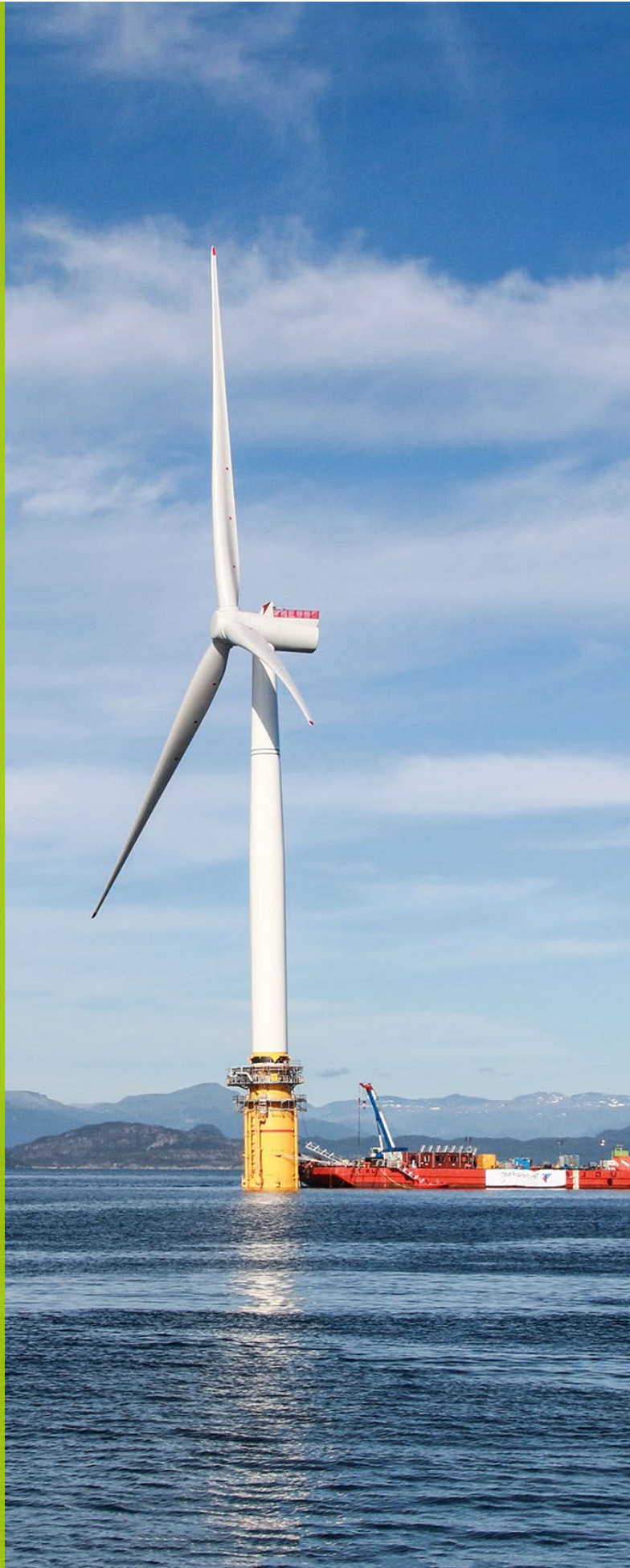
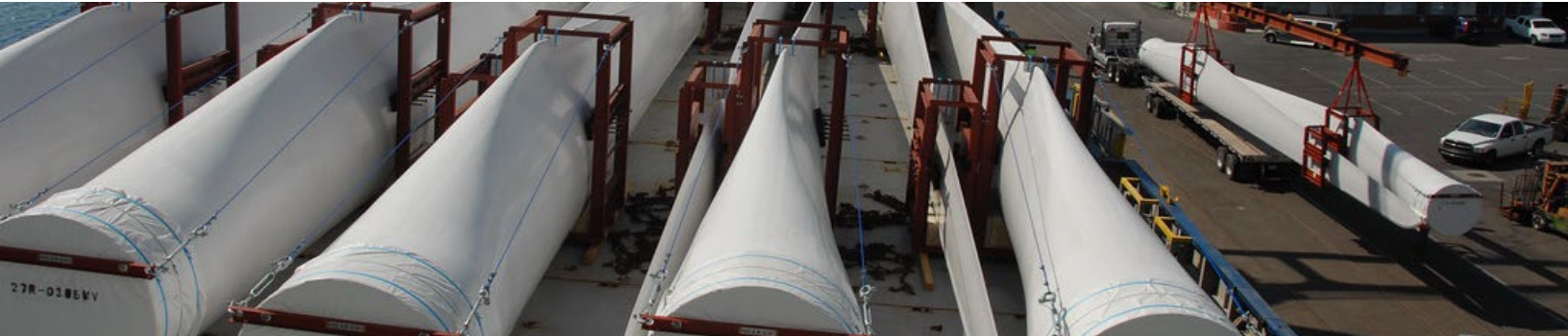


# Floating Offshore Wind Manual

Port Requirements,  
Opportunities, and Impacts





# Introduction

BW Research prepared this report on behalf of Renewable Northwest to present stakeholders in the port management and development environment with a comprehensive manual on the different opportunities and requirements in the floating offshore wind industry. The research team analyzed various technical reports, case studies, and existing port examples in the offshore wind supply chain across the United States (US) and internationally to understand the potential opportunities and benefits of different activities in this growing industry. Unlike a typical ports assessment, which examines specific ports and makes recommendations for each based on technical requirements and attributes, this report is intended to provide port managers with information about various port-related activities for offshore wind (OSW) so that they can make informed decisions based on their own specialized local needs.

Federal and state governments have developed a suite of new investments and policies to attract suppliers and developers to support offshore wind. On the US West Coast, the need for floating turbines presents an additional layer of complexity since this technology is less mature than fixed-bottom technologies and includes some different supply chain requirements. Floating offshore wind (floating OSW or OFW) is an important piece of the region's energy goals, which presents both an opportunity and a need for a local supply chain and port infrastructure to bolster the industry.

Within the nation's offshore wind goals, the target for floating offshore wind is to generate 15 GW of electricity by 2035, with a large portion coming from the West Coast. To reach this goal the Bureau of Ocean Energy Management (BOEM) announced in 2022 five winners of lease areas off the coast of California to develop an estimated 4.6 GW of offshore wind energy. In 2024, BOEM announced the proposed sale of two further lease areas off the coast of Oregon, potentially providing up to 3.1 GW of electricity. In addition, BOEM anticipates an additional lease sale off the coast of California by early 2028.

In the European Union (EU) and the US East Coast, the offshore wind industry has brought about new and expanded local manufacturing opportunities, robust investments in disadvantaged communities, and other long-term economic benefits. It has also led to the creation of local, high-wage jobs in the EU, and such benefits are also starting to surge in the US East Coast. This report gives more insight into the port needs and economic impacts of a floating offshore wind supply chain as a first step for port managers and communities that want to analyze the potential economic opportunities of this growing industry.

## How To Use This Report

This report provides detailed information on various construction and manufacturing activities related to offshore wind to support port managers and directors in determining whether and which activities might be worth pursuing for their communities. Most of the information is based on a port facility of a typical

size, representing a midpoint of a range of potential. The following information is included for each type of floating offshore wind port:

- Port Activities: Work done at the facility for each type of port
- Logistics Requirements: Access to rail or truck transportation
- Permitting and Construction Timeline Estimates
- Physical Port Requirements: Area, draft, wharf, depth, width, loading capacity, and storage
- Workforce Effects: Job creation potential, average wages, and occupations
- Equipment Requirements: Types of cargo handled, cranes, utilities, and other needs

This report was authored by Nicole Hughes and Casey MacLean from Renewable Northwest and Phil Jordan, Julian Ugalde, and Sophia Nelson from BW Research.

Renewable Northwest and BW Research would like to thank the interviewees and the reviewers for this project.



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# Funding Opportunities

## For Offshore Wind Activities

This section provides a high-level overview of some of the policies and investments at the state and federal level aimed towards ports, manufacturers, and developers in the offshore wind industry. This chapter is intended to provide port managers with an initial, but not exhaustive, list of available funding opportunities in this industry to introduce them to existing investments and policies.

### Existing and Future Policies

The federal government has led policy and investment efforts to develop a robust offshore wind industry in the US with the Inflation Reduction Act (IRA) of 2022 and the Infrastructure Investment and Jobs Act (IIJA) of 2021, also known as the Bipartisan Infrastructure Law (BIL). State governments and local agencies have also established several programs to develop a local supply chain and capture economic benefits through jobs, taxes, and longstanding economic activities.

At the state level, agencies prioritize creating a supply chain able to comply with the needs of the offshore wind industry, focusing on infrastructure, manufacturing capabilities, domestic production, benefits to local communities, and good-quality jobs. For example, Massachusetts, Rhode Island, and Connecticut signed a regional collaboration agreement to seek multi-state proposals in offshore wind. New York is investing \$700 million in supply chain infrastructure exclusively for offshore wind. Programs and investments like these become increasingly important as states set ambitious offshore wind plans, such as Oregon's goal of 3 GW of floating offshore wind by 2030. Since floating offshore wind turbines require onshore fabrication and assembly due to their size, unlike fixed-bottom turbines, investments into port infrastructure and different port activities are key in the US West Coast, which will develop exclusively around floating technology, given the deeper waters.

Some examples of existing policies:

- **IRA Advanced Manufacturing Production Tax Credit**  
Tax credit for US companies manufacturing or selling clean energy equipment domestically. In wind energy, the final credit amount is determined by the component type and the rated capacity of the turbine in watts. This focuses on the turbine's tier 1 components (blades, nacelles, towers), platforms, critical minerals, and vessels. Floating technology is given heavier tax incentives, as floating platforms receive double the dollar amount per watt of rated capacity compared to fixed-bottom platforms. The program started on December 31, 2022, and ends on December 31, 2032. The tax credits are:

|                                    |                                   |
|------------------------------------|-----------------------------------|
| <b>Blades</b>                      | \$0.02 per watt of rated capacity |
| <b>Nacelles</b>                    | \$0.05 per watt of rated capacity |
| <b>Towers</b>                      | \$0.03 per watt of rated capacity |
| <b>Fixed-bottom platforms</b>      | \$0.02 per watt of rated capacity |
| <b>Floating platforms</b>          | \$0.04 per watt of rated capacity |
| <b>Critical mineral production</b> | 10% of the cost of production     |
| <b>Vessels</b>                     | 10% of the vessel's sale price    |

For example, a nacelle manufacturer for 15 MW turbines will receive a tax credit of \$750,000 per turbine (\$0.05 x 15,000,000 watts).

- **Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) and the Wind Energy Technologies Office (WETO), [Offshore Wind National and Regional Research and Development](#)**

This program spans a range of offshore wind components, focusing on innovation and technology advancement. Floating offshore wind is central to the program, as several grants available prioritize floating platforms, manufacturing of floating-specific components, and efficient deployment of floating turbines. EERE will award close to \$49 million, split into individual awards ranging between \$200,000 and \$5 million.

- **Department of Transportation Maritime Administration, [Port Infrastructure Development Program \(PIDP\)](#)**

This program aims to enhance the dependability, efficiency, and safety of cargo movement through ports. It grants funds to various port infrastructure upgrades, including those that lower port-related greenhouse gas emissions and encourage the implementation of clean energy, including facilities supporting floating offshore wind. To be granted over five years, from 2022 to 2026, \$2.25 billion was allocated for the PIDP program under the Bipartisan Infrastructure Law, of which \$450 million was made available in fiscal year 2024 (FY24). The PIDP received an additional \$50 million via the FY24 Appropriations Act. In total, \$500 million is available to be dispersed through discretionary grant awards in the third year of the PIDP.

- **Department of Transportation, [Infrastructure for Rebuilding America \(INFRA\) Grant Program](#)**

The competitive INFRA grant program provides funding for multimodal freight and roadway projects with national or regional significance over five years. From the BIL, approximately \$2.7 billion of the \$8 billion allocated for INFRA was available through early 2024. Grant recipients may receive funding for transportation infrastructure projects that indirectly support floating offshore wind, such as port or highway renovations that facilitate the transportation of oversized wind turbine components. The Humboldt Bay Harbor in California received \$427 million in early 2024 for new offshore wind infrastructure.

- **Washington Department of Commerce, [Energy Programs in Communities \(EPIC\)](#)**

This program, developed by the WA Department of Commerce, offers funding for the planning, designing, and constructing of clean energy projects in the state. This is particularly relevant for offshore wind projects that leverage private and federal funding. Further grants are available for clean energy projects in tribal or disadvantaged communities. About \$117 million is available for grants through the program, which started in early 2024.

- **[Oregon Port Revolving Fund](#)**

Although not specifically focused on clean energy, this program focuses on improving Oregon's port infrastructure to boost economic activities. The state's offshore wind industry can be one of the main benefactors of such programs, as port infrastructure is central to its growth. This program provides

loans of up to \$3 million for planning and constructing port facilities and infrastructure. This program comes from Business Oregon.

The examples presented above are a small portion of the incentives available nationwide and at the state level. Developing these programs and incentives are key to guaranteeing long-term stability for the local offshore wind industry. States like New York have prioritized in-state manufacturing and made funding opportunities available to attract manufacturers and investors.

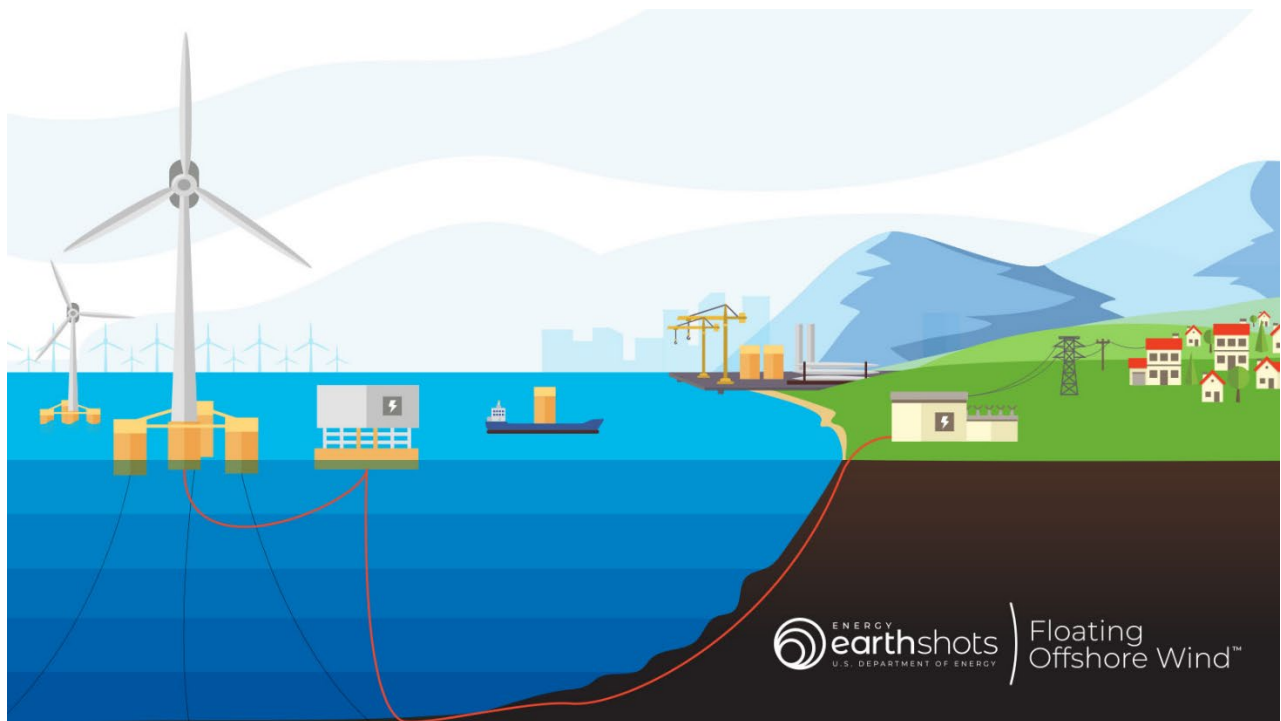
As BOEM announces and auctions lease areas, states develop further incentives to attract investments and build a local supply chain. With the California and Oregon lease areas, it will be key to implement local manufacturing of floating-specific components and bring assembly abilities to regional ports.

# Floating Offshore Wind Farms & Turbines

Floating offshore wind requires a variety of structures onshore and offshore working together to generate electricity and supply it to the grid. Figure 1 shows a finalized floating offshore wind farm and the interactions between ports, vessels, turbines, and the electric infrastructure to provide power to the grid. The economic benefits that accrue to local communities vary as a floating offshore wind project matures, going from the jobs created in the manufacturing of components to the staging and integration of turbines and finally moving to a longer period of power generation and operations and maintenance activities.

The wind turbines manufactured and assembled in several ports and facilities onshore are towed out to sea using offshore wind-specific vessels and connected using array cables to provide electricity to the offshore substation, which sends the generated power onshore through high-voltage export cables.

**Figure 1. Floating Offshore Wind Farm**



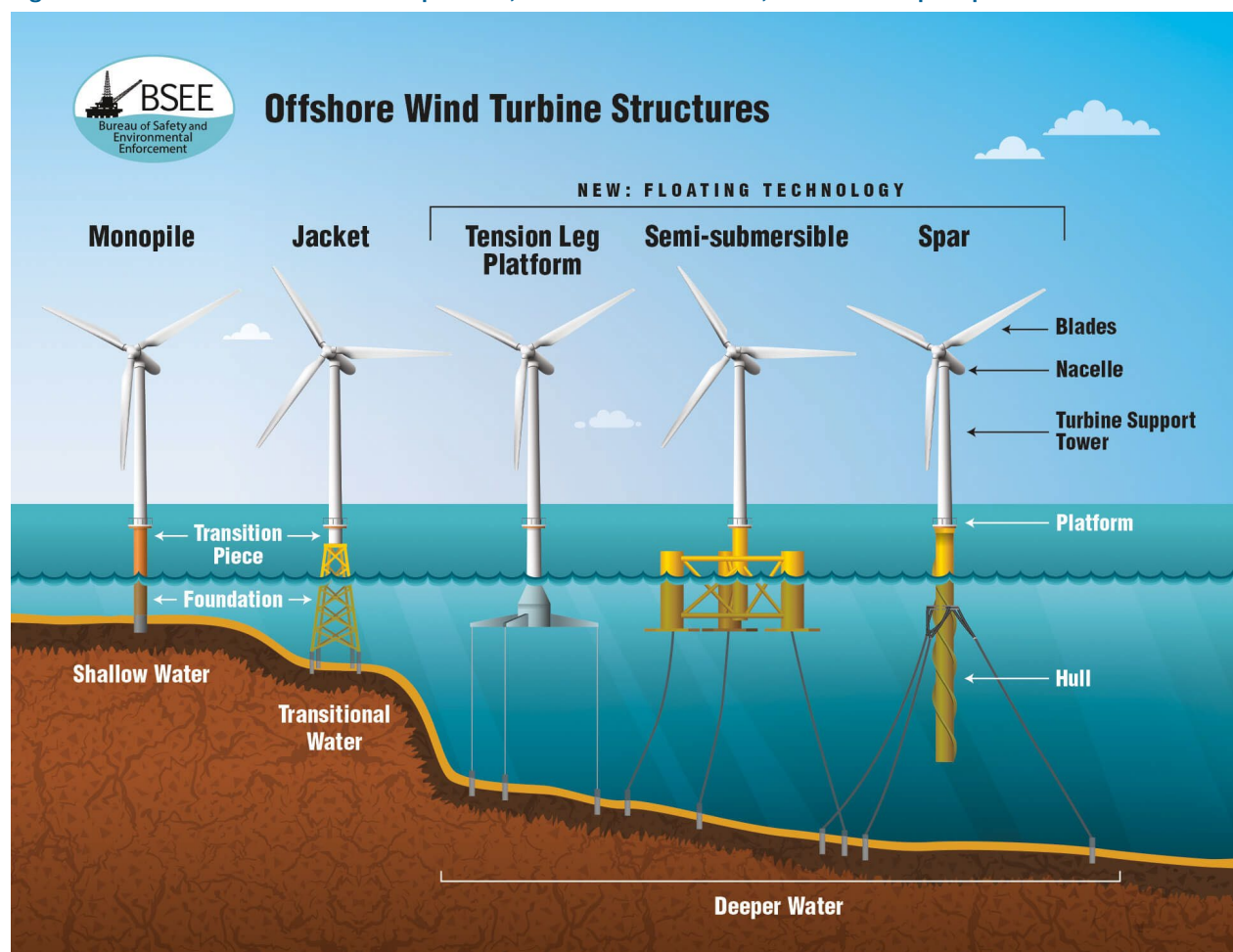
Source: US Department of Energy, "Floating Offshore Wind Shot", <https://www.energy.gov/eere/wind/floating-offshore-wind-shot>

Figure 2 shows the different structures in offshore wind, starting with fixed-bottom foundations (left) and moving on to floating platforms for deeper waters, such as those on the US West Coast. Floating offshore wind turbines have similar component needs. The three largest components common to all technologies are the blades, which capture the kinetic energy from the wind; the nacelle that houses the hub where the blades attach and support the turbine rotation to generate electricity; and the towers that lift the turbine about 400 feet, or 120 meters, over the sea surface. Floating platforms are another major component of floating turbines, and this study presents the port activities and requirements for three platform technologies: tension leg, semi-submersible, and spar.

The floating offshore wind industry has developed different technologies around floating platforms, but large-scale deployment on the West Coast has not started. This report dives deeper into the three floating technologies shown below since none of these technologies have established themselves as the clear path forward in the market, and each technology has different labor, materials, and logistics needs.

The following sections of this report cover the port activities, various requirements, and workforce impacts for each type of port involved in floating offshore wind development.

**Figure 2. Offshore Wind Turbines: Components, Foundation Structures, and Water Depth Specifications**



Source: Bureau of Safety and Environmental Enforcement, "Renewable Energy Policy Statement", <https://web.archive.org/web/20200728214215/https://www.bsee.gov/what-we-do/renewable-energy/renewable-energy-policy-statement>.



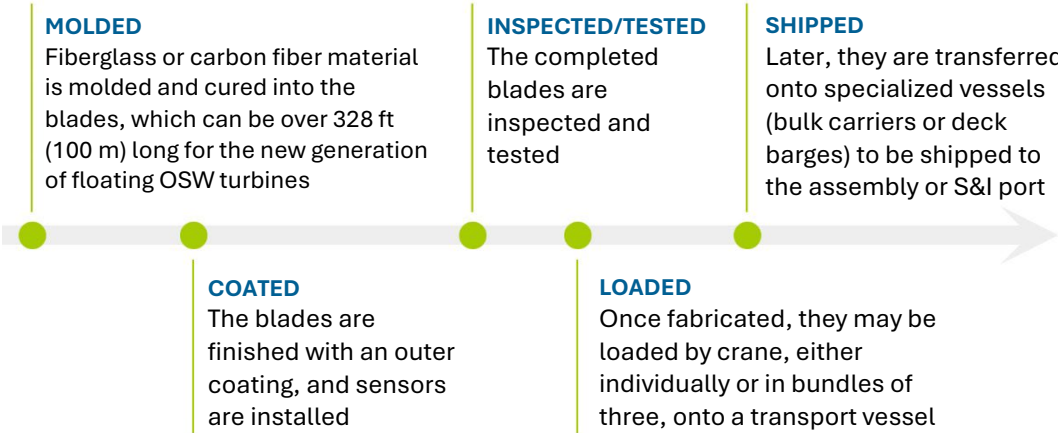
Component Manufacturing Activities

# Blades

Blades are the turbine components that capture the kinetic energy when displaced by the wind and their handling after manufacturing and in the assembly phases requires caution as they are highly fragile. Blade manufacturing facilities are key in ensuring a supply of blades for a local offshore wind farm. Blade manufacturing, along with the manufacturing of other large components, represents one of the most significant challenges to developing a robust floating wind supply chain because of the blades’ size, complexity, and material needs. Due to the size requirements of floating offshore wind turbines, blades must be of an adequate size to fulfill the capacity expectations for floating wind farms.

## Port Activities

Although several blade manufacturing processes exist, the most common practice involves resin infusion, large molds, and consumable vacuum bags to make two full-length shells with an aerodynamic design. The shells are then either glued around a central load-bearing spar or have other structural components incorporated and connected for proper load-bearing using glass fiber shear webs.



**EXAMPLES OF EXISTING PORTS OR FACILITIES**

General Electric facility in Gasp , Quebec, Canada  
LM Wind Power facilities in Kolding, Denmark and Bergama, Turkey  
*Previously planned Siemens Gamesa facility at Port of Coeymans, New York, USA*

## Logistics Requirements



**Road access  
required to  
receive materials**

**Rail access  
required to  
receive materials**

## Estimated Permitting & Construction Timelines

**PERMITTING**  
Approximately 1 year

**CONSTRUCTION OF FACILITY**  
Approximately 1.5 - 2 years  
*Operations are estimated to start 2.5 – 3 years after permitting process begins*

# Blades

## Physical Port Requirements

### TOTAL AREA

**100 acres**

Minimum

### NAVIGABLE WIDTH

**200-400 ft**

### NAVIGABLE DEPTH

Must be able to accommodate heavy-lift cargo vessels, including bulk carrier vessel with 32 ft draft

### DRAFT AT BIRTH

**18 ft**

Minimum for deck barge vessel

**32 ft**

Minimum bulk carrier vessel

### WHARF LENGTH

**650 ft**

Minimum (heavy-lift wharf)

With minimum width of

**120 ft** Quayside

### NUMBER & SIZE OF TERMINALS OR BERTHS

One terminal for manufacturing facility & shipping

### SIZE OF BERTH

A port's berth must accommodate a bulk carrier and a deck barge, with the following dimensions, at a minimum:  
BULK CARRIER – D 37 ft W 113 ft L 588 ft  
DECK BARGE – D 21 ft W 114 ft L 429 ft

### LOADING & BEARING CAPACITIES

WHARF LOADING 4,000 – 6,000 psf  
YARD LOADING 4,000 – 6,000 psf  
BEARING CAPACITY 2,000 – 3,000 psf

### STORAGE NEEDS

Large bespoke transportation frames to store blades  
Storage space of 14.8-17.3 acres for 240 blades

### AIR DRAFT

**200 ft**

Minimum clearance above the water line

## Workforce



**\$51,200 - \$126,800**

**U.S. MEAN ANNUAL WAGES  
AS OF 2023Q4**

### JOB CREATION POTENTIAL

Approximately 59 direct jobs and 64 indirect jobs per 1 GW, on average, annually between 2024 and 2030.

### OCCUPATIONS

Aerospace engineers  
Computer-controlled machine tool operators, metal and plastic  
Engineering technicians  
Heavy equipment operators  
Industrial production managers  
Inspectors, testers, sorters, samplers, and weighers  
Machinists  
Materials engineers  
Mechanical engineers  
Team assemblers  
Welders, cutters, solderers, and brazers

UNITS OF MEASURE psf = pounds per square foot ft = feet GW = gigawatt

## Equipment and Amenities

### CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Primarily fiberglass and carbon fiber

### CRANE NEEDS

- Gantry cranes to lift and transfer the blades onsite
- Vessel-based craneage to lift and transport the blades onto the vessel
- Mobile craneage preferred

### ELECTRICITY/UTILITY NEEDS

A shore power connection for vessels

### OTHER NEEDS

Crawler cranes, forklifts, cherry pickers, multiple axle trailer  
Self-propelled modular trailers (SPMTs)  
Rotor lifts and bespoke trolleys  
Bulk carriers or deck barges (specialized to carry blades)  
Roll-on/roll-off capabilities  
Greenhouse gas emission reduction initiatives  
Shoreside vessel services (standard ship services and security requirements)  
Offices, bathroom, and indoor storage/warehouse buildings

## Component Manufacturing Activities

# Nacelles

Nacelle manufacturing sites are essential to the floating offshore wind supply chain. Located at the top of the tower, nacelles support turbine rotation and electricity generation. Nacelles are complex components that require a supply of steel and other composite components and are, therefore, a major source of local skilled direct and indirect jobs. Nacelle facilities usually represent a large investment and are an important source of domestic content as different US states seek to create a local supply chain.

## Port Activities

### PRODUCTION

Production of individual nacelle subcomponents (e.g. structural housing, gearboxes, rotor shaft, generators, transformers, control systems, etc.)

### ASSEMBLY OF NACELLE

Structural and electrical assembly of the nacelle using the drivetrain, yaw drive, and electrical controls

### ASSEMBLY OF DRIVETRAIN

Assembly of the drivetrain with rotor shaft, gearbox, and generator

### QUALITY CONTROL

Quality control testing of assembled nacelles before being transported to a Staging & Integration port/site

### EXAMPLES OF EXISTING PORTS OR FACILITIES

GE Renewable Energy factory in Montoir-de-Bretagne, France  
Siemens Gamesa facilities in Cuxhaven, Germany and Taichung, Taiwan  
Planned Vestas facility in Szczecin, Poland  
*Previously planned Siemens Gamesa facility at Port of Coeymans, New York, U.S.*

## Logistics Requirements



**Road access  
required**



**Rail access  
required**

## Estimated Permitting & Construction Timelines

### PERMITTING

Approximately 2 years

### CONSTRUCTION OF FACILITY

Approximately 2 years

*Construction is able to start halfway through the permitting process, so operations are estimated to start 3 years after permitting process begins*

# Nacelles

## Physical Port Requirements

### TOTAL AREA

**25 acres**  
Minimum

### NAVIGABLE DEPTH & WIDTH

Must allow for heavy-lift cargo vessels to travel, may be over

**1,000 ft long**  
**400 ft wide**

### DRAFT AT BIRTH

Must allow for heavy-lift cargo vessels to travel

**33-90 ft**

### WHARF LENGTH

**800 ft**  
Minimum (heavy-lift wharf)

### NUMBER & SIZE OF TERMINALS OR BERTHS

One terminal for  
manufacturing facility &  
shipping

### SIZE OF BERTH

**500 ft**  
Minimum

### LOADING & BEARING CAPACITIES

WHARF LOADING 4,000 – 6,000 psf  
YARD LOADING 4,000 – 6,000 psf  
BEARING CAPACITY 2,000 – 3,000 psf

### STORAGE NEEDS

Frames and warehouse(s) to  
store completed nacelles

### AIR DRAFT

**200 ft**  
Minimum clearance above the  
water line

## Workforce



**\$51,200 - \$126,800**

**U.S. MEAN ANNUAL WAGES  
AS OF 2023Q4**

### JOB CREATION POTENTIAL

Approximately 225 direct jobs and 407 indirect jobs per 1 GW, on average, annually between 2024 and 2030.

### OCCUPATIONS

Aerospace engineers  
Computer-controlled machine tool operators, metal and plastic  
Engineering technicians  
Heavy equipment operators  
Industrial production managers  
Inspectors, testers, sorters, samplers, and weighers  
Machinists  
Materials engineers  
Mechanical engineers  
Team assemblers  
Welders, cutters, solderers, and brazers

**UNITS OF MEASURE** psf = pounds per square foot ft = feet GW = gigawatt

## Equipment and Amenities

### CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Nacelles and their components (including the generator, gearbox, control system, main bearing, and more)

### CRANE NEEDS

- Electric Over-Head Travelling (EOHT) cranes, up to 75 tons capacity, to move within fabrication facility
- Multiple 350-ton capacity mobile cranes for loadout activities
- Crawler cranes

### ELECTRICITY/UTILITY NEEDS

A shore power connection for vessels

### OTHER NEEDS

Self-propelled modular transporters (SPMTs) used to transport nacelles leaving fabrication facility

Forklifts, cherry pickers, multiple axle trailer

Roll-on/roll-off capabilities

Greenhouse gas emission reduction initiatives

Shoreside vessel services (standard ship services and security requirements)

Offices, bathroom, and indoor storage/warehouse buildings

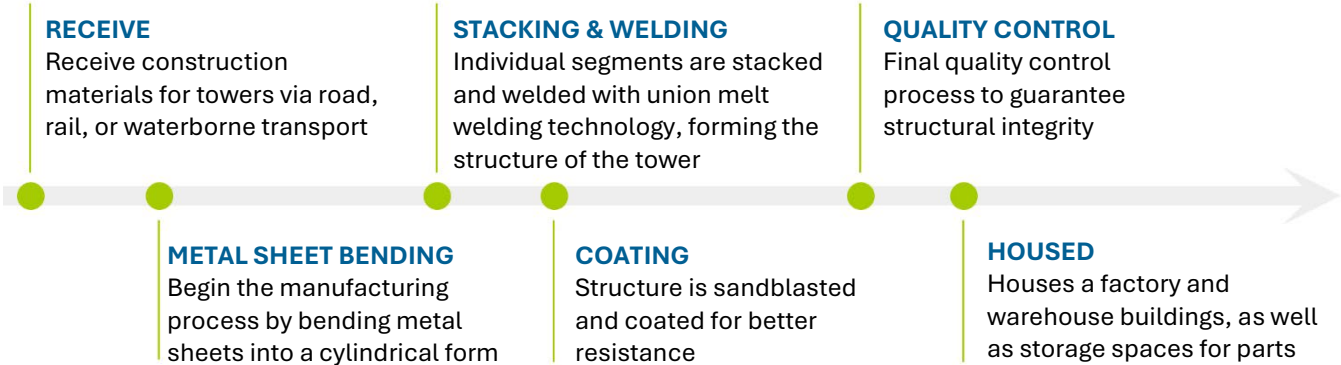


Component Manufacturing Activities

# Towers

Towers for offshore wind are manufactured at ports due to their size and weight, and they are transported to S&I ports using vessels. Tower manufacturing facilities are key to regions’ long-term plans for offshore wind since they have the potential to create various skilled jobs and are steel-intensive, which makes tower facilities an attractive source of federal funding for domestic steel. It is important to consider not only the labor requirements of these facilities but also the need for energy and materials since these components require large amounts of steel and energy. Towers lift turbines off the sea surface to provide access to the nacelle and other control equipment for maintenance and repair and to create height and space for the turbines to spin. It is a tapered cylinder rooted into the platform at the base and supports the nacelle at the head. Each turbine incorporates four tower pieces. Towers are usually around 400 ft (120 m) tall and weigh over 800 tons.

## Port Activities



### EXAMPLES OF EXISTING PORTS OR FACILITIES

Port of Bilbao in Bilbao, Spain  
*Planned facility at Port of Albany, New York, U.S.*

## Logistics Requirements



Road access  
required

Rail access  
required

## Estimated Permitting & Construction Timelines

**PERMITTING**  
Approximately 1-2 years

**CONSTRUCTION OF FACILITY**  
Approximately 2 years  
*Operations are estimated to start 3-4 years after permitting process begins*

# Towers

## Physical Port Requirements

### TOTAL AREA

**50-100+ acres**

### NAVIGABLE DEPTH

**25-38 ft**

### NAVIGABLE WIDTH

**150-200 ft**

### DRAFT AT BIRTH

**38 ft**

Minimum

### WHARF LENGTH

**800 ft**

Minimum (heavy-lift wharf)

### NUMBER & SIZE OF TERMINALS OR BERTHS

One terminal for manufacturing facility & shipping with minimum 1 deep draft berth

### SIZE OF BERTH

**650 ft**

Minimum of quayside length

### LOADING & BEARING CAPACITIES

WHARF LOADING 6,000 psf minimum under crane

YARD LOADING 2,000 – 3,000 psf

BEARING CAPACITY 2,000 – 3,000 psf

### STORAGE NEEDS

Completed component storage, on frames to raise off the ground

### AIR DRAFT

**200 ft**

Minimum clearance above the water line. Towers are typically transported horizontally to the S&I port or out to sea

## Workforce



**\$45,400 - \$126,800**

**U.S. MEAN ANNUAL WAGES  
AS OF 2023Q4**

### JOB CREATION POTENTIAL

Approximately 73 direct jobs and 94 indirect jobs per 1 GW, on average, annually between 2024 and 2030.

### OCCUPATIONS

Assemblers and Fabricators  
Coating, Painting, Spraying Machine Setters, Operators, and Tenders  
Drafters  
First-Line Supervisors of Mechanics, Installers, and Repairers  
Industrial Engineers  
Industrial Machinery Mechanics  
Industrial Production Managers  
Inspectors, Testers, Sorters, Samplers, and Weighers  
Material Moving Workers  
Mechanical Engineers  
Mechanical Engineering Technologists and Technicians  
Mining and Geological Engineers, Including Mining Safety Engineers  
Office Clerks  
Welders, Cutters, Solderers, and Brazers

UNITS OF MEASURE psf = pounds per square foot ft = feet GW = gigawatt

## Equipment and Amenities

### CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Steel, fiberglass, iron and copper

### CRANE NEEDS

500 - 1,000 tons

### ELECTRICITY/UTILITY NEEDS

A shore power connection for vessels

Natural gas to be used as energy source for bending the steel at tower facilities

### OTHER NEEDS

75ft of clearance between vessels

Greenhouse gas emission reduction initiatives

Shoreside Vessel Services (standard ship services and security requirements)

Offices, bathroom, and indoor storage/warehouse buildings

Specialized equipment, including forklifts, crawler cranes, cherry pickers

Self-propelled modular transporters (SPMTs) or marine railway

Roll-on/roll-off capabilities

## Component Manufacturing Activities

# Semi-Submersible Platforms

Semi-submersible platforms have been one of the most popular technologies in floating wind. However, adopting it on a large scale for higher capacity (and consequently, much heavier) turbines will be determined by developer preferences. These platforms are appealing since they have a lower cost than other floating platform options, but there are supply chain implications since they can be made of steel, concrete, or a combination of both. Semi-submersibles consist of multiple columns and pontoons for stability and buoyancy but are less stable than Spars and TLPs. Turbines are usually installed on these platforms onshore and then towed offshore. Note that the details included are primarily based on steel semi-submersible platforms.

## Port Activities

### FOR STEEL-BASED PLATFORMS:

#### COMPONENT FABRICATION

Large steel plates are bent and shaped to create individual sections of the platform

#### QUALITY CONTROL

Testing and inspection of welds and overall structural integrity is performed

#### ELECTRICAL SYSTEMS

Integration of electrical components and cabling systems for power transmission

#### TRANSPORT AND ASSEMBLY

Large components are transported to coastal assembly sites or shipyards. When concrete is utilized, the concrete is typically poured and set around steel rods for reinforcement

#### WELDING AND ASSEMBLY

Specialized welding techniques are used to join the steel components.

#### MOORING SYSTEM INTEGRATION

Attachment points for mooring lines are incorporated into the platform design.

#### CORROSION PROTECTION

Applying protective coatings to prevent corrosion in the marine environment.

### EXAMPLES OF EXISTING PORTS OR FACILITIES

Pemamek Ltd. in Houston, Texas, U.S.  
Fred. Olsen in Oslo Norway  
Principle Power in Portugal and Scotland

## Logistics Requirements



**Road access  
required**

**Rail access  
preferred but not  
required**

## Estimated Permitting & Construction Timelines

### PERMITTING

Approximately 1-2 years

### CONSTRUCTION OF FACILITY

Approximately 2 years

*Operations are estimated to start 3 – 4 years after permitting process begins*

## Semi-Submersible Platforms

## Physical Port Requirements

## TOTAL AREA

**75-80 acres**Minimum with 20-40 acre  
fabrication yard

## NAVIGABLE DEPTH

**33-40 ft (10-12 m)**

## NAVIGABLE WIDTH

**328-443 ft (100-135 m)**

## DRAFT AT BIRTH

**28-38+ ft**

## WHARF LENGTH

**1,200 ft**

Minimum (heavy-lift wharf)

NUMBER & SIZE OF  
TERMINALS OR BERTHS**1-2 deep draft berths**

## SIZE OF BERTH

**470 ft length Minimum****38 ft depth Minimum**

## LOADING &amp; BEARING CAPACITIES

WHARF LOADING 6,000 psf Minimum  
under crane

YARD LOADING 4,000-6,000 psf

BEARING CAPACITY 7,000 psf Minimum  
(approx. 10 tons per square meter)

## STORAGE NEEDS

Land and Wet Storage are required. Wet  
storage area is approximately 1.9 square  
miles or 1,236 acres to store six 15 MW  
turbines, which is the usual upper limit of  
turbines stored at a time, but this might vary  
according to deployment schedules and  
downtime risks.

## AIR DRAFT

**650 ft**Minimum clearance above  
the water line

## Workforce

**\$43,300 - \$107,500****U.S. MEAN ANNUAL WAGES  
AS OF 2023Q4**

## JOB CREATION POTENTIAL

Approximately 84 direct jobs and 160 indirect jobs  
per 1 GW, on average, annually between 2024 and  
2030.

## OCCUPATIONS

Team Assemblers

Welders, Cutters, Solderers, and Brazers

Marine Engineers and Naval Architects

Plumbers, Pipefitters, and Steamfitters

Structural Metal Fabricators and Fitters

Coating, Painting, and Spraying Machine Setters,  
Operators, and Tenders

Drafters

First-Line Supervisors of Mechanics, Installers, and  
Repairers

UNITS OF MEASURE psf = pounds per square foot ft = feet GW = gigawatt

## Equipment and Amenities

## CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Steel, concrete, or both

## CRANE NEEDS

- 500-1,000+ ton capabilities
- Crawler cranes

## ELECTRICITY/UTILITY NEEDS

A shore power connection for vessels

## OTHER NEEDS

Forklifts, cherry pickers

Roll-on/roll-off capabilities

Greenhouse gas emission reduction initiatives

Shoreside vessel services (standard ship services and security  
requirements)

Offices, bathrooms, and indoor storage/warehouse buildings

Self-propelled modular transporters (SPMT)

Submersible barge, heavy transport vessel (HTV), ramp system,  
or direct transfer capabilities for transferring platform from land  
into water

Installation vessels: Anchor Handling Tug and support tugs

## Component Manufacturing Activities

# Spar Buoys Platforms

Spar foundations are suitable for waters deeper than 100 meters since they consist of a vertically floating cylinder, but their height presents challenges for transportation and installation. The supply chain for this technology might include steel, concrete, or a mix of both, depending on developer preferences. Spar platforms, however, are not considered likely to happen for large-scale floating offshore wind on the US West Coast, as the California State Lands Commission sees the technology unfeasible due to the deep draft requirements. Note that the details included are primarily based on spar buoy platforms constructed of steel.

## Port Activities

### FOR STEEL-BASED PLATFORMS:

#### COMPONENT FABRICATION

Large steel plates are bent & shaped to create individual sections of the platform

#### QUALITY CONTROL

Testing and inspection of welds and overall structural integrity is performed

#### ELECTRICAL SYSTEMS

Integration of electrical components and cabling systems for power transmission

#### TRANSPORT & ASSEMBLY

Large components are transported to coastal assembly sites or shipyards. When concrete is utilized, the concrete is typically poured and set around steel rods for reinforcement

#### WELDING & ASSEMBLY

Specialized welding techniques are used to join the steel components.

#### MOORING SYSTEM INTEGRATION

Attachment points for mooring lines are incorporated into the platform design.

#### CORROSION PROTECTION

Application of protective coatings to prevent corrosion in the marine environment.

### EXAMPLES OF EXISTING PORTS OR FACILITIES

Pemamek Ltd. in Houston, Texas, U.S.  
Siemens Gamesa's TetraSpar in Norway

## Logistics Requirements



**Road access  
required**

**Rail access  
preferred but  
not required**

## Estimated Permitting & Construction Timelines

### PERMITTING

Approximately 1-2 years

### CONSTRUCTION OF FACILITY

Approximately 2 years

*Operations are estimated to start 3 – 4 years after permitting process begins*

# Spar Buoys Platforms

## Physical Port Requirements

### TOTAL AREA

**75-80 acres**

Minimum with 20 - 40 acre  
fabrication yard

### NAVIGABLE DEPTH

296 ft in sheltered

### NAVIGABLE WIDTH

197-296 ft (60-90 m)

### DRAFT AT BIRTH

**20-270 ft**

### WHARF LENGTH

**1,200 ft**

Minimum (heavy-lift wharf)

### NUMBER & SIZE OF TERMINALS OR BERTHS

**1-2 deep draft berths**

### SIZE OF BERTH

**470 ft**

Minimum length

### LOADING & BEARING CAPACITIES

WHARF LOADING Minimum 6,000 psf  
under crane

YARD LOADING 4,000 - 6,000 psf

BEARING CAPACITY 7,000 psf Minimum  
(approx. 10 tons per square meter)

### STORAGE NEEDS

Land and Wet storage are Required. Wet  
storage area is approximately 1.9 square miles  
or 1,236 acres to store six 15 MW turbines,  
which is the usual upper limit of turbines  
stored at a time, but this might vary according  
to deployment schedules and downtime risks.

### AIR DRAFT

**650 ft**

Minimum clearance above the  
water line

## Workforce



**\$43,300 - \$107,500**

**U.S. MEAN ANNUAL WAGES  
AS OF 2023Q4**

### JOB CREATION POTENTIAL

Approximately 84 direct jobs and 160 indirect jobs  
per 1 GW, on average, annually between 2024 and  
2030.

### OCCUPATIONS

Team Assemblers

Welders, Cutters, Solderers, and Brazers

Marine Engineers and Naval Architects

Plumbers, Pipefitters, and Steamfitters

Structural Metal Fabricators and Fitters

Coating, Painting, and Spraying Machine Setters,  
Operators, and Tenders

Drafters

First-Line Supervisors of Mechanics, Installers, and  
Repairers

UNITS OF MEASURE psf = pounds per square foot ft = feet GW = gigawatt

## Equipment and Amenities

### CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Steel, concrete, or both

### CRANE NEEDS

- 500-1,000+ ton capabilities
- Crawler cranes

### ELECTRICITY/UTILITY NEEDS

A shore power connection for vessels

### OTHER NEEDS

Forklifts, cherry pickers

Roll-on/roll-off capabilities

Greenhouse gas emission reduction initiatives

Shoreside vessel services (standard ship services, shore  
power, and security requirements)

Offices, bathroom, and indoor storage/warehouse  
buildings

Self-propelled modular transporters (SPMT)

Submersible barge or heavy transport vessel (HTV)

Installation vessels: Anchor handling tug and crane barge

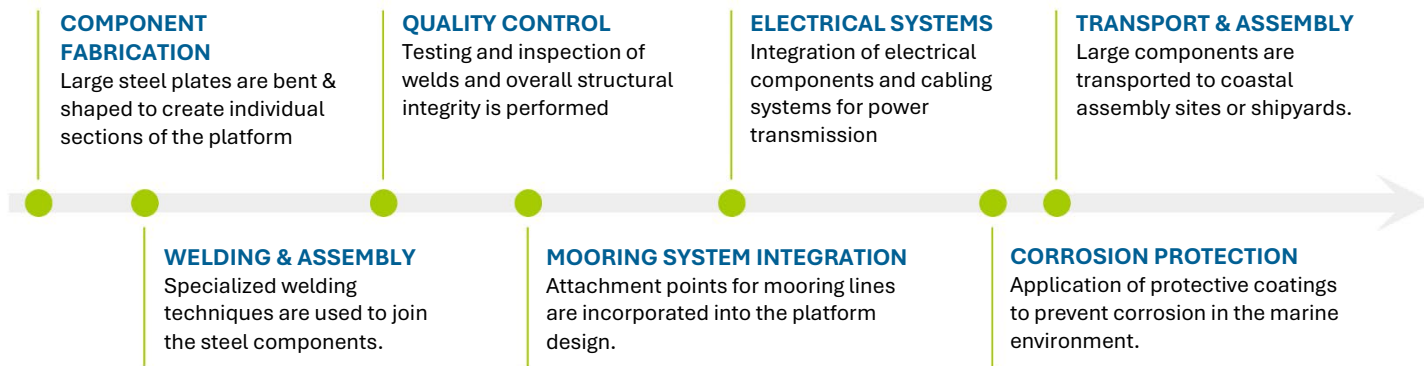


## Component Manufacturing Activities

# Tension Leg Platforms (TLP)

Tension Leg Platforms (TLP) have less technology readiness than Semi-submersible or Spar technologies but present the most stability of the three platform types. These foundations are made of steel and, therefore, require a strong supply of these materials for the manufacturing process. Since turbines can be installed on the TLP onshore, the installation process is facilitated, like semi-submersible platforms; thus, their port requirements are similar.

## Port Activities



### EXAMPLES OF EXISTING PORTS OR FACILITIES

Pemamek Ltd. in Houston, Texas, U.S.  
PelaStar in partnership with General Electric

## Logistics Requirements



**Road access  
required**

**Rail access  
preferred but  
not required**

## Estimated Permitting & Construction Timelines

### PERMITTING

Approximately 1-2 years

### CONSTRUCTION OF FACILITY

Approximately 2 years

*Operations are estimated to start 3 – 4 years after permitting process begins*

# Tension Leg Platforms

## Physical Port Requirements

### TOTAL AREA

**75-80**

Minimum acres with 20-40 acre fabrication yard

### NAVIGABLE DEPTH

33 ft Minimum

### NAVIGABLE WIDTH

296-443 ft (90-135 m)

### DRAFT AT BIRTH

**28-38+ ft**

### WHARF LENGTH

**1,200 ft**

Minimum (heavy-lift wharf)

### NUMBER & SIZE OF TERMINALS OR BERTHS

**1-2 deep draft berths**

### SIZE OF BERTH

**470 ft**

Minimum length

**38 ft**

Minimum depth

### LOADING & BEARING CAPACITIES

WHARF LOADING 6,000 psf Minimum  
under crane

YARD LOADING 4,000-6,000 psf

BEARING CAPACITY 7,000 psf Minimum  
(approx. 10 tons per square meter)

### STORAGE NEEDS

Land and Wet Storage are required. Wet storage area is approximately 1.9 square miles or 1,236 acres to store six 15 MW turbines, which is the usual upper limit of turbines stored at a time, but this might vary according to deployment schedules and downtime risks.

### AIR DRAFT

**650 ft**

Minimum clearance above the water line

## Workforce



**\$43,300 - \$107,500**

**U.S. MEAN ANNUAL WAGES  
AS OF 2023Q4**

### JOB CREATION POTENTIAL

Approximately 84 direct jobs and 160 indirect jobs per 1 GW, on average, annually between 2024 and 2030.

### OCCUPATIONS

Team Assemblers

Welders, Cutters, Solderers, and Brazers

Marine Engineers and Naval Architects

Plumbers, Pipefitters, and Steamfitters

Structural Metal Fabricators and Fitters

Coating, Painting, and Spraying Machine Setters, Operators, and Tenders

Drafters

First-Line Supervisors of Mechanics, Installers, and Repairers

UNITS OF MEASURE psf = pounds per square foot ft = feet GW = gigawatt

## Equipment and Amenities

### CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Steel

### CRANE NEEDS

- 500-1,000+ ton capabilities
- Crawler cranes

### ELECTRICITY/UTILITY NEEDS

A shore power connection for vessels

### OTHER NEEDS

Forklifts, cherry pickers

Roll-on/roll-off capabilities

Greenhouse gas emission reduction initiatives

Shoreside vessel services (standard ship services, shore power, and security requirements)

Offices, bathroom, and indoor storage/warehouse buildings

Self-propelled modular transporters (SPMT)

Submersible barge, heavy transport vessel (HTV), ramp system, or direct transfer capabilities for transferring platform from land into water

Installation vessels: Anchor Handling Tug and support tugs

## Component Manufacturing Activities

# Array Cables

Array cables require transportation from ports to the offshore wind farm but are not usually manufactured at or near port facilities; they are only stored. They are shorter and lighter than export cables and are used to transmit power from the array of floating wind turbines to the offshore substation. Sometimes, array cables are also used to transmit power from the substation to the turbines when wind generation from the turbines is not working properly. Array cables can be manufactured at inland facilities and later stored at staging and integration ports or sites.

## Port Activities

### INSULATED

The cable cores are insulated through a catenary continuous vulcanization (CCV) process

### STABILIZED

Armor and ropes are applied and twisted around the cable to stabilize the helix

### STORED

Array cables are often stored at Staging and Integration ports or sites

### WOUND

The cores are then wound together with a fiber optic cable into a helix structure

### LOADED

Cables may be loaded onto the vessel to be wound using carousels, turntables, or cable tanks onboard, or they may be wound onshore using drums and then lifted onto the vessel with a heavy-lift crane

### EXAMPLES OF EXISTING PORTS OR FACILITIES

Prysmian facility in Brayton Point, Massachusetts, USA  
JDR Cables facility in Cambios, England  
Hellenic Cables facility in Corinth, Greece

## Logistics Requirements



**Road access  
required**



**Rail access  
preferred but not  
required**



## Estimated Permitting & Construction Timelines

### PERMITTING

Approximately 1-2 years

### CONSTRUCTION OF FACILITY

Approximately 2 years

*Operations are estimated to start 3 – 4 years after permitting process begins*

# Array Cables

## Physical Port Requirements

### TOTAL AREA

**5-30+ acres**

(for 25 MW pre-commercial farm to  
300 MW commercial farm)

### NAVIGABLE WIDTH

**92 ft Minimum**

### NAVIGABLE DEPTH

**16.5 ft Minimum**

at Lowest Astronomical Tide (LAT)

### DRAFT AT BIRTH

**20-30 ft**

For loaded cable installation vessel

**30 ft**

Minimum berth depth

### WHARF LENGTH

**500 ft**

Minimum

### NUMBER & SIZE OF TERMINALS OR BERTHS

Need multiple terminals for  
consistent port access since the  
loading time for array cables can  
span several days.

### SIZE OF BERTH

**328-492 ft**

Quayside length

### LOADING & BEARING CAPACITIES

Depending on the wind farm size, array  
cable weight may range from 100 to 1,000  
tons in total

WHARF LOADING 1,000 psf Minimum  
YARD LOADING 1,000 – 2,000 psf  
BEARING CAPACITY 1,000 psf Minimum

### STORAGE NEEDS

Often stored at the staging and  
integration ports. For every 1-2 array  
cable carousels, 3-7 acres is required.

### AIR DRAFT

**200 ft Minimum clearance  
above the water line**

## Workforce



**\$48,000 - \$119,700**

**U.S. MEAN ANNUAL WAGES  
AS OF 2023Q4**

### JOB CREATION POTENTIAL

**Approximately 17 direct jobs and 27 indirect jobs per 1 GW, on average, annually between 2024 and 2030.** OFW facilities that manufacture array and export cable together can be compared to submarine cable manufacturing facilities, which create around 100 full-time, operations jobs and an additional 500 jobs for construction of the facility.

### OCCUPATIONS

Coil Winders, Tapers, and Finishers

Electrical & Electronic Engineering Technologists and Technicians

Electrical & Electronics Repairers, Commercial and Industrial Equipment

Electrical & Electronics Repairers, Powerhouse, Substation, and Relay

Electrical, Electronic, & Electromechanical Equipment Assemblers,

Except Coil Winders, Tapers, and Finishers

Electrical Engineers

Engineers, All Other

First-Line Supervisors of Mechanics, Installers, & Repairers

Riggers

Welders, Cutters, Solderers, and Brazers

## Equipment and Amenities

### CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Core materials:

Copper, aluminum, ethylene propylene (EPR) or cross-linked polyethylene (XLPE), steel wire

Fiber-optic cables required for winding the cores

### CRANE NEEDS

Heavy-lift crane at the quayside if cables were pre-wound onshore to load onto the vessels (if the vessels do not have heavy-lift cranes onboard)

### ELECTRICITY/UTILITY NEEDS

Dynamic and dry- and wet-static cables of 132 kilovolts should be tested.

### OTHER NEEDS

If pre-winding the cables onshore, drums are needed to wind the cables

UNITS OF MEASURE psf = pounds per square foot ft = feet GW = gigawatt

## Component Manufacturing Activities

# Export Cables

Export cables do not require manufacturing at or near ports, but their installation requires heavy subsea and onshore engineering activities. Export cables are long and heavy cables that transmit power from the offshore substation to the electrical infrastructure onshore. Once fabricated, export cables are typically loaded directly onto vessels.

## Port Activities

### INSULATED

The cable cores are insulated through a catenary continuous vulcanization (CCV) process

### APPLIED/TWISTED

A armor and ropes are applied and twisted around the cable to stabilize the helix

### FED

Lastly, the cables are fed from the storage facility directly to the vessel, which requires a direct path from the storage facility to the vessel docking site, using a large cable carousel

### WOUND

The cores are then wound together with a fiber optic cable into a helix structure

### COILED

The cables are coiled using a cable turntable to be stored later

## EXAMPLES OF EXISTING PORTS OR FACILITIES

Nexans facility in Charleston, North Carolina, USA  
Prysmian facility in Brayton Point, Massachusetts, USA  
JDR Cables facility in Cambios, England  
Hellenic Cables facility in Corinth, Greece

## Logistics Requirements



**Road access  
required**

**Rail access  
preferred but  
not required**

## Estimated Permitting & Construction Timelines

### PERMITTING

Approximately 1-2 years

### CONSTRUCTION OF FACILITY

Approximately 2 years

*Operations are estimated to start 3 – 4 years after permitting process begins*

# Export Cables

## Physical Port Requirements

### TOTAL AREA

## 17-30+ acres

For 300 MV Commercial Farm

### NAVIGABLE WIDTH

92 ft Minimum

### NAVIGABLE DEPTH

16.5 ft Minimum

at Lowest Astronomical Tide (LAT)

### DRAFT AT BIRTH

20-30 ft

for loaded cable installation vessel

30 ft

Minimum berth depth

### WHARF LENGTH

## 500 ft

Minimum

### NUMBER & SIZE OF TERMINALS OR BERTHS

Need multiple terminals for consistent port access since the loading time for export cables can span several days. Rate of loading is about 26ft/min

### SIZE OF BERTH

## 328-492 ft

Quayside length

### LOADING & BEARING CAPACITIES

Must withstand the weight of the coiled cables (AC cable weighs approx. 50 lb/ft)

WHARF LOADING 1,000 psf Minimum

YARD LOADING 1,000 – 2,000 psf

BEARING CAPACITY 1,000 psf Minimum

### STORAGE NEEDS

Cables are coiled around turntables in storage. Both dry- and wet-storage strategies exist for cables. For every 2-6 export cable carousels, 3-7 acres is required.

### AIR DRAFT

200 ft Minimum clearance  
above the water line

## Workforce



## \$48,000 - \$119,700

U.S. MEAN ANNUAL WAGES  
AS OF 2023Q4

### JOB CREATION POTENTIAL

Approximately 34 direct jobs and 54 indirect jobs per 1 GW, on average, annually between 2024 and 2030. OFW facilities that manufacture array and export cable together can be compared to submarine cable manufacturing facilities, which create around 100 full-time, operations jobs and an additional 500 jobs for construction of the facility.

### OCCUPATIONS

Coil Winders, Tapers, and Finishers

Electrical and Electronic Engineering Technologists and Technicians

Electrical and Electronics Repairers, Commercial and Industrial Equipment

Electrical and Electronics Repairers, Powerhouse, Substation, and Relay

Electrical, Electronic & Electromechanical Equipment Assemblers, Except

Coil Winders, Tapers & Finishers

Electrical Engineers

Engineers, All Other

First-Line Supervisors of Mechanics, Installers, and Repairers

Riggers

Welders, Cutters, Solderers, and Brazers

## Equipment and Amenities

### CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Core materials: copper, aluminum, ethylene propylene (EPR) or cross-linked polyethylene (XLPE), lead, polypropylene, metal, and bitumen

Fiber-optic cables required for winding the cores

### CRANE NEEDS

A crane is not typically used

### ELECTRICITY/UTILITY NEEDS

North American and international standards require the testing of cables with up to 550 kilovolts

### OTHER NEEDS

Horizontal armoring machine

Cable turntables, each approximately 98 ft wide

Large cable carousel security requirements)

UNITS OF MEASURE psf = pounds per square foot ft = feet GW = gigawatt



Component Manufacturing Activities

# Anchors

There are four main types of anchors used in floating offshore wind, and a region’s floating wind plans must consider establishing local manufacturing of one or more types of anchors to avoid project delays and supply chain uncertainties. These are heavy components, part of the mooring system, and can only be transported to the wind farm using vessels. Therefore, they have specific port requirements that vary depending on the chosen anchor type. The four types of anchors used in floating OSW are Drag embedment, Suction pile, Driven pile, and Gravity base. Anchors secure floating wind turbines and mooring lines in place, in or on the seabed. Each anchor type has a unique form and specific requirements around raw materials and is suited for different ocean geographies. There are typically five anchors used per turbine.

## Port Activities

**FOR DRAG EMBEDMENT ANCHOR**

Steel plates are cut into desired profiles and welded together for the final profile. Most drag embedment anchors will consist of flat plate, but sometimes rolled steel is used.

**FOR GRAVITY BASE ANCHORS**

Concrete is formed around steel rebar framework.

**FOR SUCTION & DRIVEN PILE ANCHORS**

Sections of seam-welded rolled steel plates are welded together.

**EXAMPLES OF EXISTING PORTS**

Anchors can be manufactured or fabricated anywhere on land. Current anchor suppliers include Delmar Systems Vryhof, Bruce Anchor, Swift Anchors, Subsea Micropiles, Global Energy Group, RCAM Technologies, and Mooreast

## Logistics Requirements



**Road access required**

(Must be able to accommodate 150-500 tons of anchors per turbine or over 3,000 tons per turbine with gravity anchors)

**No rail requirements**

## Estimated Permitting & Construction Timelines

**PERMITTING**

Approximately 1-2 years

**CONSTRUCTION OF FACILITY**

Approximately 2 years

*Operations are estimated to start 3 – 4 years after permitting process begins*

# Anchors

## Physical Port Requirements

### TOTAL AREA

**10-30 acres**

### NAVIGABLE WIDTH

**200-400 ft**

### NAVIGABLE DEPTH

33 ft Minimum, must be able to accommodate heavy-lift cargo as individual drag embedment anchors can weigh up to 100 tons

### DRAFT AT BIRTH

**20-30 ft**

Minimum

### WHARF LENGTH

**300 ft**

Minimum

### NUMBER & SIZE OF TERMINALS OR BERTHS

Two terminals, one for shipping and one for manufacturing and assembly. Size depends on production volume.

### SIZE OF BERTH

Varies according to size of Anchor Handling Vessel, usually over 165 ft

### LOADING & BEARING CAPACITIES

Must be able to accommodate 150-500 tons of anchors per turbine or over 3,000 tons per turbine with gravity anchors

WHARF LOADING 500 psf Minimum  
YARD LOADING 500 psf Minimum  
BEARING CAPACITY 500 psf Minimum

### STORAGE NEEDS

Must be stored at an anchor laydown area, approximately 5-15 acres for facilities serving a single staging and integration port with 30-40 anchors.

### AIR DRAFT

No air draft restrictions

## Workforce



**\$71,800 - \$129,000**

**U.S. MEAN ANNUAL WAGES  
AS OF 2023Q4  
AT A STAGING &  
INTEGRATION PORT**

### JOB CREATION POTENTIAL

Anchor storage areas may be located at independent facilities, but are often part of larger facilities such as a staging and integration port.

**100-200 jobs may be created at an S&I port for a single wind farm or project.**

*\*Upper bound reflects the larger project sizes expected on the west coast of the U.S.*

## Equipment and Amenities

### CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Typically, S355 steel, shackles, and caps with valves  
For gravity anchors, concrete, shackles, and rebar

### OTHER NEEDS

CAD and CNC software

CNC cutters and machining equipment

Press brakes

Roll forming machines

Lifting equipment

Induction pipe bending machines

Various drills, grinders, and saws

Surfacing equipment

Welding equipment

Sometimes coating equipment

For gravity anchors, slip forming, or concrete casting equipment

Lifting and handling equipment

UNITS OF MEASURE psf = pounds per square foot ft = feet GW = gigawatt

## Component Manufacturing Activities

# Mooring Lines

Mooring lines often require several raw materials to manufacture since they connect the anchor to the turbine substructure and need different tension levels and flexibility throughout the component. Although their manufacturing does not need to be at ports, access to ports by road is required to transport the finished mooring lines to the ports where they will be installed. Several considerations exist for establishing local manufacturing of these components since their materials can vary from steel to nylon or polyester to wire ropes.

## Port Activities

### FORM THE CHAINS

Manufacturing workers heat, form, weld, shape, and coat multiple lengths of bar stock to form the chains

### FORGING AND WELDING

Steel is forged and welded to create the jewelry that connects the ropes, chains, and anchors

### FORM ROPES

At a manufacturing facility, synthetic strands are twisted together to form the mooring line ropes.

### EXAMPLES OF EXISTING PORTS OR FACILITIES

Mooring lines, like anchors, can be manufactured or fabricated anywhere on land. Current Mooring line suppliers include Bexco, Bridon-Bekaert, Dynamica Ropes, Lankhorst, Vicinay, FibreMax, InterMoor, and Mooreast

## Logistics Requirements



### Road access required

(must be able to accommodate the weights of the chains (1,100-1,600 lbs per link), synthetic rope (33.5 lbs per foot), and jewelry (550-20,000 lbs))

### No rail requirement

## Estimated Permitting & Construction Timelines

### PERMITTING

Approximately 1-2 years

### CONSTRUCTION OF FACILITY

Approximately 2 years

*Operations are estimated to start 3 – 4 years after permitting process begins*

# Mooring Lines

## Physical Port Requirements

### TOTAL AREA

**10-30 acres**

### NAVIGABLE WIDTH

**200-400 ft**

### NAVIGABLE DEPTH

33 ft Minimum, must be able to accommodate heavy-lift cargo vessels

### DRAFT AT BIRTH

**20-30 ft**

Minimum

### WHARF LENGTH

**300 ft**

Minimum

### NUMBER & SIZE OF TERMINALS OR BERTHS

Two terminals, one for shipping and one for manufacturing and assembly. Size depends on production volume.

### SIZE OF BERTH

Varies according to size of Anchor Handling Vessel, usually over 165 ft

### LOADING & BEARING CAPACITIES

Must be able to accommodate the weights of the chains (1,100-1,600 lbs per link), synthetic rope (33.5 lbs per foot), and jewelry (550-20,000 lbs)

WHARF LOADING 500 psf Minimum  
YARD LOADING 500 psf Minimum  
BEARING CAPACITY 500 psf Minimum

### STORAGE NEEDS

Must be stored at a mooring laydown area, approximately 5-15 acres for facilities serving a single staging and integration port with 50,000-100,000 ft of chain.

### AIR DRAFT

No air draft restrictions

## Workforce



**\$71,800 - \$129,000**

**U.S. MEAN ANNUAL WAGES  
AS OF 2023Q4  
AT A STAGING &  
INTEGRATION PORT**

### JOB CREATION POTENTIAL

Mooring line storage areas may be located at independent facilities but are often part of larger facilities such as a staging and integration port.

**100-200 jobs may be created at an S&I port for a single wind farm or project.**

*\* Upper bound reflects the larger project sizes expected on the west coast of the U.S.*

## Equipment and Amenities

### CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Steel (R3, R3S, R4, R4S or R5 steel bar) and synthetic rope fiber (polyester or nylon)

### OTHER NEEDS

CAD and CNC software  
CNC cutters & machining equipment  
Press brakes  
Roll forming machines  
Lifting equipment  
Induction pipe bending machines  
Various drills, grinders and saws  
Surfacing equipment  
Welding equipment  
Sometimes coating equipment  
Heat treatment equipment  
Extrusion machines  
Twisting or braiding equipment  
Tensioning and spooling equipment  
Cutting and splicing equipment  
Oven for curing/heat setting  
Lifting and handling equipment

UNITS OF MEASURE psf = pounds per square foot ft = feet GW = gigawatt



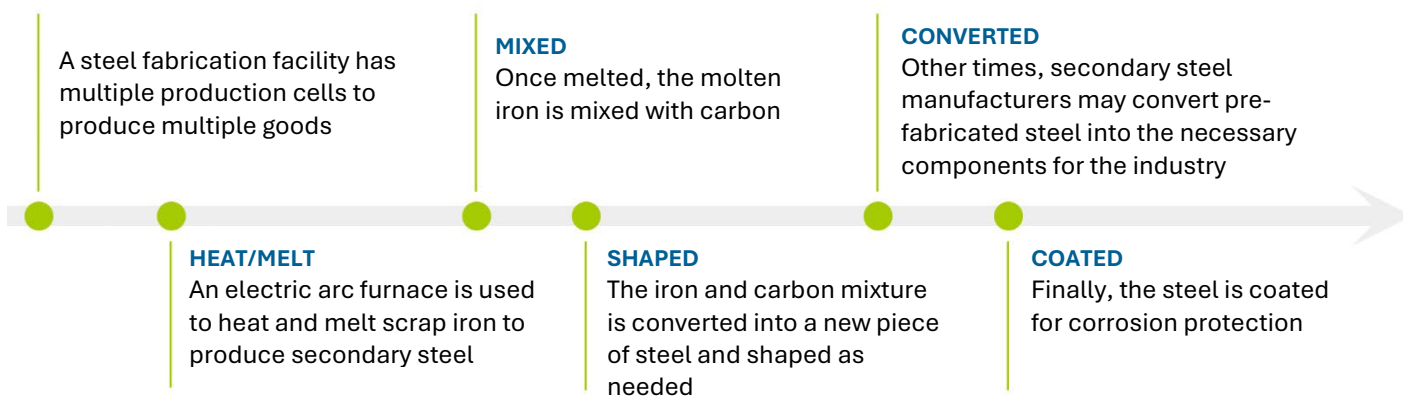
## Component Manufacturing Activities

# Secondary Steel

Secondary steel manufacturing is one of the focal points in the planning and implementation of a floating offshore wind industry for two main reasons: it represents a large portion of the subcomponents added to the assembled turbine (including ladders, walkways, and railings); and domestic steel and manufactured steel products are heavily emphasized in federal funding policies, including the Build America and Buy America Act, and for that reason, developers show interest in local supply.

*Primary steel is incorporated into tower and platform technologies.*

## Port Activities



### EXAMPLES OF EXISTING PORTS OR FACILITIES

Secondary steel can be manufactured or fabricated anywhere on land. Current suppliers include Hutchinson Engineering, Kersten, Smulders, Vallourec, and Wilton Engineering

## Logistics Requirements



### Road access required

(if facility is at a port or shipyard, road access is only required for receiving the raw materials)



### Rail access required

(if facility is at a port or shipyard, rail access is only required for receiving the raw materials)



## Estimated Permitting & Construction Timelines

### PERMITTING

Approximately 5 – 8 months

### CONSTRUCTION OF FACILITY

Approximately 2 years

*Operations are estimated to start 2.5 – 3 years after permitting process begins*

# Secondary Steel

## Physical Port Requirements

### TOTAL AREA

**2.5 - 50+ acres**

### NAVIGABLE DEPTH

**22-40 ft**

### NAVIGABLE WIDTH

**75 – 200 ft**

### DRAFT AT BIRTH

**30-40 ft**

### WHARF LENGTH

**300-700 ft**

Quayside length

### NUMBER & SIZE OF TERMINALS OR BERTHS

At least one terminal, depends  
on manufacturing output.

### SIZE OF BERTH

**150-700 ft**

length

**22-40 ft**

depth

### LOADING & BEARING CAPACITIES

WHARF LOADING 2,000 – 3,000 psf  
YARD LOADING 2,000 – 3,000 psf  
BEARING CAPACITY 2,000 – 3,000 psf

### STORAGE NEEDS

Space required to store  
prefabricated parts, 1-8 acres

### AIR DRAFT

**100-200 ft**

## Workforce



**\$42,500 - \$126,800**

**U.S. MEAN ANNUAL WAGES  
AS OF 2023Q4**

### JOB CREATION POTENTIAL

In 2021, there were 131,400 workers in the steel industry  
across the U.S.

### OCCUPATIONS

First-Line Supervisors of Production and Operating Workers  
Industrial Production Manager

Inspectors, Testers, Sorters, Samplers, and Weighers

Machinist

Molding, coremaking, and Casting Machine Setters,  
Operators, and Tenders, Metal and Plastic

Welders, Cutters, Solderers, and Brazers

Electricians

Carpenters

Construction Laborers

Materials Engineers

Team Assemblers

## Equipment and Amenities

### CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Aluminum

Glass-fiber reinforced plastic

Rubber

Paint and coating material

S355, S460, S690 and S700 steel - may be in standard forms, such as box  
sections, tubulars, and plate

### CRANE NEEDS

Gantry crane

Cranes must be able to accommodate secondary steel weighing  
approximately 100 tons for a single, steel semi-submersible platform for a  
15 MW turbine

### ELECTRICITY/UTILITY NEEDS

Metallurgical plants typically use coal, coke, oil, gas, and electricity  
(generally coal-based) to meet their needs for energy

### OTHER NEEDS

Requires a fabrication building (approximately 36,000-165,000 square feet) and a  
laydown or storage area

*Equipment needs:*

CAD and CNC software

CNC cutters and machining equipment

Press brakes

Roll forming machines

Lifting equipment

Induction pipe bending machines

Various drills, grinders, and saws

Surfacing equipment

Welding equipment

Coating equipment

UNITS OF MEASURE psf = pounds per square foot ft = feet GW = gigawatt

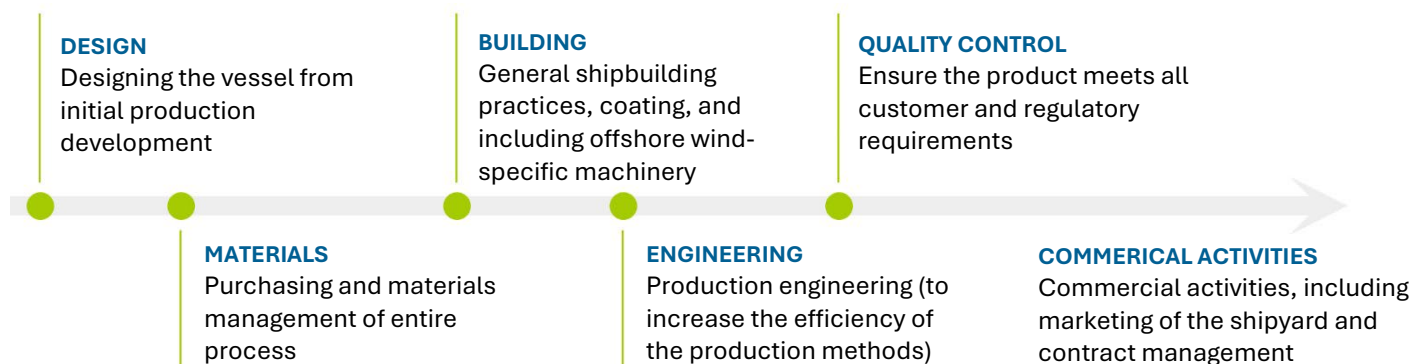
## Component Manufacturing Activities

# Crew Transfer Vessels (CTV), Service Accommodation Transfer Vessels (SATV), and Service Operation Vessels (SOV)

Various vessel types are involved in installing a floating offshore wind farm. Vessels are subject to the Jones Act, a law regulating maritime shipping in the United States generally, which also affects the manufacturing, operations, and ownership requirements of offshore wind vessels. Vessel manufacturing is, therefore, a required aspect of the local supply chain for a future offshore wind ecosystem. Since floating offshore wind is a nascent industry in the United States, this chapter covers various vessel types, including:

- Crew Transfer Vessels (CTVs): transport individuals and some equipment from the mainland to the offshore wind farms.
- Service Accommodation Transfer Vessels (SATVs): transport workers from the mainland to the offshore wind farm, similar to CTVs, but also provide sleeping accommodations to allow workers to stay at sea for several weeks. Construction for these vessels started recently, with the first delivered in Singapore in 2020.
- Service Operation Vessels (SOVs): stay at sea close to the wind farms to provide accommodations for workers and platform assistance to workers who need to perform maintenance and repair work on the turbines.

## Port Activities



### EXAMPLES OF EXISTING PORTS OR FACILITIES

There are few vessel manufacturers for OSW in the U.S. Below are examples of facilities that manufacture CTVs, SATVs, and SOVs. Not all are specific to OSW- some are built to serve multiple industries.

#### Crew Transfer Vessels:

St. Johns Ship Building in Palatka, Florida, U.S.  
Blount Boats in Warren, Rhode Island, U.S.  
Colonna's Shipyard in Norfolk, Virginia, U.S.

#### Service Accommodation Transfer Vessels:

DLBA Naval Architects in Chesapeake, Virginia, U.S.  
Penguin Shipyard in Singapore

#### Service Operation Vessels:

Edison Chouest Offshore (with Ørsted and Eversource) in Florida, Mississippi, and Louisiana, U.S.  
Ulstein in Ulsteinvik, Norway  
Other manufacturers include Siemens Gamesa, ICE Marine Design, ABB Marine Services, and Vard Marine

Component Manufacturing Activities

## Crew Transfer Vessels, Service Accommodation Transfer Vessels, and Service Operation Vessels

## Physical Port Requirements

### TERMINAL & BERTH LENGTH REQUIREMENTS

Must be able to accommodate:

|       |                 |
|-------|-----------------|
| CTVs  | 65-90 ft long   |
| SATVs | 100-130 ft long |
| SOVs  | 200-400 ft long |

### TERMINAL & BERTH WIDTH REQUIREMENTS

Must be able to accommodate:

|       |               |
|-------|---------------|
| CTVs  | 22-30 ft long |
| SATVs | 30-50 ft long |
| SOVs  | 50-80 ft long |

### DRAFT AT BIRTH

|       |          |
|-------|----------|
| CTVs  | 5-10 ft  |
| SATVs | 10-16 ft |
| SOVs  | 16-25 ft |

### WEIGHT OR BEARING REQUIREMENTS

Must be able to accommodate:

CTVs that weigh 15-30 tons & can bear around 1-15 tons  
 SATVs that weigh around 5,000 tons & can bear around 1.4 tons per square foot  
 SOVs that weigh around 2,000-4,000 tons

### STORAGE NEEDS

No minimum storage size requirements, wet storage required

## Workforce



**\$50,900 - \$107,500**

**U.S. MEAN ANNUAL WAGES  
AS OF 2023Q4**

### JOB CREATION POTENTIAL

Edison Chouest Offshore Jones Act-compliant SOV involved over 600 workers across Florida, Mississippi, and Louisiana.

### OCCUPATIONS

Carpenters  
 Electricians  
 First-Line Supervisors of Production and Operating Workers  
 Inspectors, Testers, Sorters, Samplers, and Weighers  
 Marine Engineers and Naval Architects  
 Plumbers, Pipefitters, and Steamfitters  
 Riggers  
 Structural Metal Fabricators and Fitters  
 Surveyors  
 Welders, Cutters, Solderers, and Brazers

## Equipment and Amenities

### CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Steel, fiberglass, aluminum, wood, and other materials

### OTHER NEEDS

Shipyards may include several support shops including electrical, carpentry, pipe, sandblasting, and painting specializations alongside pier space, dry docks, railway, boat yard, and administrative offices

Marine Travelift boat hoist with 820 metric ton capacity

UNITS OF MEASURE psf = pounds per square foot ft = feet GW = gigawatt

## Port Activities

# Staging & Integration (S&I)

Staging and Integration (S&I) ports are specialized port facilities used for receiving, storing, assembling, and integrating the various components of floating offshore wind turbines before being towed to the installation site at sea. S&I ports are responsible for all the assembly requirements that will not be completed offshore, requiring specific maritime equipment capable of performing heavy lifting at the installation site. S&I ports, in contrast to manufacturing ports that typically only manufacture single components, need to be able to accommodate fully constructed turbines, which requires a very specific set of infrastructures. The latest generation of floating offshore wind turbines requires purpose-built ports to facilitate the complex assembly and installation of structures.

## Port Activities

### RECEIVE/STAGE/STORE

Receive, stage, and store all types of floating offshore wind turbine components

### TRANSPORT

Transport the assembled turbine out to sea in the appropriate vessel

May eventually be involved in decommissioning floating wind projects

### ASSEMBLE

Assemble the floating wind turbine system for towing to the offshore wind area

### MAINTENANCE

Conduct major maintenance tasks, such as replacing a nacelle or blade

## EXAMPLES OF EXISTING PORTS OR FACILITIES

New Bedford Marine Commerce Terminal in New Bedford, Massachusetts, U.S.  
Port of Hull in East Riding of Yorkshire, England  
Eemshaven in Eemshaven, Netherlands  
Port of Esbjerg, Denmark

## Logistics Requirements



**Road access  
required**

**Rail access  
preferred but**

## Estimated Permitting & Construction Timelines

### PERMITTING

Approximately 1.5 years

### CONSTRUCTION OF FACILITY

Approximately 1.5 - 2 years

*Facility operations are estimated to start partially 3 years after permitting process begins and to be fully operational approximately 3.5 years after permitting begins.*

# Staging & Integration

## Physical Port Requirements

### TOTAL AREA

**30-100 acres**

### NAVIGABLE DEPTH

**40-100 ft**

Draft at sinking basin

### NAVIGABLE WIDTH

**150-200 ft**

### DRAFT AT BIRTH

**32-40 ft**

Minimum Mean Lower Low Water

### WHARF LENGTH

**1,000 - 2,000 ft**

### NUMBER & SIZE OF TERMINALS OR BERTHS

Small commercial terminals:

1 multi-purpose berth

Large commercial terminals:

2-3 Minimum berths

### SIZE OF BERTH

**1,000-1,500 ft**

of quayside length

**100 ft**

Minimum width

### LOADING & BEARING CAPACITIES

WHARF LOADING 6,000 psf Minimum  
under crane

YARD LOADING 2,000 – 4,000 psf

BEARING CAPACITY 3,000 – 6,000+ psf

### STORAGE NEEDS

Land and Wet Storage are required. Wet storage area is approximately 1.9 square miles or 1,236 acres to store six 15 MW turbines, which is the usual upper limit of turbines stored at a time, but this might vary according to deployment schedules and downtime risks.

### AIR DRAFT

**1,100 ft**

Minimum clearance above the water line

May require coordination with airport and federal aviation administration

## Workforce



**\$71,800 - \$129,000**

**U.S. MEAN ANNUAL WAGES  
AS OF 2023Q4**

### JOB CREATION POTENTIAL

**100-200 jobs may be created at an S&I port for a single wind farm or project.**

### OCCUPATIONS

Carpenters  
Construction laborers  
Crane operators  
Electricians  
High voltage technicians  
Mechanical engineers  
Project engineers  
Riggers  
Vessel administrators  
Welders  
Wind turbine installation managers

## Equipment and Amenities

### CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Turbine components (blades, nacelles, towers, platforms, cables, anchors, mooring lines)

### CRANE NEEDS

- Minimum 1,000 tons
- Minimum 300 ft height
- On wharf with loading capacity of > 6,000 psf

### ELECTRICITY/UTILITY NEEDS

Electricity must run to both the berth and the wharf for the port operations (equipment and lighting) and the moored vessels  
Water must run to both the berth (potable) and the wharf (non-potable)  
Internet  
Need refueling options for vessels

### OTHER NEEDS

Breakwater for metocean protection  
Environmental mitigation allowance  
Specialized equipment  
Forklifts  
Crawler cranes  
Cherry pickers  
SPMT or marine railway  
Roll-on/roll-off capabilities  
Greenhouse gas emission reduction initiatives  
Offices, bathroom, and indoor storage/warehouse buildings  
Provisioning for vessels (e.g., food, water, sewage system)



## Port Activities

# Operations & Maintenance (O&M)

Operations and Maintenance (O&M) sites serve as a long-term base for wind farm operations. They need storage space for spare parts, warehouses, offices, ship repair services, provisioning and fuel for vessels, marine facilities, and onshore lodging. To respond quickly to potential issues or malfunctions at the farm, they must be within 40 nautical miles of a floating offshore wind farm. In addition to repairs and daily operations, O&M sites also support regular maintenance of the wind turbines.

## Port Activities

### STATIONED

Wind farm workers and vessels to carry workers and equipment are all stationed at an O&M port

### MONITOR

Monitor the OSW farm and turbine functioning to stay alert on any accidents or other concerns

### EXAMPLES OF EXISTING PORTS OR FACILITIES

New Bedford Foss Marine Terminal in New Bedford, Massachusetts, U.S.  
Port of Peterhead in Peterhead, England  
Thyboron Port in Thyboron, Denmark  
Port of Grimsby in Humber, England

## Logistics Requirements



Road access  
required

Rail access  
preferred but not  
required

## Estimated Permitting & Construction Timelines

### PERMITTING

Approximately 1.5 years

### CONSTRUCTION OF FACILITY

Approximately 1.5 - 2 years

*Facility operations are estimated to start partially 3 years after permitting process begins and to be fully operational approximately 3.5 years after permitting begins.*

## TOTAL AREA

**5-10 acres**

per project or farm

## NAVIGABLE WIDTH

Minimum 100 ft

## NAVIGABLE DEPTH

Minimum 12-25 ft,  
More for larger vessels

## DRAFT AT BIRTH

**20-30 ft**

Minimum

## WHARF LENGTH

**300 ft**

Minimum

NUMBER & SIZE OF  
TERMINALS OR BERTHS**1-5 berths**

## SIZE OF BERTH

**135-195 ft width**  
**500-750 ft length**LOADING & BEARING  
CAPACITIES

|                  |                |
|------------------|----------------|
| WHARF LOADING    | 100 – 500 psf  |
| YARD LOADING     | Not applicable |
| BEARING CAPACITY | 500 – 600 psf  |

## STORAGE NEEDS

**Spare part storage**

## AIR DRAFT or BRIDGE HEIGHTS

**100-150 ft**

clearance above the water line

## Workforce



## TECHNICIANS &amp; MANAGEMENT

**\$79,000**

## OPERATIONS &amp; MAINTENANCE

**\$55,000**

## ANNUAL WAGES

BASED ON SOURCE PUBLISHED IN 2021

## JOB CREATION POTENTIAL

Approximately 447 workers per 1 GW will be employed annually at O&M sites, for both fixed-bottom and floating OSW.

## Equipment and Amenities

## CARGO REQUIREMENTS

(what types of cargo will need to be handled for the activities)

Turbine components (blades, nacelles, towers, platforms, cables, anchors, mooring lines)

## CRANE NEEDS

- 400-500 psf
- Crawler cranes

## ELECTRICITY/UTILITY NEEDS

Electricity must run to both the berth and the wharf for the ports operations (equipment and lighting) and for the moored vessels  
Water must run to both the berth (potable) and the wharf (non-potable)  
Internet

Need refueling options for vessels

## OTHER NEEDS

Crew Transfer Vessel (CTV)  
Service Accommodation Transfer Vessel (SATV)  
Service Operating Vessel (SOV)  
Floating Offshore Installation Vessels  
Vessel or ship repair services  
Protected Harbor  
Forklifts  
Offices, bathroom, and indoor storage/warehouse buildings  
Onshore lodging and amenities  
Provisioning for vessels (e.g., food, water, sewage system)



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***\*Where data was reported in the metric system, it was converted to imperial system for consistency.***

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