery and installation berth This clustered operation would require additional operational and logistical planning to manage component transfers between sites.

LIMITATIONS AND RESTRICTIONS

The Port benefits from no air draft, channel width, or navigational restrictions. Operations will be restricted to a feedering system between available sites. Existing bearing capacity of the wharf is below typical wind standards and will have to be improved to support wind activities. The Port has stated that they are not in control of any expansion area, restricting the Port's capability to support floating OSW projects.

**AACE 18R-97 Class 5 (-30%, +50%). Range depends on selected activities the port will service. Values includes construction contingency, for further detail on cost estimate refer to section 6.3 of the report.*

*** Level 1 Schedule. Range covers design, permitting and construction activities depending on selected activities the port will service and permitting requirements. For further detail, refer to section 6.3 of the report.*

CHANNEL PORT AUX BASQUES - PORT PROFILE

PORT DETAILS

Port Name	Channel Port aux Basques
Ownership	Transport Canada
Operator	Port aux Basques Harbour Authority
Location	Channel Port aux Basques, Newfoundland and Labrador (47.34, 59.07)
Data Source	Port Questionnaire, Port Website
Port Readiness	Proposed Port with development plans

PROPOSED CHARACTERISTICS / INFRASTRUCTURE

Upland area	13.4 ha
Upland bearing capacity	TBD during design
Wharf length	TBD during design
Wharf bearing capacity	TBD during design
Water frontage	758 m
Water depth at berth / shoreline	- 3 mCD
Minimum access channel depth and width	- 24 mCD x 80 m
Distance to main navigation channel	2,900 m
Vertical clearance limitations	No airdraft restriction
Tidal range at wharf	1.4 – 2.3 m
Ice-in conditions	Ice Free
Distance to nearest offshore wind lease areas	70 nautical miles

POTENTIAL FOR FUTURE DEVELOPMENTS

Construction Estimate*	$324 million CAD
Project Timeline**	69 – 93 months

PORT PLAN

Figure 1: Channel Port aux Basques, NL

Figure 2: Proposed greenfield area for expansion (Source: Moffatt & Nichol on Google Earth)

Channel Port aux Basques has served as a major shipping hub since 1898, continually expanding to accommodate larger vessels. It is home to the primary terminal in Newfoundland for Marine Atlantic Inc, which provides the island's sole freight and passenger ferry connection with Nova Scotia. The harbour also accommodates Canadian Coast Guard cutters, cruise ships, liquid bulk ships, and regularly hosts vessels exceeding 200 m in length.

At present, the port does not have formal agreements or partnerships with Indigenous groups but expresses interest in developing such relationships as opportunities arise.

POTENTIAL FOR EXPANSION AND FUTURE DEVELOPMENTS

An initial 13.4-ha greenfield site on the harbour's eastern shoreline has been identified for potential development. No infrastructure or design work has been conducted for the proposed site. In addition, 200-ha of developable land on the eastern shore could be made available for future expansion.

OSW DEVELOPMENT USE-CASE

The proposed development site could support fixed-bottom offshore wind (OSW) marshalling. Expansion beyond the initial development site would need to be considered to support floating OSW assembly activities.

LIMITATIONS AND RESTRICTIONS

There are no air draft restrictions for OSW activities at Port aux Basques. Dredge will be required for the channel to become unrestricted for fixed-bottom OSW operations. Vardy's Island will remain a navigational obstacle that would require further assessment. Additionally, significant dredging into rock material, around the development area, will be necessary to provide adequate berth depth for OSW operations, and detailed navigational and berth assessments are recommended prior to development. Wet storage considerations will be required for the facility to serve as a staging and integration. Dredging of the channel and removal of rock material has not been considered in development of the construction cost estimate.

**AACE 18R-97 Class 5 (-30%, +50%). Range depends on selected activities the port will service. Values includes construction contingency, for further detail on cost estimate refer to section 6.3 of the report.*

***Level 1 schedule. Range covers design, permitting and construction activities depending on selected activities the port will service and permitting requirements. For further detail, refer to section 6.3 of the report.*

PORT DETAILS

Port Name	Port of Argentia
Ownership	Argentia Capital Inc
Operator	Argentia Management Authority Inc
Location	Argentia, Newfoundland and Labrador, (47.30N, 53.98W)
Data Source	Port Questionnaire, Port Official Website
Port Readiness	Operating Port with development plans and permitting ongoing / approved

CURRENT CHARACTERISTICS / INFRASTRUCTURE

Upland area	220 ha (70 ha of paved runway)
Upland bearing capacity	12 t/m^2 at paved runway, various for rest of upland
Wharf length	430 m + 448m (wharf expansion)
Wharf bearing capacity	5 t/m^2
Water frontage	11,830 m
Water depth at berth / shoreline	-11 mCD
Minimum access channel depth and width	Unknown
Distance to main navigation channel	2,000 m
Vertical clearance limitations	No airdraft restriction
Tidal range at wharf	1.6 m
Ice-in conditions	Ice Free
Distance to nearest offshore wind lease areas	250 nautical mile

POTENTIAL FOR FUTURE DEVELOPMENTS

Construction Estimate*	\$8.8 – \$230 million CAD
Project Timeline**	21 – 51 months

PORT PLAN

Figure 1: Argentia, NL

Figure 2: Port of Argentia proposed OSW area (Source: Moffatt & Nichol on Google Earth)

PORT OVERVIEW AND CURRENT OPERATIONS

The Port of Argentia, located in the southeastern region of Newfoundland, Canada, is a multipurpose industrial port occupying the former site of a U.S. naval air base. In addition to its industrial operations, the port servers as a seasonal gateway to mainland Canada via a RoPax ferry service operated by Marine Atlantic to and from North Sydney. The Port supports a range of sectors including marine transportation, renewable energy, aquaculture, offshore oil, and mining, and container shipping.

The Port's strategic location and available infrastructure position it as a key site for offshore wind (OSW) in Atlantic Canada. The site is actively used for fixed-bottom offshore wind components storage and has previously supported large-scale industrial projects, including the recent construction of a concrete, gravity-based drilling rig. A graving dock was custom built for this purpose, dredged to approximately 18 m.

The Port does not currently hold active agreements or partnerships with Indigenous communities. However, it is engaging with local Indigenous groups to assess the potential impacts associated with its planned dock expansion project, currently in development, including considerations to historical fishing grounds within Placentia Bay.

POTENTIAL FOR EXPANSION AND FUTURE DEVELOPMENTS

Aside from the 70-ha of uplands currently used for OSW marshalling, the remaining 220-ha storage area at Port of Argentia will require strengthening to meet the requirements for supporting larger component marshalling. The Port has planned for an 448 m extension to the quay (Copper Cove) with a Ro-Ro ramp in the northern end.

OSW DEVELOPMENT USE-CASE

The Port of Argentia currently supports fixed-bottom OSW marshalling and, with targeted infrastructure upgrades, could accommodate floating staging & integration, foundation assembly, or serve as a combined floating facility. The existing graving dock offers potential as a sinking basin or floating integration area.

LIMITATIONS AND RESTRICTIONS

The Port benefits from no air draft, channel width, or navigational restrictions. The existing bearing capacity of the wharf is below the study threshold, however the terminal has successfully served the industry to date. Further analysis is required to assess the existing berth's long term capability to service the industry. To fully support floating OSW, an additional quay would have to be developed to allow for the launch of assembled foundations. Considerations for wet storage and sinking basin will also be required.

** AACE 18R-97 Class 5 (-30%, +50%). Range depends on selected activities the port will service. Values includes construction contingency, for further detail on cost estimate refer to section 6.3 of the report.*

*** Level 1 Schedule. Range covers design, permitting and construction activities depending on selected activities the port will service and permitting requirements. For further detail, refer to section 6.3 of the report.*

PORT DETAILS

Port Name	Port of Mortier Bay
Ownership	Town of Marystown
Operator	N/A
Location	Mortier Bay, Newfoundland and Labrador (47.11, 55.75)
Data Source	Port Questionnaire
Port Readiness	Proposed Port with development plans and permitting ongoing / approved

PROPOSED CHARACTERISTICS / INFRASTRUCTURE

Upland area	44 ha (to be reclaimed land)
Upland bearing capacity	TBD during design
Wharf length	Greenfield (500m – 700m)
Wharf bearing capacity	TBD during design
Water frontage	700 m
Water depth at berth / shoreline	-10 mCD
Minimum access channel depth and width	-30 mCD x 700 m
Distance to main navigation channel	Adjacent to main navigation channel
Vertical clearance limitations	No airdraft restriction
Tidal range at wharf	1.43 m
Ice-in conditions	Ice Free
Distance to nearest offshore wind lease areas	210 nautical miles

POTENTIAL FOR FUTURE DEVELOPMENTS

Construction Estimate*	$470 - $965 million CAD
Project Timeline**	69 – 109 months

PORT PLAN

Figure 1: Mortier Bay, NL

Figure 2: Proposed area for Port of Mortier Bay (Source: Moffatt & Nichol on Google Earth)

PORT OVERVIEW AND CURRENT OPERATIONS

The Town of Marystown, located in Mortier Bay on the island of Newfoundland, is a maritime focused town with a history in fishing, shipbuilding and ship repair. In 2009, the town continued its maritime involvement with the development of the Mortier Bay Industrial Park, which includes plans for the development of a new deep-water facility, the Port of Mortier Bay. The proposed port layout features 44-ha of reclaimed land and a quay ranging from 500 to 700 m in length at -30 mCD.

The current operations in Mortier Bay includes fish processing operations, Grieg Seafoods, Marbase, Peter Kiewitt & Sons, St Lawrence Fluorspar Mine, Spaceport project, and other local businesses. The town has stated that indigenous groups will be partnering with Everwind Fuels to ship hydrogen from the current facilities in Mortier Bay to Point Tupper in Nova Scotia.

POTENTIAL FOR EXPANSION AND FUTURE DEVELOPMENTS

In addition to the proposed terminal development, additional wharf and upland expansion opportunities are available as required. A potential 5-ha laydown area and 250 m of quay are being considered at Powers Cove.

OSW DEVELOPMENT USE-CASE

The Port of Mortier Bay, when fully developed and constructed, will meet the requirements support fixed-bottom offshore wind (OSW) marshalling projects and serve as a full floating offshore wind facility, capable of handling both staging & integration and foundation assembly operations.

LIMITATIONS AND RESTRICTIONS

There are no air draft, channel width, or navigational restrictions at the Port of Mortier Bay site. As a greenfield development, site-specific limitations will be determined during detailed engineering and permitting of OSW-specific facilities. It should be noted that any inland expansion would require significant excavation of the adjacent hillside terrain which will entail significant increase to the cost of the development. To fully support floating offshore wind, considerations for wet storage and sinking basin will also be required.

* AACE 18R-97 Class 5 (-30%, +50%). Range depends on selected activities the port will service. Values includes construction contingency, for further detail on cost estimate refer to section 6.3 of the report.

** Level 1 Schedule. Range covers design, permitting and construction activities depending on selected activities the port will service and permitting requirements. For further detail, refer to section 6.3 of the report.

PORT DETAILS

Port Name	Atlantic Canada Bulk Terminal
Ownership	Provincial Energy Ventures
Operator	Harbour Logistic Services
Location	Sydney, Nova Scotia, (46.14, -60.18)
Data Source	Port Questionnaire, Port Website
Port Readiness	Operating Port

CURRENT CHARACTERISTICS / INFRASTRUCTURE

Upland area	40 ha
Upland bearing capacity	Over 40 t/m^2
Wharf length	Two berth facility with 350 m
Wharf bearing capacity	14 t/m^2
Water frontage	900 m
Water depth at berth / shoreline	- 13 mCD
Minimum access channel depth and width	- 13 mCD x 800 m
Distance to main navigation channel	On main navigation channel
Vertical clearance limitations	No airdraft restriction
Tidal range at wharf	1 m
Ice-in conditions	Navigation is not impacted by Ice
Distance to nearest offshore wind lease areas	25 nautical miles

POTENTIAL FOR FUTURE DEVELOPMENTS

Construction Estimate*	$135 - $230 million CAD
Project Timeline**	27 – 51 months

PORT PLAN

Figure 1: Sydney, NS

Figure 2: Atlantic Canada Bulk Terminal Source: Moffatt & Nichol on Google Earth)

PORT OVERVIEW AND CURRENT OPERATIONS

Atlantic Canada Bulk Terminal is a 40-ha deep-water port located in Sydney, Nova Scotia, within a densely populated urban area. The site operates as a bulk material handling facility and has been used for marshalling offshore wind (OSW) components.

The Port features a 350 m wharf, with mooring dolphins extending the effective berthing length to 500 m. Past OSW activities have included the handling of monopiles, transition pieces, anode cages, and blades.

POTENTIAL FOR EXPANSION AND FUTURE DEVELOPMENTS

Atlantic Canda Bulk Terminal has the potential to develop two additional quays equating to ~450 m of wharf. The terminal has expressed a willingness to expand and improve facilities to further support OSW activities.

OSW DEVELOPMENT USE-CASE

At present, the site serves as a storage facility for fixed-bottom OSW components. With targeted infrastructure upgrades, the site will be capable of supporting fixed offshore wind marshalling, floating OSW staging & integration, floating foundation assembly, or as a combined floating facility.

LIMITATIONS AND RESTRICTIONS

The terminal benefits from no air draft or channel width restrictions. The existing bearing capacity of the wharf is below the study threshold. However the Port has successfully serviced the industry including RoRo of XXL monopiles and storage of blades. The wharf structure has embedded crane rails that allow for the handling of heavy cargo, including XXL monopiles for OSW projects.

The current wharf length (350m) is slightly below the established minimum criteria, however the existing dolphins allow the Port to serve a marshalling facility for fixed-bottom. To fully support floating OSW, an additional quay would have to be developed to allow for combined foundation assembly and turbine integration operations. Considerations for wet storage and sinking basin will also be required.

** AACE 18R-97 Class 5 (-30%, +50%). Range depends on selected activities the port will service. Values includes construction contingency, for further detail on cost estimate refer to section 6.3 of the report.*

*** Level 1 Schedule. Range covers design, permitting and construction activities depending on selected activities the port will service and permitting requirements. For further detail, refer to section 6.3 of the report.*

PORT DETAILS

Port Name	Melford International Terminal
Ownership	Melford International Terminal Inc.
Operator	N/A
Location	Middle Melford, Nova Scotia, (45.53, -61.30)
Data Source	Port Questionnaire
Port Readiness	Proposed Port with development plans and permitting approved

PROPOSED CHARACTERISTICS / INFRASTRUCTURE

Upland area	41 ha
Upland bearing capacity	TBD during design
Wharf length	TBD during design
Wharf bearing capacity	TBD during design
Water frontage	730 m
Water depth at berth / shoreline	- 18.5 mCD
Minimum access channel depth and width	- 36.5 mCD x 3,000 m
Distance to main navigation channel	500 m
Vertical clearance limitations	No air draft restrictions
Tidal range at wharf	0.6 m
Ice-in conditions	Ice Free
Distance to nearest offshore wind lease areas	65 nautical miles

POTENTIAL FOR FUTURE DEVELOPMENTS

Construction Estimate*	$260 - $442 million CAD
Project Timeline**	48 – 63 months

PORT PLAN

Figure 1: Middle Melford, NS

Figure 2: Melford International Terminal (Source: Moffatt & Nichol on Google Earth)

PORT OVERVIEW AND CURRENT OPERATIONS

Melford International Terminal is a greenfield port development site located on the southern shore of the Strait of Canso in Middle Melford, Nova Scotia, within a rural area. The phase 1 site comprises over 40-ha of developable land and 730 m of water frontage. A container and multi-use terminal have been proposed and received permitting but construction has not yet commenced.

The project is financially backed by Cyrus Capital Partners, with Millbrook First Nation holding an ownership stake.

POTENTIAL FOR EXPANSION AND FUTURE DEVELOPMENTS

Melford International Terminal Inc. owns an additional 23.5 ha of uplands with 365 m of permitted waterfront, immediately adjacent to the planned terminal footprint, available for future expansion. Beyond this, the terminal controls an additional 485 ha of land directly behind the proposed terminal area, providing long-term potential for further offshore wind (OSW) related development.

OSW DEVELOPMENT USE-CASE

Once developed, the site will be well positioned to support the OSW industry. Subject to final build-out, Melford International will meet the requirement to support fixed OSW marshalling projects and serve as a full floating offshore wind facility, capable of handling both staging & integration and foundation assembly operations. The extensive available uplands and waterfront area provide the flexibility to integrate OSW operations either within or adjacent to the planned container terminal footprint.

LIMITATIONS AND RESTRICTIONS

The terminal benefits from no air draft, channel width, or navigational restrictions. As a greenfield development, site-specific limitations will be determined during detailed engineering and permitting of OSW-specific facilities. To fully support floating offshore wind, considerations for wet storage and sinking basin will also be required.

** AACE 18R-97 Class 5 (-30%, +50%). Range depends on selected activities the port will service. Values includes construction contingency, for further detail on cost estimate refer to section 6.3 of the report.*

*** Level 1 Schedule. Range covers design, permitting and construction activities depending on selected activities the port will service and permitting requirements. For further detail, refer to section 6.3 of the report.*

NOVAPORTE - PORT PROFILE

PORT DETAILS

Port Name	Novaporte Wind Terminal
Ownership	Novaporte (Sydney Harbour Investment Partners (SHIP), Membertou Development Corporation, Cape Breton Regional Municipality)
Operator	Blue Water Shipping
Location	Sydney, Nova Scotia, (46.17, -60.22)
Data Source	Port Questionnaire
Port Readiness	Proposed Port with development plans and permitting ongoing/approved

PROPOSED CHARACTERISTICS / INFRASTRUCTURE (FULL DEVELOPMENT)

Upland area	202 ha
Upland bearing capacity	15 t/m^2
Wharf length	1,600 m
Wharf bearing capacity	30 t/m^2
Water frontage	1,600 m
Water depth at berth / shoreline	- 13.9 mCD
Minimum access channel depth and width	- 16.5 mCD x 225 m
Distance to main navigation channel	On main navigation channel
Vertical clearance limitations	No airdraft restriction
Tidal range at wharf	1.4 m
Ice-in conditions	Ice Free
Distance to nearest offshore wind lease areas	26 nautical miles

POTENTIAL FOR FUTURE DEVELOPMENTS

Construction Estimate*	\$346 - \$654 million CAD
Project Timeline**	48 – 63 months

PORT PLAN

Figure 1: Sydney, NS

Figure 2: Novaporte Port Plan (Source: Moffatt & Nichol on Google Earth)

PORT OVERVIEW AND CURRENT OPERATIONS

Novaporte is a greenfield site planned for development as an offshore wind (OSW) terminal within Sydney Harbour, Nova Scotia. Phase One (I) of the project will include an 80-ha facility featuring a minimum 350 m quay wall, with Mediterranean stern mooring capabilities (~ 180m), with a bearing capacity of 20 t/m^2 and 16.5 mCD harbour depth. The wind terminal will be operated by Blue Water Shipping, an offshore wind logistics company headquartered in Denmark.

The project includes meaningful Indigenous participation. Membertou First Nation is an equity partner in the Novaporte, and through consultation, all 13 Nova Scotia Mi'kmaq communities now hold ownership of 100-ha of land in the adjacent Novaporte Energy Park. Additionally, SHIP owns and operates Point Edward Marine in the nearby Sydport Industrial Park.

POTENTIAL FOR EXPANSION AND FUTURE DEVELOPMENTS

Novaporte is planned to be developed in two phases, with Phase Two (II) planned to expand facilities for OSW marshalling, assembly and storage. Because of the size of the waterside asset, the Port would be well positioned to also support other business revenue streams such as Ro-Ro, bulk and break bulk and the export of fuels.

OSW DEVELOPMENT USE-CASE

Upon completion of Phase I, Novaporte will meet all the requirements to support the development of fixed-bottom and floating OSW projects. The port will feature a heavy-lift quay with a 30 t/m^2 bearing capacity and a berth depth of 13.9 m, suitable for Wind Turbine Installation Vessels (WTIVs), heavy transport vessels, RoRo vessels, and delivery barges. Novaporte will include a 550 m turning circle, 158 m wide dredged berthing area, and berth pockets suitable for jack-up vessels. Additionally, Phase I will offer 80 ha (200 acres) of high-capacity, compacted upland storage and assembly space, ideal for handling and staging WTG components and foundations.

LIMITATIONS AND RESTRICTIONS

The location benefits from no air draft, channel width, or navigational restrictions. To fully support floating OSW, considerations for wet storage and sinking basin will also be required.

* *AACE 18R-97 Class 5 (-30%, +50%). Range depends on selected activities the port will service. Values includes construction contingency, for further detail on cost estimate refer to section 6.3 of the report.*

** *Level 1 Schedule. Range covers design, permitting and construction activities depending on selected activities the port will service and permitting requirements. For further detail, refer to section 6.3 of the report.*

PORT DETAILS

Port Name	Port of Sheet Harbour
Ownership	QSL
Operator	POSHA
Location	Sheet Harbour, Nova Scotia, (44.90, -62.50)
Data Source	Port Questionnaire, Port Website
Port Readiness	Operating Port actively under construction or recent expansion

CURRENT CHARACTERISTICS / INFRASTRUCTURE

Upland area	32 ha
Upland bearing capacity	20 t/m^2
Wharf length	150 m
Wharf bearing capacity	15 t/m^2
Water frontage	815 m
Water depth at berth / shoreline	- 10 mCD to -11 mCD
Minimum access channel depth and width	- 14 mCD x 200 m
Distance to main navigation channel	On main navigation channel
Vertical clearance limitations	No air draft restriction
Tidal range at wharf	1.5 m
Ice-in conditions	Ice Free
Distance to nearest offshore wind lease areas	50 nautical miles

POTENTIAL FOR FUTURE DEVELOPMENTS

Construction Estimate*	$247 - $490 million CAD
Project Timeline**	52 – 80 months

PORT PLAN

Figure 1: Sheet Harbour, NS

Figure 2: Port of Sheet Harbour proposed OSW area (Source: Moffatt & Nichol on Google Earth)

PORT OVERVIEW AND CURRENT OPERATIONS

Port of Sheet Harbour (POSH) is a 32 ha deep-water port located in Sheet Harbour, Nova Scotia. Current operations include marine transport and construction, quarry, wood chips, offshore and onshore wind, OEMC's, cement, and mining. The Port has served as a storage facility of transition pieces and anode cages for Vineyard Wind 1, with jack-up operations conducted in the quayside.

The Port is regularly used by the Halifax regional Municipality and bordering municipalities; and maintains relationships with local Indigenous businesses through sub-contracting opportunities, and local Indigenous fisheries rely on access to the Port.

POTENTIAL FOR EXPANSION AND FUTURE DEVELOPMENTS

The Port has stated that they are undergoing expansion plans to develop the waterfront on either side of the existing quay. This will make available approximately 33 ha of land for offshore wind activity. It is noted that more operational options will be available once the expansion is complete. An additional 47 ha further inland from the waterfront development is available as potential future expansion.

OSW DEVELOPMENT USE-CASE

The Port of Sheet Harbour, once expansion plans has been fully completed, will meet the requirements for development of a fixed-bottom or floating marshalling port, floating staging & integration, foundation assembly, or serve as a combined floating facility.

LIMITATIONS AND RESTRICTIONS

The Port benefits from no air draft, channel width, or navigational restrictions. A key limitation at Port of Sheet Harbour is the ability to dedicate the existing wharf space for OSW activity due to the continued use of the existing wharf for existing operations. In order to service floating offshore wind staging & integration activities, considerations for wet storage will also be required.

** AACE 18R-97 Class 5 (-30%, +50%). Range depends on selected activities the port will service. Values includes construction contingency, for further detail on cost estimate refer to section 6.3 of the report.*

*** Level 1 Schedule. Range covers design, permitting and construction activities depending on selected activities the port will service and permitting requirements. For further detail, refer to section 6.3 of the report.*

PORT DETAILS

Port Name	Port Hawkesbury Paper
Ownership	Stern Partners
Operator	Port Hawkesbury Paper GP
Location	Hawkesbury, Nova Scotia, (45.59, -61.35)
Data Source	Port Questionnaire and Interview
Port Readiness	Operating Port with development plans

CURRENT CHARACTERISTICS / INFRASTRUCTURE

Upland area	100 ha (30 ha for OSW development)
Upland bearing capacity	Unconfirmed
Wharf length	165 m (existing)
Wharf bearing capacity	Unconfirmed
Water frontage	370 m
Water depth at berth / shoreline	- 10 mCD
Minimum access channel depth and width	- 14 mCD x 200 m
Distance to main navigation channel	On main navigation channel
Vertical clearance limitations	No current airdraft restriction
Tidal range at wharf	1.5 m
Ice-in conditions	Ice Free
Distance to nearest offshore wind lease areas	70 nautical miles

POTENTIAL FOR FUTURE DEVELOPMENTS

Construction Estimate*	$357 million CAD
Project Timeline**	45 – 63 months

PORT PLAN

Figure 1: Hawkesbury, NS

Figure 2: Port Hawkesbury (Source: Moffatt & Nichol on Google Earth)

PORT OVERVIEW AND CURRENT OPERATIONS

Port Hawkesbury Paper is a 100 hectare deep-water port in Hawkesbury, Nova Scotia. Most of the site, roughly 80 hectares, functions as a paper mill operated by Port Hawkesbury Paper GP. Auxiliary business operated by Port Hawkesbury Paper includes marine transport of industrial bulk materials, breakbulk cargo, large component transloading, vessel safe haven, vessel bunkering and dockside maintenance/ repair. The proposed development area consist of approximately 30 hectares of land on the western portion of the site. A rail line owned by the Canadian National Railway crossed the potential development area and supply the paper mill.

The port doesn't have any existing partnerships with indigenous communities, however, 50% of facilities security team are from First Alliance Security which is owned and operated by the We'koqma'q Band.

POTENTIAL FOR EXPANSION AND FUTURE DEVELOPMENTS

Port Hawkesbury includes multiple brown and greenfield parcels available for development. The majority of the developable area is located on the western portion of the site with an undeveloped waterfront.

OSW DEVELOPMENT USE-CASE

The proposed development area would be suitable for fixed-bottom offshore wind marshalling activities as well as floating offshore wind staging & integration activities.

LIMITATIONS AND RESTRICTIONS

Several challenges would need to be addressed prior to development. A critical transportation corridor crosses the proposed development area. This rail line would need to be relocated or upgraded to allow for regular crossing by SPMT's and cranes. A large portion of the site has historically been used as a landfill and would need to be remediated before development. A 345kv transmission line crossing the Strait of Canso, located between Hawkesbury and the mouth of the strait, has been proposed. Should construction of this power line move forward, Port Hawkesbury would be restricted to an air draft of 75 meters which would prevent WTG marshalling operations, but not fixed-bottom foundation marshalling.

** AACE 18R-97 Class 5 (-30%, +50%). Range depends on selected activities the port will service. Values includes construction contingency, for further detail on cost estimate refer to section 6.3 of the report.*

*** Level 1 Schedule. Range covers design, permitting and construction activities depending on selected activities the port will service and permitting requirements. For further detail, refer to section 6.3 of the report.*

6. Port Infrastructure Improvements

Following the public information session, attendees were invited to respond to a questionnaire regarding current infrastructure and any future development plans. Based on the questionnaire responses, a RAG analysis (red, amber, green) was carried out assessing each site's readiness to act as a primary offshore wind port. For cases where a site did not meet the criteria for a specific type of primary offshore wind port, further analysis was conducted to determine required upgrades to bring the facility in line with project criteria. This further analysis was desktop based, no site visits or detailed engineering packages were included in this study. A representative layout of each site's development scenarios can be found in Appendix A.

The overview of each shortlisted port's suitability for various primary port activity is shown in Table 6.1. Suitability was determined by the ability to comply with minimum criteria for various offshore wind activities specified in this study (see Section 4.3). It should be noted that for the purpose of this study, a 1 GW project with a one-year installation timeline for fixed-bottom projects and one integrated unit per week for floating projects was considered. Indication that a site is not suitable by these criteria does not necessarily mean that it is incapable of a particular activity on a project specific basis. While this study aims to identify sites that are viable for long term commercial operations in the 1 GW range, selection of a particular site will require further analysis on a project by project basis considering an individual developer's timeline and project specific criteria. Viability of 1 GW throughput at each site may also be further constrained by weather, metocean conditions, and other factors not considered in this assessment.

Any infrastructure gaps identified throughout the study are described in the table below. If a port's current or proposed development characteristics do not meet the infrastructure requirements for different primary port activities defined in Section 4.3, the required infrastructure works or restraints are identified in the respective cell. The infrastructure requirements for each of the identified ports are discussed further below and classified as either Red, Amber or Green. The definitions for Red, Amber and Green is specified below.

- Green: Main infrastructure meets requirement, minor upgrade works required
- Amber: Moderate infrastructure works required
- Red: No availability or potential for expansion

Main infrastructure components are defined as the wharf length, upland area and channel width. Upgrade works are defined as upland and/or wharf bearing capacity strengthening, and/or berth pocket dredging.

TABLE 6.1: RAG MATRIX OF SHORTLISTED PORTS

Port Name	Fixed Marshalling	FLOW Staging & Integration	FLOW Foundation Assembly	FLOW Combined
Port of Belledune (New Brunswick)	- Upland Expansion - Wharf capacity - Dredge at berth	- Restraint with berth channel width	- Restraint with berth channel width	- Restraint with berth channel width
Port Saint John (Long wharf terminal & Lower cove terminal), (New Brunswick)	- Upland capacity - Wharf capacity - Dredge at berth and channel	- Upland capacity - Wharf capacity - Dredge at berth and channel - Potential restraint with channel width	- No upland expansion available	- No upland expansion available
Channel Port aux Basques (Newfoundland and Labrador)	- Greenfield site	- Restraint with channel	- Restraint with channel	- Restraint with channel
Port of Argentia (Newfoundland and Labrador)	- Upland capacity	- Upland capacity	- New Foundation Launch wharf - Upland capacity - Upland expansion - Wharf capacity	- New Foundation Launch wharf - Upland capacity - Upland expansion - Wharf capacity
Port of Mortier Bay (Newfoundland and Labrador)	- Greenfield site	- Greenfield site	- Greenfield site	- Greenfield site

Port Name	Fixed Marshalling	FLOW Staging & Integration	FLOW Foundation Assembly	FLOW Combined
Atlantic Canada Bulk Terminal (Nova Scotia)	- Wharf capacity	- Wharf capacity	- Wharf extension - Wharf capacity	- Wharf extension - Wharf capacity
Melford International Terminal (Nova Scotia)	- Greenfield site	- Greenfield site	- Greenfield site	- Greenfield site
Novaporte (Nova Scotia)	- Greenfield site	- Greenfield site	- Greenfield site	- Greenfield site
Port of Sheet Harbour (Nova Scotia)	- Wharf extension - Wharf capacity - Upland extension	- Wharf extension - Wharf capacity - Upland extension	- Wharf extension - Wharf capacity - Upland extension	- Wharf extension - Wharf capacity - Upland extension
Port Hawkesbury Paper (Nova Scotia)	- Upland capacity - Wharf capacity - Wharf extension - Dredge at berth	- Upland capacity - Wharf capacity - Wharf extension - Dredge at berth	- Not enough upland expansion	- Not enough upland expansion

Source: Moffatt & Nichol

6.1. Construction Cost Estimate and Timeline Assumptions

Cost estimates, prepared in Canadian Dollars, have been produced for each site's development scenarios. Each viable use case (fixed marshalling or FLOW staging & integration, FLOW foundation assembly and FLOW combined foundation assembly and staging & integration) for each candidate port was priced out. These categories are based on the criteria specified in Section 4.3. Note: fixed marshalling is categorised together with FLOW staging & integration as the infrastructure requirements for both are the same. These estimates represent an AACE 18R-97 Class 5 Estimate, which carries an approximate accuracy of -30% to +50%. A localized increase of 20% has been applied to account for the higher labour and material costs in Newfoundland and Labrador (NL). A 30% contingency has been applied to the total development cost to account for project unknowns. Site specific attributes such as geotechnical and environmental data were not considered in the creation of cost estimates or timelines. These cost estimates are an 'Opinion of Probable Construction Cost' made by a consultant. In providing opinions of construction cost, it is recognized that neither the client nor the consultant has control over the cost of labor, equipment, materials, or the contractor's means and methods of determining constructability, pricing or schedule. This opinion of construction cost is based on the consultant's reasonable professional judgement and experience and does not constitute a warranty, expressed or implied, that contractor's bids or negotiated prices for the work will not vary from the estimate. Cost estimates are composed of the following line items and relevant assumptions.

- General Assumptions
  - Pricing assumes all resources are readily available locally
  - Estimate is based on unencumbered contractor access to the site
  - Estimate does not include any costs for property lease or acquisition expenses
  - No extreme weather risk included (force majeure)
  - Price does not include environmental restrictions
  - Price does not include any associated costs due to hazardous waste
  - Price does not include any costs for post construction site remediation or reconstruction
  - Costs for owner's project management or overhead expenses are not included
  - Estimates includes utilities designed to the site's limit of work and assumes adequate municipal water and electrical service is available and adequate for project needs. Additional offsite utility infrastructure costs are not included.
  - Estimates exclude soft costs and environmental mitigation requirements
- Contractor Mobilization
  - Mobilization costs are assumed as 5% of direct construction costs excluding dredge.
- Wharf (Concrete caisson structures of 17m x 17m x 30m)

  - Demolition of Existing Structures
  - Construction of Concrete Caisson (Stone bedding, casting and placement, infill)
  - Ground Improvement of soil behind Concrete Caisson
  - Installation of Dense Graded Aggregate (DGA) Topping Surface
  - Installation of Wharf Appurtenances (Fenders, Bollards)
  - Assumed Load Rating of 25 t/m^2 for Fixed Marshalling, FLOW Staging & Integration, FLOW Foundation Assembly
- Reclamation / Infill
  - Rockfill Containment Dike (As required dependent on exposure to metocean conditions)
  - Reclamation of new land through dredge material or imported fill
  - Ground improvements
  - Installation of Dense Graded Aggregate (DGA) Topping Surface
  - Utilities
- Uplands
  - Demolition of Existing Buildings & Pavement
  - Compaction of Upland Soil
  - Installation of DGA Topping Surface
  - Installation of Site Stormwater, Water, Electrical
  - Building Unit Costs Not Included
- Berth Pocket and Access Channel Dredging
  - Mobilization
  - Assuming 30% Contaminated Dredge, 70% Clean Dredge
  - Assuming dredged material can be removed via hydraulic or mechanical dredge methods
  - Considers localized dredge for vessel maneuvering and berthing
- Construction Indirect
  - General Conditions, Bonds & Insurance, Corporate Overhead & Profit

Development timelines have been established for each port's development scenarios structured as a Level 1 Schedule — a high-level program identifying major milestones under a design-bid-build delivery model. These milestones are grouped into three categories: Design (D), Permitting (P), and Construction (C). Timelines for Design and Construction activities have been developed based on Moffatt & Nichol's project experience in similar infrastructure developments.

Permitting timelines are subject to significant variability, largely driven by the specifics of each project's design and its anticipated environmental impacts. At this stage, with limited site-specific environmental data available, the permitting schedules conservatively reflect maximum assumed durations for permitting activities to account for potential regulatory review periods and environmental permitting complexities. Permitting efforts are expected to begin as early as the design allows and will proceed concurrently with design development wherever possible.

6.2. Port of Belledune, New Brunswick

With upgrades, the Port of Belledune would be suitable for supporting fixed wind turbine generator (WTG) and foundation (FOU) marshalling. FLOW operations are not feasible at the Port due to the restricted berth width between the northern and southern terminals.

6.2.1. Construction Cost Estimates

Required improvements include upgrading the bearing capacity of the existing wharf, dredging of the berth pocket and development of additional upland area.

TABLE 6.2: COST ESTIMATE - PORT OF BELLEDUNE

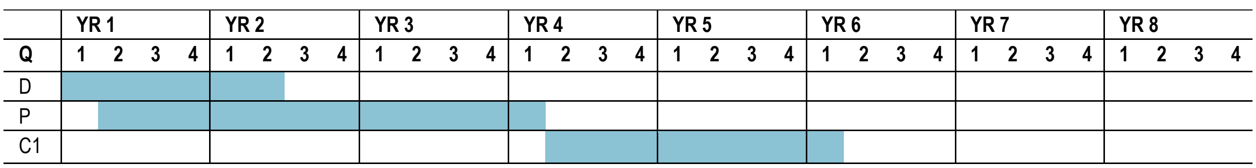
Item	Description	Total Cost (Fixed Marshalling)
1	Contractor Mobilization/Demobilization	$ 4,800,000
2	Wharf	$ 59,300,000
3	Reclamation / Infill	$ 5,600,000
4	Uplands	$ 31,900,000
5	Berth Pocket Dredging	$ 4,500,000
6	Access Channel Dredging	$ -
Direct Cost		**$ 106,100,000**
7.1	Supervision (General Conditions)	$ 12,700,000
7.2	Bonds & Insurance	$ 2,100,000
7.3	Corporate Overhead & Profit	$ 15,900,000
Total Construction Cost without Contingency		**$ 136,800,000**
8	Contingency	$ 41,100,000
Total Project Cost		**$ 177,900,000**

Source: Moffatt & Nichol

6.2.2. Project Development Timelines

The total estimated time for this development will be 45 to 63 months, with the permitting timeline expected to range between 18 and 36 months, depending on the specific design and environmental impacts. The breakdown of the design, (maximum) permitting and construction durations are shown below.

TABLE 6.3: DEVELOPMENT TIMELINE - PORT OF BELLEDUNE



*Q = quarter, D = design, P = permitting, C1 = construction fixed marshalling

Source: Moffatt & Nichol

6.3. Port Saint John (Long Wharf & Lower Cove Terminals), New Brunswick

The Port, if upgraded, will be capable of supporting fixed WTG and FOU marshalling activities and FLOW Staging & Integration.

6.3.1. Construction Cost Estimates

Required improvements include upgrading the bearing capacity of the existing wharf and upland area. The current berth pockets and access channel will require dredging to -11 mCD.

TABLE 6.4: COST ESTIMATE - PORT SAINT JOHN

Item	Description	Total Cost (Fixed Marshalling, FLOW Staging & Integration)
1	Contractor Mobilization/Demobilization	$ 6,000,000
2	Wharf	$ 58,800,000
3	Reclamation / Infill	$ 4,500,000
4	Uplands	$ 56,100,000
5	Berth Pocket Dredging	$ 2,900,000
6	Access Channel Dredging	$ 24,700,000
Direct Cost		**$ 153,000,000**
7.1	Supervision (General Conditions)	$ 18,300,000
7.2	Bonds & Insurance	$ 3,100,000

7.3	Corporate Overhead & Profit	$ 22,900,000
Total Construction Cost without Contingency		**$ 197,300,000**
8	Contingency	$ 59,200,000
Total Project Cost		**$ 256,500,000**

Source: Moffatt & Nichol

6.3.2.Project Development Timelines

The total estimated time for this development will be 45 to 63 months, with the permitting timeline expected to range between 18 and 36 months, depending on the specific design and environmental impacts. The breakdown of the design, (maximum) permitting and construction durations are shown below.

TABLE 6.5: DEVELOPMENT TIMELINE - PORT SAINT JOHN

	YR 1				YR 2				YR 3				YR 4				YR 5				YR 6				YR 7				YR 8			
Q	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
D																																
P																																
C1																																
C2																																

*Q = quarter, D = design, P = permitting, C1 = construction fixed marshalling; C2 = construction FLOW Staging & Integration

Source: Moffatt & Nichol

6.4. Channel-Port aux Basques, Newfoundland and Labrador

The Port, if developed, will be capable of supporting fixed WTG and FOU marshalling activities.

6.4.1.Construction Cost Estimates

Required development for Channel-Port aux Basques includes land reclamation, construction of a wharf, development of the upland area to the required bearing capacity and dredging the berth pocket and navigational channel. Significant dredge will be required for the development to meet the depth requirements for OSW activity. Hence, further analysis of geotechnical conditions will be required to provide a more accurate cost estimate. The navigational channel is similarly restricted at Vardy's Island which will inhibit FLOW operations at the Port. In addition, the existing rock outcropping west of proposed facility may present difficulties in berthing of vessels, this may require removal. Cost for this activity had not been included in this assessment.

TABLE 6.6: COST ESTIMATE – CHANNEL-PORT AUX BASQUES

Item	Description	Total Cost (Fixed Marshalling)
1	Contractor Mobilization/Demobilization	$ 9,400,000
2	Wharf	$ 71,100,000
3	Reclamation / Infill	$ 33,300,000
4	Uplands	$ 52,600,000
5	Berth Pocket Dredging *	$ 25,500,000
6	Access Channel Dredging **	$ -
Direct Cost		**$ 225,200,000**
7.1	Supervision (General Conditions)	$ 27,000,000
7.2	Bonds & Insurance	$ 4,500,000
7.3	Corporate Overhead & Profit	$ 33,800,000
Total Construction Cost without Contingency		**$ 290,500,000**
8	Contingency	$ 87,200,000
Total Project Cost		**$ 324,300,000**

*Dredge will include rock and would require further assessment of dredge works.

** Access to main channel will require significant dredge and is not included in the cost estimate

Source: Moffatt & Nichol

6.4.2. Project Development Timelines

The total estimated time for this development will be 69 to 93 months, with the permitting timeline expected to range between 36 and 60 months, depending on the specific design and environmental impacts. The breakdown of the design, (maximum) permitting and construction durations are shown below.

TABLE 6.7: DEVELOPMENT TIMELINE – CHANNEL-PORT AUX BASQUES

	YR 1				YR 2				YR 3				YR 4				YR 5				YR 6				YR 7				YR 8			
Q	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
D																																
P																																
C1																																

*Q = quarter, D = design, P = permitting, C1 = construction fixed marshalling

Source: Moffatt & Nichol

6.5. Port of Argentia, Newfoundland and Labrador

The Port, once upgraded, will be capable of supporting fixed WTG and FOU marshalling, FLOW foundations assembly and staging & integration activities. Different levels of upgrades can be considered by the Port to support different OSW activities. The cost of these upgrades excludes those associated with the planned Cooper Cover Marine Expansion as this project is already under development by the port.

6.5.1. Construction Cost Estimates

Minor expansion of the existing upland area will be required to meet the criteria for fixed-bottom OSW activities. The Port will require expansion of the upland area and an additional berth to meet the criteria for FLOW activities.

TABLE 6.8: COST ESTIMATE - PORT OF ARGENTIA

Item	Description	Total Cost (Fixed Marshalling, FLOW Staging & Integration)	Total Cost (FLOW Assembly, FLOW Combined)
1	Contractor Mobilization/Demobilization	$ 300,000	$ 6,500,000
2	Wharf	$ -	$ 35,800,000
3	Reclamation / Infill	$ -	$ 3,400,000
4	Uplands	$ 5,000,000	$ 91,500,000
5	Berth Pocket Dredging	$ -	$ -
6	Access Channel Dredging	$ -	$ -
Direct Cost		**$ 5,300,000**	**$ 137,200,000**
7.1	Supervision (General Conditions)	$ 600,000	$ 16,500,000
7.2	Bonds & Insurance	$ 100,000	$ 2,700,000
7.3	Corporate Overhead & Profit	$ 800,000	$ 20,600,000
Total Construction Cost without Contingency		**$ 6,800,000**	**$ 177,000,000**
8	Contingency	$ 2,000,000	$ 53,100,000
Total Project Cost		**$ 8,800,000**	**$ 230,100,000**

Source: Moffatt & Nichol

6.5.2. Project Development Timelines

The total estimated time for this development will be 21 to 36 months, with the permitting timeline expected to range between 12 and 24 months, depending on the specific design and environmental impacts. The breakdown of the design, (maximum) permitting and construction durations are shown below.

TABLE 6.9: DEVELOPMENT TIMELINE – PORT OF ARGENTIA

	YR 1				YR 2				YR 3				YR 4				YR 5			
Q	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
D																				
P																				
C1																				
C2																				
C3																				
C4																				

*Q = quarter, D = design, P = permitting, C1 = construction fixed marshalling , C2 = construction FLOW Staging & Integration, C3 = construction FLOW FOU assembly, C4 = construction FLOW combined

Source: Moffatt & Nichol

6.6. Port of Mortier Bay, Newfoundland and Labrador

Currently a greenfield site, if constructed, the site will be capable of supporting fixed WTG and FOU marshalling, FLOW foundation assembly and staging & integration activities.

6.6.1. Construction Cost Estimates

The Port will require the construction of a wharf and reclamation of an upland area to meet the criteria for primary offshore wind activities. Development costs were estimated for each type of primary offshore wind port, shown below.

TABLE 6.10: COST ESTIMATE - PORT OF MORTIER BAY

Item	Description	Total Cost (Fixed Marshalling, FLOW Staging & Integration)	Total Cost (FLOW Foundation Assembly)	Total Cost (FLOW Combined)
1	Contractor Mobilization/Demobilization	$ 13,300,000	$ 22,300,000	$ 32,600,000
2	Wharf	$ 70,300,000	$ 75,300,000	$ 101,700,000
3	Reclamation / Infill	$ 196,400,000	$ 296,200,000	$ 441,000,000
4	Uplands	-	-	-
5	Berth Pocket Dredging	-	-	-
6	Access Channel Dredging	-	-	-
Direct Cost		**$ 280,000,000**	**$ 393,800,000**	**$ 575,300,000**
7.1	Supervision (General Conditions)	$ 33,600,000	$ 47,300,000	$ 69,000,000
7.2	Bonds & Insurance	$ 5,600,000	$ 7,900,000	$ 11,500,000
7.3	Corporate Overhead & Profit	$ 42,000,000	$ 59,100,000	$ 86,300,000
Total Construction Cost without Contingency		**$ 361,200,000**	**$ 508,100,000**	**$ 742,100,000**
8	Contingency	$ 108,400,000	$ 152,400,000	$ 222,600,000
Total Project Cost		**$ 469,600,000**	**$ 660,500,000**	**$ 964,700,000**

Source: Moffatt & Nichol

6.6.2. Project Development Timelines

The total estimated time for this development will be 69 to 109 months, with the permitting timeline expected to range between 36 and 60 months, depending on the specific design and environmental impacts. The breakdown of the design, (maximum) permitting and construction durations are shown below.

TABLE 6.11: DEVELOPMENT TIMELINE – PORT OF MORTIER BAY

	YR 1				YR 2				YR 3				YR 4				YR 5				YR 6				YR 7				YR 8				YR 9			
Q	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
D																																				
P																																				
C1																																				
C2																																				
C3																																				
C4																																				

*Q = quarter, D = design, P = permitting, C1 = construction fixed marshalling , C2 = construction FLOW Staging & Integration, C3 = construction FLOW FOU assembly, C4 = construction FLOW combined

Source: Moffatt & Nichol

6.7. Atlantic Canada Bulk Terminal, Nova Scotia

The Port, once upgraded, will be capable of supporting fixed WTG and FOU marshalling, FLOW foundation assembly and staging & integration activities.

6.7.1. Construction Cost Estimates

Upgrades to the existing wharf are required to meet offshore wind criteria and extension will be required to support FLOW activities.

TABLE 6.12: COST ESTIMATE - ATLANTIC CANADA BULK TERMINAL

Item	Description	Total Cost (Fixed Marshalling, FLOW Staging & Integration)	Total Cost (FLOW Foundation Assembly)	Total Cost (FLOW Combined)
1	Contractor Mobilization/Demobilization	$ 3,800,000	$ 4,500,000	$ 6,500,000
2	Wharf	$ 38,300,000	$ 42,100,000	$ 62,300,000
3	Reclamation / Infill	$ 15,900,000	$ 17,500,000	$ 28,300,000
4	Uplands	$ 22,600,000	$ 30,700,000	$ 40,000,000
5	Berth Pocket Dredging	$ -	$ -	$ -
6	Access Channel Dredging	$ -	$ -	$ -
Direct Cost		**$ 80,600,000**	**$ 94,800,000**	**$ 137,100,000**
7.1	Supervision (General Conditions)	$ 9,700,000	$ 11,000,000	$ 16,500,000
7.2	Bonds & Insurance	$ 1,600,000	$ 1,900,000	$ 2,700,000
7.3	Corporate Overhead & Profit	$ 12,100,000	$ 14,200,000	$ 20,600,000
Total Construction Cost without Contingency		**$ 104,000,000**	**$ 121,900,000**	**$ 176,900,000**
8	Contingency	$ 31,200,000	$ 36,700,000	$ 53,100,000
Total Project Cost		**$ 135,200,000**	**$ 158,600,000**	**$ 230,000,000**

Source: Moffatt & Nichol

6.7.2. Project Development Timelines

The total estimated time for this development will be 27 to 51 months, with the permitting timeline expected to range between 12 and 24 months, depending on the specific design and environmental impacts. The breakdown of the design, (maximum) permitting and construction durations are shown below.

TABLE 6.13: DEVELOPMENT TIMELINE – ATLANTIC CANADA BULK TERMINAL

	YR 1				YR 2				YR 3				YR 4				YR 5				YR 6				YR 7			
Q	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
D																												
P																												
C1																												
C2																												
C3																												
C4																												

*Q = quarter, D = design, P = permitting, C1 = construction fixed marshalling , C2 = construction FLOW Staging & Integration, C3 = construction FLOW FOU assembly, C4 = construction FLOW combined

Source: Moffatt & Nichol

6.8. Melford International Terminal, Nova Scotia

This greenfield site, once constructed, will be capable of supporting fixed WTG and FOU marshalling, FLOW assembly and staging & integration activities.

6.8.1. Construction Cost Estimates

A new upland area and wharf will need to be constructed to support primary OSW activities. The designed wharf would need to be extended to support FLOW activities.

TABLE 6.14: COST ESTIMATE - MELFORD INTERNATIONAL TERMINAL

Item	Description	Total Cost (Fixed Marshalling, FLOW Staging & Integration)	Total Cost (FLOW Foundation Assembly)	Total Cost (FLOW Combined)
1	Contractor Mobilization/Demobilization	$ 6,500,000	$ 7,800,000	$11,300,000
2	Wharf	$ 57,600,000	$ 61,400,000	$81,700,000
3	Reclamation / Infill	$ 17,200,000	$ 18,300,000	$25,600,000
4	Uplands	$ 55,800,000	$ 75,700,000	$119,600,000
5	Berth Pocket Dredging	$ 18,100,000	$ 19,000,000	$25,000,000
6	Access Channel Dredging	$ -	$ -	$ -
Direct Cost		**$ 155,200,000**	**$ 182,200,000**	**$263,200,000**
7.1	Supervision (General Conditions)	$18,600,000	$ 21,900,000	$31,600,000
7.2	Bonds & Insurance	$3,100,000	$ 3,600,000	$5,300,000
7.3	Corporate Overhead & Profit	$23,300,000	$ 27,300,000	$39,500,000
Total Construction Cost without Contingency		**$ 200,200,000**	**$ 235,000,000**	**$339,600,000**
8	Contingency	$ 60,100,000	$ 70,500,000	$ 101,900,000
Total Project Cost		**$ 260,300,000**	**$ 305,500,000**	**$441,500,000**

Source: Moffatt & Nichol

6.8.2. Project Development Timelines

The Port has reported having all permits in hand, a six month period has been allowed for consultation and completion, this has been considered in the development timeline. The total time for development is estimated to be 48 to 63 months. A breakdown of the design, permitting and different construction durations are shown below.

TABLE 6.15: DEVELOPMENT TIMELINE - MELFORD INTERNATIONAL TERMINAL

	YR 1				YR 2				YR 3				YR 4				YR 5				YR 6				YR 7				YR 8			
Q	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
D																																
P																																
C1																																
C2																																
C3																																
C4																																

*Q = quarter, D = design, P = permitting, C1 = construction fixed marshalling; C2 = construction FLOW Staging & Integration, C3 = construction FLOW FOU assembly, C4 = construction FLOW combined

Source: Moffatt & Nichol

6.9. Novaporte, Nova Scotia

This greenfield site, once constructed, will be capable of supporting fixed WTG and FOU marshalling, FLOW assembly and staging & integration activities.

6.9.1. Construction Cost Estimates

Novaporte requires the completion of land reclamation activities to create a suitable upland area, construction of a new wharf, and dredging to meet the criteria for primary offshore wind ports. Cost estimates for each development scenario are shown below.

TABLE 6.16: COST ESTIMATE - NOVAPORTE

Item	Description	Total Cost (Fixed Marshalling, FLOW Staging & Integration)	Total Cost (FLOW Foundation Assembly)	Total Cost (FLOW Combined)
1	Contractor Mobilization/Demobilization	$9,400,000	$11,900,000	$18,000,000
2	Wharf	$57,600,000	$61,400,000	$81,700,000
3	Reclamation / Infill	$27,300,000	$38,000,000	$59,000,000
4	Uplands	$103,000,000	$138,300,000	$219,000,000
5	Berth Pocket Dredging	$9,200,000	$9,500,000	$12,200,000
6	Access Channel Dredging	$-	$-	$-
Direct Cost		**$ 206,500,000**	**$ 259,100,000**	**$ 389,900,000**
7.1	Supervision (General Conditions)	$ 24,800,000	$ 31,100,000	$ 46,800,000
7.2	Bonds & Insurance	$ 4,100,000	$ 5,200,000	$ 7,800,000
7.3	Corporate Overhead & Profit	$ 31,000,000	$ 38,900,000	$ 58,500,000
Total Construction Cost without Contingency		**$ 266,400,000**	**$ 334,300,000**	**$ 503,000,000**
8	Contingency	$ 79,900,000	$ 100,300,000	$ 150,900,000
Total Project Cost		**$ 346,300,000**	**$ 434,600,000**	**$ 653,900,000**

Source: Moffatt & Nichol

6.9.2. Project Development Timelines

The Port has reported having all permits in hand with a six month period required for consultation and completion. This has been considered in the development timeline. The total development timeline is estimated at 48-63 months. A breakdown of this timeline is shown below.

TABLE 6.17: DEVELOPMENT TIMELINE - NOVAPORTE

	YR 1				YR 2				YR 3				YR 4				YR 5				YR 6				YR 7				YR 8			
Q	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
D																																
P																																
C1																																
C2																																
C3																																
C4																																

*Q = quarter, D = design, P = permitting, C1 = construction fixed marshalling; C2 = construction FLOW Staging & Integration, C3 = construction FLOW FOU assembly, C4 = construction FLOW combined

Source: Moffatt & Nichol

6.10. Port of Sheet Harbour, Nova Scotia

The Port, once upgraded, will be capable of supporting fixed WTG and FOU marshalling, FLOW assembly and staging & integration activities.

6.10.1. Construction Cost Estimates

The Port requires extension of the existing wharf, reclamation and development of additional upland area to meet the criteria for primary offshore wind activities.

TABLE 6.18: COST ESTIMATE - PORT OF SHEET HARBOUR

Item	Description	Total Cost (Fixed Marshalling, FLOW Staging & Integration)	Total Cost (FLOW Foundation Assembly)	Total Cost (FLOW Combined)
1	Contractor Mobilization/Demobilization	$ 7,000,000	$ 7,400,000	$ 13,900,000
2	Wharf	$ 37,400,000	$ 41,700,000	$ 63,700,000
3	Reclamation / Infill	$ 76,900,000	$ 51,200,000	$ 136,700,000
4	Uplands	$ 25,900,000	$ 55,800,000	$ 78,100,000
5	Berth Pocket Dredging	$ -	$ -	$ -
6	Access Channel Dredging	$ -	$ -	$ -
Direct Cost		**$ 147,200,000**	**$ 156,100,000**	**$ 292,400,000**
7.1	Supervision (General Conditions)	$ 17,700,000	$ 18,700,000	$ 35,100,000
7.2	Bonds & Insurance	$ 2,900,000	$ 3,100,000	$ 5,800,000
7.3	Corporate Overhead & Profit	$ 22,100,000	$ 23,400,000	$ 43,900,000
Total Construction Cost without Contingency		**$ 189,900,000**	**$ 201,300,000**	**$ 377,200,000**
8	Contingency	$ 57,000,000	$ 60,400,000	$ 113,200,000
Total Project Cost		**$ 246,900,000**	**$ 261,700,000**	**$ 490,400,000**

Source: Moffatt & Nichol

6.10.2. Project Development Timeline

The total estimated time for this development will be 52 to 80 months, with the permitting timeline expected to range between 18 and 36 months, depending on the specific design and environmental impacts. The breakdown of the design, (maximum) permitting and construction durations are shown below.

TABLE 6.19: DEVELOPMENT TIMELINE - PORT OF SHEET HARBOUR

	YR 1				YR 2				YR 3				YR 4				YR 5				YR 6				YR 7				YR 8			
Q	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
D																																
P																																
C1																																
C2																																
C3																																
C4																																

*Q = quarter, D = design, P = permitting, C1 = construction fixed marshalling, C2 = construction FLOW Staging & Integration, C3 = construction FLOW FOU assembly, C4 = construction FLOW combined

Source: Moffatt & Nichol

6.11. Port Hawkesbury Paper, Nova Scotia

The Port, once upgraded, will be capable of supporting fixed WTG and FOU marshalling and FLOW staging & integration activities.

6.11.1. Construction Cost Estimates

The Port will require construction of a new wharf, reclamation and development of the upland area and dredging of both the berth pocket and navigational channel to meet the criteria for fixed-bottom OSW activities. Any upgrades to or removal of the rail line running through the development area and removal or remediation of the existing landfill are not included in this assessment.

TABLE 6.20: COST ESTIMATE - PORT HAWKESBURY PAPER

Item	Description	Total Cost (Fixed Marshalling)
1	Contractor Mobilization/Demobilization	$ 7,100,000
2	Wharf	$ 57,600,000
3	Reclamation / Infill	$ 32,500,000
4	Uplands	$ 51,800,000
5	Berth Pocket Dredging	$ 20,600,000
6	Access Channel Dredging	$ 43,500,000
Direct Cost		**$ 213,100,000**
7.1	Supervision (General Conditions)	$ 25,600,000
7.2	Bonds & Insurance	$ 4,300,000
7.3	Corporate Overhead & Profit	$ 32,000,000
Total Construction Cost without Contingency		**$ 275,000,000**
8	Contingency	$ 82,500,000
Total Project Cost		**$ 357,500,000**

Source: Moffatt & Nichol

6.11.2. Project Development Timelines

The total estimated time for this development will be 45 to 63 months, with the permitting timeline expected to range between 18 and 36 months, depending on the specific design and environmental impacts. The breakdown of the design, (maximum) permitting and construction durations are shown below.

TABLE 6.21: DEVELOPMENT TIMELINE - PORT HAWKESBURY PAPER

	YR 1				YR 2				YR 3				YR 4				YR 5				YR 6				YR 7				YR 8			
Q	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
D																																
P																																
C1																																

*Q = quarter, D = design, P = permitting, C1 = construction fixed marshalling

Source: Moffatt & Nichol

6.12. Construction Cost Estimate Summary

The summary of the construction cost estimates for each of the shortlisted port and the respective OSW activity the construction aims to support is shown below.

TABLE 6.22: SUMMARY OF CONSTRUCTION COST ESTIMATES

Port	Province	Fixed Marshalling, FLOW Staging & Integration	FLOW Foundation Assembly	FLOW Combined
Port of Belledune	NB	$ 177,900,000	-	-
Port Saint John	NB	$ 256,500,000	-	-
Channel Port aux Basques	NL	$ 324,300,000	-	-
Port of Argentia	NL	$ 8,800,000	$ 230,100,000	$ 230,100,000
Port of Mortier Bay	NL	$ 469,600,000	$ 660,500,000	$ 964,700,000
Atlantic Canada Bulk Terminal	NS	$ 135,200,000	$ 158,600,000	$ 230,000,000
Melford International Terminal	NS	$260,300,000	$ 305,500,000	$ 441,500,000
Novaporte	NS	$ 346,300,000	$ 434,600,000	$ 653,900,000
Port of Sheet Harbour	NS	$ 246,900,000	$ 261,700,000	$ 490,400,000
Port Hawkesbury Paper	NS	$ 357,500,000	-	-

* Note that all costs are in CAD.

** The construction cost estimates are shown as a Class 5 estimate and the range is defined in Section 6.1

Source: Moffatt & Nichol

7. Conclusions and Recommendations

The study analysis concluded that by 2036 approximately nine (seven fixed-bottom and two floating) US ports and between two and three Canadian ports will be required to support the offshore wind (OSW) industry in North America.

The provinces of Atlantic Canada contain a significant number of existing commercial port areas and brownfield and greenfields to support both the US and Canadian OSW marketplaces. Seventy-seven (77) sites in Atlantic Canada were initially identified as having the potential to function as ports in support of the OSW industry. This initial list was created by the Moffatt & Nichol team as well as via public outreach to the ports of Atlantic Canada. This list was then narrowed to 26 sites based on the minimum criteria established in Section 4.2.1. This minimum criteria contained items such as sufficient air draft and adequate developable uplands, that could not be easily corrected or adjusted. The list was then further reduced based on additional supplemental criteria (see Section 4.2.4), and the port's willingness to participate in the study. This second reduction produced the final list of 10 sites that can be considered suitable for primary offshore wind port activities. These 10 sites are listed in Table 7.1.

These 10 sites consisted of six brownfields and four greenfields. Six of the 10 sites had the capability to develop enough quay length and uplands to support floating offshore wind (FLOW) activities. It should be noted that for the purpose of this study, a 1 GW project with a one-year installation timeline for fixed-bottom projects and one integrated unit per week for floating projects was considered. Indication that a site is not suitable by these criteria does not necessarily mean that it is incapable of a particular activity on a project specific basis.

TABLE 7.1: SHORTLIST OF OFFSHORE WIND PORTS AND RESPECTIVE OSW ACTIVITIES

Port Name**	Region	Fixed Marshalling	FLOW Staging & Integration	FLOW Foundation Assembly	FLOW Combined
Port of Belledune (BF)	New Brunswick	Y	N	N	N
Port Saint John (BF)	New Brunswick	Y	Y	N	N
Channel Port aux Basques (GF)	Newfoundland & Labrador	Y	N	N	N
Port of Argentia* (BF)	Newfoundland & Labrador	Y	Y	Y	Y
Port of Mortier Bay (GF)	Newfoundland & Labrador	Y	Y	Y	Y
Atlantic Canada Bulk Terminal (BF)	Nova Scotia	Y	Y	Y	Y
Melford International Terminal (GF)	Nova Scotia	Y	Y	Y	Y
Novaporte (GF)	Nova Scotia	Y	Y	Y	Y
Port of Sheet Harbour (BF)	Nova Scotia	Y	Y	Y	Y
Port Hawkesbury Paper (BF)	Nova Scotia	Y	Y	N	N

* Assumes proposed Copper Cover expansion is fully installed.

** BF = brownfield, GF = greenfield

*** N = No, Y = yes

Source: Moffatt & Nichol

It should be noted that three of the brownfield facilities (Atlantic Canada Bulk Terminal, Port of Argentia, and Port of Sheet Harbor) have already begun servicing the US OSW market. These ports have primarily acted as storage/transshipment yards for OSW wind turbine generator (WTG) and foundation components.

The existing condition at each of the 10 sites was established via direct outreach. These existing conditions included characteristics such as quay length, uplands area as well as the capacity of these areas (if known). In addition, the sites were asked to identify any areas under their control that were available for potential expansion. The Moffatt & Nichol team then performed a gap analysis to establish the required upgrades for each site to service one of the four offshore wind port types:

- Fixed Marshalling (WTG and Foundations)
- FLOW Staging & Integration
- FLOW Foundation Assembly
- FLOW Combined Staging & Integration and Foundation Assembly

A Class 5 cost estimate, in accordance with AACE 18R 97, as well as a development timeline (permitting, design and construction) was then created for each site. These cost estimates and project development timelines are shown below in Table 7.2

TABLE 7.2: SUMMARY OF CONSTRUCTION COST ESTIMATES AND PROJECT DEVELOPMENT TIMELINES

Port	Province	Project Development Timeline	Fixed Marshalling, FLOW Staging & Integration	FLOW Foundation Assembly	FLOW Combined
Port of Belledune	NB	45 – 63 Months	$ 177,900,000	-	-
Port Saint John	NB	45 – 63 Months	$ 256,500,000	-	-
Channel Port aux Basques	NL	69 – 93 Months	$ 324,300,000	-	-
Port of Argentia	NL	21 – 36 Months	$ 8,800,000	$ 230,100,000	$ 230,100,000
Port of Mortier Bay	NL	69 – 109 Months	$ 469,600,000	$ 660,500,000	$ 964,700,000
Atlantic Canada Bulk Terminal	NS	27 – 51 Months	$ 135,200,000	$ 158,600,000	$ 230,000,000
Melford International Terminal	NS	48 – 63 Months	$260,300,000	$ 305,500,000	$ 441,500,000
Novaporte	NS	48 – 63 Months	$ 346,300,000	$ 434,600,000	$ 653,900,000
Port of Sheet Harbour	NS	52 – 80 Months	$ 246,900,000	$ 261,700,000	$ 490,400,000
Port Hawkesbury Paper	NS	45 – 63 Months	$ 357,500,000	-	-

Source: Moffatt & Nichol

The purpose of this study was to identify sites that can serve as the large marshalling and foundation assembly ports to support the fixed-bottom and floating OSW industry. It is important to note that this was a high-level, desktop study. Information was gathered via publicly available information and through direct outreach and correspondence with the ports. No site visits were performed as a part of this work and site specific environmental or geotechnical conditions were not considered.

The port development layouts show one potential layout that complies with the minimum established criteria for each of the offshore wind port types. The location of the proposed buildout was guided by the areas the selected ports made available to the study. Other development options and specific layouts are possible. The level of cost estimate presented in the study is appropriate for budgetary purposes where minimal engineering has been performed.

Following this assessment, the project team recommends the following continued work:

- Study of potential funding opportunities to support the development of primary offshore wind ports. This should consider both provincial and federal level government funding as well as private equity
- Further, in depth, study of individual sites and their capabilities and challenges in completing the required infrastructure upgrades necessary to support primary OSW activities.
- Although the study focuses on primary ports for delivering OSW projects, many of the ports identified in initial screening can be considered for secondary activities. As it is predicted that there are significant demand for these ports in the future, a separate study, focused on assessing port capable of secondary OSW activities.

8. References

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Appendix A. Port Infrastructure Layouts