

Capturing Offshore Wind Market Share
May 27, 2021

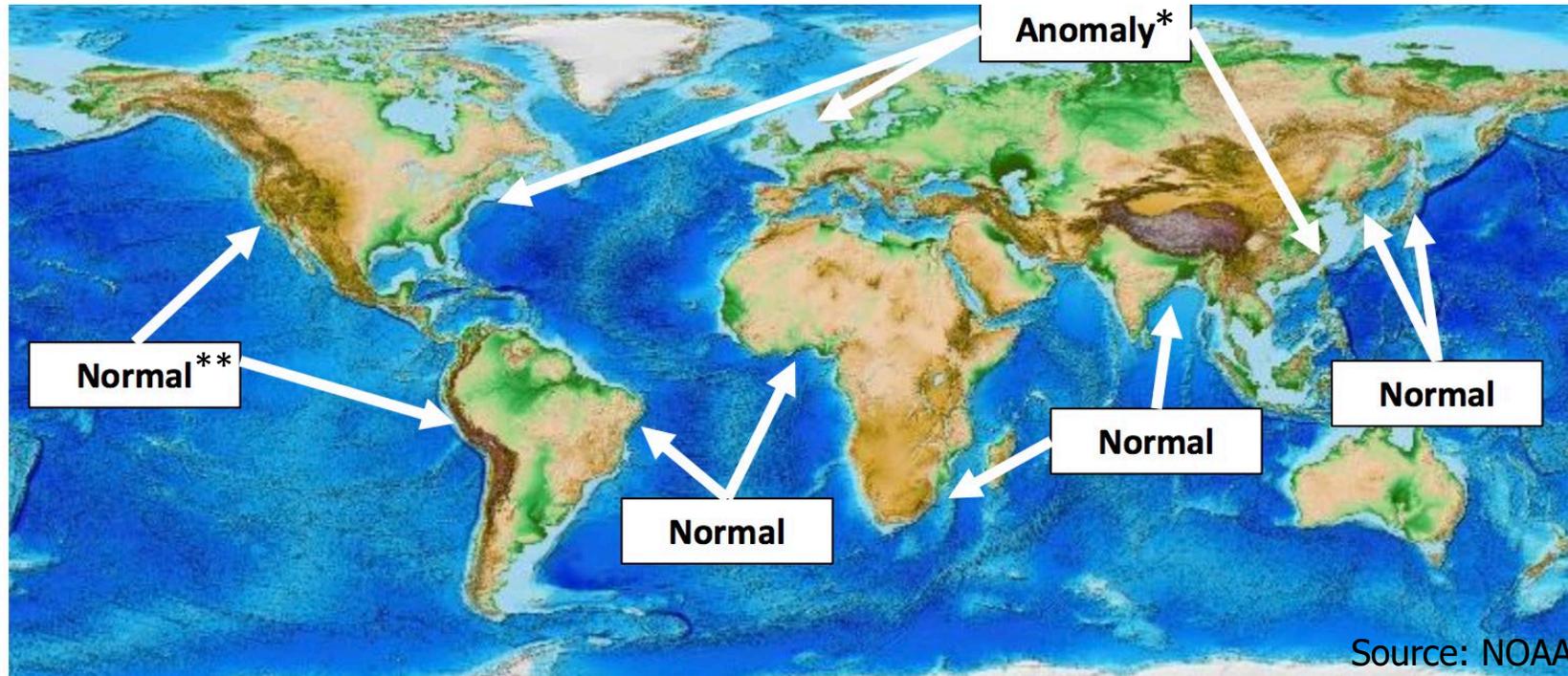
West Coast Offshore Wind

Presented by
Jim Lanard



Deep Water Projects on Floating Foundations – Meeting Market Demands

Water Depths Near Population Centers



*Anomaly: Limited world-wide shallow water areas (<50m) for fixed foundations

**Normal: Considerably more developable wind farm areas will require floating foundations

Foundation Technologies



Monopile

Jacket

Twisted Jacket

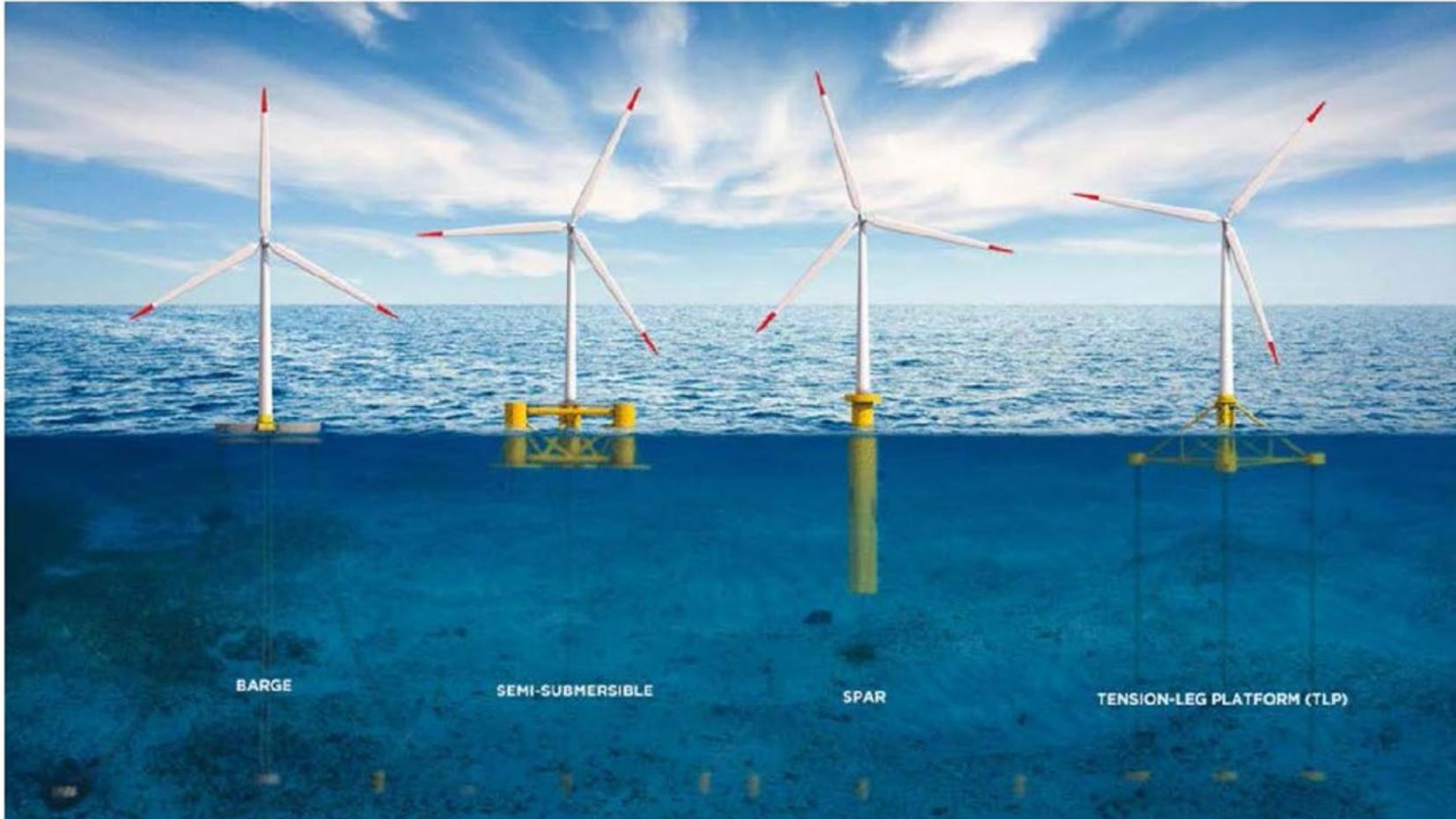
Semi-Sub

TLP

Spar

Source: NREL

Floating Foundation Designs – Four Broad Classes



Development of floating offshore wind foundations informed by experience with large-scale oil and gas platforms

Early versions have performed well

Source: NREL

Floating Offshore Wind Projects (Asia and the Middle East)

Project Name	Country	Status	COD	Project Size (MW)	Substructure Type	Substructure Name	Turbine	Site Water Depth (m)
Shanghai Electric Floating Demonstrator	China	Planning	2023	4	TBD	TBD	TBD	TBD
V-Type Floating Demonstration	China	Planning	2023	12	Spar	TBD	TBD	TBD
Kyushu Wind Lens	Japan	Operational	2012	0.06	Steel semisubmersible	Wind Lens Floater	3 kilowatts (kW) (RIAMWIND)	55
Fukushima Phase 1	Japan	Operational	2013	2	Steel semisubmersible	Fukushima Mirai	2 MW (Hitachi)	120
Fukushima Phase 2	Japan	Operational	2015	7	Steel semisubmersible	Fukushima Shimpuu	7 MW (Mitsubishi)	120
Fukushima Phase 2	Japan	Operational	2016	5	Steel spar	Hamakaze Spar	5 MW (Hitachi)	120
Goto Sakiyama	Japan	Operational	2016	2	Steel spar	Steel Spar	2 MW (Hitachi)	100
Hibiki Demo	Japan	Operational	2018	3	Barge	Ideol Damping Pool	3 MW (Aerodyn)	55
Kitakyushu NEDO	Japan	Operational	2019	3	Barge	Ideol Damping Pool	3 MW (Aerodyn)	100
Equinor-Hitachi Zosen	Japan	Planning	2022	TBD (Commercial Scale)	TBD	TBD	TBD	TBD
Acacia	Japan	Planning	2023	TBD (Commercial Scale)	Barge	Ideol Dampening Pool	8 MW	TBD
WindFloat Japan	Japan	Planning	TBD	TBD	Steel semisubmersible	PPI WindFloat	TBD	TBD
KFWind	South Korea	Permitting	2025	500	Steel semisubmersible	PPI WindFloat	63 x 8 MW (MHI Vestas)	150
Donghae Gray Whale	South Korea	Permitting	2025	200	TBD	TBD	TBD	150
Donghae TwinWind	South Korea	Permitting	2025	200	Multiturbine steel semisubmersible	Hexicon	20 x 10 MW	150
KNOC/Equinor	South Korea	Permitting	2026	200	TBD	TBD	TBD	150
Ulsan White Heron	South Korea	Permitting	2026	200	TBD	TBD	TBD	150
Donghae - MOTIE	South Korea	Planning	2022	200	Steel semisubmersible	TBD	TBD	TBD
Donghae 1	South Korea	Planning	2023	200	Spar	TBD	TBD	TBD
Ulsan Demos	South Korea	Planning	2021	5.75	Steel semisubmersible	TBD	TBD	TBD
Floating W1N	Taiwan	Planning	2025	500	Steel semisubmersible	TBD	TBD	TBD
EOLFI – W3	Taiwan	Planning	2030	500	TBD	TBD	TBD	TBD
Plambeck Emirates	Saudi Arabia	Planning	2024	500	Steel semisubmersible	Saipem HexaFloat	TBD	TBD

Floating Offshore Wind Projects (Europe)

Project Name	Country	Status	COD	Project Size (MW)	Substructure Type	Substructure Name	Turbine	Site Water Depth (m)
Floatgen Demo	France	Operational	2018	2	Barge	Ideol Dampening Pool	2 MW (MHI Vestas)	33
EOLMED (Gruissan)	France	Permitting	2021	25	Barge	Ideol Dampening Pool	4 x 6.2 MW (Senvion)	55
Provence Grand Large Wind Farm	France	Permitting	2021	25.2	Steel tension-leg platform	SBM Windfloater	3 x 8.4 MW (Siemens Gamesa)	90
EOLink Demo	France	Permitting	2021	6	Steel semisubmersible	EOLink	6 MW	36
EFGL - Les éoliennes flottantes du Golfe du Lion	France	Permitting	2022	30	Steel semisubmersible	PPI WindFloat	3 x 10 MW (MHI Vestas)	70
Groix-Belle-Ile	France	Permitting	2022	28.5	Steel semisubmersible	Naval Sea Reed	3 x 9.5 MW (MHI Vestas)	60
Bretagne Sud	France	Planning	2025	TBD	Steel semisubmersible	Naval Sea Reed	TBD	TBD
EOLMED (Commercial)	France	Planning	2025	250	Barge	Ideol Dampening Pool	TBD	TBD
EOLink Commercial	France	Planning	TBD	TBD	Steel semisubmersible	EOLink	TBD	TBD
Gicon SOF	Germany	Planning	2021	2.3	Steel tension-leg platform	Gicon TLP	2.3 MW (Siemens Gamesa)	TBD
AFLOWT	Ireland	Planning	2022	6	Steel semisubmersible	Saipem HexaFloat	TBD	100
Inis Ealga floating wind farm	Ireland	Planning	2026	700	TBD	TBD	TBD	TBD
Hywind I Demo	Norway	Operational	2009	2.3	Steel spar	Equinor Hywind	2.3 MW (Siemens Gamesa)	220
TetraSpar Demo	Norway	Permitting	2021	3.6	Steel spar	TetraSpar	3.6 MW (Siemens Gamesa)	200
FLAGSHIP Demonstration	Norway	Permitting	2022	10	Concrete semisubmersible	OO-Star Wind Floater	10 MW+ (TBD)	TBD
Hywind Tampen	Norway	Permitting	2022	88	Concrete spar	Equinor Hywind	11 x 8 MW (Siemens Gamesa)	300
NOAKA	Norway	Planning	TBD	TBD	Steel spar	Equinor Hywind	8 MW (Siemens Gamesa)	200
Test Area Stadt	Norway	Permitting	2025	10	TBD	TBD	TBD	TBD

Floating Offshore Wind Projects (Europe [Continued])

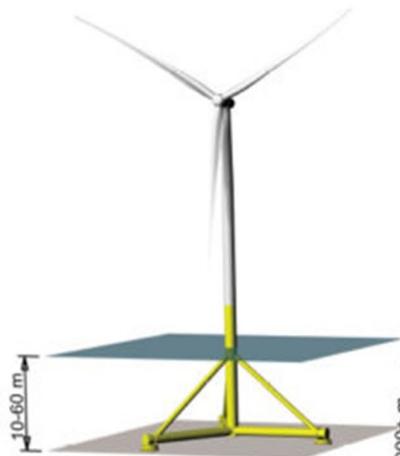
Project Name	Country	Status	COD	Project Size (MW)	Substructure Type	Substructure Name	Turbine	Site Water Depth (m)
WindFloat Atlantic	Portugal	Operational	2020	25	Steel semisubmersible	PPI WindFloat	3 x 8.3 MW (MHI Vestas)	100
W2Power	Spain	Operational	2019	0.02	Multiturbine steel semisubmersible	W2Power	100 kW	600
BlueSATH	Spain	Operational	2020	0.03	Concrete semisubmersible	SATH	Aeolos-H 30kW	80
DemoSATH	Spain	Operational	2020	2	Concrete semisubmersible	SATH	2 MW (XEMC Darwind)	80
Floating Power Plant	Spain	Planning	2021	8	Hybrid wind-wave semisubmersible	P80	5 MW+ (TBD)	600
FLOCAN 5	Spain	Planning	2024	25	Steel semisubmersible	TBD	TBD	TBD
X1 Wind	Spain	Permitting	2021	2	Steel tension-leg platform	PivotBuoy	2 MW (MHI Vestas)	600
Nautilus/Balea	Spain	Planning	2023	8	Steel semisubmersible	Nautilus Semi-sub	8 MW (TBD)	120
Equinor Floating Project (Juan Grande)	Spain	Planning	2024	200	Steel spar	Equinor Hywind	TBD	TBD
Iberdrola Demo	Spain	Planning	TBD	TBD	TBD	TBD	TBD	TBD
CanArray	Spain	Planning	TBD	TBD	Multiturbine steel semisubmersible	W2Power	6 MW (TBD)	600
SeaTwirl 1	Sweden	Operational	2015	0.03	Steel spar (VAWT*)	SeaTwirl	30-kW VAWT	35
SeaTwirl 2	Sweden	Permitting	2021	1	Steel spar (VAWT)	SeaTwirl	1-MW VAWT	100
Hywind Scotland	UK	Operational	2017	30	Steel spar	Equinor Hywind	6 MW (Siemens Gamesa)	112
Kincardine Phase 1	UK	Operational	2018	2	Steel semisubmersible	PPI WindFloat	2 MW (MHI Vestas)	62
Kincardine Phase 2	UK	Under Construction	2020	50	Steel semisubmersible	PPI WindFloat	5 x 9.5 MW (MHI Vestas)	62
Marine Power Systems	UK	Planning	2023	TBD	Wind-wave hybrid steel semisubmersible	DualSub	TBD	TBD
Dolphyn Phase 1	UK	Planning	2024	2	Steel semisubmersible	PPI WindFloat +Electrolyzer	2 MW (MHI Vestas)	TBD
Erebus	UK	Planning	2025	96	Steel semisubmersible	PPI WindFloat	TBD	70
Dolphyn Phase 2	UK	Planning	2027	400	Steel semisubmersible	PPI WindFloat +Electrolyzer	10 MW	TBD
Dounreay Tri	UK	Planning	TBD	10	Multiturbine steel semisubmersible	Hexicon	5 MW (TBD)	TBD
Katanes Floating Energy Park	UK	Planning	2022	8	Hybrid wind-wave semisubmersible	P80	5 MW+ (TBD)	TBD
Dyfed Floating Energy Park	UK	Planning	TBD	TBD	Hybrid wind-wave semisubmersible	P80	5 MW+ (TBD)	TBD

Floating Offshore Wind Projects (North America)

Project Name	Country	Status	COD	Project Size (MW)	Substructure Type	Substructure Name	Turbine	Site Water Depth (m)
Aqua Ventus	United States	Permitting	2023	12	Concrete semisubmersible	VoltturnUS	10 MW + (TBD)	100
Castle Wind	United States	Planning	TBD	1,000	Steel semisubmersible	TBD	TBD	900
Magellan Stiesdal	United States	Planning	TBD	TBD	Steel spar	TetraSpar	TBD	TBD
Oahu North	United States	Planning	TBD	400	Steel semisubmersible	TBD	TBD	850
Oahu South	United States	Planning	TBD	400	Steel semisubmersible	TBD	TBD	650
Progression South	United States	Planning	TBD	400	Steel semisubmersible	TBD	TBD	600
Redwood Coast	United States	Planning	TBD	150	Steel semisubmersible	PPI WindFloat	8 MW+ (TBD)	600

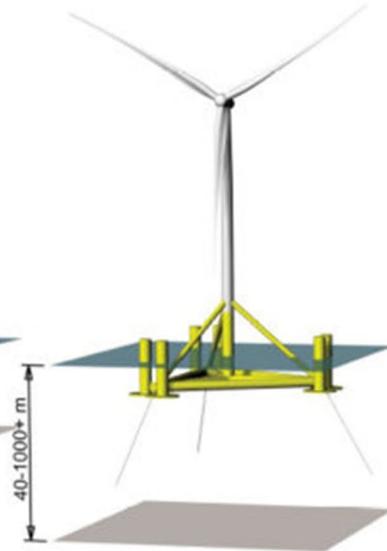
Source: Offshore Wind California

Industrialized Tetra Foundations from Stiesdal Offshore Technologies – A Promising Approach



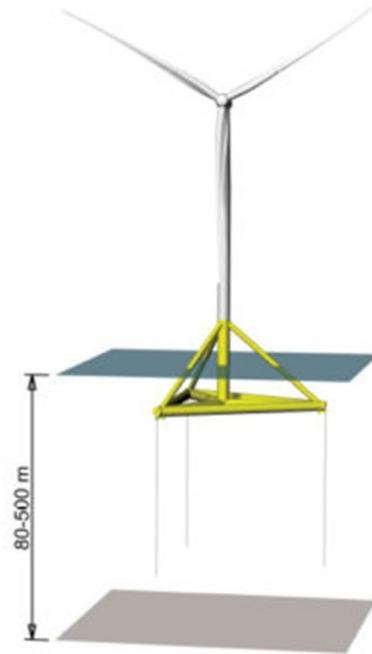
TetraBase®
Fixed foundation

Bottom-fixed foundation with crane-free offshore installation. Suited for 10-60 m depth.



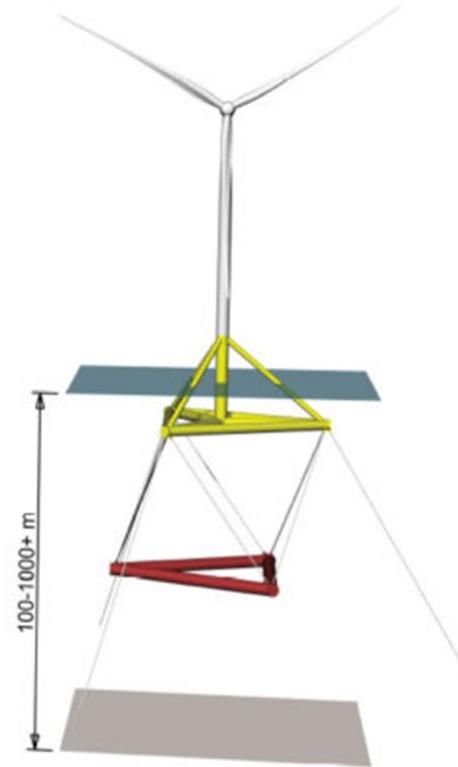
TetraSub®
Floating foundation

Floating foundation in semisubmersible configuration. Suited for 40-1000+ m depth.



TetraTLP®
Floating foundation

Floating foundation in tension-leg platform configuration. Suited for 80-500 m depth.



TetraSpar®
Floating foundation

Floating foundation in spar-buoy configuration. Suited for 100-1000+ m depth.

Manufacturing Opportunities



The components for the Tetra foundations were manufactured by Welcon A/S in Give, Denmark. Welcon is the world's leading supplier of offshore wind turbine towers, and its automated production lines are ideally suited for the manufacturing of the tubular braces and tanks for the Tetra concept. Photo credit: The TetraSpar Demonstrator Project ApS

Transportation opportunities



Road transport, center column. Photo credit: The TetraSpar Demonstrator Project ApS

Assembly jobs



Up-ending of the center column at the port of Grenaa, Denmark.
Photo credit: The TetraSpar Demonstrator Project ApS

Assembly



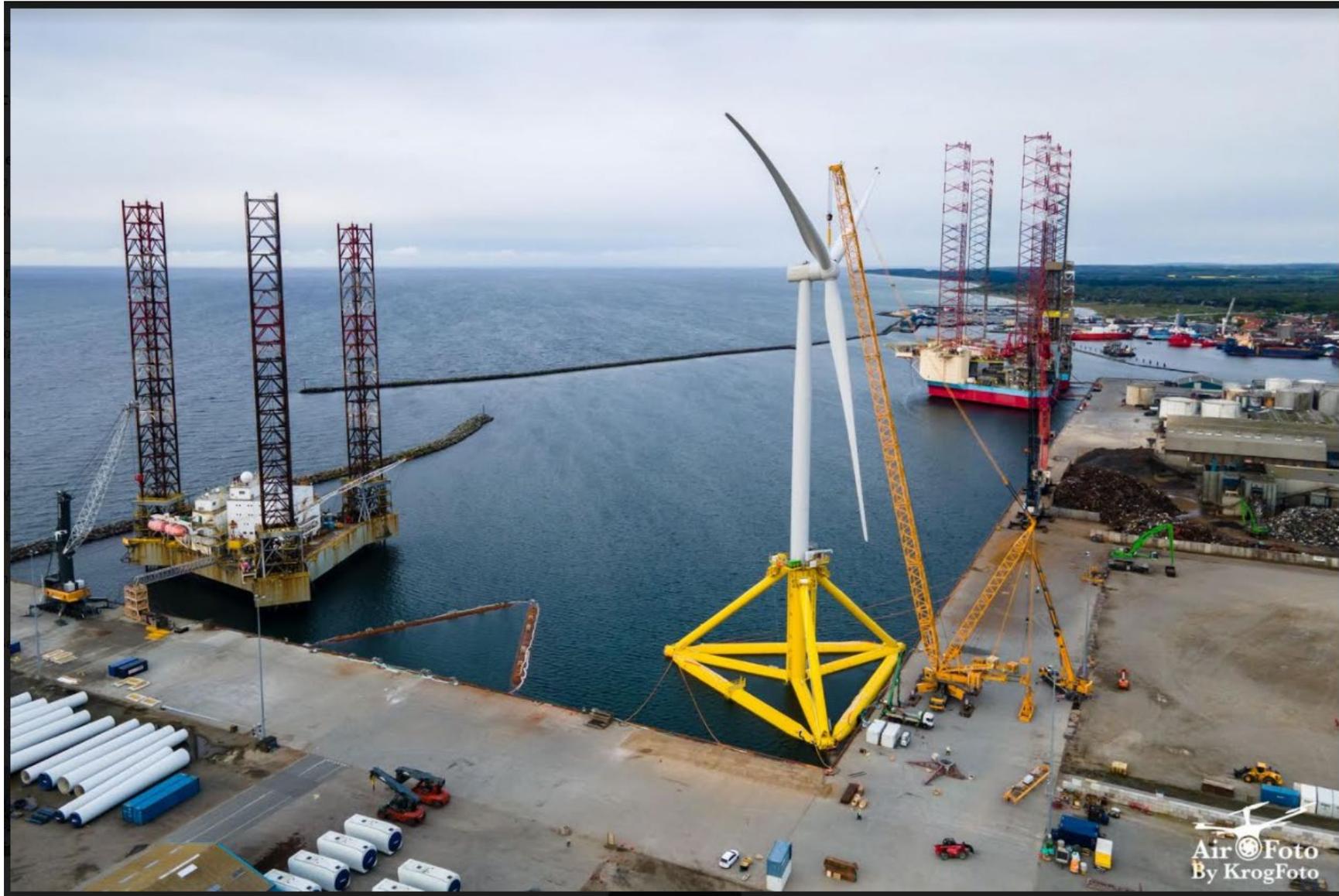
Mounting of the diagonals using maintenance-free proprietary technologies for fast assembly.
Photo credit: The TetraSpar Demonstrator Project ApS

Completed Foundation and Keel



Completed foundation and keel. Photo credit: The TetraSpar Demonstrator Project ApS

Preparing TetraSpar Demo for Tow Out



Assembly and Transport of SOT Foundations

Serialized Assembly of TetraBase Foundation



Important factors for utility-scale deployment

- Work with existing quayside depths
- Minimize use of expensive infrastructure (e.g., drydocks)
- Avoid need for specialized installation vessels (especially in the US)

OSW Jobs (partial list)

- Welder
- Crane operator
- Ironworker
- Heavy equipment operator
- Industrial electrician
- Warehouse manager
- Fuel bunkering
- Painter
- Sandblaster
- Machinist
- Millwright
- Carousel and tensioner operator
- Laborer
- Pilot
- Helicopter repair technician
- Emergency response personnel
- Master (Captain)
- Deck officer
- Deck cadet
- Diver
- ROV operator
- ROV technician
- ROV vessel crew
- Marine engineer
- Rigger
- Hoist and winch operator
- Elevator technician
- Plumber
- HVAC technician
- Protective coating technician
- Wind turbine technician
- Plater
- Scaffolder
- Cable jointer
- Rope access technician
- Fiber optics technician

US DOD's Siting Clearinghouse Works with BOEM to Deconflict OSW Activities in NY Bight

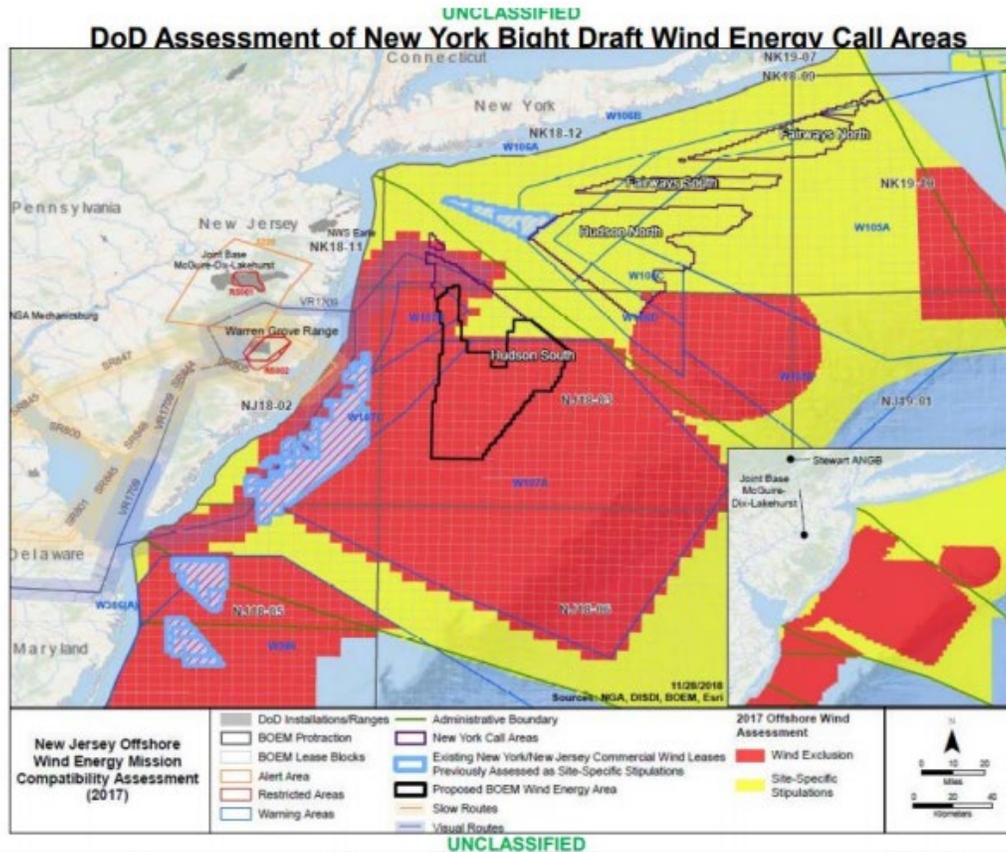


Figure 11: Preliminary DOD Offshore Wind Compatibility Assessment as presented by the DOD at the November 28, 2018, New York Bight Task Force Meeting.

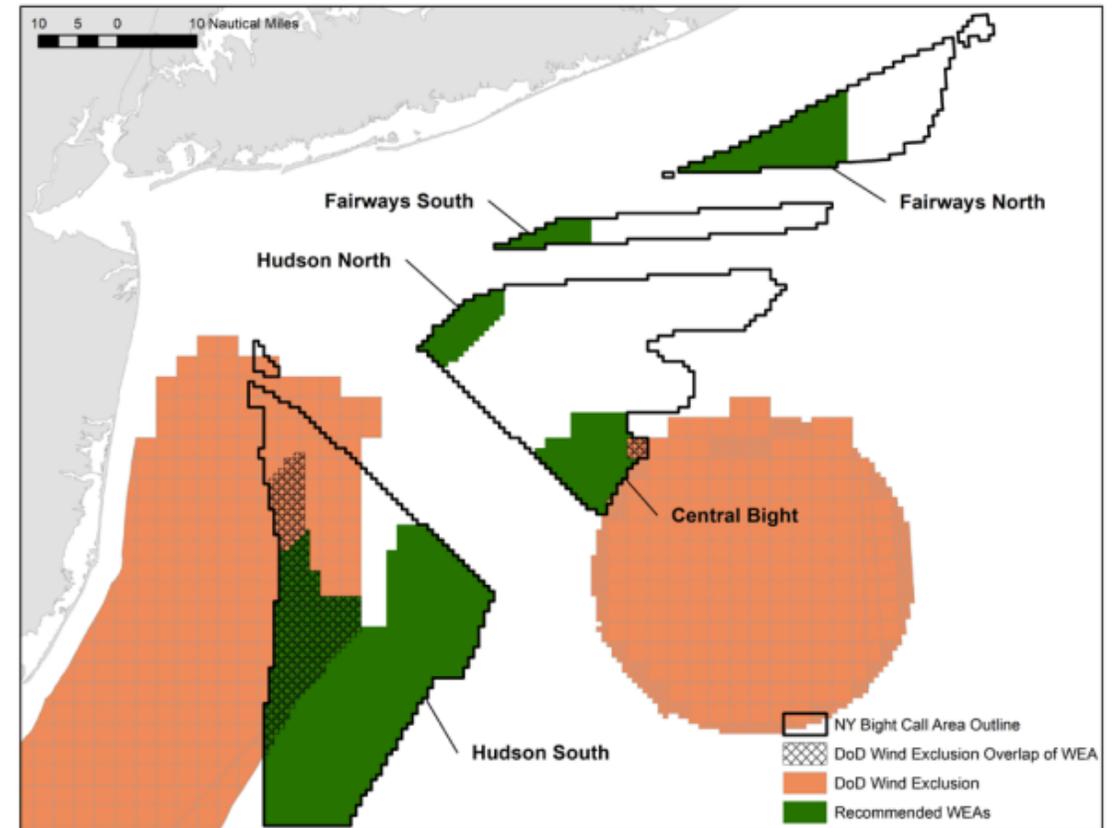
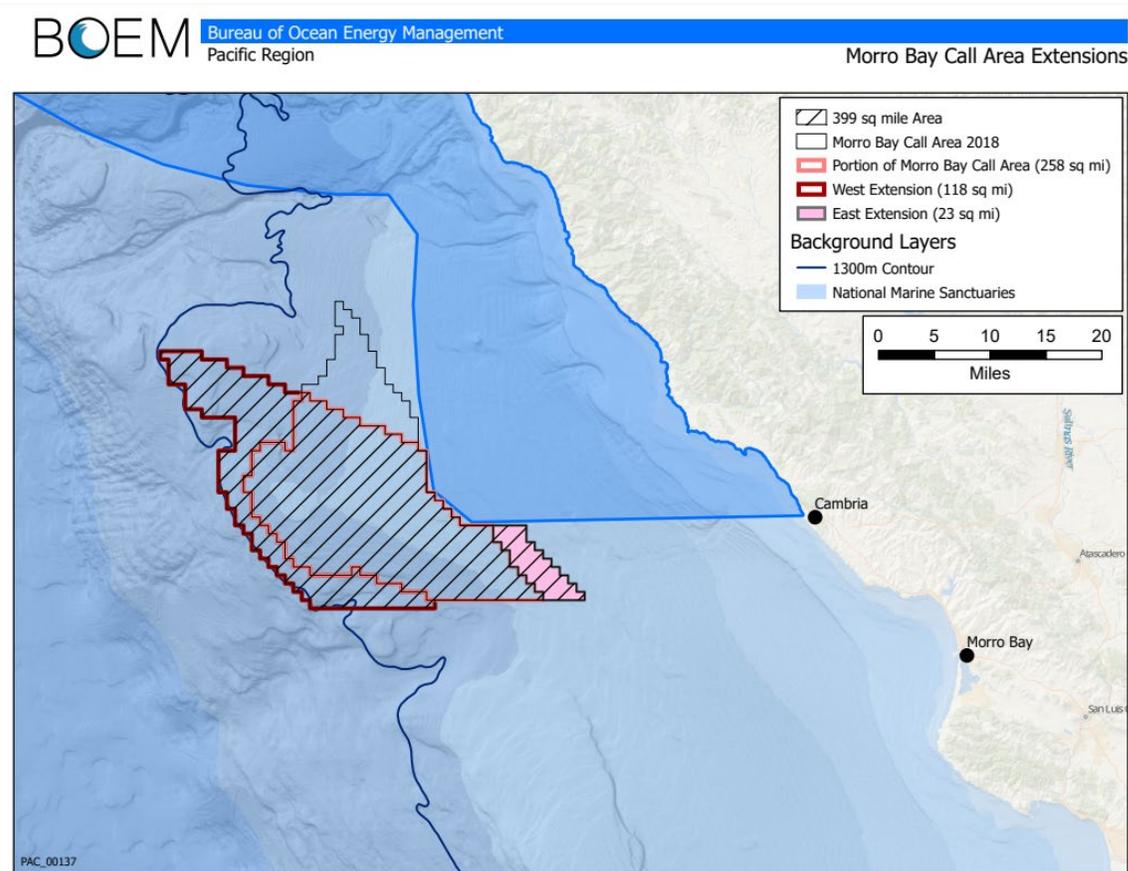
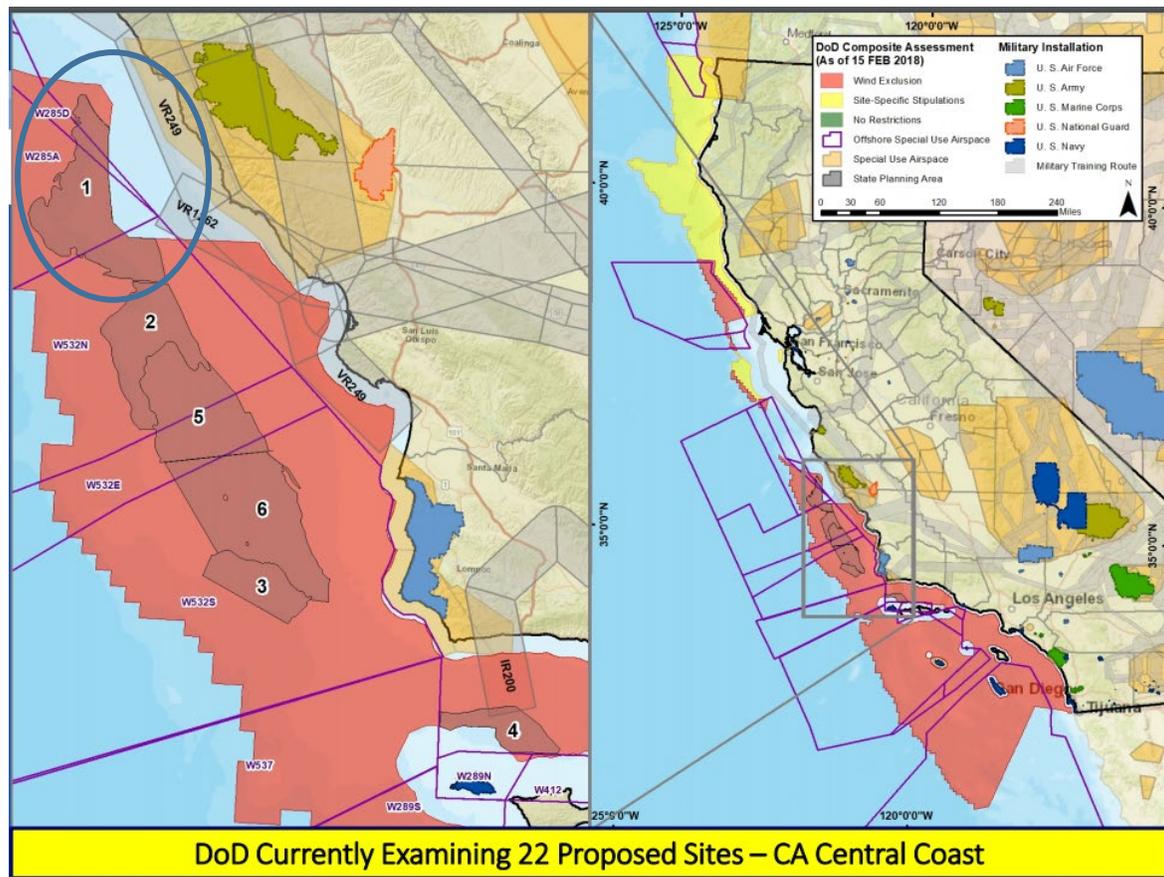


Figure 12: December 2020 DOD Offshore Wind Compatibility Assessment

Source: US DOI BOEM Memo by James F. Bennett on NY Bight Area ID (March 26, 2021)

US DOI—US DOD—Newsom Administration Resolve Use Conflicts; Advance OSW off Morro Bay



Source: BOEM CA Intergovernmental RE Task Force, September 17, 2018

Source: US DOI BOEM, May 25, 2021

Offshore Wind for California

- CA SB 100 Report
 - 140 GW of new RE needed by 2045
 - 10 GW of that should be OSW; saves ratepayers \$900M by 2045
- Costs associated with 1 GW OSW Farm
 - CapEx (excl transmission and substation) \$3B
 - Transmission and substation (TBD)
 - OpEx \$55M per year (rough estimate)
- Community Benefits Considerations
 - Areas served by power purchasers (CCAs)
 - Points of interconnect for transmission
 - Assembly/fabrication and O&M ports
 - Underserved communities
- Outreach to
 - EJ groups
 - Tribal Nations
 - Fishing industry



Crystal Ball Gazing

- CA
 - Auctions mid-2022 (*confirmed!*)
 - Highly competitive auctions with many qualified bidders – including “oil majors” with intent to become “energy majors”
 - 3-4 leases off Central Coast
 - 2-3 leases off North Coast
 - State agencies rapidly gear up to adopt OSW policies and act on permit and transmission applications
- HI
 - Auctions similar in timing to CAs?
 - Several developers previously submitted unsolicited lease applications
 - BOEM published Call for Nominations in 2016
- OR
 - Government and stakeholders re-energized
 - Auctions soon after CA’s



Source: NREL 2019 Offshore Wind Technology Data Update (Oct. 2020)

Thanks for Your Attention

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Stiesdal

Turbine installation



Source: TetraSpar Demo
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Photo courtesy of Welcon A/S