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Learning from the Experts Webinar Series

Vessel Types

Noe Rouxel
Offshore Wind Advisory – North America
DNV

May 11, 2022

DNV

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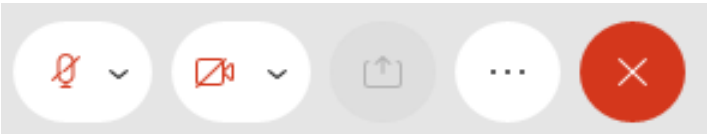

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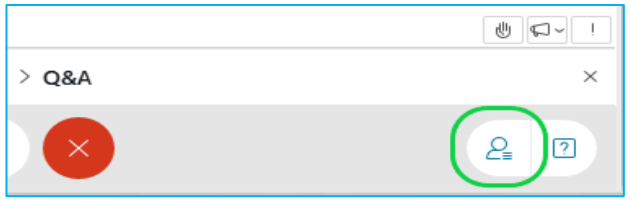

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Learning from the Experts

This webinar series is hosted by NYSERDA's offshore wind team and features experts in offshore wind technologies, development practices, and related research.

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WHEN TRUST MATTERS

Vessels for Offshore Wind

Noe Rouxel, Offshore Wind Advisory – North America

11 May 2022

Content

1. Who is DNV

2a. Maritime activity on an offshore wind farm

    2b. Details on the most impactful vessels

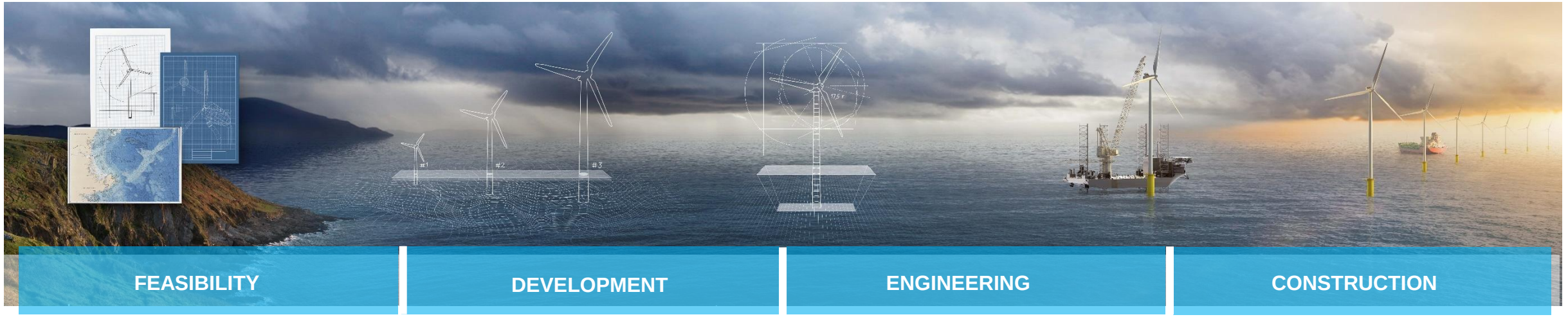
3. The Jones Act

4. Expected demand in the US

5. Industry trends

Who is DNV

Offshore Wind Advisory Services



FEASIBILITY	DEVELOPMENT	ENGINEERING	CONSTRUCTION
▪ Lease area evaluations ▪ Feasibility studies ▪ CAPEX & OPEX estimation ▪ Energy assessment & remote sensing technology selection ▪ LiDAR validation ▪ Survey design & oversight ▪ Survey data management	▪ Avian risk assessment ▪ Environmental studies ▪ SAP/COP preparation ▪ Navigation risk assessment ▪ Third party EIS preparation ▪ State RFP bid preparation ▪ Interconnection studies ▪ Decommissioning studies ▪ Stakeholder Engagement	▪ Technical due diligence ▪ Lenders Technical Advisor ▪ Supply contract review ▪ Manufacturing observation	▪ Marine Warranty Surveyor ▪ Construction monitoring ▪ Power performance testing

Maritime activity on an Offshore Wind Farm

Life cycle of a wind farm

Different activities in the different phases of the project:

Development

- Bathymetry Surveys
- Geotechnical Surveys
- UXO Surveys
- Floating Lidar installation

Construction

- Component transport
- Seabed Preparation
- Foundation installation
- Cable Laying
- Wind Turbine Installation
- OSS installation
- Scour protection installation
- Crew Transfer

Operation & Maintenance

- Inspections
- Preventive and light maintenance
- Subsea inspections
- Replacement of major components
- Crew Transfer

Decommissioning

- Foundation removal
- Cable removal
- Wind Turbine removal
- Dredging
- Component transport
- Crew Transfer

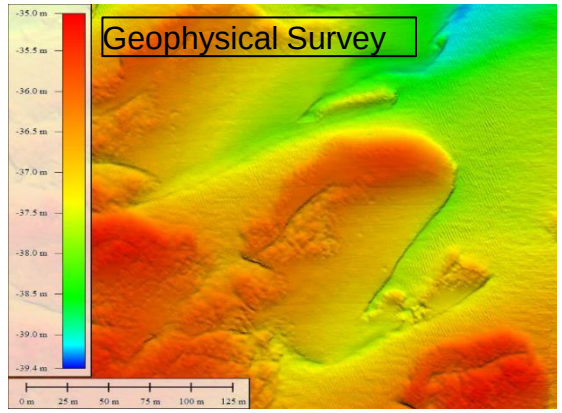
Development and permitting phase

Medium-sized vessels, collecting site data

Development

- Bathymetry Surveys
- Geotechnical Surveys
- UXO surveys
- Floating Lidar installation

Vessels	Type
	Metocean Survey Buoy Deployment
	Environmental Survey
	Geotechnical Survey/Jack Up/ Floating Drill Vessel
	Geophysical Survey



Construction Phase (1/6)

Component transport

Construction

- Component transport
- Seabed Preparation
- Foundation installation
- Cable Laying
- Wind Turbine Installation
- OSS installation
- Scour protection installation
- Crew Transfer

Barge and Tug

- Transport of large components (Offshore Substation Foundation and Topside, Jackets,…)

Transport vessel

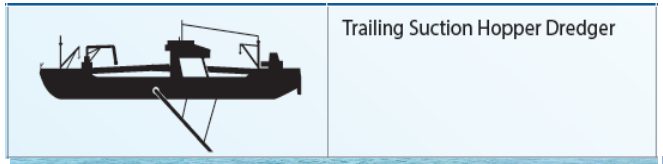
- Long distance transport of wind turbine components

Construction Phase (2/6)

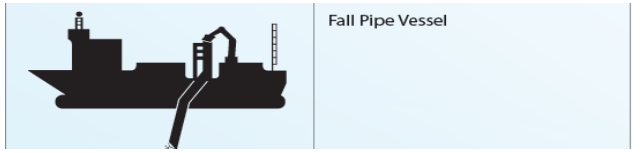
Seabed preparation and rock dumping

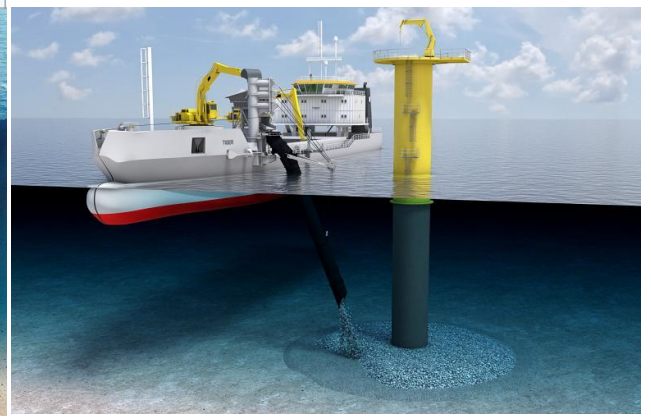
Construction

- Component transport
- Seabed Preparation
- Foundation installation
- Cable Laying
- Wind Turbine Installation
- OSS installation
- Scour protection installation
- Crew Transfer



- Deepening of port accesses
- Flattening of sand waves on seabed
- Levelling of seabed before the installation of gravity based foundations (GBS)





- Installation of scour protection around monopiles
- Protection of subsea cables
- Installation of rock matt for the GBS

Construction Phase (3/6)

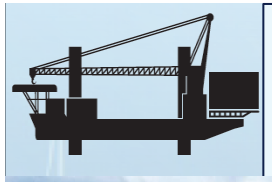
Installation of the foundations

Construction

- Component transport
- Seabed Preparation
- Foundation installation
- Cable Laying
- Wind Turbine Installation
- OSS installation
- Scour protection installation
- Crew Transfer

Heavy Lift Vessel (HLV)

- Installation of components requiring heavy liftings (monopiles, Jackets, OSS,…)



Jack-up crane vessel

- Lifting and Installation of foundations

Support and noise mitigation vessels

- Generation of bubble curtains to mitigate the noise generated by the pile driving

Construction Phase (4/6)

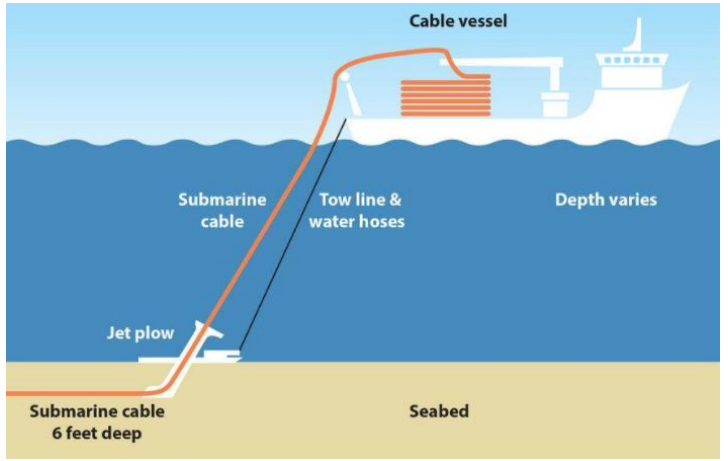
Cable Laying

Construction

- Component transport
- Seabed Preparation
- Foundation installation
- Cable Laying
- Wind Turbine Installation
- OSS installation
- Scour protection installation
- Crew Transfer

Cable Laying Vessel (CLV)

- Export cable Laying between the windfarm and the shore
- Inter-array cable laying between the wind turbines
- Cable burial (may be simultaneous to cable laying)
- Installation of cable protections

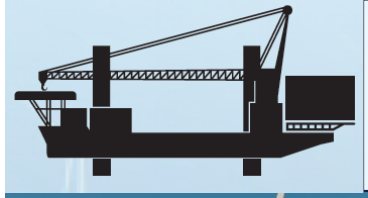


Construction Phase (5/6)

Wind turbine installation

Construction

- Component transport
- Seabed Preparation
- Foundation installation
- Cable Laying
- Wind Turbine Installation
- OSS installation
- Scour protection installation
- Crew Transfer



Wind Turbine installation vessel

- Transportation of components form marshalling harbour to offshore site
- Installation of wind turbine components:
  1. Mast
  2. Nacelle
  3. Blades (x3)

Construction Phase (5/6)

Wind turbine installation

Construction

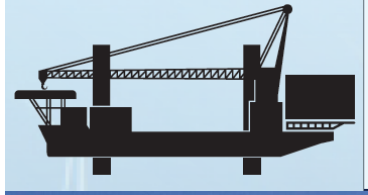
- Component transport
- Seabed Preparation
- Foundation installation
- Cable Laying
- Wind Turbine Installation
- OSS installation
- Scour protection installation
- Crew Transfer

Construction Phase (5/6)

OSS installation

Construction

- Component transport
- Seabed Preparation
- Foundation installation
- Cable Laying
- Wind Turbine Installation
- OSS installation
- Scour protection installation
- Crew Transfer



Semi Submersible crane vessel (SSCV)

- Installation of heavy structures (>5,000t) such as HVDC OSS topside and foundations.

- Crane capacity up to 24,000 t (2x12,000t)
- Good seakeeping

- Slow transit speed
- Small global fleet, based in northern Europe
- High cost

Construction Phase (6/6)

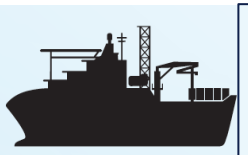
Personnel transfer and accommodation

Construction

- Component transport
- Seabed Preparation
- Foundation installation
- Cable Laying
- Wind Turbine Installation
- Scour protection installation
- Crew Transfer and accommodation

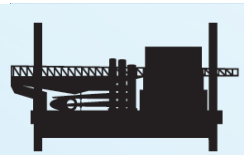
Crew Transfer Vessel (CTV)

- Crew changes of installation vessels
- Bring technicians and light equipment to the offshore structures



Service Operation Vessel (SOV)

- Conduct wind turbine commissioning
- Transfer crew and equipment to offshore structures
- House crew offshore



Accommodation platform or flotel

- Accommodate a high number of technicians offshore for the duration of the commissioning work

Operation & Maintenance Phase (1/2)

“Light” Maintenance and inspections

Operation & Maintenance

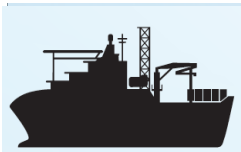
- Inspections
- Preventive and light maintenance
- Subsea inspections
- Crew Transfer
- Replacement of major components

Crew Transfer Vessel (CTV)

- Transfer of Maintenance technicians from shore to the offshore structures

Service Operation Vessel (SOV)

- Conducts wind turbine commissioning
- Transfer crew and equipment to offshore structures
- House crew offshore



Diving Support Vessel

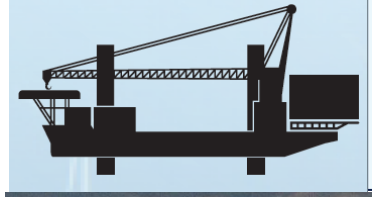
- Accommodate a high number of technicians offshore for the duration of the commissioning work

Operation & Maintenance Phase (1/2)

Exceptional heavy maintenance (replacement of a major component)

Operation & Maintenance

- Inspections
- Preventive and light maintenance
- Subsea inspections
- Crew Transfer
- Replacement of major components



Jack-up crane vessel (WTIV)

- Lifting and replacement of heavy components (blade, gearbox, generator, main transformer)

Floating Offshore Wind

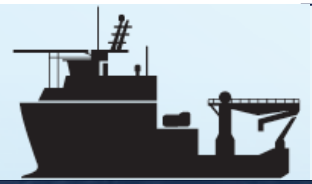
Component transport

FOW Construction

- Anchors and mooring lines installation
- Wind turbine towing
- Wind turbine hook-up

Anchor Handling Tugs (AHT)

- Tow the floating wind turbines (Turbine + Floating foundation) from the construction port to the installation site.
- Install certain types of anchors



Subsea construction vessels

- Install suction pile anchors
- May install inter-array cables and/or cable accessories
- Perform other subsea operations requiring lifting, ROV, etc…

Vessel details – most impactful

Wind Turbine Installation Vessel (WTIV)

- 4 or 6 legged
- Self-propelled: 8-12 knots typical transit speed
- Jack-up by hydraulic jacks typically
- Dynamically Positioned (DP)
- In transit Hs limit typically 2.5-3m
- Jacking up Hs limit typically 1.5-2.5m
- Lift capacity typically 500-3,000t

Fred.Olsen Windcarrier

+ Very good stability during lifts

- Long Jacking time (up & down process)
- Geotech. survey to be performed before installation
- May not be suitable for all seabed

Heavy Lift Vessel (HLV)

- Floating crane
- Self-propelled: 12-14 knots typical transit speed
- 8-point moored or Dynamically Positioned (DP)
- Working Hs limit typically 1-2 m (vessel and task dependent)
- Lift capacity typically 3,000-5,000 t
- Working stability from ballasting

+ suitable for any seabed
+ quick positioning
+ Fast transit speed
+ Higher crane capacity

- Less stable for precise lifts
- Reduced weather window
- Risk of “loosing” the position during operations

Heavy Lift Vessel (HLV)

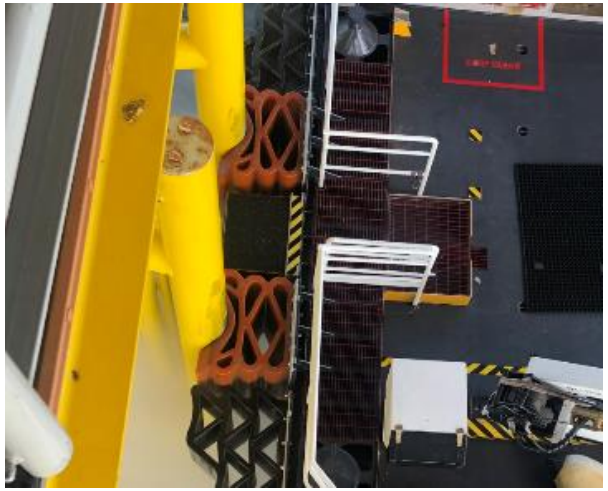
Crew Transport Vessel (CTV)

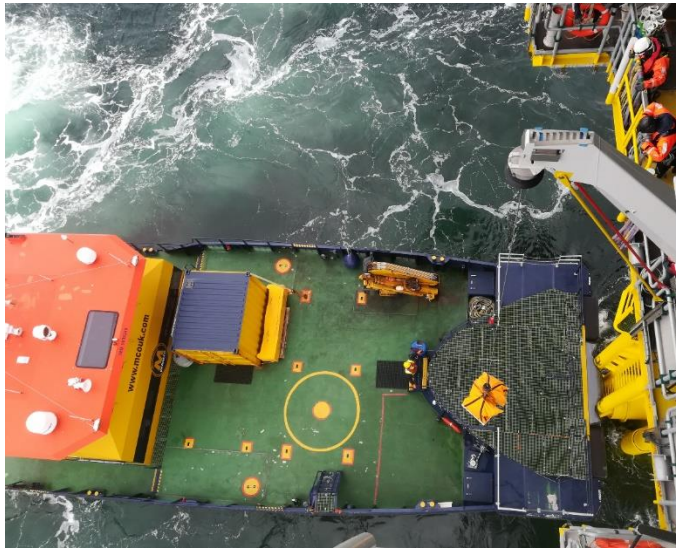
Main Features:

- Fast transit speed (18 to 35 knots)
- POB: 12 or 24
- Length: 20 to 35m
- Bow Fender adapted to boat landings
- Boat Landing transfer up to 1.5m significant waves

May also include:

- Deck space to carry 10 feet containers
- Capability to perform offshore bunkering
- Boat landing gripper systems
- Deck crane

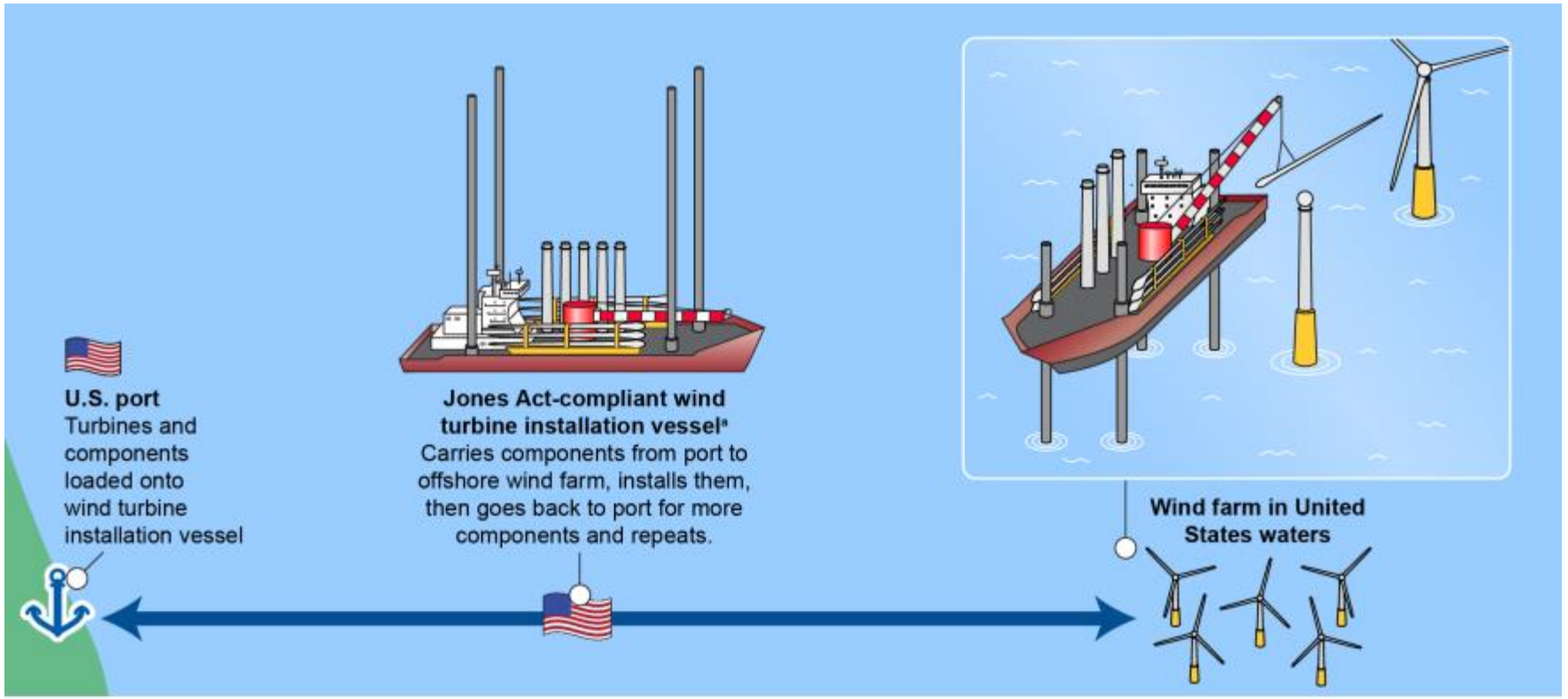




The Jones Act

The Jones Act

- Jones Act prevents non-U.S. ships engaging in coastwise trade from one U.S. point to another



Source: GAO

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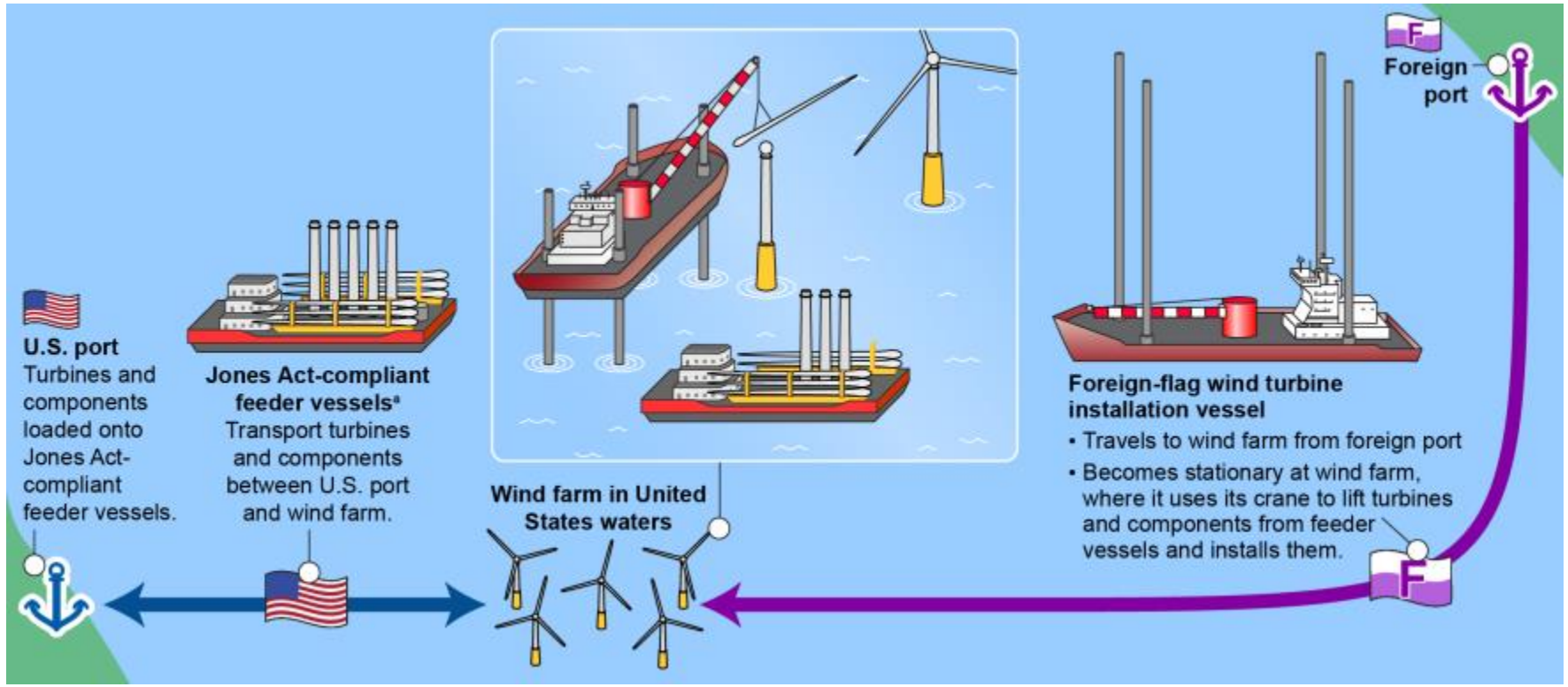
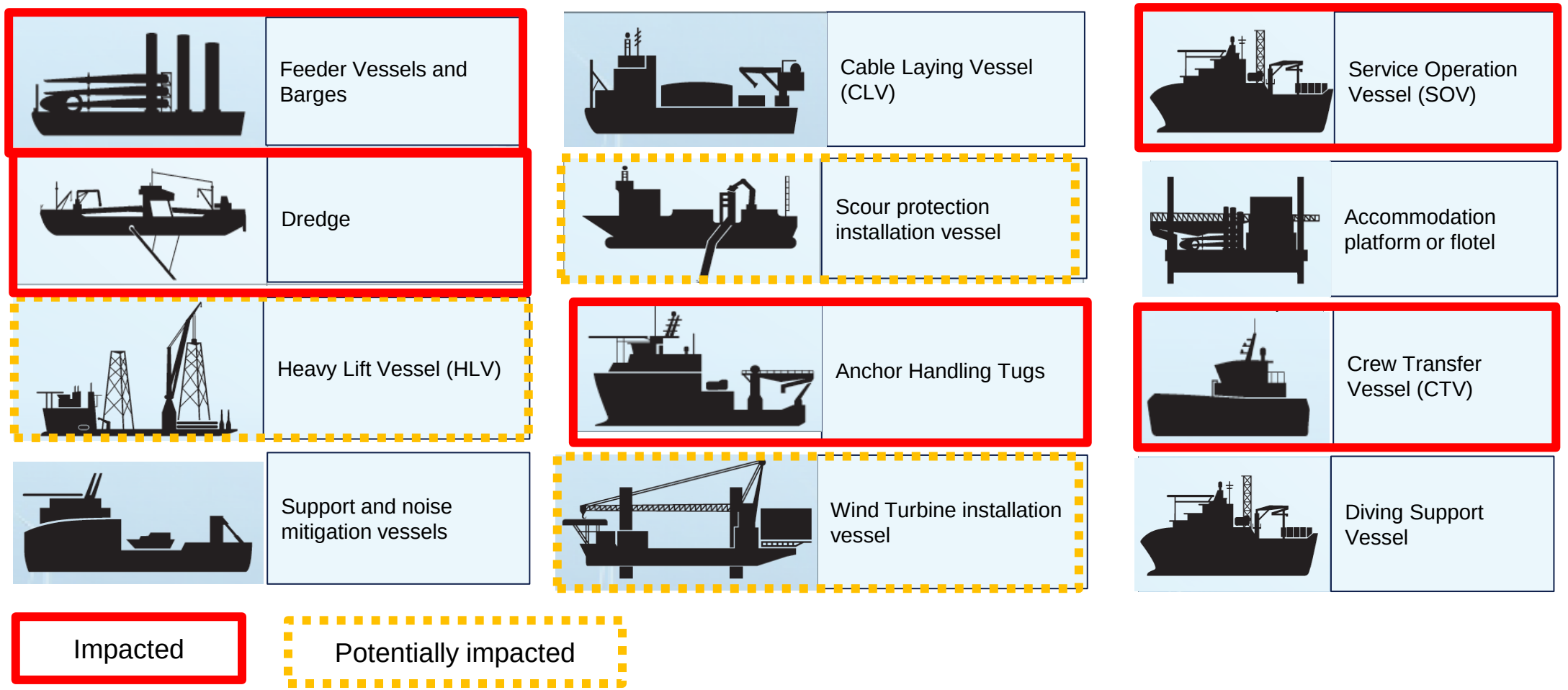


Source: GAO

The Jones Act

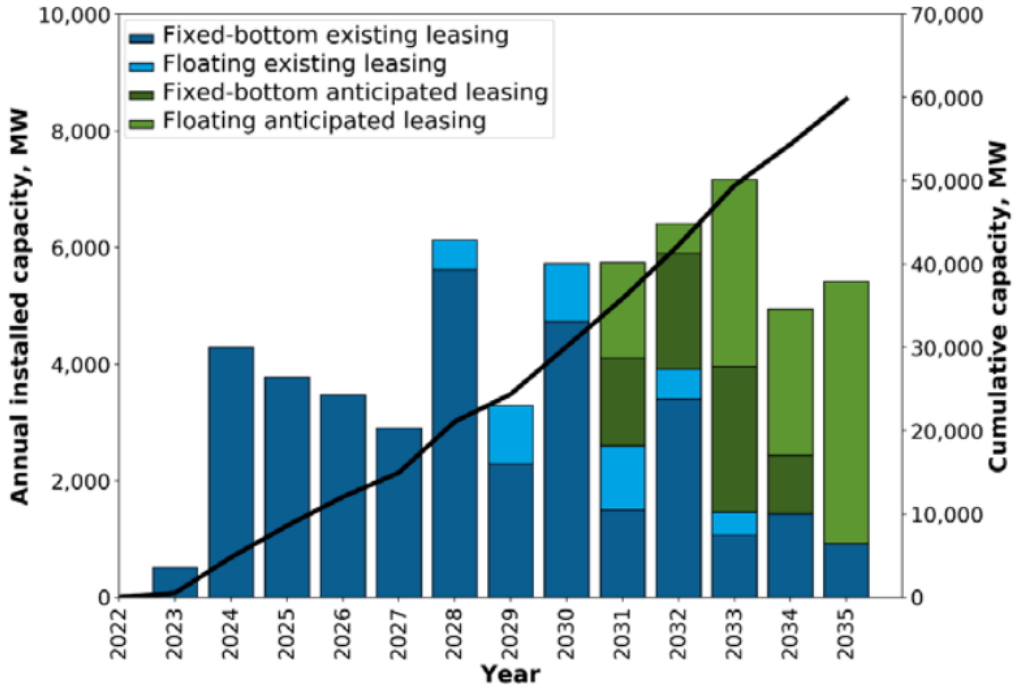
- The most impacted categories of vessels



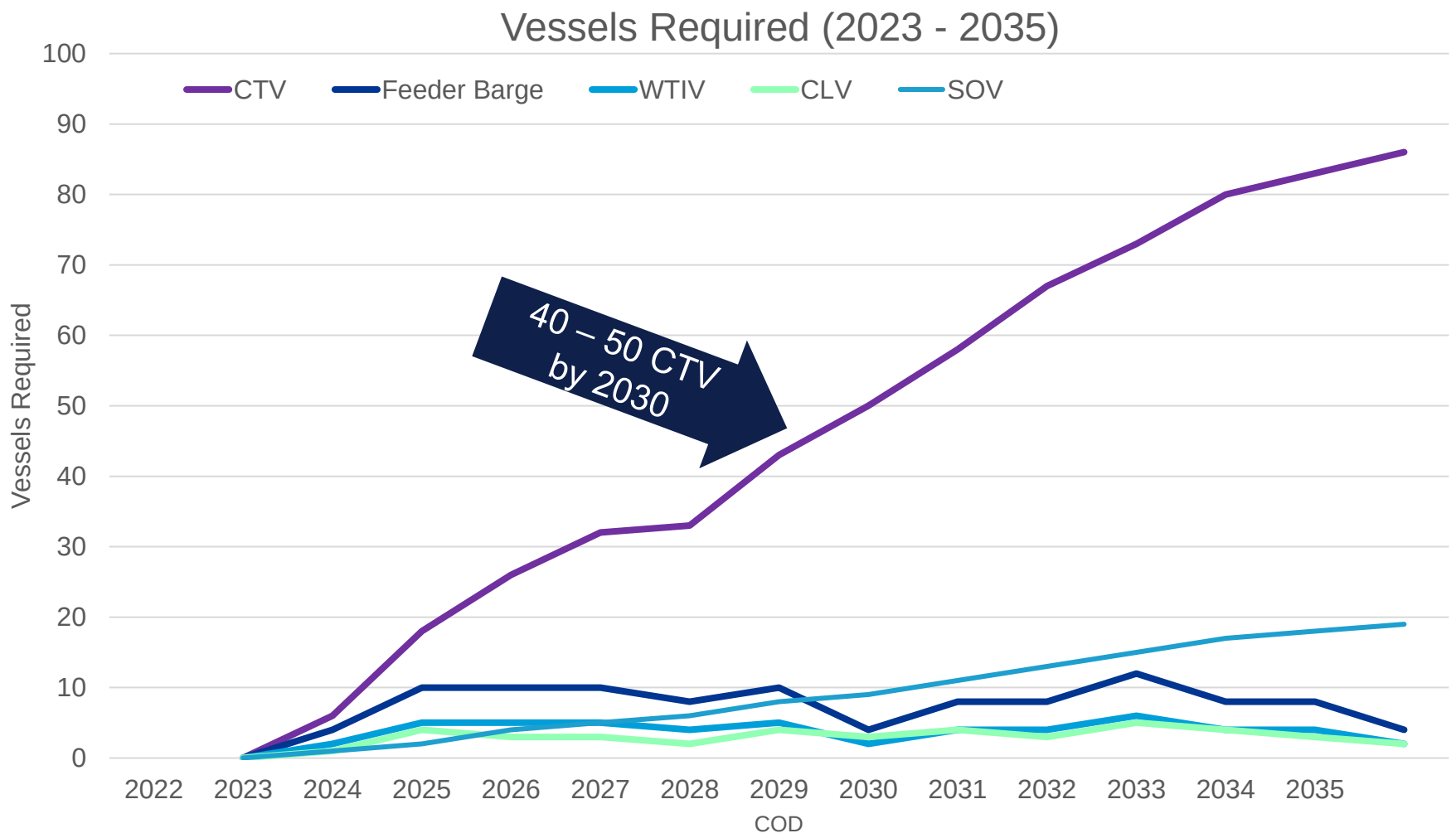
Expected demand

US demand forecast

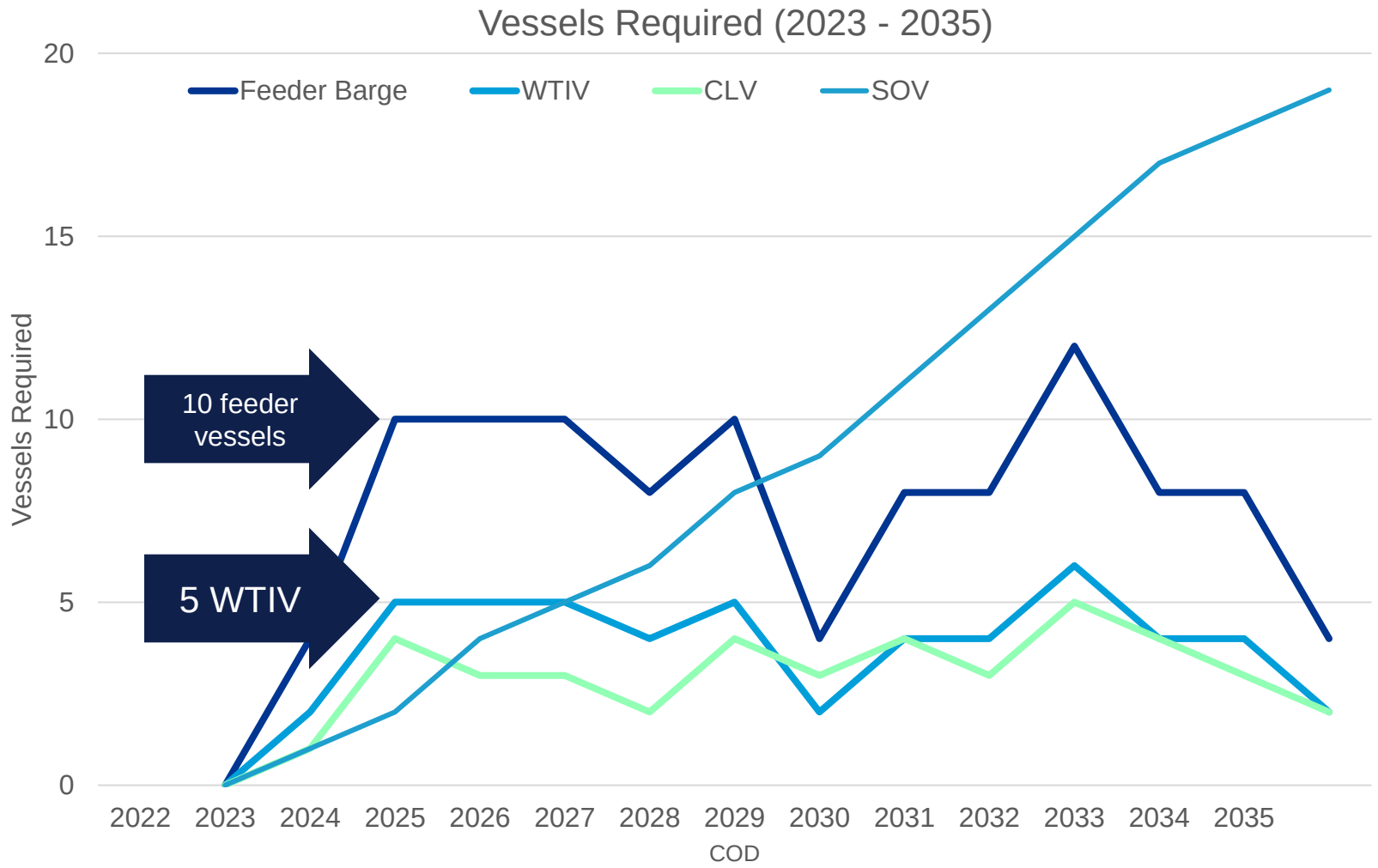
- In 2021 DNV, in collaboration with the National Renewable Energy Laboratory (NREL) and the Business Network for Offshore Wind evaluated how the U.S. supply chain can evolve to achieve the national offshore wind energy target and create local economic benefits.
- 30 GW by 2030… and more to come:
  - 2,100 Wind turbines and foundations
  - 6,800 Miles of cables



US demand forecast



US demand forecast



US Jones Act fleet

- The Existing and future US fleet:

1 Jones Act compliant WTIV in construction: **Charybdis (2,200t, 56m, 144m)**

- 2-3 SOVs under construction:

- CTV: 4 in operation + several under construction

- Significant Tugs and transport barge fleet

- 1 Scour protection installation vessel ordered

- Several US AHTS, mostly in the Gulf coast

Industry trends

Larger Installation vessels

- Wind turbines are expected to reach more than 22 MW in the next decade
- The newbuilt fleet needs to anticipate the increase of future structure sizes and project scale
  - Maximum hub height: up to 160 m
  - Nacelle weight up to 1000 tonnes
  - Blades up to 140 m
- More deck space to carry more and larger components

Development of integrated feeder vessels concepts

- DP feeder vessels
- WTIV/barges interfaces
- Jack-up feeder barges

Unmanned and Autonomous Vessels

- Surveys
- Guard/Safety vessels

Thank you

Any Questions?

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www.dnv.com

Coming Next:

May 25, 1:00 p.m. ET

Workforce Development

Phil Jordan, BW Research Partnership & Harvard University

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