Planning for Offshore Wind Infrastructure on the U.S. West Coast

PIANC APAC 2024

Presenter: Jennifer Lim

moffatt & nichol

Who We Are

moffatt & nichol

Creative People, Practical Solutions.®

- Port Infrastructure Consultant
- Since 1945, Naval Shipyards in Long Beach
- Experts where land meets water
- West & East Coasts, & Gulf of Mexico coastline
- Ports & Harbors
- All Maritime Business Lines
  - Offshore wind, containers, bulk cargo, marinas, etc.

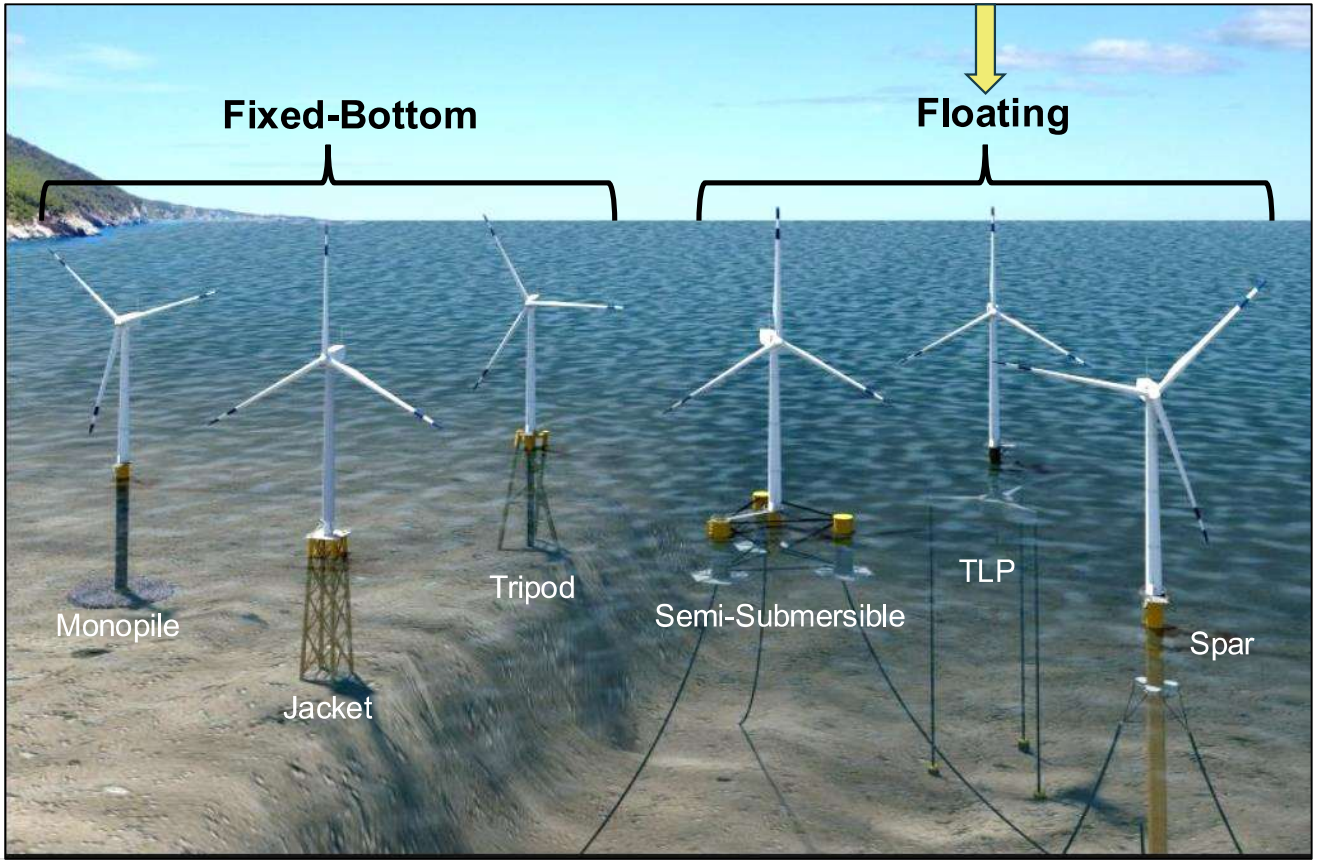
Jennifer Lim, P.E.

- Marine Structural Engineer
- Port Infrastructure Expert
- Offshore Wind Ports
- Author of Federal / State Offshore Wind Report for BOEM, California State Lands Commission, and NREL
- Project Manager of Port of Long Beach Pier Wind Project

Fixed-Bottom vs. Floating Offshore Wind

- **Fixed-Bottom WTG:**
  - Attached to the seabed by monopiles or jacket structures
  - Water Depth < 200 ft (60 m)
- **Floating WTG:**
  - Buoyant and stabilized to seabed via mooring lines and anchors
  - Water Depth > 200 ft (60 m)

U.S. West Coast



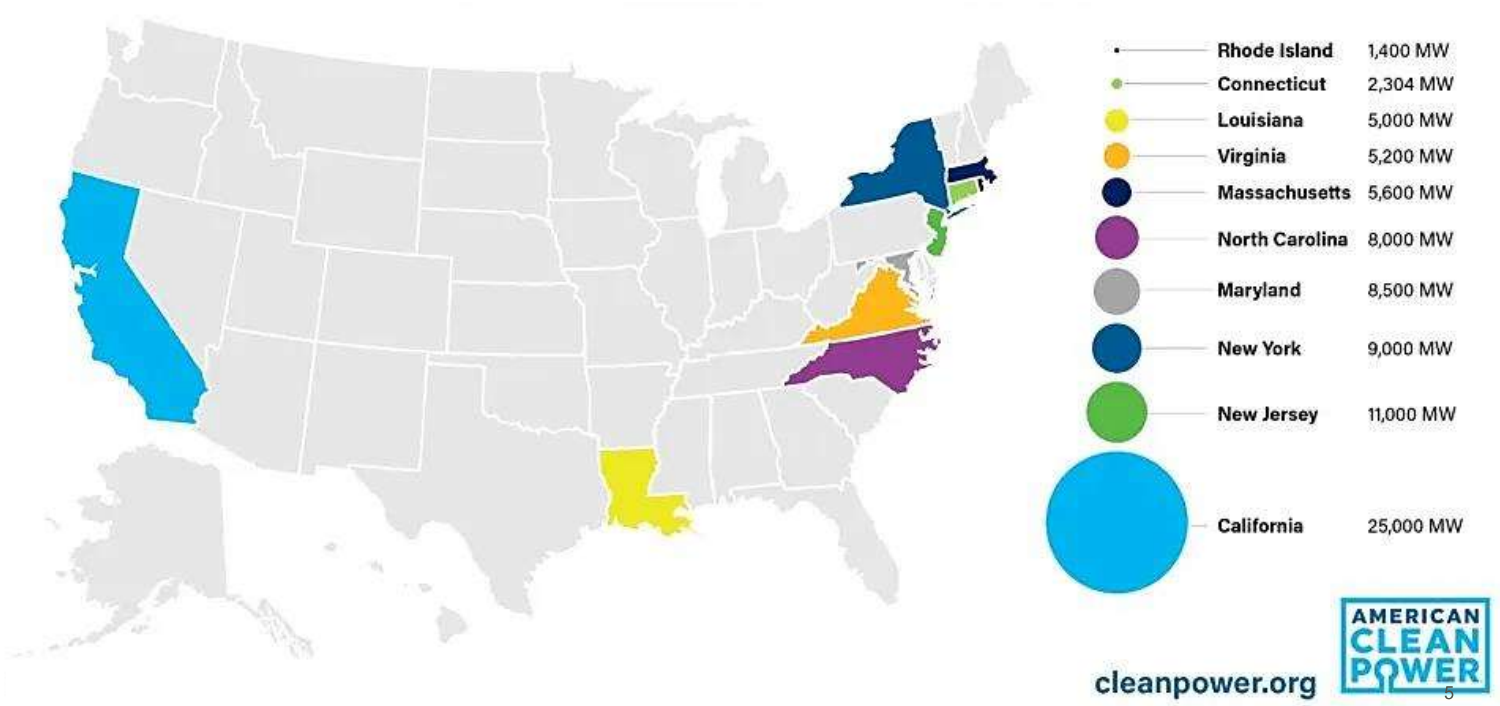
Source: NREL

Fixed vs. Floating Offshore Wind

Source: NREL

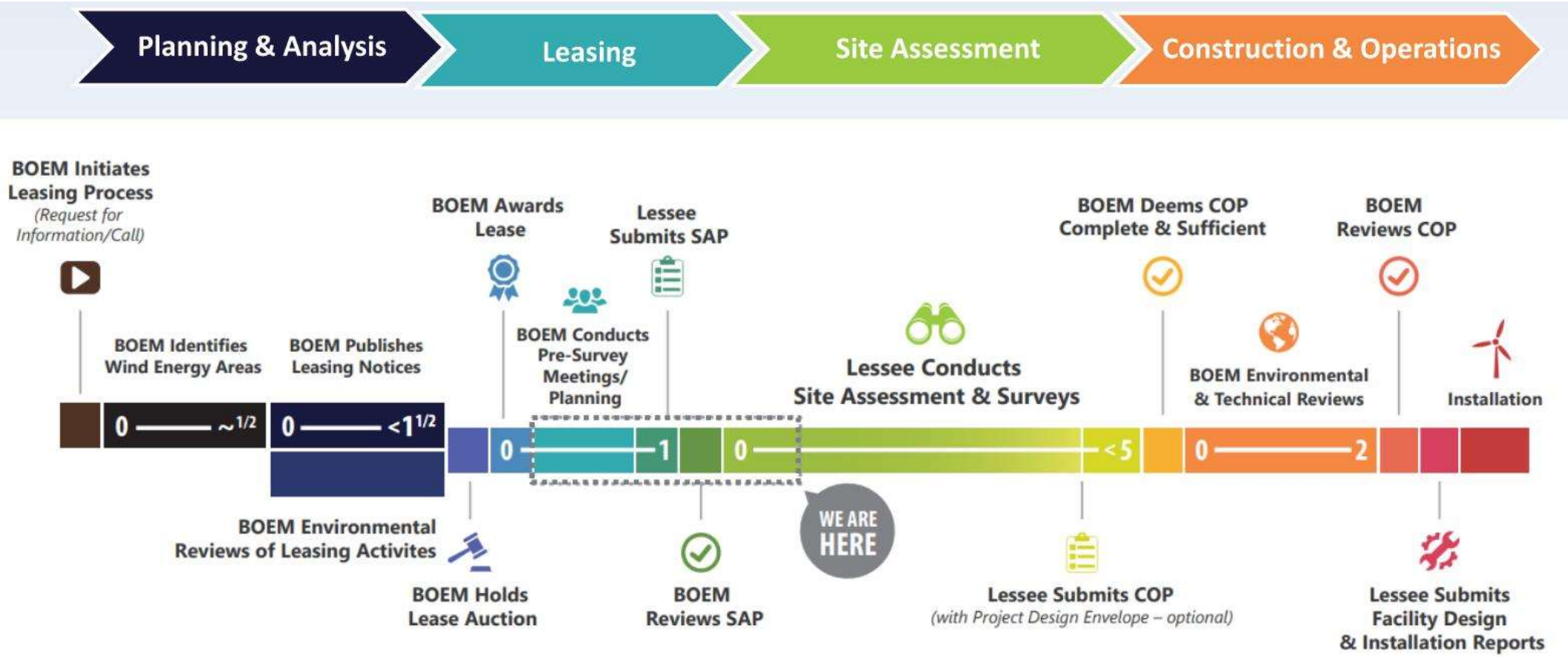
U.S. Offshore Wind Goals

- **Federal Goals**
  - (2021) 30 GW of offshore wind by 2030 and 110 GW by 2050
  - (2022) 15 GW of floating offshore wind and lower cost by 70% by 2035
- **California (2022)**
  - 2 to 5 GW by 2030
  - 25 GW by 2045
- **Oregon (2021)**
  - 3 GW by 2030



Source: U.S. Department of Energy (2023) and American Clean Power

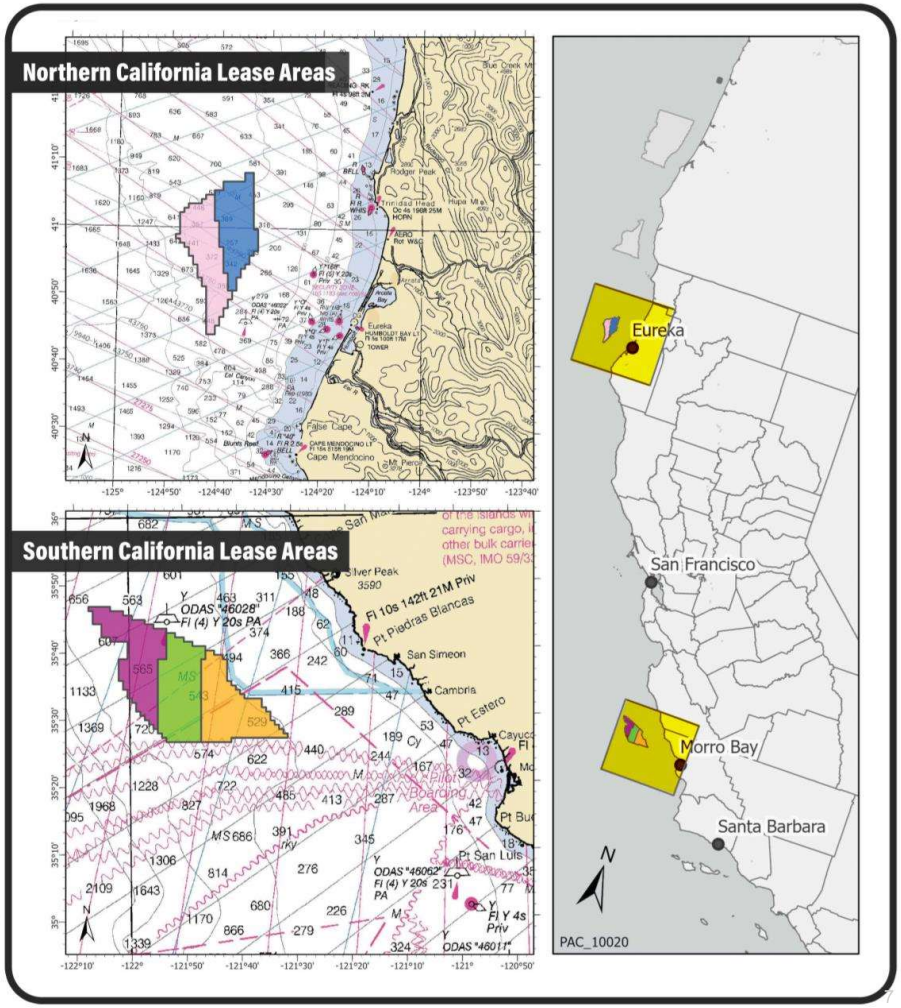
BOEM's Offshore Wind Authorization Process



Source: BOEM (2024)

Potential Energy Impact of the California Lease Areas

LEASE AREA	DEVELOPABLE ACRES	INSTALLATION CAPACITY (MW)[1]	POWER PRODUCTION (MWh/yr)[2]	HOMES POWERED[3]
RWE Offshore Wind Holding	63,338	769	2,694,436	269,136
California North Floating	69,031	838	2,936,632	293,328
Central California Offshore Wind	80,062	972	3,405,888	340,200
Equinor US	80,418	976	3,421,025	341,712
Invenergy California Offshore	80,418	976	3,421,025	341,712



BOEM Bureau of Ocean Energy Management

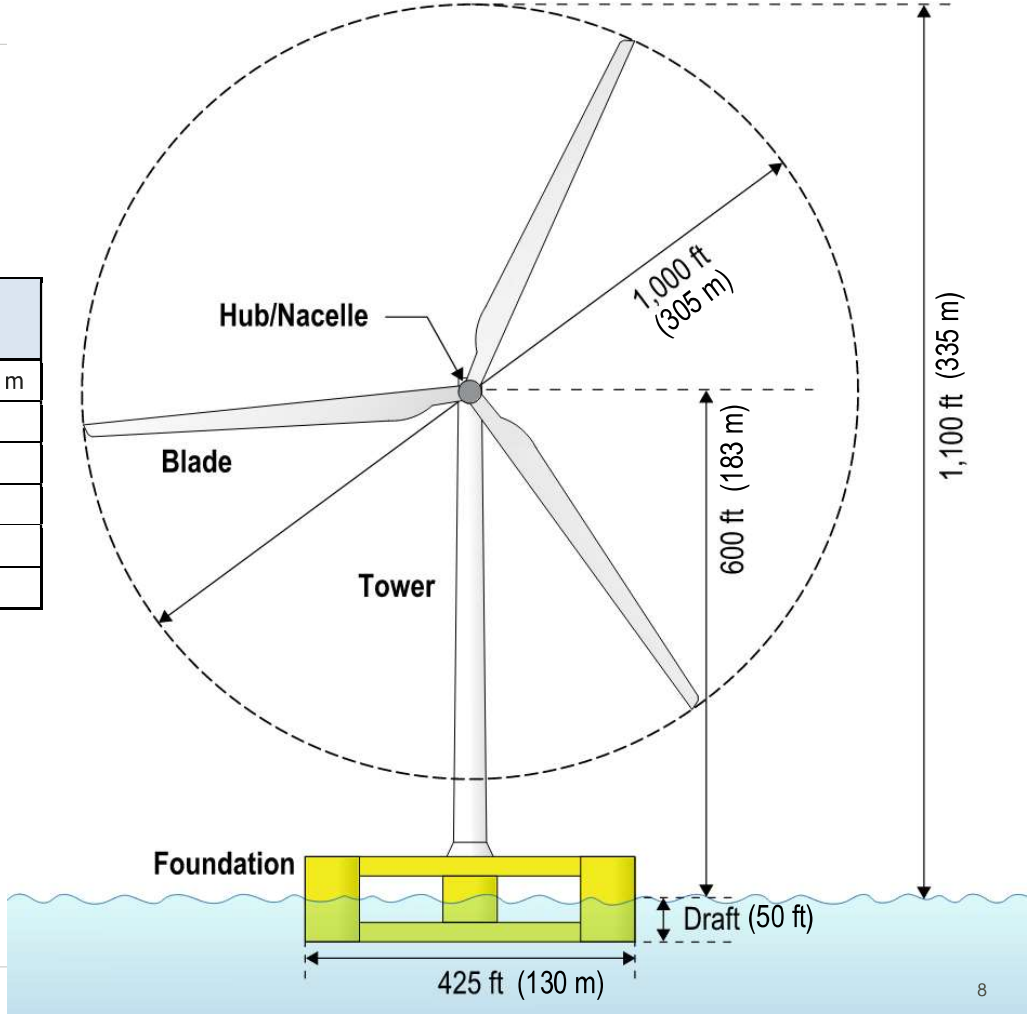
[1]Megawatts (MW) based on 3MW/sqkm
[2]Based upon 350 homes per MW
[3]Formula = Capacity (MW) * 8760 (hrs/yr) * 0.4 (capacity factor)

Source: BOEM (2022)

Future Offshore Wind Turbine Dimensions

- Dimensions shown are for a turbine that is approximately 25 MW

Floating Offshore Wind Turbine	Approximate Dimension [ft]	Approximate Dimension [m]
Foundation Beam / Width	Up to 425 ft x 425 ft	Up to 130 m x 130 m
Draft (Before integration)	15 to 25 ft	4.5 to 7.5 m
Draft (After integration)	20 to 50 ft	6 to 15 m
Hub/Nacelle Height (from Water Level)	Up to 600 ft	Up to 183 m
Tip Height (from Water Level)	Up to 1,100 ft	Up to 335 m
Rotor Diameter	Up to 1,000 ft	Up to 305 m



Floating Foundations

Source: Principle Power

Source: Central Marseilles (2017)

Tower Sections

Source: Journal of Commerce

Nacelle

Source: Riviera Maritime Media (2019)

Source: Siemens Gamesa (2024)

Blades

Source: New England News Collaborative

Floating Offshore Wind Turbine Assembly Operations

Source: Riviera Maritime Media, New England News Collaborative, Journal of Commerce, Principle Power, EDP Renewables, Port of Esbjerg-Christer Holte, Port of Vancouver USA, The Times UK

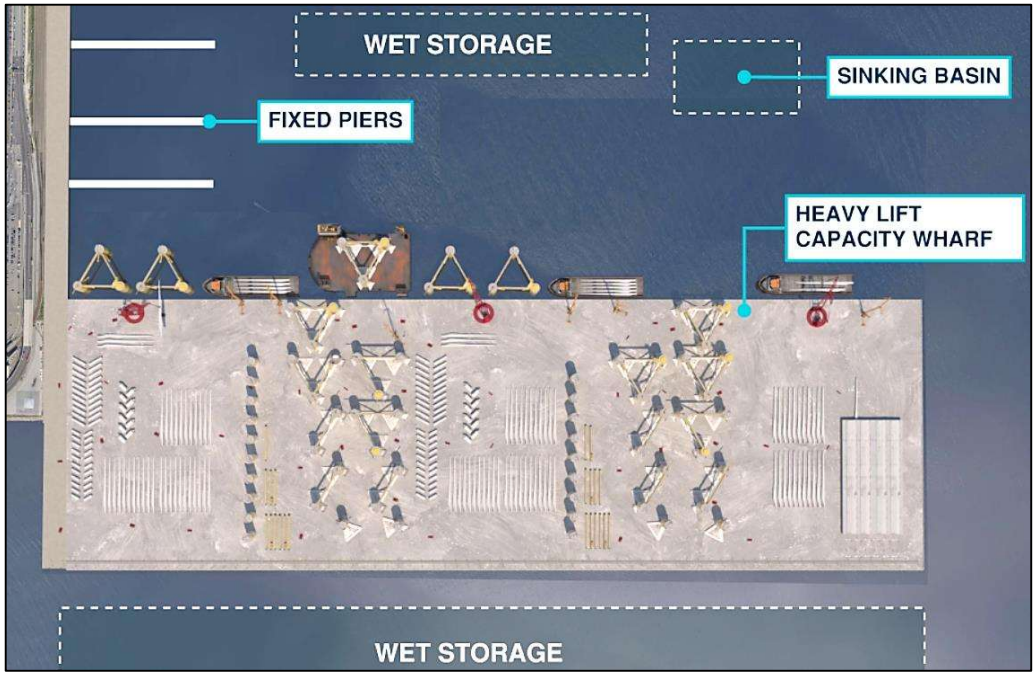
Offshore Wind Requires Ports

- **Component Manufacturing, Deployment Operations, and Maintenance of OSW farms requires Ports:**
  - Large laydown space
  - Sheltered harbor
  - Deep water and large width channel access
  - Heavy load capacity infrastructure and equipment
- **Existing port terminals on the U.S. West Coast are not adequate to support OSW**
  - Requires significant development and investment
  - Requires a multi-port strategy
  - Adding a new maritime industry without displacing or replacing existing maritime uses

Source: Principle Power

OSW Port Requirements

- **Staging & Integration (S&I) Site:** a port site to receive, stage, and store offshore wind components and assemble the floating turbine system for towing to the offshore wind area.
- **Manufacturing/Fabrication (MF) Site:** a port site that receives raw materials via road, rail, or waterborne transport and creates larger components in the offshore wind supply chain.



Design Requirement	Staging and Integration (S&I)	Manufacturing (MF)
Acreage, minimum	30-100 acres *(12-40 ha)*	30-100 acres *(12-40 ha)*
Wharf Length	1,500 ft *(455 m)*	800 ft *(245 m)*
Minimum Draft at Berth	38 ft *(11 m)*	38 ft *(11 m)*
Draft at Sinking Basin	40-100 ft *(12-30 m)*	40-100 ft *(12-30 m)*
Wharf Live Load Capacity	6,000 psf *(30 t/m^2)*	6,000 psf *(30 t/m^2)*
Uplands / Yard Loading (for WTG components)	2,000-3,000 psf *(10-15 t/m^2)*	2,000-3,000 psf *(10-15 t/m^2)*

Source: Port of Long Beach

OSW Port Requirements

- **Operation & Maintenance (O&M) Site:** a base of wind farm operations with warehouses/offices, spare part storage, and a marine facility to support O&M vessels for crew transfer
- **Laydown Site:** a site to receive and stage mooring lines, anchors, and electrical cables

Design Requirement	Operations & Maintenance (O&M)	Anchor & Mooring Line Storage	Electrical Cable Laydown
Acreage, minimum	2-10 acres *(0.8-4 ha)*	10-30 acres *(4-12 ha)*	20-30 acres *(8-12 ha)*
Wharf Length	300 ft (*90 m*)	300 ft *(90 m)*	500 ft *(150 m)*
Minimum Draft at Berth	20-30 ft (*6-9 m*)	20-30 ft *(6-9 m)*	30-35 ft *(9-11 m)*
Draft at Sinking Basin	Not Required	Not Required	Not Required
Wharf Loading	100-500 psf (*0.5-2.5 t/m^2)*	500 psf *(2.5 t/m^2)*	1,000 psf *(5 t/m^2)*
Uplands / Yard Loading (for WTG components)	100-500 psf *(0.5-2.5 t/m^2)*	500 psf *(2.5 t/m^2)*	1,000-2,000 psf *(5-10 t/m^2)*

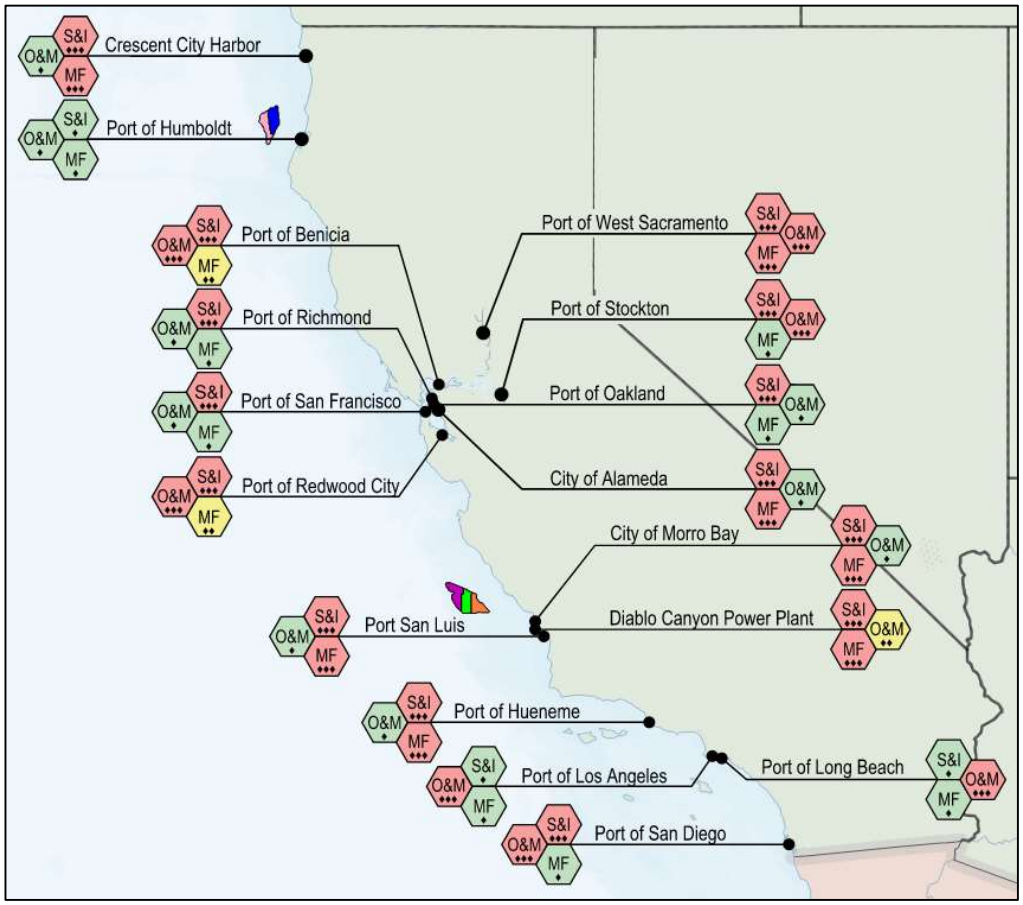
O&M

Anchor Storage

Cable Laydown

Source (top to bottom): REACH & Mott MacDonald; MAERSK Service Supply, Global Marine Group

Identifying & Selecting CA Port Sites



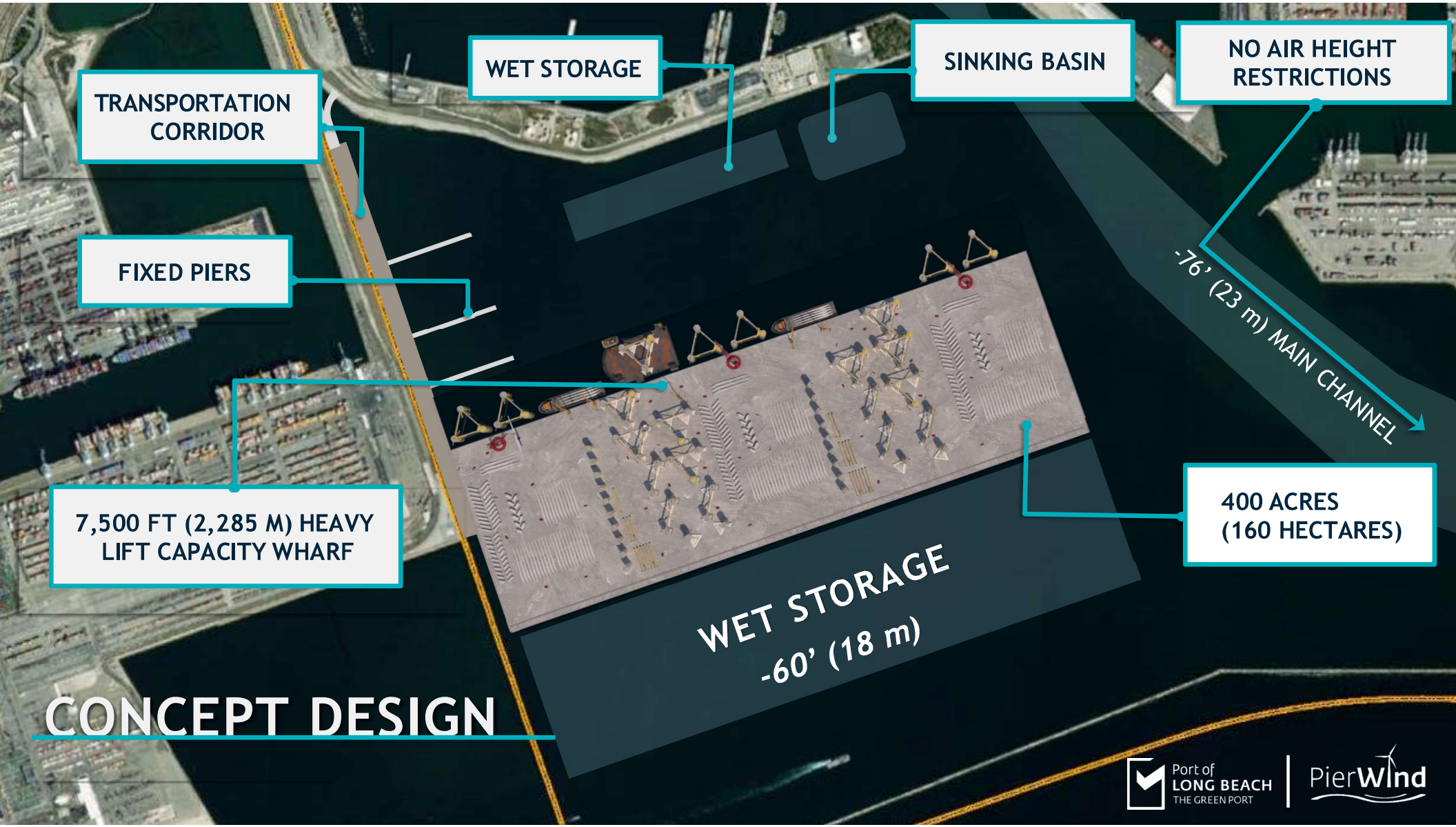
- Without S&I sites, OSW development is not possible
- **Port of Humboldt** and **Port of Long Beach** have projects underway (just completed 15% design)
- MF sites provide significant job creation and economic impact

Legend

- S&I — Staging & Integration Site
- MF — Manufacturing / Fabrication Site
- O&M — Operations & Maintenance Site
- Good candidate site S&I, MF, or O&M
- Moderate candidate site for S&I, MF, or O&M
- Not a candidate site for S&I, MF, or O&M

Typical Port Improvements Required

- **To prepare port sites for the offshore wind industry, infrastructure improvements are needed, such as:**
  - Demolition of existing facilities (buildings, marine structures, etc)
  - Construction of new wharves or berths
  - Completion of geotechnical ground improvements
  - Dredging / deepening of berth pocket
  - Deepening / widening of federal navigation channels and entrance channels
  - Install fill to raise site for sea level rise (SLR) and to provide required working surface
  - Miscellaneous civil site improvements (utilities, drainage, etc.)
  - Significant electrical improvements (electrified terminals, no emissions)
  - Construct buildings, warehouses, factories, security features, training facilities, etc.
  - Projects to mitigate environmental impacts


TRANSPORTATION CORRIDOR
WET STORAGE
SINKING BASIN
NO AIR HEIGHT RESTRICTIONS
FIXED PIERS
-76' (23 m) MAIN CHANNEL
7,500 FT (2,285 M) HEAVY LIFT CAPACITY WHARF
400 ACRES (160 HECTARES)
WET STORAGE
-60' (18 m)
CONCEPT DESIGN
Port of LONG BEACH THE GREEN PORT
PierWind


Port of
LONG BEACH
THE GREEN PORT
PierWind

REDWOOD MARINE OFFSHORE WIND & HEAVY LIFT MULTIPURPOSE TERMINAL

CONCEPT DESIGN

HUMBOLDT BAY HARBOR RECREATION & CONSERVATION DISTRICT

Thank you

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