

OFFSHORE WIND REPORT
POSITIONING FOR U.S. EXPANSION:
U.S. PORTS AND VESSELS INNOVATION

MARCH 2021



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DISCLAIMER

This report is based on ABS experience and on available public information from various sources referenced in Section 7, and ABS provides a summary of the general technical overview in the fields of Offshore Wind and Support Vessels. While ABS uses reasonable efforts to include accurate and up-to-date information in this report, ABS makes no warranties or representations as to its accuracy or completeness. ABS assumes no liability or responsibility for any errors or omissions in the content of this report nor for any consequences associated with using this information.

EXECUTIVE SUMMARY

Demand for wind farm support vessels in the United States (U.S.) is expected to increase to support planned construction projects for both fixed and floating offshore wind farms in U.S. waters. The East Coast states are primarily for fixed foundations, and California and Hawaii are key states for floating wind farms.

In the International Energy Agency's (IEA's) recent report, *Offshore Wind Outlook 2019*, the United States is anticipated to add nearly 40 gigawatts (GW) of offshore wind capacity by 2040, totaling a \$100 billion investment. State activities are driving this demand, with the East Coast leading the effort targeting a combined stated goal of 20 GW with the majority to be installed before 2030.

The construction and maintenance of offshore wind projects calls for a combination of expertise that is comparatively new to the U.S. market and requires a variety of specialist support tonnage.

Several East Coast ports may be viable for offshore wind use, such as New Bedford in Massachusetts, Tradepoint Atlantic in Maryland, New London and Bridgeport in Connecticut, Port of Providence in Rhode Island, Port of Virginia in southeastern Virginia, and the newly announced New Jersey Wind Port. Twelve port infrastructure investments for offshore wind have been announced since 2017. Growth of turbine and project sizes may hinder the acquisition of the increased heavy-lift capacity, ship access, overhead clearances, channel draft, and physical laydown space. The dimensions and characteristics of ports and the water depths of wind development areas provide some constraints and requirements for wind support vessel designs. The turbine sizes are also necessary in the sizing of installation vessels and transport vessels.

The Jones Act requires any vessel transporting cargo between U.S. ports to be built and flagged in the U.S. For the purposes of the Jones Act, a bottom founded (fixed) wind turbine foundation is considered a U.S. port. Dominion Energy recently confirmed plans to join a consortium of investors that is building the first U.S. offshore wind installation vessel at Keppel Amfels shipyard in Texas. The vessel, which is likely to enter service in 2023, is expected to be based out of the Hampton Roads region of Virginia with a U.S. crew.

To use a foreign, non-Jones Act installation vessel, components from a U.S. port must be transported by a U.S. built feeder vessel. The feeder vessel, which may be a jackup vessel, barge, or ship, is brought to the project site, where the foreign Wind Turbine Installation Vessel (WTIV) may lift the components off the feeder vessel onto the foundation without moving. This strategy allows the use of foreign-flagged WTIVs, but it requires additional Jones Act compliant feeder vessels.

Other wind support vessels such as a Service Operation Vessel (SOV), floating heavy-lift vessel, and Crew Transfer Vessel (CTV) operating in U.S. offshore wind farms are required to comply with the Jones Act.

As the leading provider of classification services to the global offshore industry, ABS is in a unique position to support the new vessels serving the evolving fixed and floating offshore windfarm turbine market. ABS provides a classification roadmap from concept, basic design and detailed design to construction and in-service operation of a range of wind farm vessels and the equipment installed onboard, that will help owners, operators, designers, shipyards and manufacturers meet Class rules and international and U.S. regulations. ABS will class the first Jones Act compliant WTIV under construction at Keppel Amfels for Dominion Energy and the first Jones Act compliant SOV to be built at Edison Chouest for Ørsted and Eversource. ABS has also issued AIPs for a series of wind support vessels, such as WTIVs, SOVs, feeder vessels and CTVs from U.S. and European designers.

OFFSHORE WIND FARMS AND VESSELS

OFFSHORE WIND FORECAST

In the International Energy Agency's (IEA's) recent report [1], *Offshore Wind Outlook 2019*, global offshore wind capacity is anticipated to reach 560 GW by 2040, totaling an \$840 billion investment.

The European Union is leading projected installed capacity additions in offshore wind. It is followed by China, with the U.S. predicted to be third by 2030, as shown in Figure 1 [2].

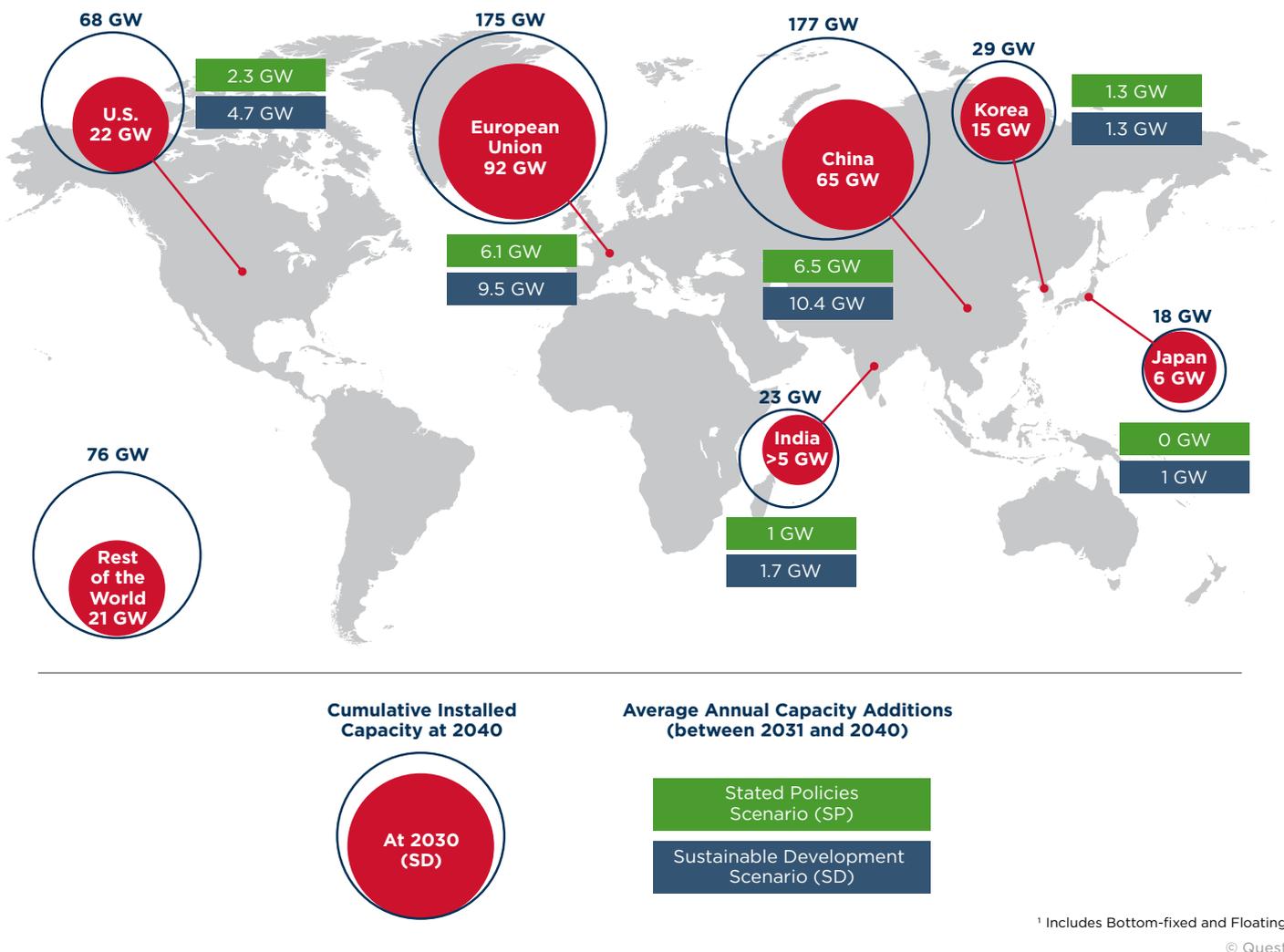
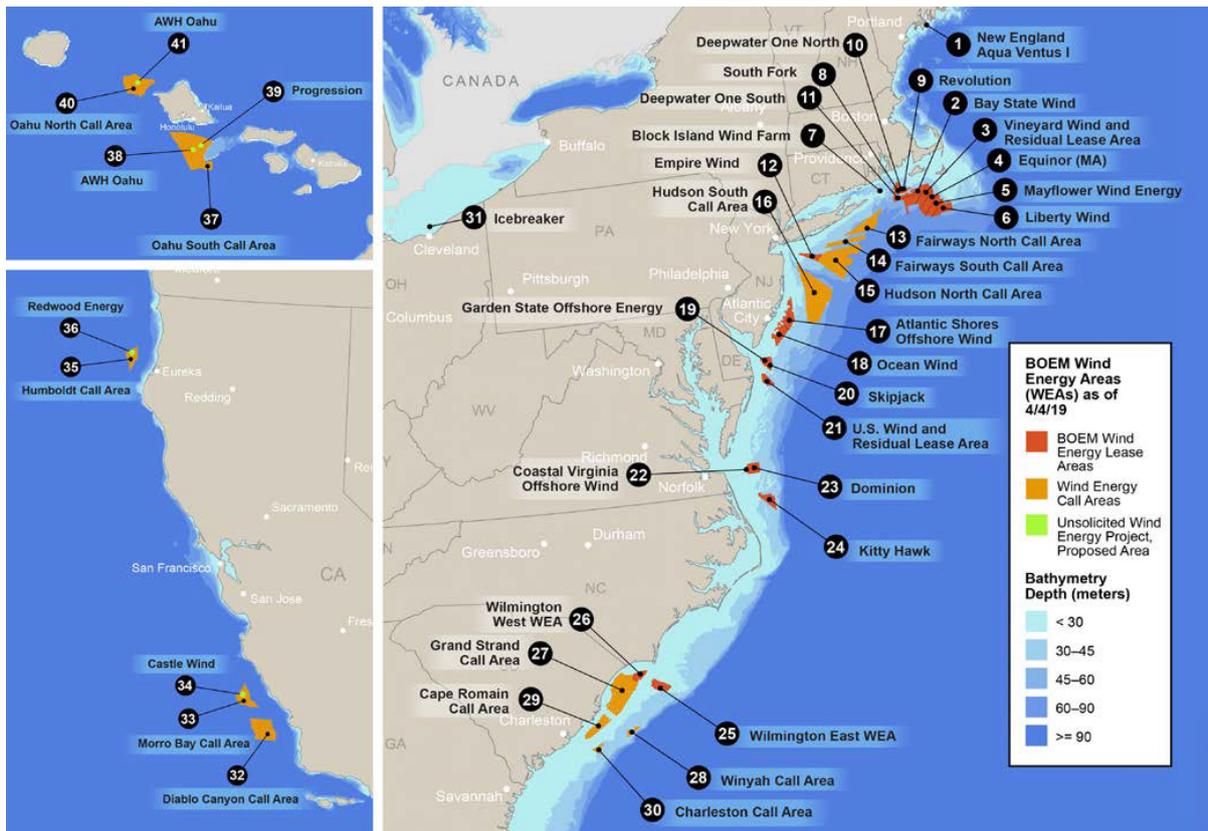


Figure 1: Global Offshore Wind Forecast [2]

The IEA's *Offshore Wind Outlook 2019* [1] states the U.S. is anticipated to add nearly 40 GW of offshore wind capacity by 2040, totaling a \$100 billion investment. State activities are driving this demand, with the East Coast leading the effort targeting a combined stated goal of 20 GW, the majority to be installed before 2030. With stable policies in place, the Department of Energy found the U.S. could develop a total of 86 GW of offshore wind projects by 2050.

Figure 2 shows a map of offshore wind pipeline activity as of March 31, 2019, as well as Bureau of Ocean Energy Management (BOEM) Call Areas, for the entire U.S., provided by National Renewable Energy Laboratory (NREL) [3].



© NREL

Figure 2: Locations of U.S. Offshore Wind Pipeline Activity and Call Areas as of March 2019. [3]

In the U.S., both Federal and State levels show strong support for offshore wind. The East Coast states are primarily for fixed foundations, and California and Hawaii are key states for floating wind farms.

The construction and maintenance of offshore wind projects call for a combination of expertise that is comparatively new to the U.S. market and requires a variety of specialist support tonnage.

EMERGING CHALLENGES

Several trends are developing within the offshore wind energy market.

- The industry is seeking accelerated cost reductions through larger turbines with rated capacities of 10 megawatts (MW) and beyond.
- Demand for wind farm support vessels is expected to increase in order to support planned construction projects for both fixed and floating offshore wind farms.
- The floating wind energy project pipeline is growing, with multiple floating pilot projects advancing.
- Infrastructure development is important for emerging markets.
- The emerging challenges associated with developing both offshore wind farms and supporting vessels can be categorized into four (4) aspects:
 - Technical challenges related to the design of complex installations.
 - Operational challenges to reduce operating expenses.
 - Environmental challenges around transitioning into low carbon footprint operations.
 - Regulatory challenges around compliance with the international and local regulations.

WIND FARM VESSELS

The demand for vessels to support offshore wind farm installations, maintenance, service, repairs, and crew transfer is increasing. Globally the total number of vessels required will increase by five times in 2025 in comparison with that in 2018.

POSITIONING FOR U.S. EXPANSION

New vessels will need to meet the performance and capacity requirements of the intended operations. From the existing fleet, high specification subsea vessels can be modified by adding the Walk to Work offshore access gangway. Additional extensive modifications such as accommodations will need to convert the Offshore Support Vessels (OSVs) to support offshore windfarms.

Over the last few years, ABS has received numerous inquiries from owners and designers, including those from Europe seeking to access the U.S. market. As the leader in the U.S. oil and gas industry and the global offshore support vessel market, ABS is supporting this trend by providing asset classification and advice on regulatory and operational issues.

ABS has worked with owners and designers on strategies for simplifying and optimizing vessel designs. One example is the feeder vessel option to increase efficiency and to comply with regulatory requirements. Using existing OSV tonnage in a conversion scenario has also been investigated.

CLASSIFICATION OF WIND FARM VESSELS

The capabilities of wind farm support vessels are driven by offshore wind farm development. Four key types of vessels support the wind farms, and each has unique features.

- Wind Turbine Installation Maintenance and Repair Vessels (Wind IMR or WTIV) are typically self-propelled 4-legged self-elevating units for shallow water installation. As the wind turbines move to deep water, the floating type of Wind IMR can support floating wind farms.
- Service Operation Vessels (SOVs) transport the components and provide accommodation to the industry personnel with Walk to Work concept to access the wind turbine through offshore gangways.
- Cable Laying Vessels are classed in accordance with ABS OSV Rules.
- High-speed Crew Transfer Vessels (CTVs) transport the technicians to service the wind turbines regularly.

ABS has published a suite of Rules and Guides for classification of wind farm vessels considering the functions and features of each vessel type.

- *ABS Rules for Building and Classing Mobile Offshore Units* [4] apply to mobile offshore units primarily intended for the installation, maintenance, and repair of offshore wind turbines.
- The *ABS Guide for Building and Classing Wind Farm Support Vessels* [5] was published in 2018. The Guide specifies the requirements for SOVs and CTVs in addition to those in *ABS Marine Vessel Rules* [6] and *ABS High-Speed Craft Rules* [7], respectively.
- *ABS Rules for Building and Classing Marine Vessels, Part 5D Offshore Support Vessels for Specialized Services* [6], apply to Offshore Support Vessels for Specialized Services and contain specific requirements for vessels intended for turbine transport, heavy-lift, and cable laying.

All ABS Rules and Guides can be downloaded from the ABS website www.eagle.org.

REGULATORY FRAMEWORK

Internationally recognizing that the personnel on board are non-crew or passenger, the International Maritime Organization (IMO) has agreed to develop a new code to provide specific requirements for the carriage of Industrial Personnel (IP). Currently, IP may be carried on board ships meeting the Code of Safety for Special Purpose Ships, 2008 (2008 SPS Code) [8] or other standards if approved by the Flag Administration. Moving forward, to complete the regulatory regime, a new International Convention for the Safety of Life at Sea (SOLAS) Chapter shall be developed to address this new code with the estimated effective date in 2024.

In the U.S., as wind energy would be included as an energy resource, vessels engaged in wind farm development or operation, including installation, maintenance, turbine transport, crew transfers, heavy-lifting, and cable laying, may properly be certificated by the United States Coast Guard (USCG) using 46 Code of Federal Regulations (CFR) [9] Subchapter L as offshore supply vessels, Subchapter I as cargo and miscellaneous vessels, or Subchapter T as small passenger ships.

The Jones Act requires any vessel transporting cargo between U.S. ports to be built and flagged in the U.S. All interpretations and determinations of applicability of the Jones Act are made by U.S. Customs and Border Protection (CBP).

EAST COAST PORTS AND INFRASTRUCTURES

PORTS

Offshore wind farms involve large components, including turbine blades and foundations, which have been increasing in size as technology advances. Such components require large areas for staging and assembly before installation at wind farm sites. Transportation of offshore wind components over land is impractical given their size; therefore, ports and harbors along the East Coast are critical for meeting the states' offshore wind development goals.

Ports are also where the operations of wind facilities are managed. They often have offices for personnel and logistics, and the marine infrastructure for vessels that transport technicians to the offshore wind farms to conduct maintenance.

Several East Coast ports may be viable for offshore wind use, such as New Bedford in Massachusetts, Tradepoint Atlantic in Maryland, New London and Bridgeport in Connecticut, Port of Providence in Rhode Island, Port of Virginia, and the newly announced New Jersey Wind Port.

In the following table, Table 1, the current infrastructure of these ports found during this study is detailed, including lifting capacity, unimpeded access, and load out for specialized wind support vessels.

Port Characteristic	New Bedford	New London	Tradepoint Atlantic	Bridgeport	Port of Providence	Port of Virginia
State	MA	CT	MD	CT	RI	VA
Horizontal Clearance	No Restrictions					No Restrictions
Air Draft	No Restrictions	No Restrictions		No Restrictions	58.2 m (191 ft)	No Restrictions
Depth/Draft	9.14 m (30 ft)	10.36 m (34 ft)	10.97 m (36 ft)	10.36 m (34 ft)	11.89 m (39 ft)	13.10 m (43 ft)
Quayside/Berth Length	365.76 m (1200 ft)	320.04 m (1050 ft)	670.56 m (2200 ft)	258.47 m (848 ft)	246.89 m (810 ft)	1,078.99 m (3,540 ft)
Width/Beam	45.72 m (150 ft)	38.1 m (125 ft)		41.85 m (137.3 ft)	42.06 m (138 ft)	91.44 m (300 ft berth pocket/ 400 ft access channel)
Site Uniform Load Capacity	20 t/m ²		15 t/m ²		19.5 t/m ²	Project Specific
Crane Capacity	750 t		85 t		60 t	Project Specific

Table 1: Current East Coast Port Characteristics

According to the *U.S. Jones Act Compliant Offshore Wind Turbine Installation Vessel Study* conducted by GustoMSC [11], an ideal port would have no restrictions regarding the horizontal clearance and air draft. The Port of New Bedford and The Port of Virginia do not have such restrictions.

Twelve port infrastructure investments for offshore wind have been announced since 2017, among which the majority has been invested by the wind developers and the state port authorities. Growth of turbine and project sizes may hinder the acquisition of the increased heavy-lift capacity, ship access, overhead clearances, channel draft, and physical laydown space.

POSITIONING FOR U.S. EXPANSION

The Port of New Bedford in Massachusetts is continuing to expand commercially through deepening channels and berths and enlarging terminals to continue supporting the growth in offshore wind [12]. The New Bedford Marine Commerce Terminal's main terminal site can sustain uniform loads of 20 tons per square meter (t/m²) and concentrated loads of up to 100 t/m². The terminal is capable of supporting a 1,350-ton crane lifting 500 tons at 30 meters (m). A 750-ton mobile crane is locally available.

Due to its proximity to offshore wind sites in the northeast, Connecticut's New London Port is redeveloping one of its state piers to serve as a dedicated terminal for offshore wind development. The upgrades to its infrastructure and heavy-lift capabilities are expected to be completed by Spring 2022 – this includes decreased restrictions for beam, draft, and others [13].

Tradepoint Atlantic in Maryland plans for its East/West berth and finger pier to be dredged to increase the water depth [14]. Ørsted U.S. Offshore Wind announced an agreement to develop an offshore wind energy staging center at Tradepoint Atlantic. Improvements will include strengthening ground bearing capacity at the port to allow heavy-lift cranes and specialized transporters to move wind turbine components, some weighing as much as 2,000 tons, from ships onto the site.

Port of Providence in Rhode Island has been the port for Block Island Wind Project. The South Quay Marine Terminal would be used to support the development, operations, and maintenance of new offshore wind projects such as Revolution Wind. In its plan, a 1,020-foot-long waterfront wall, a dock for ferry, fire, and harbor master vessels, two concrete platforms for cargo and cranes, two deepwater berths, a small warehouse, administrative buildings, and an eight-acre heavy-load-bearing lay-down area will be in operation by 2022 [15].

Brayton Point Port, which was previously the location of a coal-fired power plant, is transforming into a renewable hub, manufacturing center, and an internal seaport. It has completed upgrades in 2020 to support heavy-lift port operations and receive deep-draft vessels at the site. In May 2019, grid asset developer Anbaric signed an agreement with the site owner, Commercial Development Company (CDC), to build a 1,200-MW high voltage direct current converter and 400-MW battery storage plant at Brayton Point to support the offshore wind industry [16].

Vineyard Wind announced in 2019 its proposed "Park City Wind" offshore wind port to transform Bridgeport into an offshore wind hub. Vineyard Wind will partner with McAllister Towing and Transportation Co. to redevelop an 18.3-acre waterfront industrial property in Bridgeport. A renovated Barnum Landing property will host hundreds of local workers hired to do critical foundation transition piece steel fabrication and final outfitting. Vineyard Wind is also committed to making Bridgeport home to Park City Wind's operations and maintenance (O&M) hub for the life of the project.

New Jersey State is planning to become an offshore wind project hub for New Jersey and the Mid-Atlantic, beginning construction on the New Jersey Wind Port (Lower Alloways Creek site). This port will have no horizontal clearance limits and will serve offshore wind projects in New Jersey and the Mid-Atlantic. Because of its size, location, and, most importantly, its unlimited air draft restrictions, this site has been identified to be developed into a major offshore wind port. Construction of the first of two phases is set to begin in 2021 and will be accessible by 2023. Phase 1 will develop a 30-acre site to accommodate marshaling activities and a 25-acre component manufacturing site. Phase 2 adds another 150+ acres to accommodate expanded marshaling activities and extensive manufacturing facilities for turbine components like blades and nacelles [17].

The New York State Energy Research and Development Authority (NYSERDA) confirmed in 2020 the Port Cortlandt waterfront site is among 11 sites competing for up to \$200 million in grant funding to develop critical port infrastructure. Port Cortlandt will be the state's next offshore wind economic hub, including vital wind turbine manufacturing, fabrication, storage, and launching facilities.

Dominion Energy has already committed to creating the expertise to position Hampton Roads to be a supply chain hub for U.S. offshore wind efforts and create thousands of clean energy jobs in Virginia.

GO Virginia has awarded a \$529,788 grant to the Hampton Roads Alliance to attract a supply chain for the offshore wind industry to the region.

Portsmouth Marine Terminal (PMT) is dedicated to offshore wind manufacturing and assembly, and is almost 300 acres, with 40 acres of PMT leased to Ørsted for staging and load-out. There is \$40 million in the 2021 state budget for infrastructure improvements directly associated with offshore wind economic development opportunities at PMT. There are additional terminals available within The Port of Virginia that are also suitable for offshore wind development. The Port of Virginia is 30 minutes to the open ocean, never freezes and still has plenty of other land along the rivers for manufacturing and assembly.

WIND DEVELOPMENT AREAS

The U.S. Department of Interior's Bureau of Ocean Energy Management (BOEM) is responsible for offshore renewable energy development in federal waters and anticipates substantial future development on the Outer Continental Shelf (OCS), especially from offshore wind energy. Figure 3 shows BOEM's Atlantic OCS Renewable Energy Areas: Massachusetts to South Carolina [18].

The water depth of BOEM's current active offshore wind leases typically ranges from 49 to 213 feet (15 to 65 meters), whereas the early projects in the North Sea were between 9.8 and 65.6 feet (3 and 20 meters) of water depth.

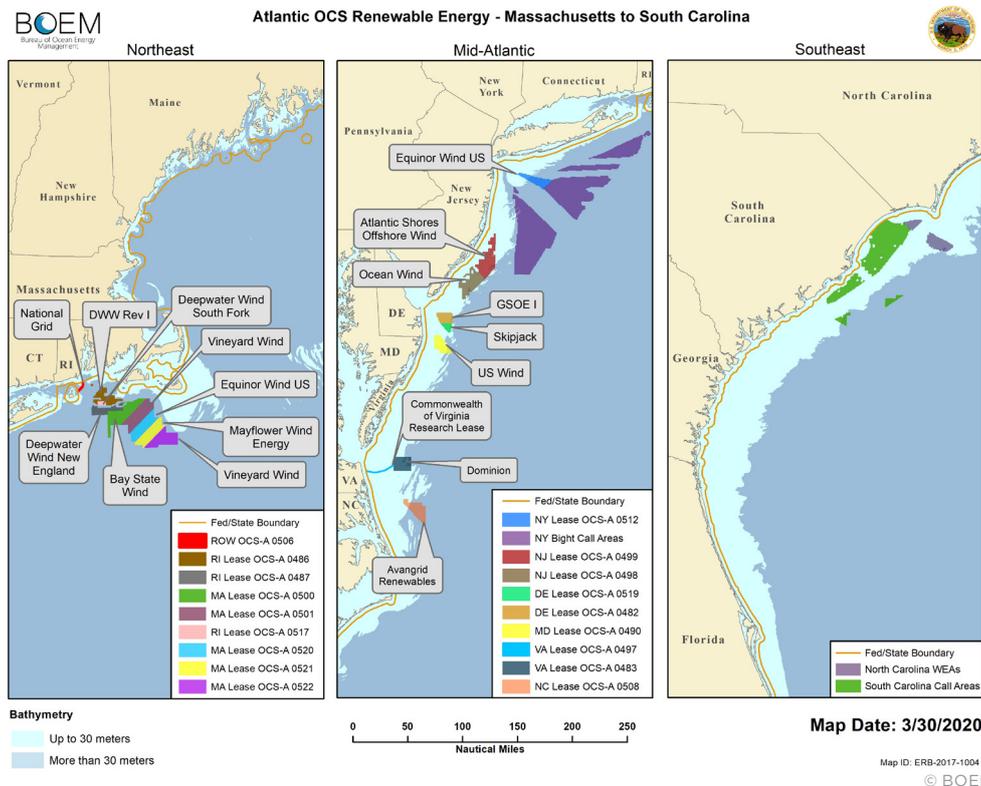


Figure 3: BOEM Atlantic OCS Renewable Energy Areas [18]

In the following table, Table 2, the current leased wind development areas from BOEM are listed. This data explores the locations of future projects that are in progress. This represents the current market for offshore wind support vessels; this list is growing every year.

Table 3 lists the wind development areas and their associated ports for installation, staging, and O&M, if different from the staging ports. As discussed in the previous section, wind developers have committed investments in the port infrastructures.

POSITIONING FOR U.S. EXPANSION

Developer	Partner HQ	State	Project Name	Status	Completion	MW Potential	Water Depth
Ørsted/ Eversource	Denmark	RI	Block Island	Installed	2016	30	75-92 ft (23-28 m)
Ørsted/ Dominion	Denmark	VA	Coastal Virginia Offshore Wind Pilot	Installed	2021	12	66-85 ft (20-26 m)
Ørsted/ Eversource	Denmark	RI	South Fork	Permitting	2022	132	102-118 ft (31-36 m)
Ørsted	Denmark	DE	Skipjack	Permitting	2022	120	60-100 ft (18-30 m)
Aqua Ventus	-	ME	New England AquaVentus I	Permitting	2022	12	200-361 ft* (61-110m)
LEEDCo/ Fred Olsen	Norway	OH	Icebreaker	Permitting	2022	21	52-62 ft (16-19 m)
Ørsted/ Eversource	Denmark	RI/ CT	Revolution	Permitting	2023	704	98-151 ft (30-46 m)
Avangrid/ CIP	Spain/ Denmark	MA	Vineyard Wind	Permitting	2023	800	118-190 ft (36-58 m)
U.S. Wind	-	MD	Maryland Offshore Wind	Permitting	2026	270	65-98 ft (20-30 m)
Ørsted/ Eversource	Denmark	NY	Sunrise	Permitting	2024	880	98-151 ft (30-46 m)
Dominion	-	VA	Coastal Virginia Offshore Wind	Permitting	2026	2,640	59-108 ft (18-33 m)
Avangrid	Spain/ Denmark	NC	Kitty Hawk	Permitting	2026	2,500	100-141 ft (31-43 m)
Ørsted/ PSEG	-	NJ	Garden State Offshore Energy	Site Control	2024	1,000	59-98 ft (18-30 m)
Ørsted/ PSEG	-	NJ	Ocean Wind	Site Control	2024	1,100	56-111 ft (17-34 m)
Avangrid/ CIP	Spain/ Denmark	NY	Liberty Wind	Site Control	2024	Up to 1,300	-
Avangrid/ CIP	Spain/ Denmark	CT	Park City Wind	Site Control	2025	804	-
Equinor/BP	Norway/UK	NY	Empire Wind	Site Control	2025	Up to 1,500	65-131 ft (20-40 m)
Shell/EDP	Portugal	MA	Mayflower Wind Energy	Site Control	2025	Up to 1,600	115-213 ft (35-65 m)
Shell/EDF	France	NJ	Atlantic Shores Offshore Wind	Site Control	2025	2,500	60-100 ft (18-30 m)
Ørsted/ Eversource	Denmark	MA	Bay State Wind	Site Control	TBD	Up to 2,000	128-164 ft (39-50 m)
Ørsted/ Eversource	Denmark	CT	Constitution	Planning	TBD	400	98-151 ft (30-46 m)
Equinor/BP	Norway/UK	MA	Equinor (MA)	Site Control	TBD	Up to 1,500	-

Table 2: Wind Development Areas

*The New England AquaVentus is a 12-MW Floating Wind Pilot.

Developer	State	Project Name	MW Potential	Port for Installation and Staging	Port for O&M
Ørsted/ Eversource	RI	Block Island	30	Port of Providence	Port of Providence
Ørsted/ Dominion	VA	Coastal Virginia Offshore Wind Pilot	12	Halifax, Canada	Port of Virginia
Ørsted/ Eversource	RI	South Fork	132	New London	-
Ørsted	DE	Skipjack	120	Tradeport Atlantic	-
Aqua Ventus	ME	New England AquaVentus I	12	-	-
LEEDCo/ Fred Olsen	OH	Icebreaker	21	Cleveland	-
Ørsted/ Eversource	RI/CT	Revolution	704	New London, ProvPort and Quonset	-
Avangrid/ CIP	MA	Vineyard Wind	800	New Bedford	-
U.S. Wind	MD	Maryland Offshore Wind	270	Tradeport Atlantic	-
Ørsted/ Eversource	NY	Sunrise	880	New London	Port Jefferson
Ørsted/ PSEG	NJ	Garden State Offshore Energy	1,000	-	Atlantic city
Ørsted/ PSEG	NJ	Ocean Wind	1,100	Tradeport Atlantic	-
Avangrid/ CIP	NY	Liberty Wind	Up to 1,300	-	-
Avangrid/ CIP	CT	Park City Wind	804	Bridgeport	-
Equinor/BP	NY	Empire Wind	Up to 1,500	South Brooklyn Marine Terminal	-
Shell/EDP	MA	Mayflower Wind Energy	Up to 1,600	New Bedford	-
Shell/EDF	NJ	Atlantic Shores Offshore Wind	2,500	Atlantic city	-
Dominion	VA	Coastal Virginia Offshore Wind	2,640	Port of Virginia	Port of Virginia
Ørsted/ Eversource	MA	Bay State Wind	Up to 2,000	New Bedford	-
Ørsted/ Eversource	CT	Constitution	400	New London	-
Avangrid	NC	Kitty Hawk	2,500	Port of Virginia	Port of Virginia
Equinor/BP	MA	Equinor (MA)	Up to 1,500	-	-

Table 3: Wind Development Areas and Port Development

TURBINE SIZES

The port characteristics from Table 1 and the water depths from Table 2 provide some constraints for a support vessel design. The rotor diameters and blade lengths for specific turbine sizes are also necessary in the sizing of installation vessels and transport vessels. The dimensions of turbines from 4 MW to 14 MW are listed in Table 4. The 10-MW, 12-MW, and 14-MW turbines are currently being developed by GE and Siemens Gamesa. The relatively larger turbines are installed or ordered in the U.S. in comparison with those currently commonly used in Europe. In the future, the even larger turbines will be made more widely available.

The turbines installed in the U.S. are 5x6 MW at Block Island and 2x6 MW at Coastal Virginia Offshore Wind pilot.

The turbines ordered for the U.S. projects are generally in the 8 to 9.5 MW range, which includes MHI Vestas V164-9.5 9.5 MW and Siemens Gamesa 8.0 167 DD 8 MW.

GE announced in 2019 that the 12-MW Haliade-X were ordered for Ørsted’s 120-MW Skipjack and 1,100-MW Ocean Wind projects, scheduled for completion off Maryland and New Jersey in 2022 and 2024 [19].

Siemens Gamesa will conditionally supply SG 14-222 Direct Drive offshore wind turbines to the 2,640-MW Dominion Energy Coastal Virginia Offshore Wind (CVOW) commercial project expected to be completed by 2026. The agreement is subject to certain conditions, including Dominion Energy’s final investment decision, governmental permitting, and other required approvals [20].

Turbine Size (MW)	Rotor Diameter (m)	Blade Length (m)
4	120	59
5	135	66
6	150	73
7	164	80
8	175	85
10	193	94
12	220	107
14	222	108

Table 4: Turbine Dimensions

TURBINE FOUNDATION

Table 2 shows a sample of the current wind farm developments and the water depth in each area. For water depths lower than 55 m, using a monopile or jacket foundation is recommended. For water depths greater than 65 m, a floating foundation should be considered. Both recommendations also depend on the size of the turbine that will be used. Figure 4, sourced from the U.S. Jones Act Compliant Offshore Wind Turbine Installation Vessel Study [11], shows the recommended foundation for the turbine depending on water depth. The figure shows depths from 0 m to 60 m and considers the monopile, extended monopile, or jacket foundation.

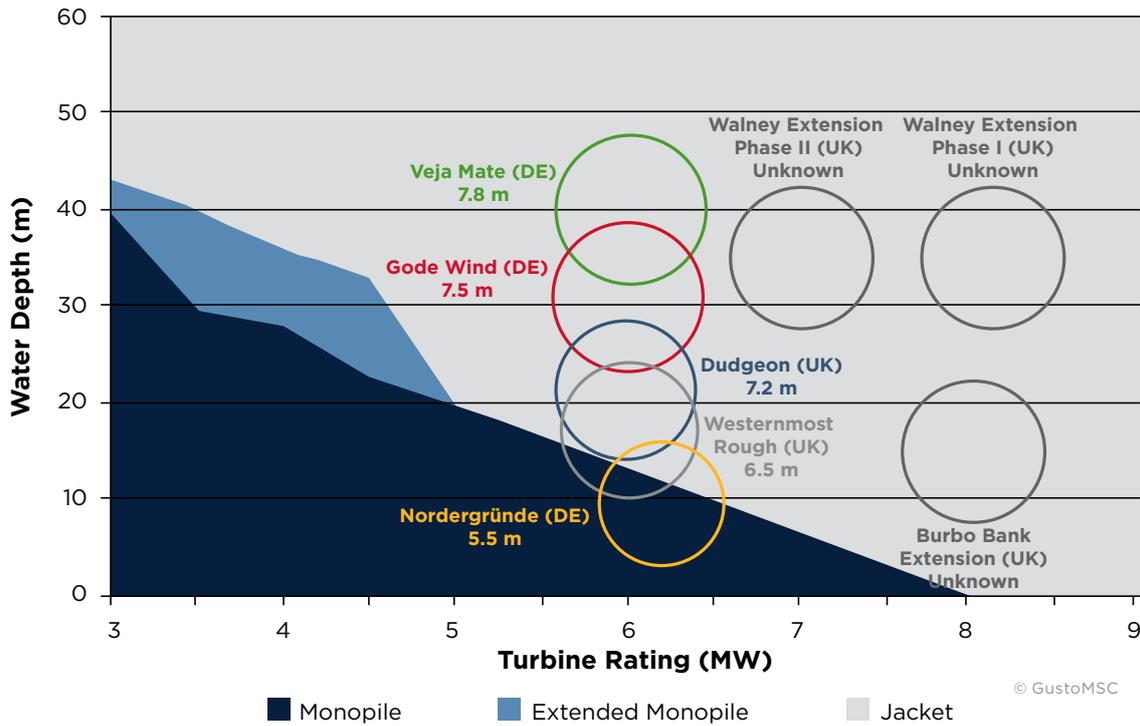


Figure 4: Foundation Type by Water Depth and Turbine Rating [11]

According to the study [11], an 8 MW turbine in 55 m of water will require a jacket that weighs approximately 975 tons, excluding piles and transition piece. The jackets are assumed to be four-leg pin piled lattice structures, which measure 30 m x 30 m x 70 m high and weigh 1,000 tons. To install such foundations, the WTIV will require a 1,500-ton crane with an outreach of 25 to 30 m. The 1,500-ton rating is required to safely lift the 1,000-ton jacket with allowances for dynamic amplification factors, splash zone effects such as wave loading and hydrodynamic added mass, lifting gear, and uncertainties in weight.

VESSELS SUPPORTING OFFSHORE WIND FARM DEVELOPMENT

The offshore wind farm industry is vessel intensive. The figure below lists the types of vessels performing activities to support the life cycle of the offshore wind farms.

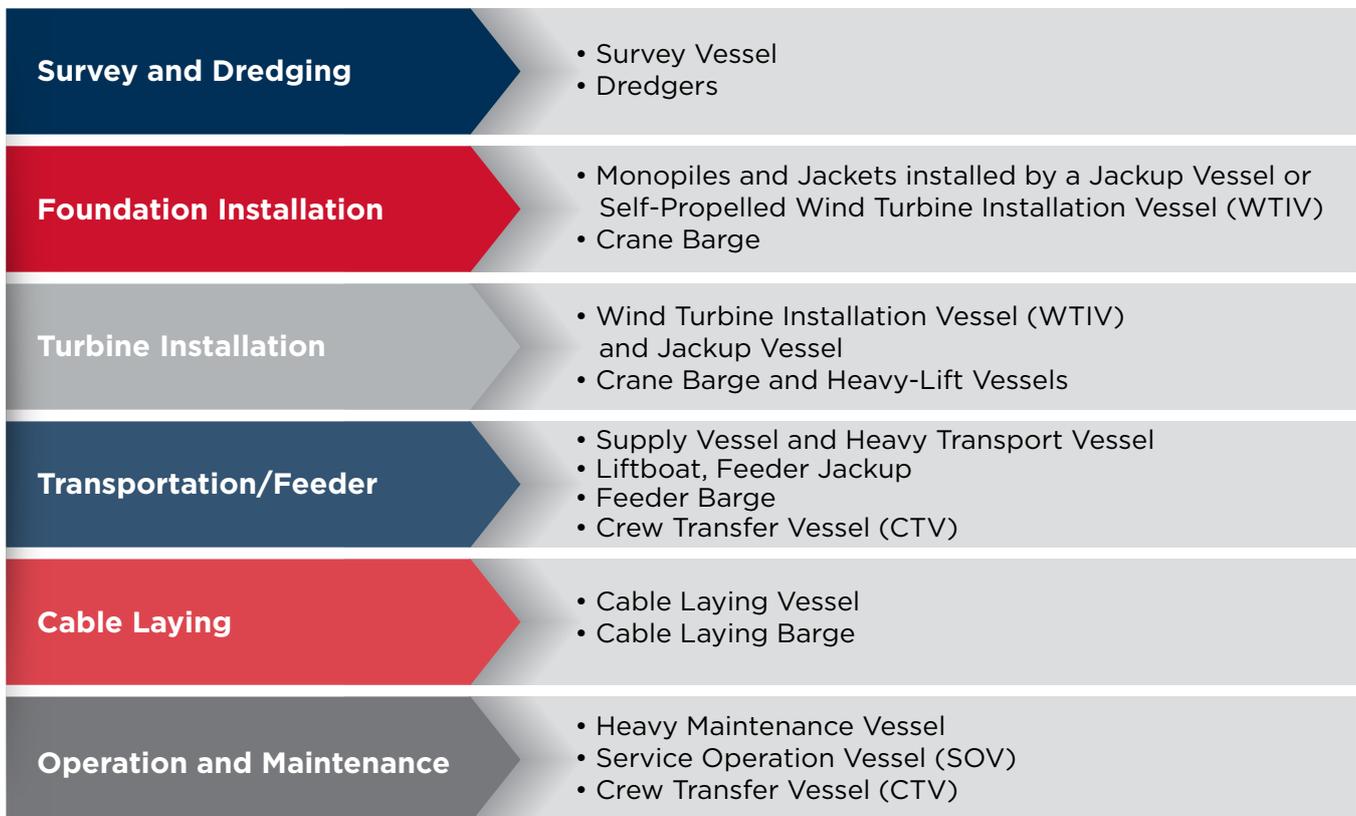


Figure 5: Vessels Support Offshore Wind Farm Life Cycle

During the installation phase, there are three main options that could be taken in the U.S. offshore wind farm development.

- The U.S. could build a U.S.-flagged purpose-built Wind Turbine Installation Vessel (WTIV). Having a specialized vessel would lower the number of support vessels. However, a U.S.-built WTIV would be considerably more expensive than a European or Asian built unit due to a lack of specialized manufacturers and suppliers in the U.S.
- A non-U.S.-flagged WTIV could be mobilized into U.S. waters. The Jones Act requires any vessel transporting cargo between U.S. ports to be built and flagged in the U.S. For the purposes of the Jones Act, a bottom founded wind turbine foundation is considered a U.S. port. Consequently, a non-Jones Act WTIV is not able to transport components from an on-shore port to a turbine foundation. To use a foreign, non-Jones Act vessel, components from a U.S. port must be transported by a U.S.-built feeder vessel [7]. The feeder vessel, which may be a barge, ship, or jackup, is brought to the project site where the foreign WTIV may lift the components off the feeder vessel onto the foundation without moving. This strategy allows the use of foreign-flagged WTIVs, but it requires additional Jones Act compliant feeder vessels and adds to the costs.
- U.S.-flagged jackups originally used in the offshore oil and gas industry could be adapted and utilized for foundation installation. This would certainly be a cheaper option than building specialized vessels from scratch; however, installation could take longer, and there would be limits on the water depth and lifting capacity the existing jackups could operate. As the turbine size increases, the existing U.S.-flagged jackups may assist the foundation installation and / or transport the components as feeder vessels.

FUNCTIONAL TRENDS

SELF-ELEVATING WIND TURBINE INSTALLATION VESSEL (WTIV)

The WTIV is a self-elevating unit with the capability of transporting multiple turbines. This unit is self-propelled and capable of dynamic positioning. Because the wind farm installation operations are conducted in elevated conditions, the vessel should have the crane capacity and reach to enable installation of large components for the on-site water depths and metocean conditions.

The current worldwide fleet has an average leg length of 85 m, allowing them to operate at water depths of approximately 45 m. Upsizing trends are in play, as some vessels that are under construction are designed to operate in water depths of about 60 m [21].

The existing WTIV fleet has crane capacities from 800 tons to 1600 tons and leg length between 72 m and 106 m. To install the jacket foundation of an 8 MW turbine in 55 m of water, the WTIV will require a 1,500-ton crane with an outreach of 25 to 30 m. This is at the upbound capacity of the existing fleet. Figure 6 shows an example of a wind turbine installation vessel.

The new WTIVs can install larger turbines of 9 MW and above, with crane capacities ranging from 1,600 to 3,000 tons, and capable of lifting to the increased turbine heights. They operate at depths from 65 m to 80 m, with accommodation for 100 - 130 persons. Their deck spaces are also increasing to transport multiple larger turbines.

For operation at the U.S. East Coast Wind Energy Area (WEA), the WTIV has four legs of a length range from 100 to 110 m and can operate in a water depth of 65 m. The unit will move and jack frequently. The design includes arrangements for 100 - 130 personnel on board (POB), including crew and industrial personnel. The industrial personnel will work on the unit performing the wind farm installation duties.

The Jones Act compliant vessel's modes of operation include port to site and site to site. The vessel must be compatible with available and future port facilities. The Jones Act requires vessels to be built in the U.S. due to the length of the legs for a WTIV capable of installing turbines in 65 m of water depth, and vessels have access to ports without overhead obstructions or concerns with air draft.

The Port of New Bedford in Massachusetts has no air draft limitations and a terminal designed to accommodate offshore wind construction. For entry into port, the WTIV will require passage through an opening no more than 45.7 m wide with vertical sides. To accommodate the Port of New Bedford, the maximum allowable hull width is 42.0 m. The water depth in the channel has been dredged to 8.7 m with the maximum allowable draft at 8.7 m [11].

The New Jersey Wind Port will have no horizontal clearance limits and will serve offshore wind projects in New Jersey and the Mid-Atlantic. Because of its size, location, and most importantly, its unlimited air draft restrictions, this site has been identified to be developed into a major offshore wind port.

The first ever Jones Act compliant WTIV will be built to ABS Class. Now under construction by Keppel AmFELS for Dominion Energy, the 472-foot vessel is designed to handle turbine sizes of 12 MW or larger and will also be capable of the installation of foundations for turbines and other heavy lifts. To be named Charybdis, the vessel will have accommodation for up to 119 crew and wind farm technicians. Port of Virginia has no restrictions on horizontal clearance limits or air draft, and will serve as the base for Charybdis.



Figure 6: First Jones Act compliant WTIV, Dominion Energy's Charybdis, will be built to ABS Class.

GustoMSC

FEEDER VESSELS

A feeder vessel is used to transport materials and components to the field where the WTIV is waiting to install them. Ideally, two or more feeder vessels are preferred to ensure the WTIV is constantly supplied. The feeder vessels may be feeder jackups, barges, or ships. The feeder vessels should have sufficient deck spaces and strength to transport the large wind turbines and their components. They would be preferred to be Dynamic Positioning (DP) vessels for maximum efficiency in transit and while maneuvering into position on-site or in the harbor.

Feeder Jackup

The new build Jones Act compliant feeder jackups are DP2 jackups that will transport wind turbine components from U.S. ports to installation vessels at offshore wind construction sites. This will enable the most effective utilization of non-Jones Act compliant installation vessels. No crane is installed to reduce costs and increase deck space, but one can be installed at a future date for the purpose of wind farm maintenance.

The feeder jackup must be compatible with the available and future port facilities. Due to the length of the legs of a jackup that is capable of transporting turbines and their components, access to ports without overhead obstructions or concerns with air draft is required.

The existing U.S. liftboats may be used as feeder jackups. However, these vessels may have limitations on the water depth and deck spaces.

Feeder Barge

The feeder barge should have sufficient deck spaces and strength to transport the wind turbines and their components. The barge may fit with the dynamic position, stabilization, and/or heave compensation systems. Onshore cranes will load the feeder barge in port to allow for at least 14 days of self-sufficiency. While it is offshore, the installation vessel will perform the offloads, and it does not require a main cargo crane. However, it may be suitable for future retrofitting of a crane for wind turbine maintenance purposes.



Figure 7: ABS Issued AIP to Neptun Ship Design "Blue Azurit"

Feeder Ship

The feeder ship is self-propelled with DP2 or DP3, allowing wind turbine manufacturers to produce welded towers ready for installation. The vessel is designed to pick up components directly from the supplier's berth, transport parts to an offshore harbor, or feed them to the installation vessel.

ABS granted Approval in Principle (AIP) to Neptun Ship Design for its 178-meter-long "Blue Azurit" Wind Turbine Transport Vessel design, the first to support transporting parts for turbines greater than 9 MW.

FLOATING HEAVY-LIFT AND INSTALLATION VESSEL

There is a limited number of floating heavy-lift and installation vessels. While the industry has been

struggling to find the optimal concept, some owners and operators have created new concepts that can operate at a greater water depth.

For example, CSBC-DEME Wind Engineering (CDWE) has decided to build a new installation vessel, "Green Jade," that will be equipped to serve the renewables market in Taiwan. "Green Jade" will have a 4,000-ton crane capacity and DP3 capability and is designed to transport the heaviest monopiles, jackets, wind turbine components, and structures in a single shipment. "Green Jade" will be capable of installing mega monopiles and jacket structures at greater water depths. With DP3 technology, this special offshore installation vessel can continue operations under the most challenging conditions.

SERVICE OPERATION VESSEL (SOV)

A wind farm Service Operation Vessel (SOV) is a unique purpose-built vessel for the deployment and accommodation of offshore support and maintenance engineers. The SOV is highly adaptable, operating not only as a means of transport but also as a hotel, a warehouse, and a workshop, transporting large quantities of supplies, equipment, and tools.

An SOV has on-site work and storage facilities plus accommodations for maintenance personnel, management, and crew, and it must be able to undertake voyages and also stay on station for several weeks at a time using DP. It will also be equipped with a motion-compensated transfer gangway to allow maintenance personnel to walk between the vessel and the offshore structure.

In comparison to traditional offshore wind service operations using crew transfer vessels (CTVs) or helicopters, an SOV promises a range of operational benefits for both wind farm operators and service teams, including enhanced safety and comfort for technicians, accelerated on-site service, increased weather availability, and improved productivity for the project.

SOVs offer superior operational flexibility through the ability to include modular accommodation modules on the deck area, making them suitable for multiple offshore construction projects, potentially including conventional oil and gas developments.

The biggest operational challenges in offshore turbine service work arise from the use of CTVs, which are the traditional means of transferring technicians to and from the wind turbines. The gangway system (which employs a motion compensation system to keep it in a fixed position relative to the turbine) reduces the risk in crew transfers, can operate in almost any weather conditions, and can cope with high wave heights.



Figure 8: First Jones Act Compliant SOV will be Built to ABS Class



Figure 9: ABS Issued AIPs to VARD 407 and 419 SOV Designs

The main advantage that an SOV offers is the ability to concentrate on skills and resources. Because the service team and technicians can be based offshore, no additional travel time to or from the wind farm is necessary.

With warehouse space immediately below the main cargo deck, an SOV carries almost every spare part the project requires to respond quickly to component failures and minimize turbine downtime.

In addition to the hydraulic gangway arrangement, an SOV provides further flexibility by acting as the Mothership for an additional crew transfer boat, which can also be used to move technicians to and from the wind turbines in a range of different weather conditions.

POSITIONING FOR U.S. EXPANSION

The first U.S.-flagged Jones Act offshore wind farm service operation vessel (SOV) ever ordered will be built to ABS Class. It will be engineered, constructed and operated by Edison Chouest Offshore (ECO) for long-term charter to service the planned Revolution Wind, South Fork Wind and Sunrise Wind offshore wind farms in the northeast United States. The 80-meter-long vessel, which will be capable of housing 70 passengers/wind turbine technicians, will operate on diesel electric power meeting EPA Tier 4 emission standards and will feature proprietary ECO Variable Frequency Drive to substantially reduce fuel consumption and greenhouse gas emissions.

The capacity exists within the U.S. shipbuilding sector to construct new assets using existing shipyards to adapt designs and experience from building conventional OSVs. Operators may also choose to convert some of the existing idle OSV tonnage by adding modular accommodation, workshop capacity on the cargo deck area, or offshore access gangway.

CREW TRANSFER VESSEL (CTV)

The crew transfer fleet is an important part of the offshore support infrastructure. Vessels have steadily increased in size as wind farms come into operation further offshore. In response, a limiting factor on the market was presented by the SOLAS regulations. This meant that any vessel built larger than 24 m Length Overall (LOA), or carrying more than 12 passengers, had to be constructed in line with the full regulations for passenger vessels or recently published Industrial Personnel Code (IP code). CTVs for the European market are getting bigger as companies install larger and more powerful turbines. Many vessels are now being built at 26 m LOA, with the occasional vessel built even larger. [22]



Figure 10: Windserve Odyssey is the first ABS-classed Jones Act CTV.

The fact that most active wind farms are relatively close to shore means that crew transfer can be performed by relatively small vessels. The latest generation of CTVs typically achieve speeds in the region of 26 knots, while the most advanced Small Waterplane Area Twin Hull (SWATH) or Surface Effect Ship (SES) vessels might have a maximum speed of up to 35 knots.

Crew transfer vessels are now 20 m to 45 m in length, ranging from catamarans to trimarans.

Atlantic Pioneer is the first U.S.-built CTV built in 2016. She is in operation under a 20-year contract with Ørsted providing transfer and service to Block Island wind farm. Atlantic Wind Transfer, who operates

the Atlantic Pioneer, ordered two catamaran CTVs in 2019 from Blount Boat shipyard. Atlantic Wind was awarded the contract by Dominion Energy in 2020 to provide offshore marine support services for the Siemens Gamesa offshore wind turbines to be installed for the first offshore wind project in U.S. federal waters.

Windserve Marine ordered two catamaran CTVs in 2019 to construct in Senesco Marine shipyard, Rhode Island. The first CTV Windserve Odyssey will join the closeout of construction and commissioning of the Coastal Virginia Offshore Wind project, however, the vessel has been built specifically for Ørsted's and Eversource's Revolution Wind project located off the southern New England coast, expected to be commissioned in 2023. Windserve Odyssey is the first ABS-classed CTV in the U.S.

In the U.S., the wind farm developer will need to work around the whales, monitoring their movements and likely suspending some operations, such as pile driving, when the animals are nearby.

The National Oceanic and Atmospheric Administration (NOAA) announces “seasonal management zones” to alert vessel operators to whales in those areas. The agency calls for 10-knot speed limits on vessels larger than 65 feet when they operate in the shifting management areas. This has been incorporated into 23 CFR, Title 50 Wildlife and Fisheries, § 224.105 Speed restrictions to protect North Atlantic Right Whales [23].

That’s a major challenge for wind developers because prime locations for turbines on the OCS often overlap with whale habitat. A 10-knot speed limit would impact the primary mission of CTVs: delivering technicians to the worksite quickly. Currently, Atlantic Pioneer and the other CTVs on order in the U.S. are under 65 feet. Some owners and developers are looking into even bigger size CTVs in the length range of 38 to 45 m.

CABLE LAYERS

As newer generations of offshore wind farms move towards operations during the next decade or so, it is expected that requirements for cabling will increase exponentially. Far-from-shore farms will require High Voltage Direct Current (HVDC) export cables of up to 80 kilometers (km) in length to be laid. Meanwhile, the upsizing in turbine capacities will add additional impetus to the cable lay demand, spurred by the increase in the number of turbines per farm. Currently, turbines are typically 500 m to 700 m apart, but larger bladed turbines with greater MW capacities may need a kilometer or more separation to reduce wind-wash turbulence effects reducing the efficacy of downwind turbines. This will increase the length of infield interconnector cabling required, typically to feed power at 33 kilovolts (kV) to a central substation platform, for conversion to a higher voltage (most commonly 132 kV) in order to transmit it down the export cable. [11]

Cable-laying will usually require a dedicated vessel or barge, which may be anchored or dynamically positioned, depending on depth and conditions offshore. A common factor will be a carousel system on the vessel/barge in which to transport and install the cable. To protect the cables, various protection methods such as trenching, burial, or rock placement may be employed depending on the bottom conditions and surrounding infrastructure. Jet trenchers or ploughs can be used to place the cable in position in a single pass.

REGULATORY COMPLIANCE

The Jones Act requires any vessel transporting cargo between U.S. ports to be built and flagged in the U.S. Under the terms of the Jones Act, a fixed offshore wind farm is considered a U.S. port. The Jones Act law requires the vessel to have U.S. ownership (75%), be U.S.-built, and U.S.-operated with a U.S. crew. An offshore wind turbine site is technically considered a port as it is a “coastwise point.” A “coastwise point” includes artificial islands and similar structures, mobile oil drilling rigs, drilling platforms, and other devices attached to the seabed of the OCS. Currently, there are limited U.S.-built relevant vessels, especially WTIVs and O&M jackups.

In order to use a foreign, non-Jones Act vessel, components from a U.S. port must first be loaded onto a U.S.-built feeder vessel. The feeder vessel is brought out to the project site where the foreign WTIV may lift the components off the feeder vessel onto the foundation without moving. This strategy allows the use of foreign-flagged vessels, but it requires additional Jones Act compliant feeder vessels. Ultimately, it would be recommended to seek determinations for the planned operations through U.S. Customs and Border Protection (CBP) for the Jones Act requirement, and as early as possible.

Regarding the Jones Act, all interpretations and determinations of applicability are made by U.S. CBP. The Coast Guard’s National Vessel Documentation Center determines if a specific vessel is eligible for coastwise service (i.e., U.S.-built), but whether a coastwise eligible vessel is needed for a specific operation must be determined by the CBP.

The United States Coast Guard (USCG) provides a roadmap for the safety standards regarding vessels in wind farm service. The USCG responses below presume U.S.-flagged vessels are used, unless specifically otherwise stated, and represent general Coast Guard policy and interpretations. Specific application of these regulations is within the purview of the cognizant Officer in Charge, Marine Inspection (OCMI), who would need to be consulted prior to getting a final, vessel-specific response. This is normally accomplished through the Application for Inspection.

“Offshore supply vessel” is defined in 46 U.S. Code (USC) 2102(19) [9] as a motor vessel that regularly carries goods, supplies, individuals in addition to the crew, or equipment in support of exploration, exploitation, or production of offshore mineral or energy resources (a similar definition exists at 46 CFR 125.160 [9]). As wind energy would be included as an energy resource, vessels engaged in wind farm development or operation, including installation, maintenance, turbine transport, crew transfers, heavy-lifting, and cable laying, may properly be certificated by the Coast Guard as OSVs, using 46 CFR Subchapter L [9].

POSITIONING FOR U.S. EXPANSION

The definitions of “crew” and “offshore worker” found at 46 CFR 125.160 [9] are nearly mutually exclusive, such that persons carried on an OSV are generally categorized as either crew or offshore workers. Those persons not meeting the definition of either would be categorized as “persons in addition to the crew” and limited to no more than 12 on an international voyage and 16 on a domestic voyage. The number of offshore workers is limited to 36 unless the vessel complies with 46 CFR 127 Subpart F [9]. Subpart F is stated as being applicable only to OSVs of at least 6,000 Gross Tonnage International Tonnage Certificate (GT ITC), but provisions to use that subpart to carry more offshore workers on OSVs of less than 6,000 GGT ITC may be authorized by the Coast Guard upon specific request. Note that Subpart F is very similar to the IMO Special Purpose Ships Code [8].

- a. Wind turbine installation vessels may be certificated under Subchapter I or L, and under either Subchapter would be eligible to participate in the Alternate Compliance Program (ACP) [24] or Navigation and Vessel Inspection Circular (NVIC) 10-82 [25].
- b. Wind turbine transport vessels may be certificated under Subchapter I or L, and under either Subchapter would be eligible to participate in the ACP [24].
- c. Persons transported on a Subchapter L service operation vessel would be considered offshore workers and would be limited to 36 unless the vessel complies with 46 CFR 127 Subpart F [9].
- d. Crew transport vessels may be either Subchapter T [9] or L. If Subchapter L is used, the maximum number of persons (offshore workers) is 36, unless the vessel complies with 46 CFR 127 Subpart F [9]. Using Subchapter T, the maximum number of persons (passengers) is 150 (or 49 overnight). As the Coast Guard does not have specific requirements for wind farm crew transfer vessels, the advantages/disadvantages of using Subchapter L versus T are similar to those found working in the oil and gas fields.
- e. A cable layer may be certificated under Subchapter L, so long as it only lays cable related to the development or production of offshore energy resources (laying cable to deliver power produced ashore to an offshore island cannot be done under Subchapter L). Subchapter L OSVs are eligible to participate in the ACP [24].

At the request of the clients and under the authorization of USCG, ABS may conduct a plan review on behalf of USCG under ACP [24], NVIC 10-82 [25] and / or NVIC 10-92 [26] for a U.S.-flagged vessel.

ACP NVIC 2-95 Change 3 [24]

The Alternate Compliance Program (ACP) is a voluntary program under which the majority of the vessel's statutory certification services are performed by recognized Classification Societies such as ABS on behalf of the USCG. This program provides an alternative to the traditional 46 CFR compliance model for the statutory certification of U.S. flag vessels. In lieu of compliance with 46 CFR, the ACP requires compliance with Class Rules, applicable IMO Instruments, and the U.S. ACP Supplement. The ACP is based on the understanding that compliance with Class Rules + IMO Instruments + U.S. ACP Supplement provides an equivalent level of safety to that under 46 CFR. The intent of this program is to reduce the regulatory burden on shipyards, as well as vessel owners and operators, by capitalizing on the survey and certification functions performed by Classification Societies. This program provides additional flexibility in vessel design and construction, thereby enhancing the competitive position of the U.S. fleet.

This program is available to U.S.-flagged vessels that are intended for international voyages and whose vessel type meets the ACP eligibility requirements per the applicable Subchapter of 46 CFR Chapter I. Additionally, these vessels must be classed with a recognized Classification Society that is authorized by the USCG to participate in the ACP. The governing requirements for the ACP are outlined in the USCG's Navigation and Vessel Inspection Circular (NVIC) 2-95, Change 3. Vessels with novel or complex designs or operations, and for which the Classification Society has no rules and/or the USCG has no regulations or policies developed, are generally not eligible to enroll in the ACP. However, the USCG's Office of Commercial Vessel Compliance (CG-CVC) may choose to enroll such vessels in the ACP subject to a Design Basis Agreement (DBA) on a case-by-case basis.

A company wishing to enroll a vessel in the ACP must apply for vessel enrollment with the cognizant Officer in Charge, Marine Inspection (OCMI). The U.S. Coast Guard's Office of Commercial Vessel Compliance (CG-CVC) may grant provisional and final enrollment authorization following a review of the enrollment application, the results of the handover survey, and related supporting documentation, as applicable. In general, this authorization remains valid so long as the vessel remains enrolled in the ACP. As a condition of enrollment, ACP vessels must be in compliance with the ACP standards at all times, regardless of whether or not the vessel actually engages on an international voyage.

NVIC 10-82, Ch2 [25]

For U.S.-flagged vessels, the NVIC 10-82 program authorizes ABS to conduct plan review and inspection on behalf of the USCG for verification of compliance with the applicable requirements of the U.S. Code of Federal Regulations (CFR) and associated statutory instruments. This program applies to new construction vessels, as well as existing vessels undergoing major modifications. The governing requirements for this program are outlined in the USCG's NVIC 10-82, Change 2.

This program essentially permits ABS to take on the U.S. Coast Guard's plan review and inspection responsibilities in most areas of new construction and major modification, as outlined under NVIC 10-82. In these areas, the U.S. Coast Guard's involvement consists primarily of liaison with ABS, policy determinations, oversight, and action on appeals. This program also includes a provision wherein the plan review and inspection responsibility for certain critical areas of new construction and major modifications are retained by the Coast Guard. Additionally, the vessel certification under this program is issued by the cognizant USCG OCMI, and the delegation of authority to ABS ends upon completion of the new construction or major modification project. A company wishing to enroll a vessel under the NVIC 10-82 program must apply for vessel enrollment with the cognizant USCG OCMI.

NVIC 10-92, Ch 2 [26]

Plans for which ABS is not authorized to review on behalf of the U.S. Coast Guard under NVIC 10-82 may be reviewed by ABS under NVIC 10-92 when requested to do so by the client.

Under the NVIC 10-92 program, the USCG may accept the certification of a registered PE or a recognized Classification Society that the vessel's plans meet the applicable requirements of the U.S. Code of Federal Regulations (CFR). The governing requirements for this program are outlined in the USCG's NVIC 10-92, Change 2.

The idea behind this program is to reduce the level of effort required by the USCG's Marine Safety Center (MSC) in approving the vessel's plans since these plans have already been certified by a PE or a recognized Classification Society. For these plans, the MSC may conduct full, partial, or no review depending on the nature of the material presented, the frequency of error routinely detected during plan review, and the impact such errors have on overall vessel safety. The level of plan review oversight would be determined by the Commanding Officer, MSC. Here it should also be noted that the NVIC 10-92 program does not cover proposals for equivalency determination. These proposals would need to be submitted separately to the MSC for their review and approval.

ABS SOLUTIONS - PILOT CASES AND COMMERCIAL PROJECTS

BLOCK ISLAND

During the installation of the Block Island Wind Farm, all vessels are Jones Act vessels except the wind turbine installation vessel:

- Week Marine's Jones Act vessels, Weeks 533 and Weeks 526, were used to install jacket foundation.
- Seacor Marine (Montco Offshore) Jones Act Liftboat (LB) Robert assisted with the foundation installation and was used for piling and lifting of the platform.
- Fred Olsen Windcarrier's foreign flag self-propelled jackup vessel Brave Tern installed five turbines of 6 MW each.
- Due to the Jones Act, Seacor Marine (Montco Offshore) Liftboat Paul and Liftboat Caitlin were used to deliver wind turbine tower components, including blades, nacelles, and three-section towers, to the wind farm project site.
- Atlantic Wind Transfers is the first U.S.-built CTV. Atlantic Pioneer has a 20-year contract to provide transfer and service on site.

ABS Group, a subsidiary of ABS, served as the Certified Verification Agent (CVA) for the first offshore wind farm in the U.S., Deepwater Wind Block Island in Rhode Island. The project achieved commercial operation, and ABS Group continues as CVA on this project. This landmark project proved the viability of offshore wind in the U.S. market and demonstrated the value of the CVA and certification process as part of the overall project team. ABS Group continues to act as CVA for the O&M phase.



Figure 11: Block Island Wind Farm

COASTAL VIRGINIA OFFSHORE WIND PILOT

The Coastal Virginia Offshore Wind (CVOW) pilot is the second U.S. offshore wind farm about 30 miles off Virginia Beach, with just two turbines in a 12-MW project. The project is the first U.S. offshore wind farm in U.S. Federal waters. [27]

The turbines were manufactured by Siemens Gamesa in Denmark and the monopile foundations by EEW in Germany. Dominion Energy awarded the Engineering, Procurement and Construction (EPC) job to two vendors: Ørsted is handling offshore construction and L.E. Myers is handling the onshore work.[28]

The major turbine components were transported from Europe to Halifax, Nova Scotia. The specialized installation vessel transported the foundations to the project site and installed them in the summer of 2020. The vessel then returned to Halifax for the pair of Siemens Gamesa turbines to install them.

The U.S. Jones Act requires that goods transported between U.S. ports only be carried by U.S.-flagged vessels, but there are no offshore wind installation vessels flying U.S. flags today, leaving Dominion Energy to park its components in Canada during the construction process.

Dominion Energy and Ørsted brought online two offshore wind turbines on September 30, 2020, which are part of the 12-MW CVOW pilot project. Dominion Energy announced that the two CVOW wind turbines are officially generating power as electrical and reliability testing gets underway 27 miles off the coast of Virginia Beach.

COMMERCIAL SCALE PROJECTS

JONES ACT COMPLIANT INSTALLATION VESSEL

The U.S. market requires forward-looking marine logistics, such as a Jones Act compliant jackup installation vessel, for the larger scale offshore wind projects.

Vineyard Wind, which could follow the Virginia pilot as the third U.S. project, will be built in two 400-MW installation seasons. Dominion Energy is already working on its own follow-up: a 2.6-GW project in Virginia to be built in three phases in 2024-2026.

Dominion Energy announced in May 2020 it is leading a consortium to build a Jones Act compliant installation vessel, and the company expects the vessel to be fully utilized on a pipeline exceeding 5 GW of U.S. offshore wind construction through 2027, enabling the investment needed for this first of its kind vessel. The vessel, which is likely to enter service in 2023, is expected to be based out of the Hampton Roads region of Virginia with a U.S. crew. This effort represents a significant step in developing a domestic manufacturing supply chain to support the multi-gigawatt opportunity for zero-carbon electricity generation in the waters off the coast of the U.S. [27].

Dominion Energy has selected Huisman to fabricate the crane to be used on the United States' first Jones Act compliant offshore wind installation vessel. The crane for this installation vessel will be able to lift 2,200 tons and will enable the installation of the new generation state-of-the-art wind turbines [29].

Dominion Energy announced on December 16, 2020 it has reached a major milestone – the keel laying – in the construction of the first Jones Act compliant offshore wind turbine installation vessel, currently being constructed by the global marine shipbuilding firm Keppel AmFELS at its Brownsville, Texas shipyard.

The vessel's hull has a length of 472 feet, a width of 184 feet and a depth of 38 feet, making it one of the biggest vessels of its kind in the world. It has accommodations for up to 119 people. The vessel is designed to handle current turbine technologies as well as next generation turbine sizes of 12 MW or larger and will also be capable of the installation of foundations for turbines and other heavy lifts.

ABS will class this highly specialized wind turbine installation vessel for the safe development of the U.S. offshore wind industry. By leveraging its extensive knowledge of U.S. regulations combined with offshore industry, ABS supports this project by providing:

- Regulatory guidance
- Discussion with USCG and stakeholders for the design basis agreement
- Basic design and detailed design review in accordance with class Rules
- On-site survey at Keppel AmFELS shipyard for classification
- Huisman 2,200-ton crane classification
- Vendor equipment coordination

JONES ACT COMPLIANT SERVICE OPERATION VESSEL

Edison Chouest Offshore (ECO), Ørsted, and Eversource announced on October 1, 2020 the execution of a long-term charter agreement for the provision of the first U.S.-flagged Jones Act compliant Service Operation Vessel (SOV). The SOV will be engineered, constructed, and operated by ECO as an integral part of the operation and maintenance of the Revolution Wind, South Fork Wind, and Sunrise Wind offshore wind farms in the northeast U.S., which are dependent on obtaining the necessary federal permits from BOEM. [30]

The 80-meter-long vessel, which will be capable of housing 70 passengers/wind turbine technicians, will operate on diesel electric power meeting EPA Tier 4 emission standards and will feature proprietary ECO Variable Frequency Drive to substantially reduce fuel consumption and greenhouse gas emissions.

ABS will class this first U.S.-flagged Jones Act SOV for compliance with *ABS Rules for Building and Classing Marine Vessels, Part 5D Offshore Support Vessels for Specialized Services* and *ABS Guide for Wind Farm Support Vessels*. The vessel will be enrolled in the Alternate Compliance Program (ACP) which the majority of the vessel's statutory certification services are performed by ABS on behalf of the U.S. Coast Guard.

LEADING CLASS SERVICES PROVIDER FOR INNOVATIVE WIND FARM VESSELS

As the leading provider of classification services to the global offshore industry, ABS is in a unique position to support the new vessels serving the evolving fixed and floating offshore windfarm turbine market.

ABS advantages in the Offshore Wind Farm market include:

- Record of WTIV classification
- Historical industry leadership with self-elevating units
- Alignment with leading designers for wind farm support vessels
- Record of heavy-lift vessel and large offshore crane classification
- Multi-disciplinary support on first U.S. offshore wind project: Block Island Wind Farm
- Classification of Jones Act compliant WTIV, SOV and CTV
- Strong relationship with USCG
- Global leadership in offshore classification and marine projects
- U.S. wind port, infrastructure, and support vessel relationship expertise
- Global resources in engineering, technology and survey

As a multi-disciplinary technical organization, ABS is prepared to support clients in achieving successful design, construction and operational outcomes. ABS offers additional services during various new construction and post-delivery stages, including:

- Access to our regulatory specialists for USCG requirements
- Independent third-party assessment of risk based strategy evaluations for specific vessel designs and operations
- "SMART" vessel functionality and capabilities workshop led by a Subject Matter Expert (SME)
- "Energy Efficiency and Environmental Performance" workshop led by an SME
- "Cyber Security Readiness" workshop led by an SME
- Development of a recommended Integrated Test Procedure (ITP) to assist in construction compliance, materials received and installed during construction
- Noise and vibration measurement support and analysis
- 24/7 Rapid Response Damage Assessment (RRDA) services in case of vessel-related emergencies
- Virtual training courses, including offshore specific topics, through ABS Learning Organization
- At the request of the client and under authorization of USCG, ABS may also conduct plan review on behalf of USCG under Alternate Compliance Program (ACP), NVIC 10-82 and/or NVIC 10-92 for a U.S.-flagged vessel

CONCLUSION

Demand for wind farm support vessels in the U.S. is expected to increase to support planned construction projects for both fixed and floating offshore wind farms in U.S. waters.

Transportation of offshore wind components over land is impractical, given their size; therefore, ports and harbors along the East Coast are critical for meeting the states' offshore wind development goals. Ports are also where the operations of wind facilities are managed. They often have offices for personnel and logistics and the marine infrastructure for vessels that take technicians to the offshore wind farms to conduct maintenance.

Several East Coast ports may be viable for offshore wind use, such as New Bedford in Massachusetts, Tradepoint Atlantic in Maryland, New London and Bridgeport in Connecticut, Port of Providence in Rhode Island, Port of Virginia in southeastern Virginia, and the newly announced New Jersey Wind Port. Twelve investments on port infrastructure for offshore wind have been announced since 2017, among which the majority has been invested by the wind developers. Growth of turbine and project sizes may hinder the acquisition of the increased heavy-lift capacity, ship access, overhead clearances, channel draft, and physical laydown space.

The dimensions and characteristics of ports and the water depths of wind development areas provide some constraints and requirements for wind support vessel designs. The rotor diameters and blade lengths of the increased turbine sizes are also necessary in the sizing of installation vessels and transport vessels. The offshore cranes on board the installation vessels should also be able to handle the turbine and component weights and lifting heights.

The construction and maintenance of offshore wind projects calls for a combination of expertise that is comparatively new to the U.S. market and requires a variety of specialist support tonnage.

The Jones Act requires any vessel transporting cargo between U.S. ports to be built and flagged in the U.S. For the purposes of the Jones Act, a bottom founded wind turbine foundation is considered a U.S. port. Dominion Energy recently confirmed its plan to join a consortium of investors that will build the first U.S. offshore wind installation vessel, expected to be in service in 2023.

A non-Jones Act wind turbine installation vessel (WTIV) is not able to transport components from an onshore port to a fixed turbine foundation. To use a foreign, non-Jones Act vessel, components from a U.S. port must be transported by a U.S.-built feeder vessel. The feeder vessel, which may be a jackup, barge, or ship, is brought to the project site where the foreign WTIV may lift the components off the feeder vessel onto the foundation without moving. This strategy allows the use of foreign-flagged WTIVs, but it requires additional Jones Act compliant feeder vessels.

Other wind support vessels such as SOVs, floating heavy-lift vessels and CTVs operating in U.S. offshore wind are required in compliance with Jones Act.

ABS offers a classification roadmap from concept, basic design and detailed design to construction and in-service operation of the wind farm support vessels. At each stage, ABS conducts an independent review of the submitted documents with respect to various design aspects including hull structures, safety, system, and stability. ABS provides classification services for a range of wind farm vessels and the certification of the installed equipment that will assist owners, operators, designers, shipyards, and manufacturers in meeting Class Rules and safety requirements for compliance with international and U.S. regulations.

With the additional wind farm developments planned in the U.S., investments in port infrastructure will continue to grow. Our extensive knowledge of U.S. regulations combined with offshore industry leadership means we are uniquely equipped to support the growing U.S. offshore wind market with a range of innovative vessels now being commissioned for U.S. wind farms. ABS is committed to playing a significant role in the safe development of the U.S. offshore wind industry.

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