

The US Offshore Wind Market and the Vessels Required to Support It

By David M. Bourg, PhD PE
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Introduction

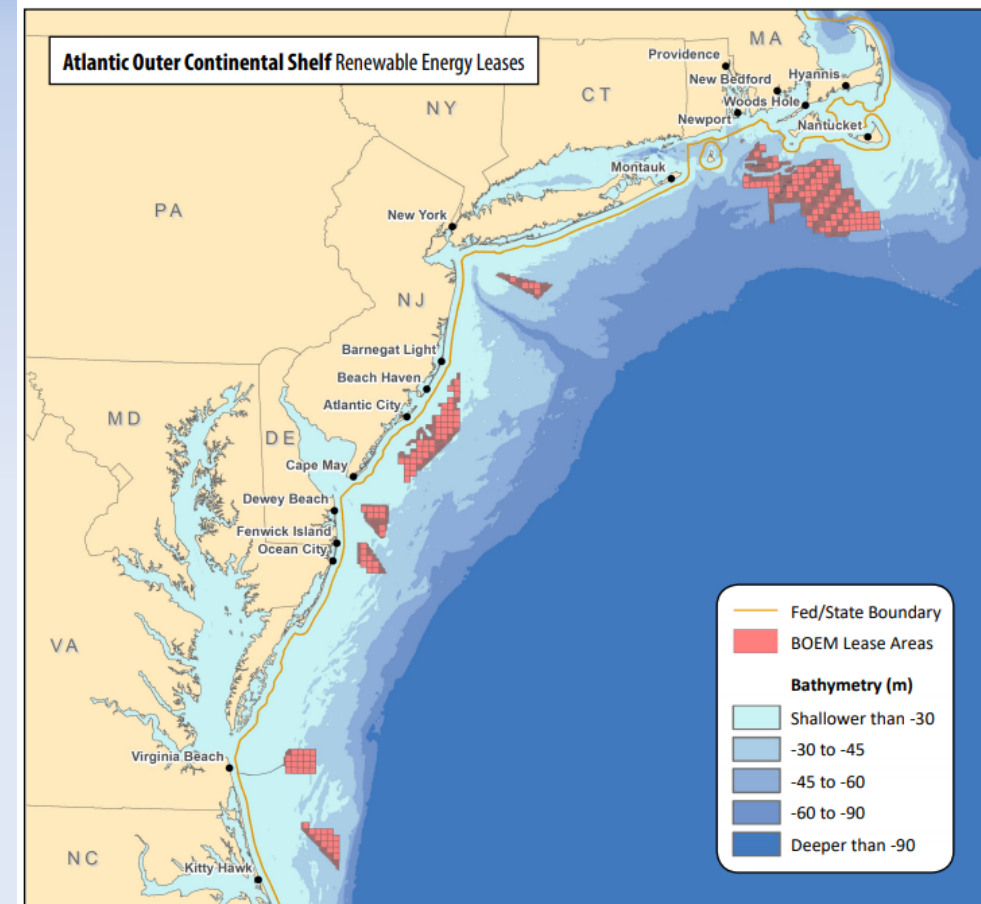
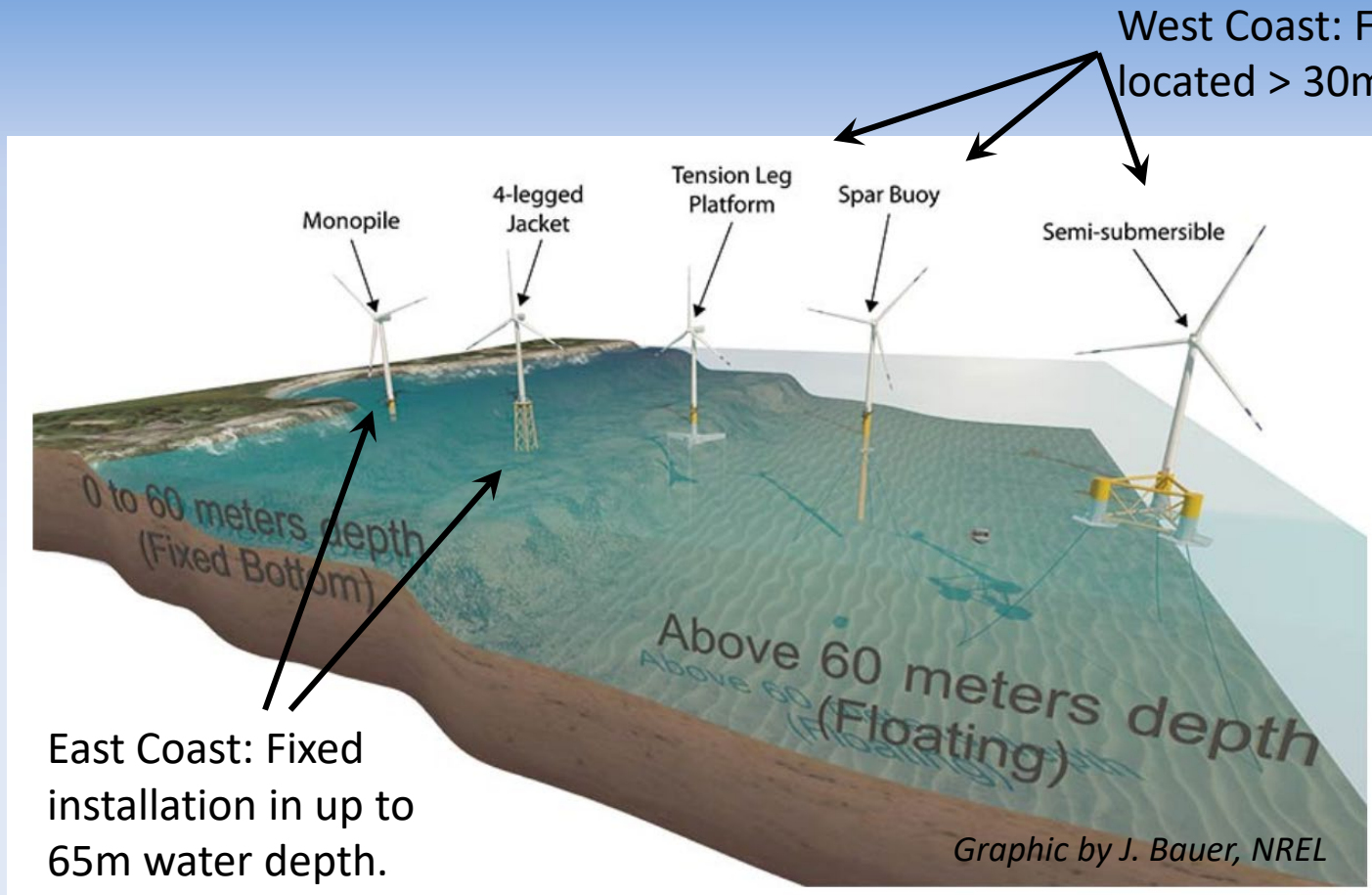
David M. Bourg, PhD, P.E.

- 30 years experience as a Naval Architect
- PhD in Engineering and Applied Science from the University of New Orleans
- Registered Professional Engineer
- Serves as Adjunct Professor of Naval Architecture at the University of New Orleans.
- Founder of MiNO Marine LLC



CONTEXT

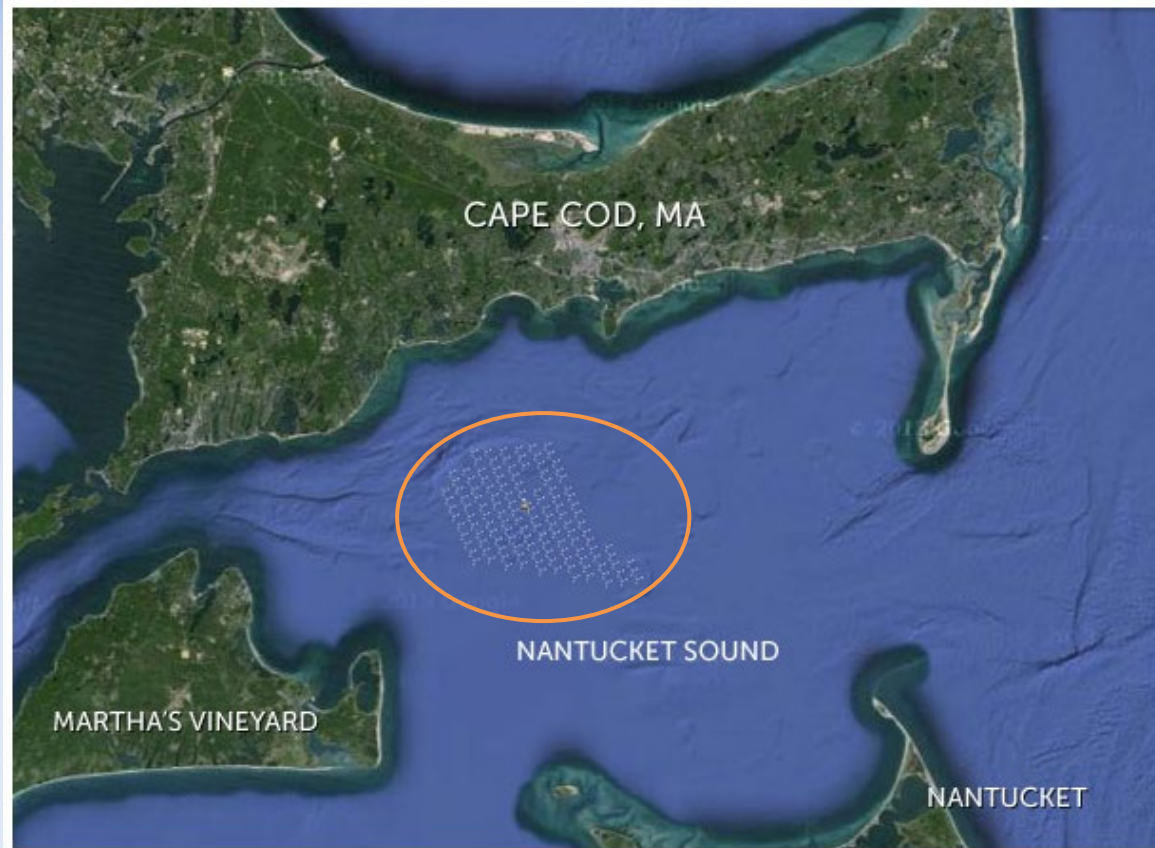
US Offshore Wind: East vs West



MINO'S INVOLVEMENT

Cape Wind

Cape Wind Site Location (Early 2000's)



Opposition From Politicians and Citizens Killed the Project



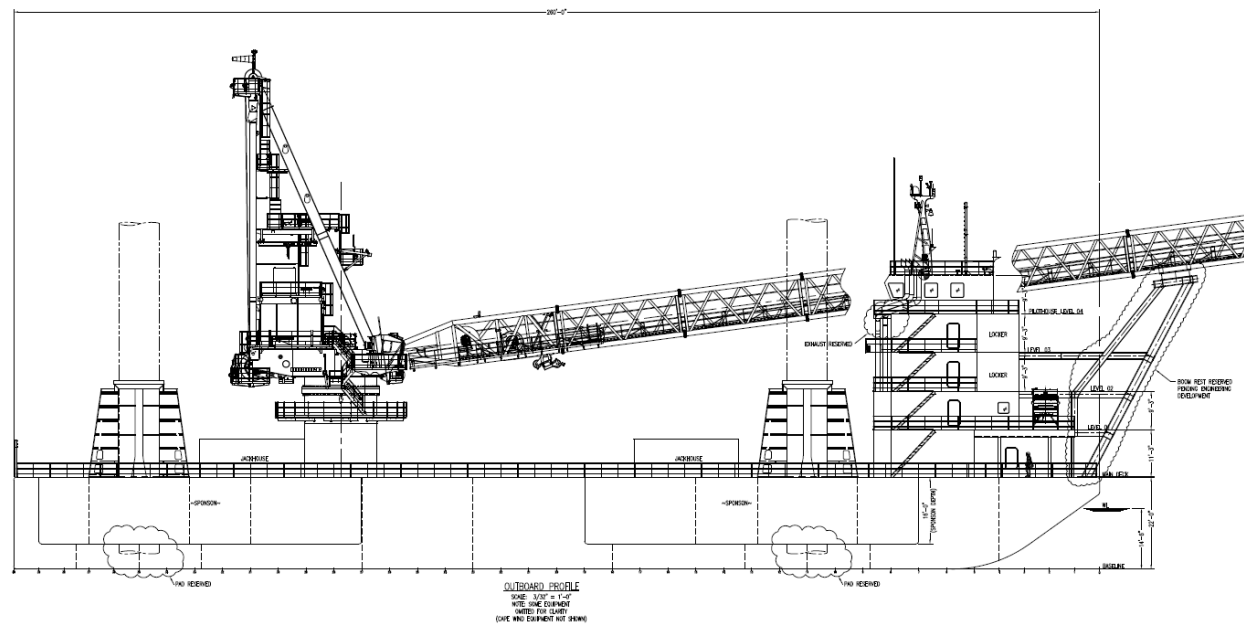
Jodi Hilton

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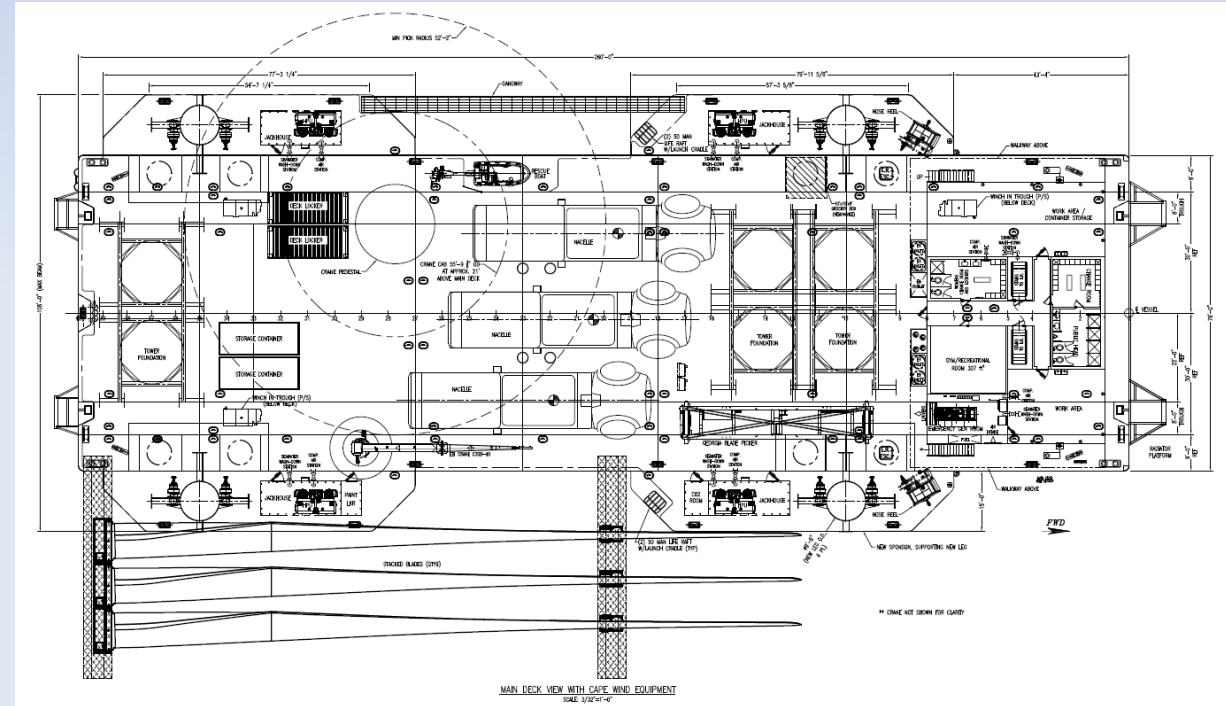
CENTERVILLE, MASS.--Audra Parker, Assistant director at the Alliance to Protect Nantucket Sound, holds a photographic simulation which shows how the proposed wind farm would look to residents who live above Craigsville Beach on Cape Cod. CREDIT: JODI HILTON

Jodi Hilton

Weeks Marine "RD MacDonald"

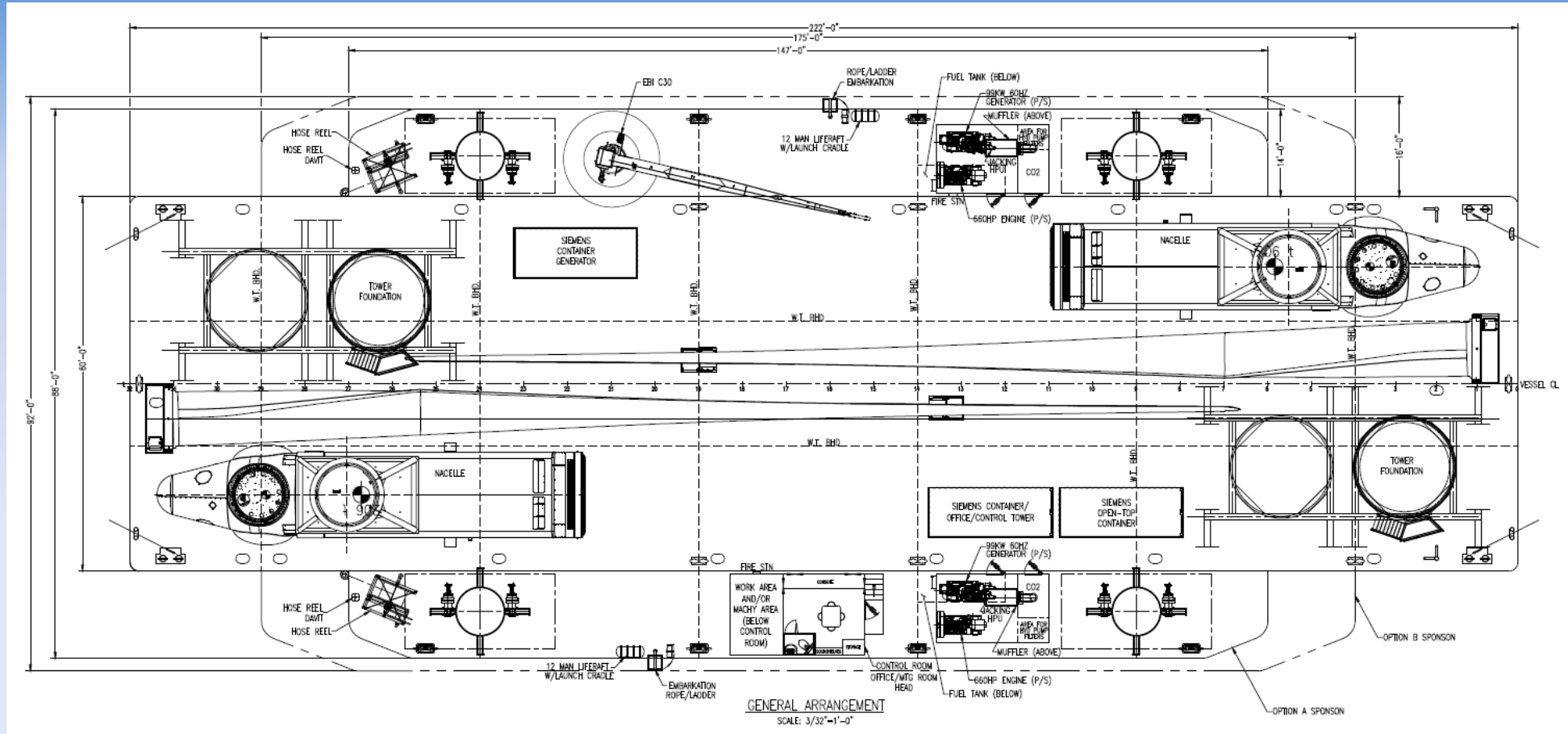


- Featured 400st primary crane.
- With ability to carry three complete 3.6MW Siemens turbines.



- MiNO designed (beginning in 2012) for Weeks Marine, based on converted 8-legged jack-up.
- Would have been the 1st Jones Act compliant WTIV.

Weeks Marine Feeder Jack-ups

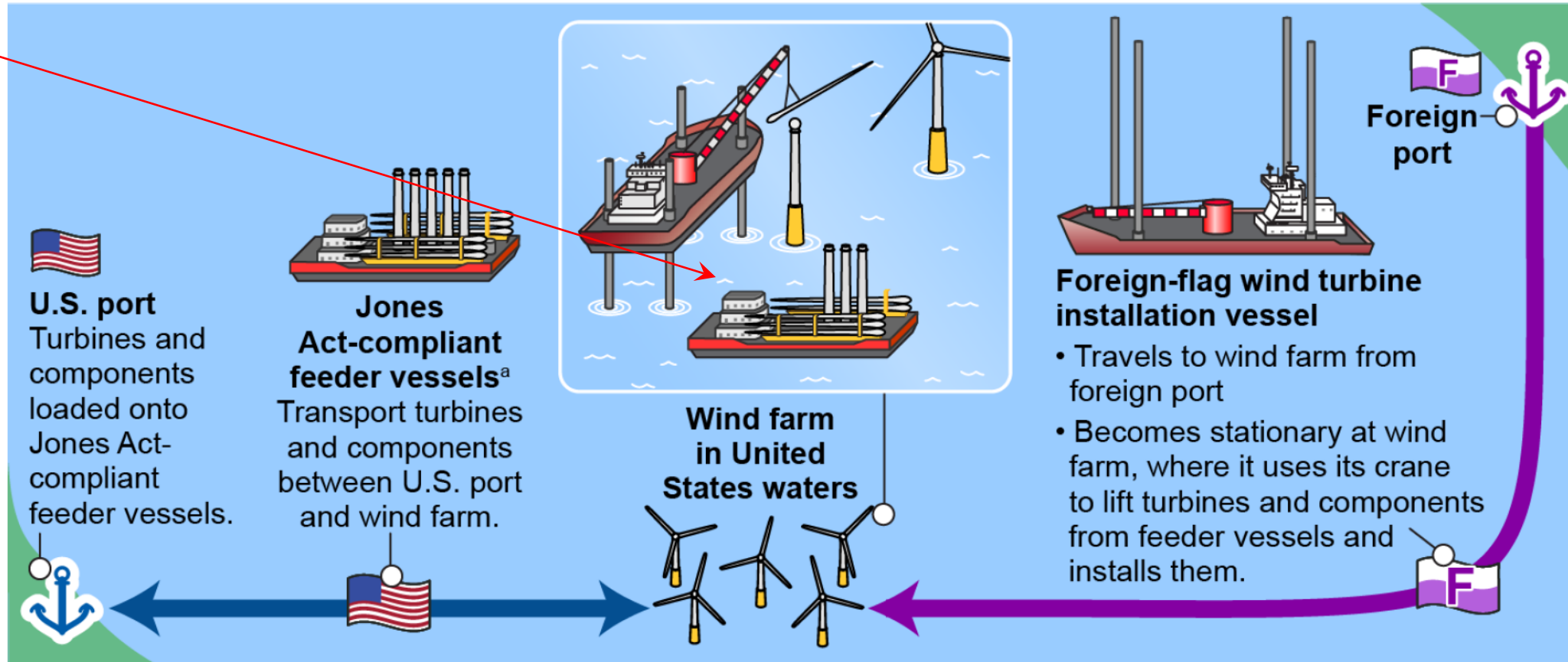


- 220ft, four-legged jack-ups
- “Feed” wind turbine components to the RDM maximizing throughput

What is Feedering?

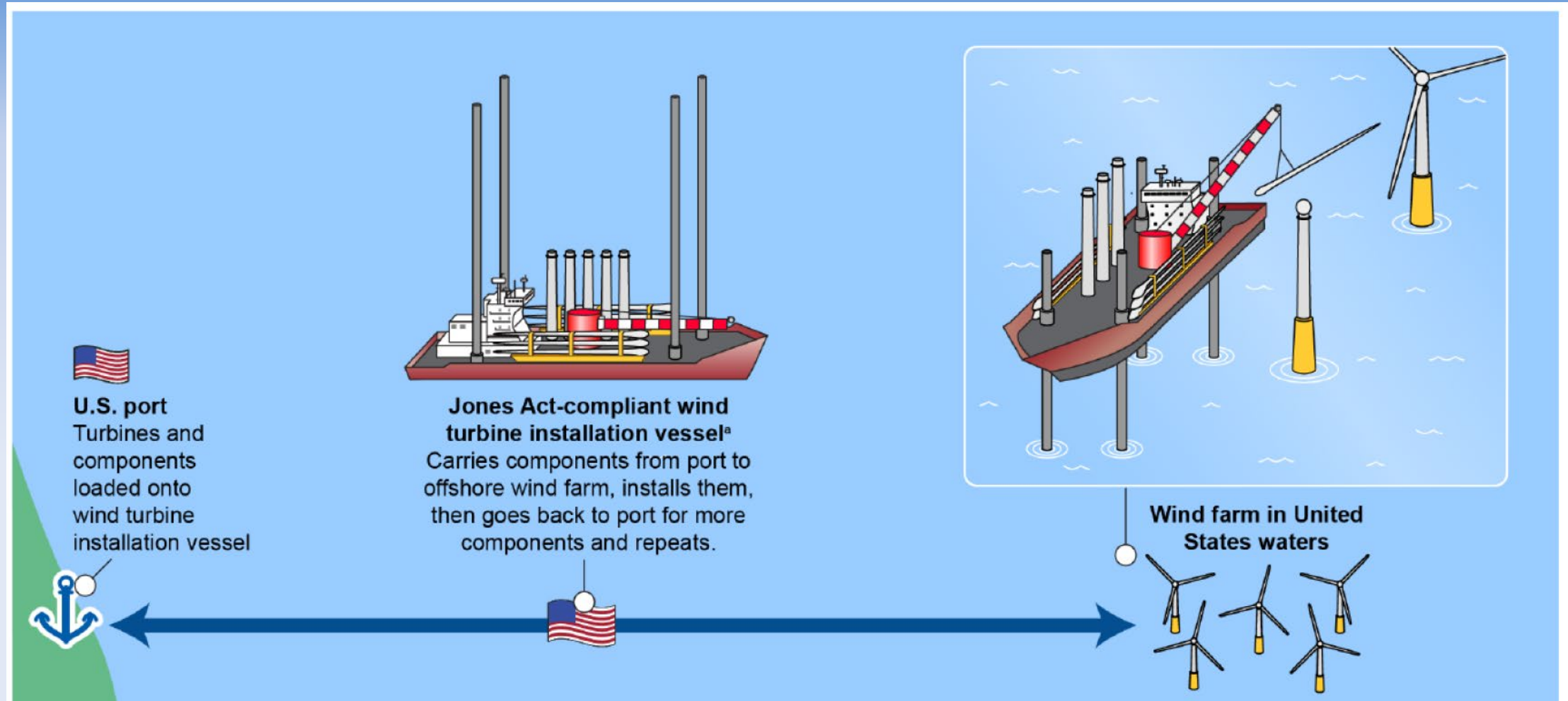
Example of an Offshore Wind Installation in U.S. Waters Using a Foreign-Flag Installation Vessel and Jones Act-Compliant Feeder Vessels

Floater!



Source: GAO. | GAO-21-153

Jones Act Compliant WTIV



Source: GAO. | GAO-21-153

L/B Robert at Block Island



L/B Robert (MiNO 335 Class) installed piles and topsides for the Block Island Project

Block Island Project

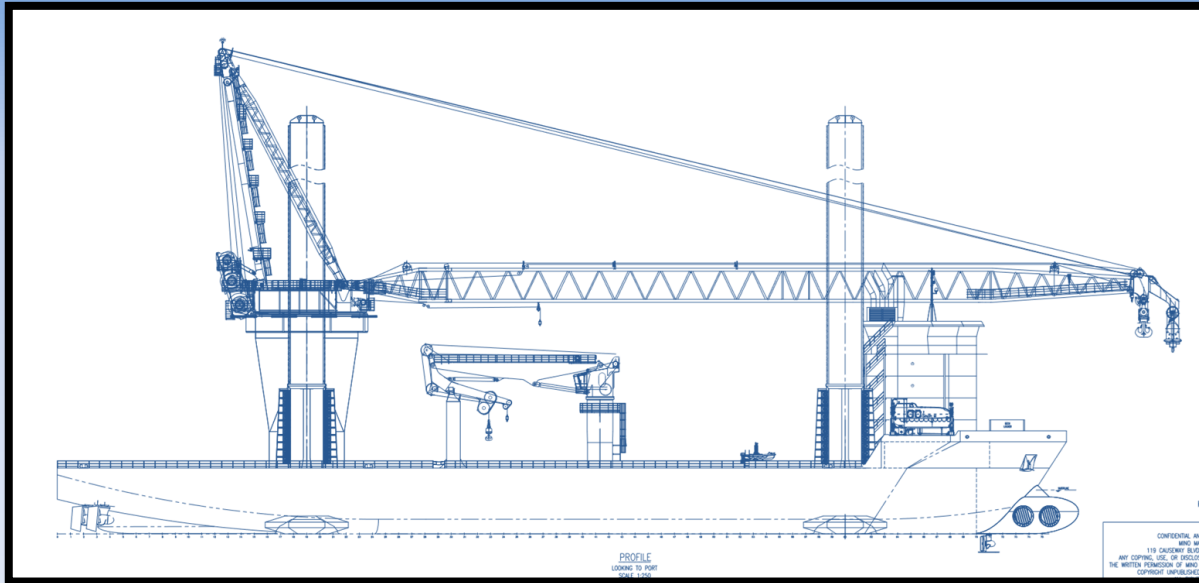
L/B Paul (MiNO 235 Class) Departing Port of Providence, RI (2016)



L/B Paul Elevated Next to Fred Olsen Wind Carrier WTIV (2016)

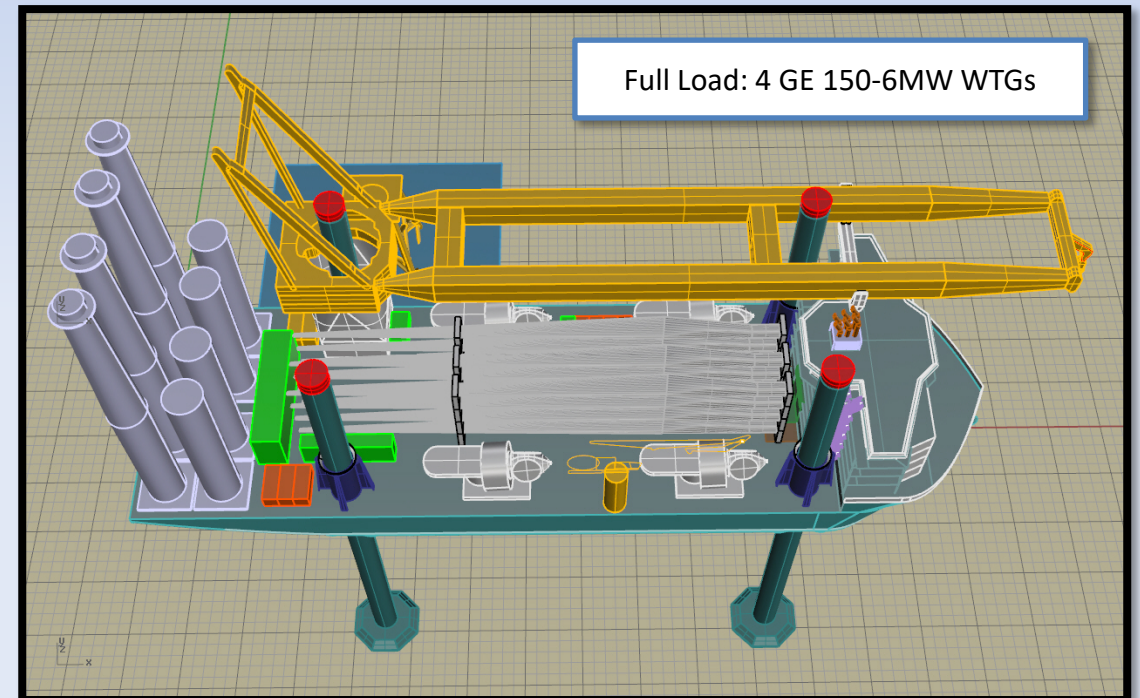


MiNO WTIV (2017)



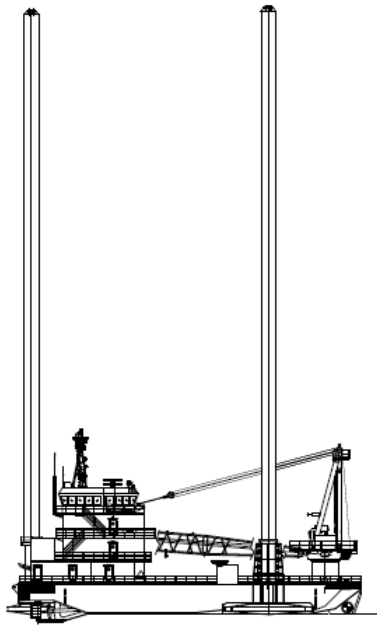
Parameter	SI	Imperial
Hull length (incl. bulbous bow)	140.0 m	459.3 ft
Breadth	40.3 m	132.2 ft
Depth	9.0 m	29.5 ft
Loadline draft	6.5 m	21.3 ft
Estimated transit speed	6.2 m/s	12.0 kt
Deck area	3,680 m ²	39,611 ft ²
Maximum deck pressure	15.0 mt/m ²	3,072 lb/ft ²
Maximum deck load	2,500,000 kg	5,511,555 lb

Parameter	SI	Imperial
Geometry	4.5m Dia. Cyl.	14.8ft
Leg length	95 m	311.7 ft
Maximum water depth (MWD)	65.0 m	213.3 ft
Air gap at MWD	4.5 m	14.7 ft
Leg elevation speed, jacking	0.75 m/min	2.5 ft/min
Leg elevation speed, tagging	1.08 m/min	3.55 ft/min
Maximum total variable load	7,000,000 kg	15,432,358 lb



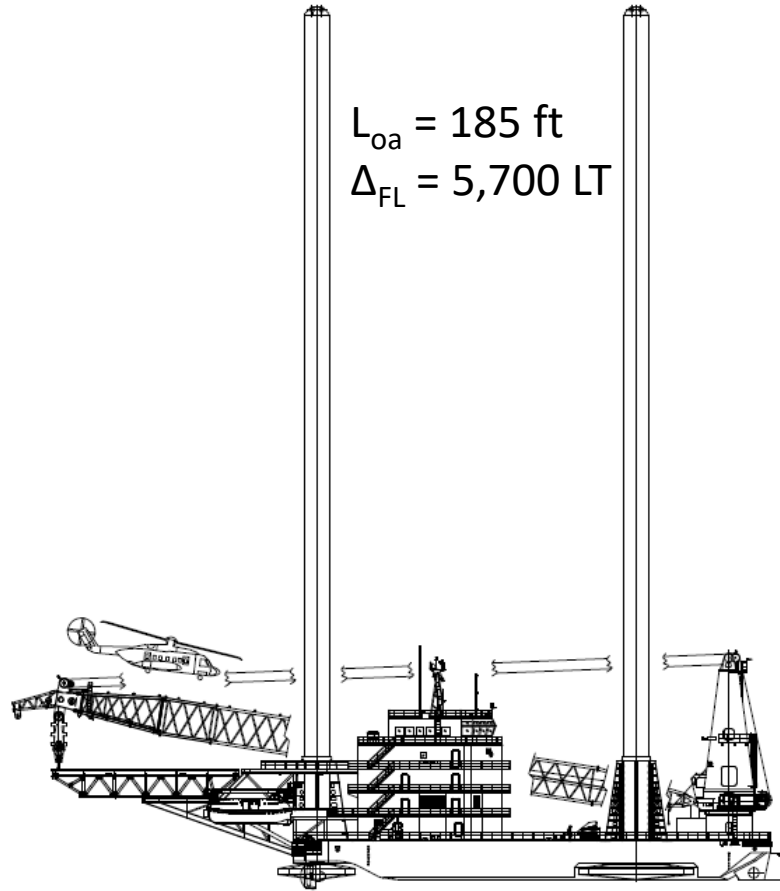
Super Feeder

$L_{oa} = 137 \text{ ft}$
 $\Delta_{FL} = 1,934 \text{ LT}$



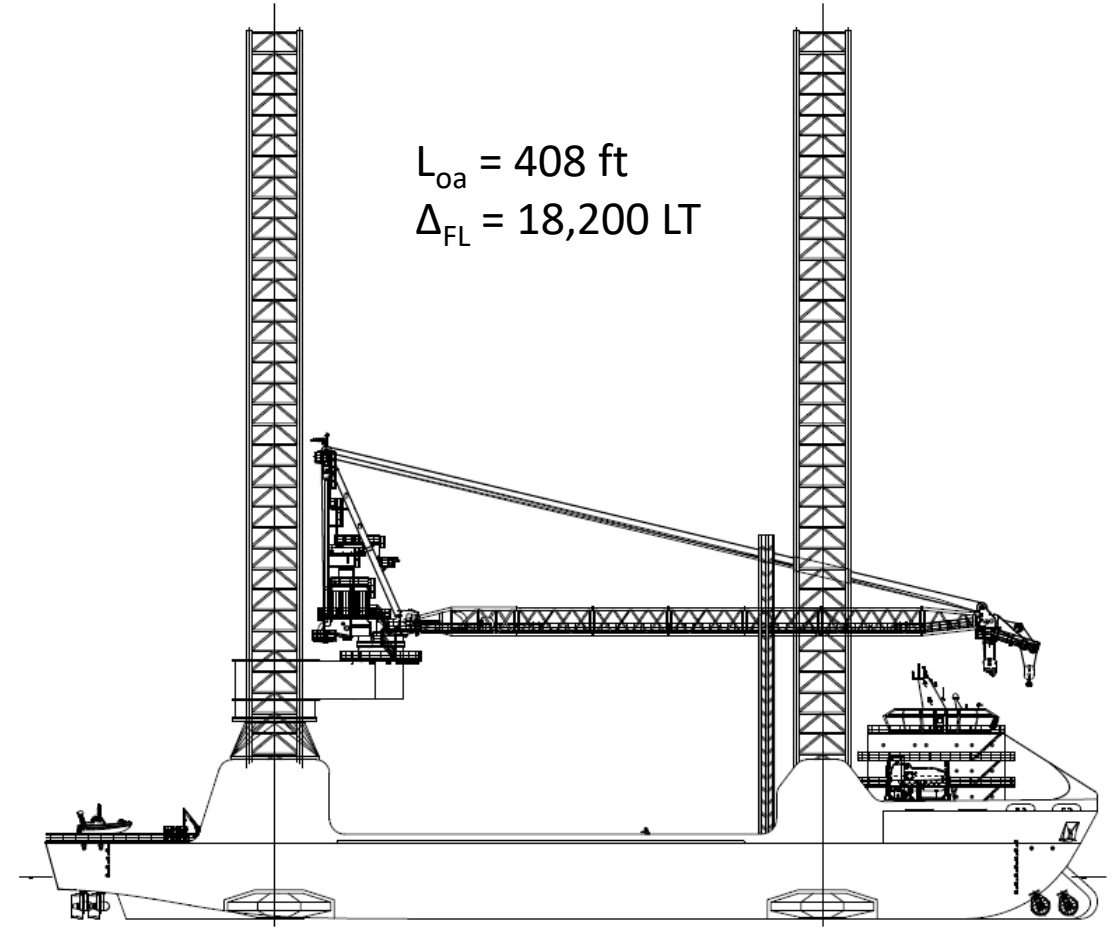
235 Class

$L_{oa} = 185 \text{ ft}$
 $\Delta_{FL} = 5,700 \text{ LT}$



335 Class

$L_{oa} = 408 \text{ ft}$
 $\Delta_{FL} = 18,200 \text{ LT}$



345 Class

Turbines Are Driving Vessel Size

- Wind turbines in Europe are on average smaller older generation turbines 4MW to 8MW.
- Turbines in the US, while initially 6MW turbines for the Block Island and Virginia pilot projects are expected to be much larger, > 10MW.

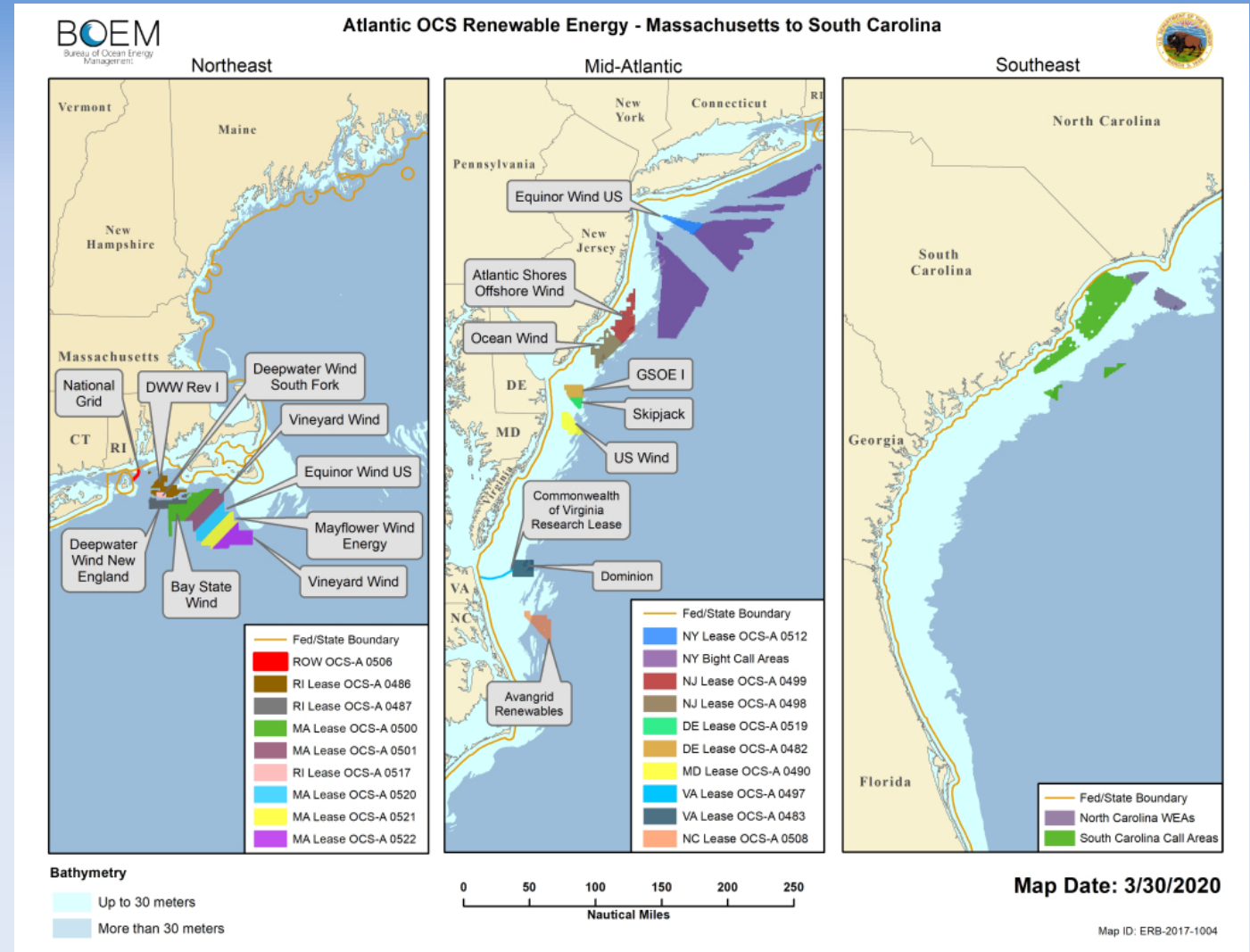
Turbine Size (MW)	Rotor Diameter (m)	Blade Length (m)
4	120	59
5	135	66
6	150	73
7	164	80
8	175	85
10	193	94
12	220	107
14	222	108

Source: ABS Offshore Wind Report, March 2021

US MARKET

Atlantic Lease Areas

- Potential ports include:
 - ProvPort
 - New Bedford
 - New London
 - Bridgeport
 - NY S. Brooklyn Marine Terminal
 - NY Arthur Kill Terminal
 - NJ Wind Port
 - Baltimore TPA
 - Hampton Roads
- None of these ports are set up to support commercial scale wind farm development



The US Market

- Expected capacity by 2030 is 20 GW.
- Current capacity is 42MW
 - Block Island, 30MW, 5 Turbines
 - Coastal Virginia Offshore Wind Pilot, 12MW, 2 Turbines
- Total European installed capacity ≈>23GW, ≈>5,100 turbines (1st in 1991)
- Jan. 27, 2021 President Biden signs executive order “that includes doubling offshore wind power generation by 2030.”

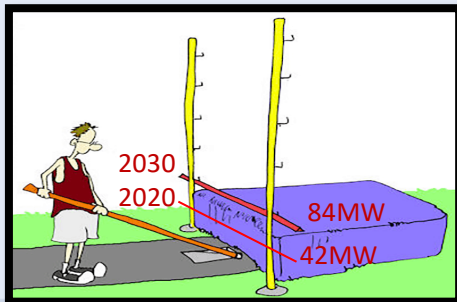
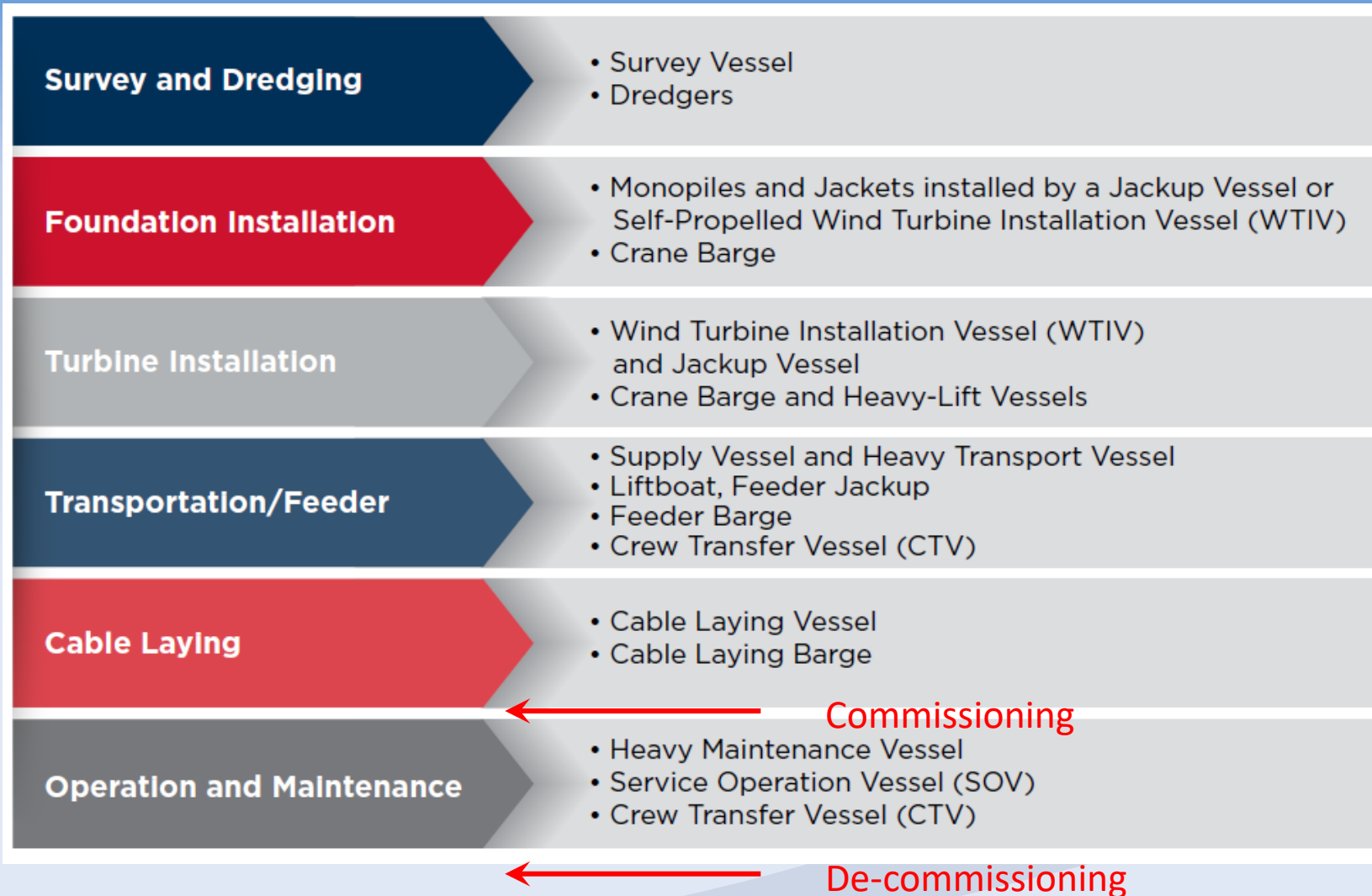


Table 1: Planned Offshore Wind Projects in Lease Areas Awarded by the Bureau of Ocean Energy Management (BOEM), as of September 2020

Project	Location	Expected capacity (MW) ^a	Expected beginning date of operation	Status of BOEM review as of September 2020 ^b
Atlantic Shores Offshore Wind	10-20 miles off the coast of NJ	Up to 2,500	Mid-2020s	Developer submitted Site Assessment Plan (SAP) in December 2019.
Bay State Wind	15 miles off the coast of Martha's Vineyard, MA	800	2024	Developer submitted Construction and Operations Plan (COP) in March 2019.
Beacon Wind	20 miles off the coast of Nantucket, MA	2,000 – 3,000	Mid-2020s	Developer had not yet submitted SAP.
Coastal Virginia Offshore Wind Demonstration Project	27 miles off the coast of Virginia Beach, VA	12	2020	Developer largely completed construction; not yet operational.
Coastal Virginia Offshore Wind Commercial Project	27 miles off the coast of Virginia Beach, VA	2,600	2026	Developer had not yet submitted COP.
Empire Wind	20 miles off the coast of Long Island, NY	2,000	Mid-2020s	Developer submitted COP in January 2020.
Garden State Offshore Energy	Off the coast of NJ and DE	1,100	2024	Developer had not yet submitted COP.
Kitty Hawk Offshore	27 miles off the coast of NC	Up to 2,500	2026	Developer had not yet submitted COP.
Mayflower Wind	30 miles off the coast of Martha's Vineyard, MA	1,200	2026	Developer had not yet submitted COP.
Ocean Wind	15 miles off the coast of Southern NJ	1,100	2024	Developer submitted COP in August 2019.
Park City Wind	23 miles off coast of MA	804	2025	Developer submitted COP in July 2020.
Revolution Wind	15 miles off the coast of RI	704	2023	Developer submitted COP in March 2020.
Skipjack Wind Farm	19 miles off the Delmarva coast	120	2023	Developer submitted COP in April 2019.
South Fork Wind Farm	35 miles off the coast of Long Island, NY	132	2022	Developer submitted COP in June 2018.
Sunrise Wind	At least 30 miles off the coast of Long Island, NY	880	2024	Developer submitted a COP in September 2020.
US Wind	17 miles off the coast of MD	270	2023	Developer submitted COP in August 2020.
Vineyard Wind	14 miles off the coast of Martha's Vineyard, MA	800	2023	Developer submitted COP in December 2017. BOEM expected to make a decision on COP in December 2020.

Source: GAO analysis of industry and BOEM information. | GAO-21-153

Wind Farm Life Cycle & Req'd Vessels



- Graphic from ABS Offshore Wind Report, March 2021.
- Does not show all required vessels such as Safety Standby Vessels, Tugs, Trenching Vessels, Anchor Handlers, Barges, Dive Support, and ROV Support vessels.

New Construction Requirements

- Reports and my experience suggest that current Jones Act compliant assets exist to fill all required vessel roles except for,
 - Wind Turbine Installation Vessel, WTIV and/or Feeders (will certainly be new construction to handle larger turbines)
 - Service Operations Vessel, SOVs (will likely be a mix of new construction and conversions)
 - Crew Transfer Vessel, CTVs (already new construction)

Regulatory Environment

- Class societies have established rules and guides specifically for offshore wind farm vessels
- 46 CFR Subchapter L applies to wind farm vessels (Subchapter T, L, I may apply depending on the vessel)
- International SPS, MLC, ILO, SOLAS apply
- Jones Act applies

The Jones Act

- Section 27 of the Merchant Marine Act of 1920, Pub. L. No. 66-261, 41 Stat. 988, 999 (1920).
- Requires vessels carrying merchandise between two US points must be,
 - 75% owned by American interests
 - Registered under the US Flag
 - Manned by US crew
- An offshore wind turbine has been ruled by the US Customs and Border Protection as a US point.

VESSELS

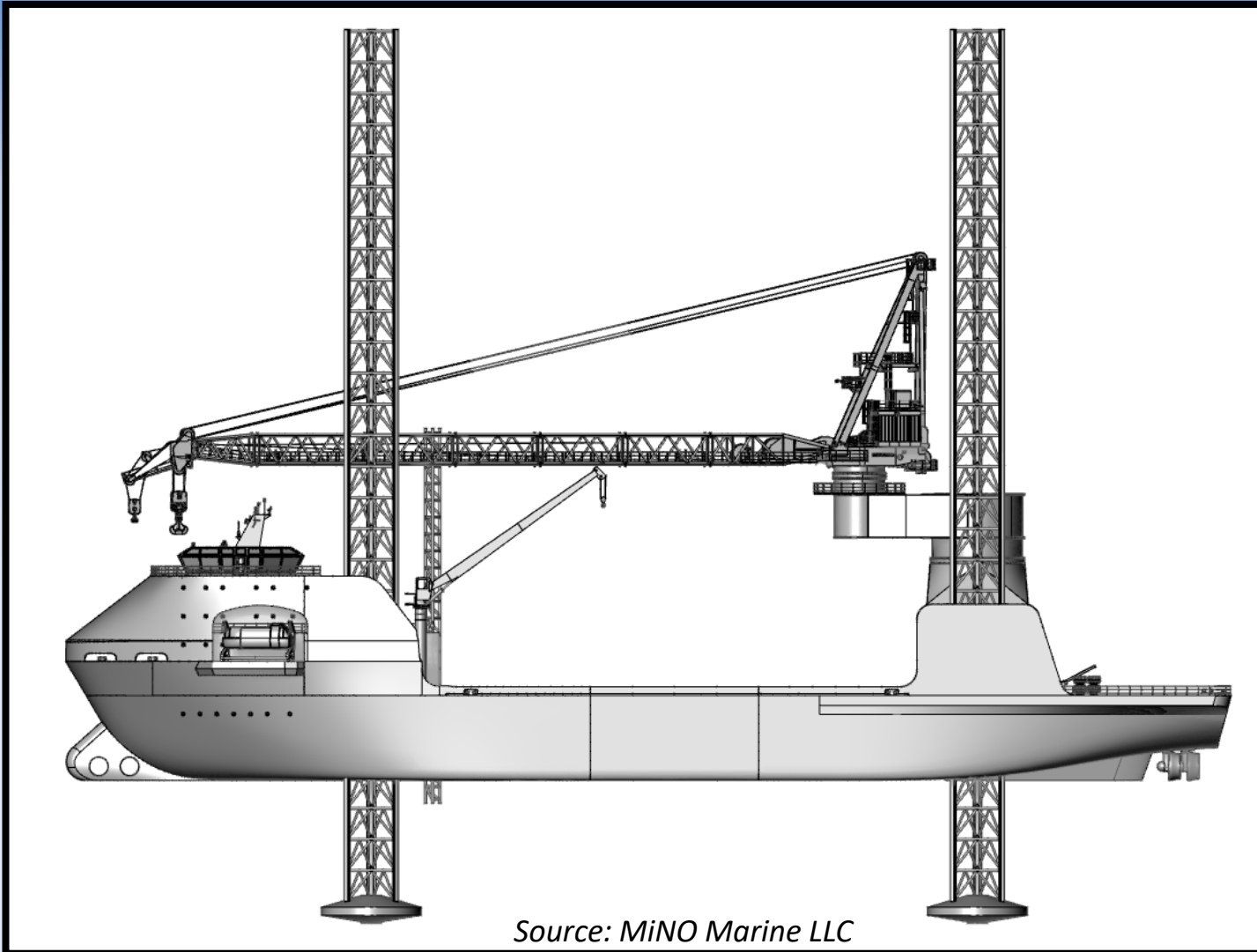
Wind Turbine Installation Vessel (WTIV)

- 1st Jones Act compliant WTIV
- Commissioned by Dominion Energy
- Keel laid Dec. 2020 at Keppel Amfels in Brownsville, TX
- 472ft x 184ft x 38ft
- Huisman crane with 426ft boom and 2,200 tons capacity
- Accom. for 119 persons
- Designed to handle 12MW turbines
- \$500M price tag.
- Up to 3 years to build.
- Dominion announced that other energy companies would be allowed to charter the vessel; however, other solutions will be required or parallel development.



Source: Dominion Energy, gCaptain article “New Details on First Jones Act Wind Turbine Installation Vessel” Feb 2021

MiNO & 2nd Wind Super Feeder



- Designed for next generation wind turbines
- 65m working water depth, unrestricted service
- 12kts fully loaded
- 124m x 40m x 9m
- Accom. for 60 persons
- Simulations show that two feeders reduce installation time by up to 30%

TABLE 1: SCENARIO PERFORMANCE RESULTS

	1. WTIV	2. Whole WFFV	3. Partial WFFV	4. Partial WFFV
Vessels (WTIV + WFFVs)	1	3	3	4
Project Duration	37 days	26 days	28 days	28 days
Baseline Slack	-	11 days	9 days	9 days
Average Time	59 hrs	40 hrs	44 hrs	45 hrs
Slack	-	24 hrs	0 hrs	9 hrs

Service Operation Vessel (SOV)



The Service Operation Vessel will be engineered, constructed and operated by ECO.

Source: ECO Press Release

- 1st Jones Act Compliant SOV
- Long-term charter for Orsted and Eversource to support Revolution Wind, South Fork Wind, and Sunrise Wind offshore wind farms
- 260ft in length
- 60 Passenger capacity
- Diesel Electric, EPA Tier 4
- Heave compensating gangway
- Comfort amenities and below deck storage for WTG components and supplies
- Stays offshore for weeks at a time

“Walk-to-Work” – Luxury Floatels

- “High standard keeps up spirits after long shifts: Returning to the vessel at the end of a long day, the high comfort on board soothes the body and mind. Everyone has single cabins, with heated bathroom floor, and their own satellite tv. There is no noise from the engines to be detected in the cabins.” Ulstein.
- “Food is the hub: The mess is the natural hub for the people on board. Hot meals are served twice daily, and food and sweets are readily available. The high-class chefs and the delicious food, and the gathering around the dinner table, are very important aspects for the social life on board. The vessel also offers a cinema, a spacious and well-equipped gymnasium, an outdoor whirl pool, and a sauna for the ultimate relaxation. The high-class comfort is important for everybody working – and living – half the year on board the vessel.” Ulstein.
- Transfers from SOVs to turbines are enabled via 3D motion compensated gangways.



Crew Transfer Vessel (CTV)

- Atlantic Pioneer was the 1st Jones Act Compliant CTV
- Commissioned in 2015 for servicing the Block Island Wind Farm
- 62ft in length, 24ft breadth
- 16 passenger capacity
- 30 kts
- Larger CTVs are on the way (typically around 24m in length with some larger)
- Hulls typically catamaran



Source: Atlantic Wind Transfers Website

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THANK YOU