Off-Shore Wind Developments in the Pacific Northwest

SUSTECH Meeting

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State Decarbonization Policies

- States of Washington and Oregon have very progressive plans to decarbonize its electric power sector

- State of Washington Clean Energy Transformation Act (CETA)
  - 2026 – no coal generation
  - 2030 – greenhouse neutral – limited (up to 20%) use of electricity from natural gas, if it is offset by other actions to be greenhouse neutral
  - 2045 – 100% renewable or non-emitting resources

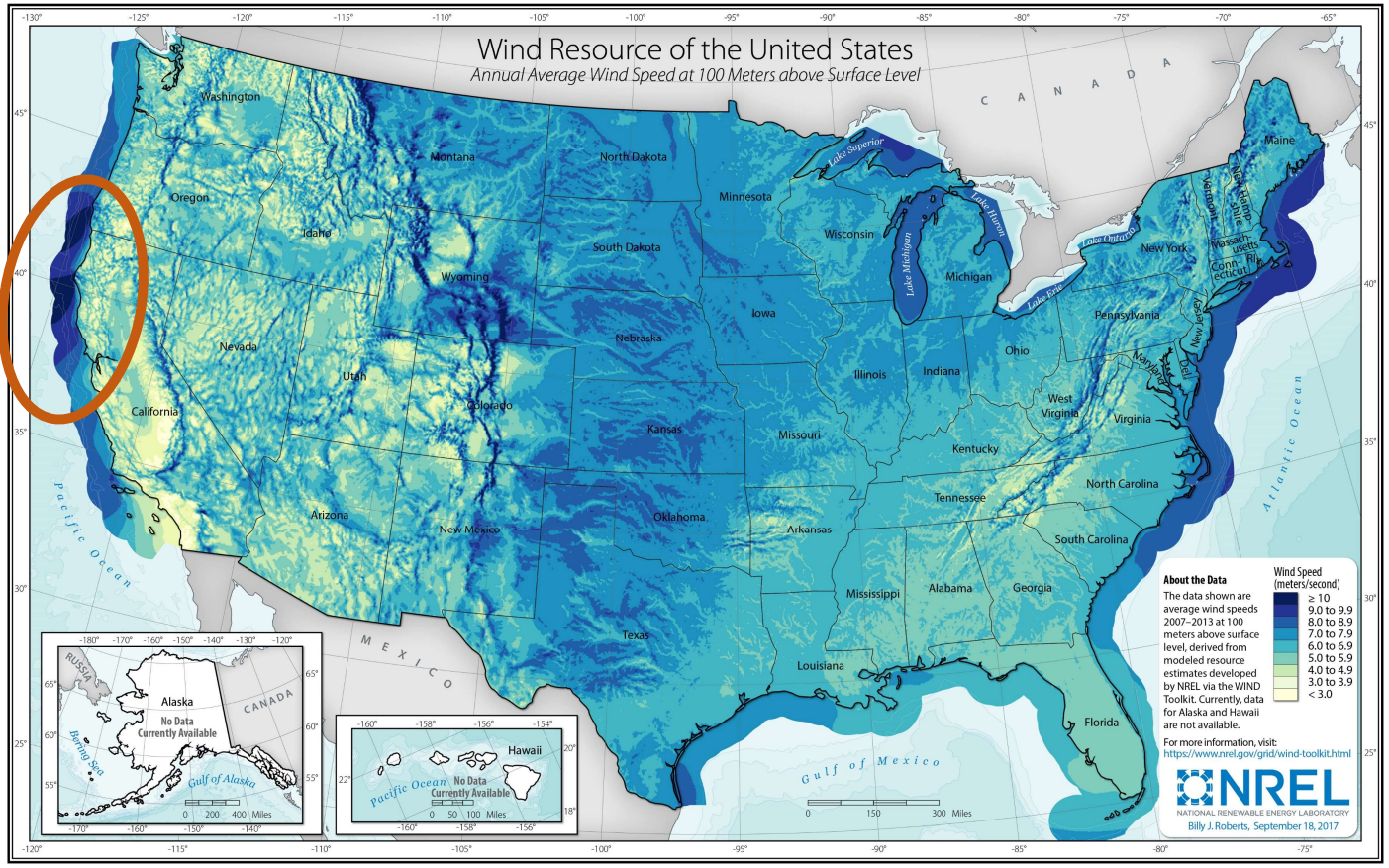
- State of Oregon Clean Power Bill
  - 2030 – 80% emission reduction relative to baseline
  - 2035 – 90% emission reduction relative to baseline
  - 2040 – 100% emission free

Why Off-Shore Wind

- A diverse portfolio of generating resources is likely needed to achieve 100% decarbonization goals set by States of California, Oregon and Washington
- Off-shore wind is a premier **energy resource** with high-capacity factor
  - Estimated 55.2% for Southern Oregon Coast off-shore wind vs. low- to mid- 40% for land-based wind*
- Off-shore wind is a good **capacity resource** and has better positive correlation with peak loads in the Pacific Northwest than land-based Gorge wind or solar plants
- Has potential to improve reliability and resiliency of electric power service for local costal communities and regional loads as a whole

*Source: PGE 2023 Integrated Resource Plan

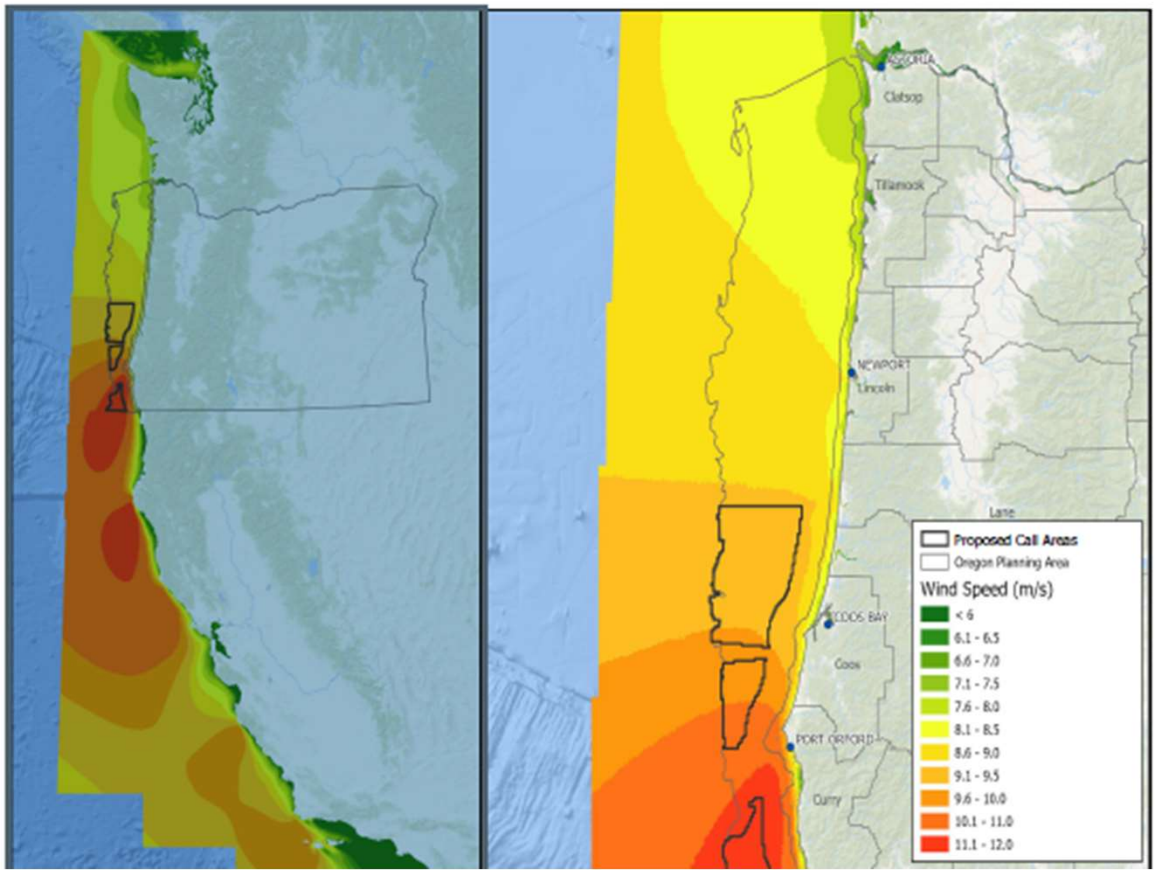
Pacific ocean wind speeds are the highest among wind resources in North America



Credit: NREL

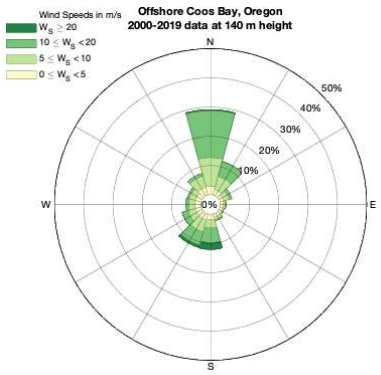
Southern Oregon

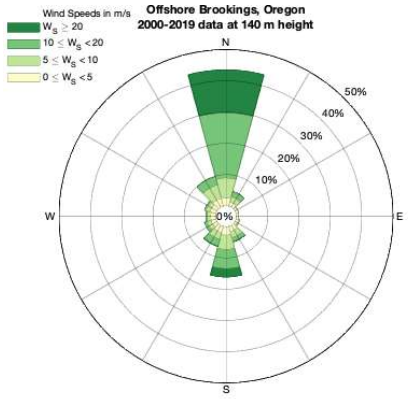
Southern Oregon and Northern California Coast (between Cape Blanco and Cape Mendocino) are among the best off-shore wind resources in the world

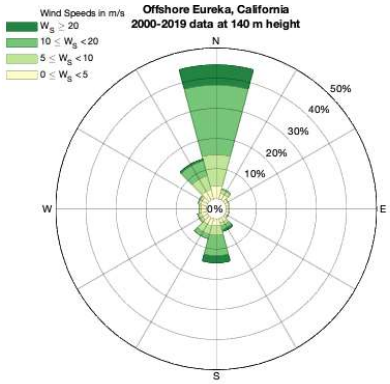


Credit: BOEM

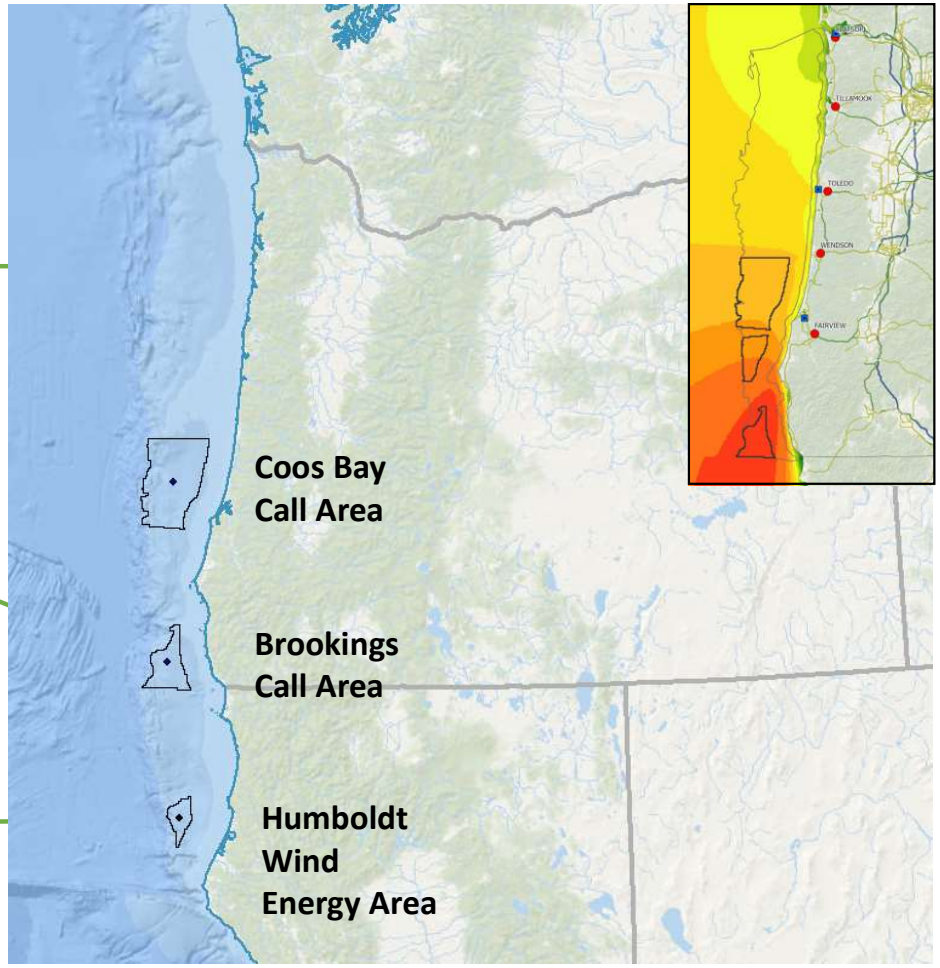
Northern CA, Southern OR offshore wind resources





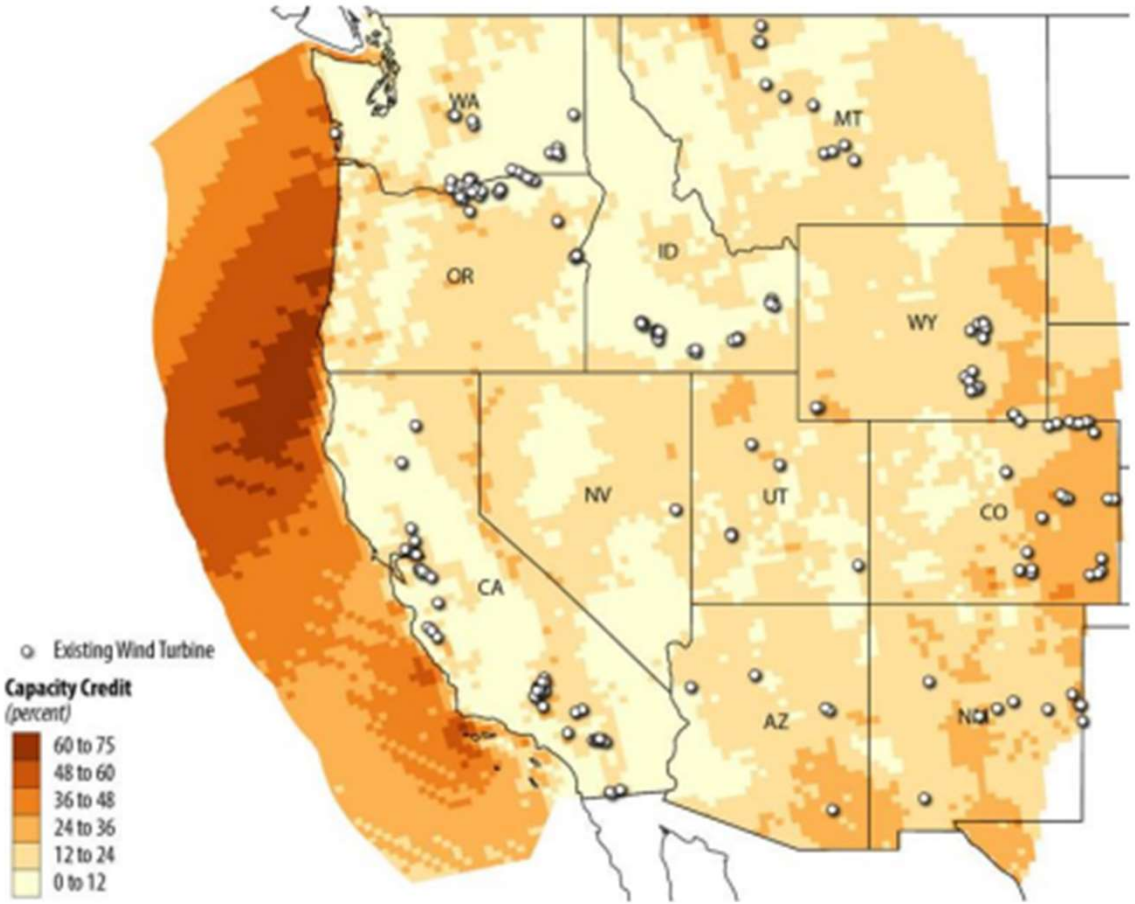


Credit: PNNL



Data source: PNW20 and CA20 extracts from Weather Research and Forecasting model.

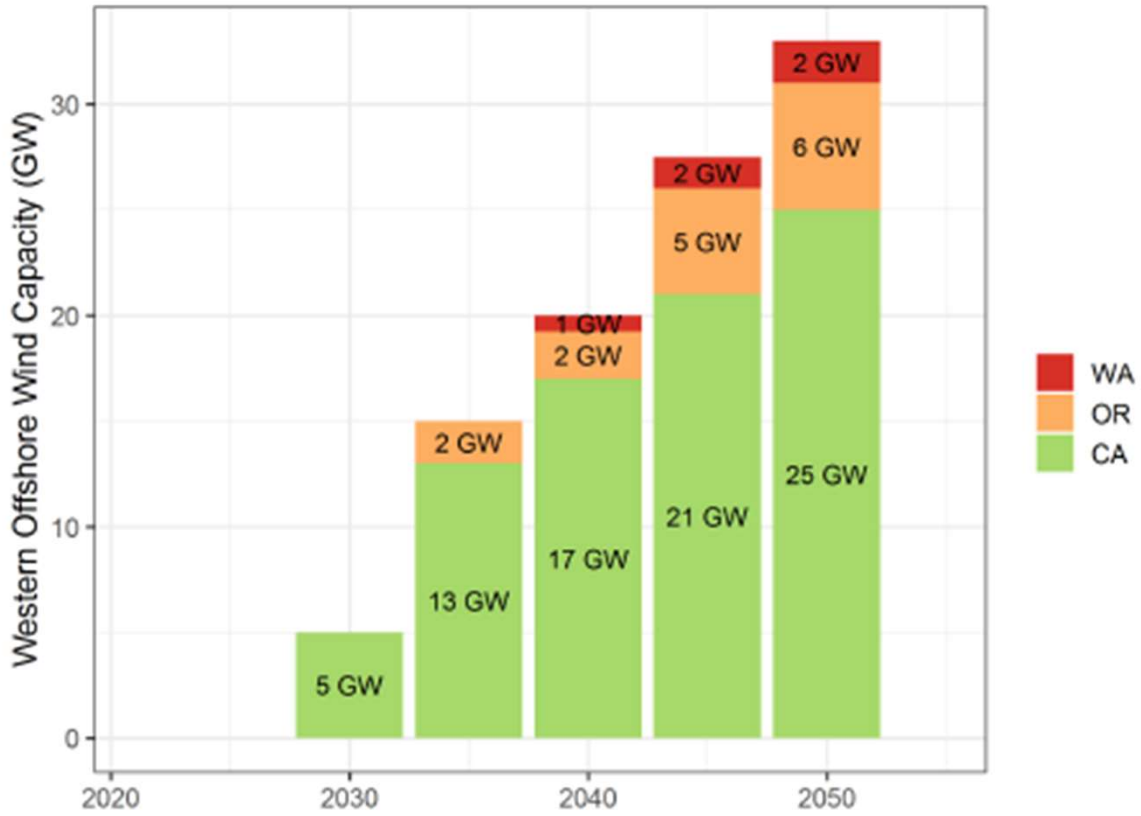
Off-Shore Wind Load Carrying Capacity



Pacific ocean wind generation correlates well with peak load conditions in the Pacific Northwest

Credit: NREL

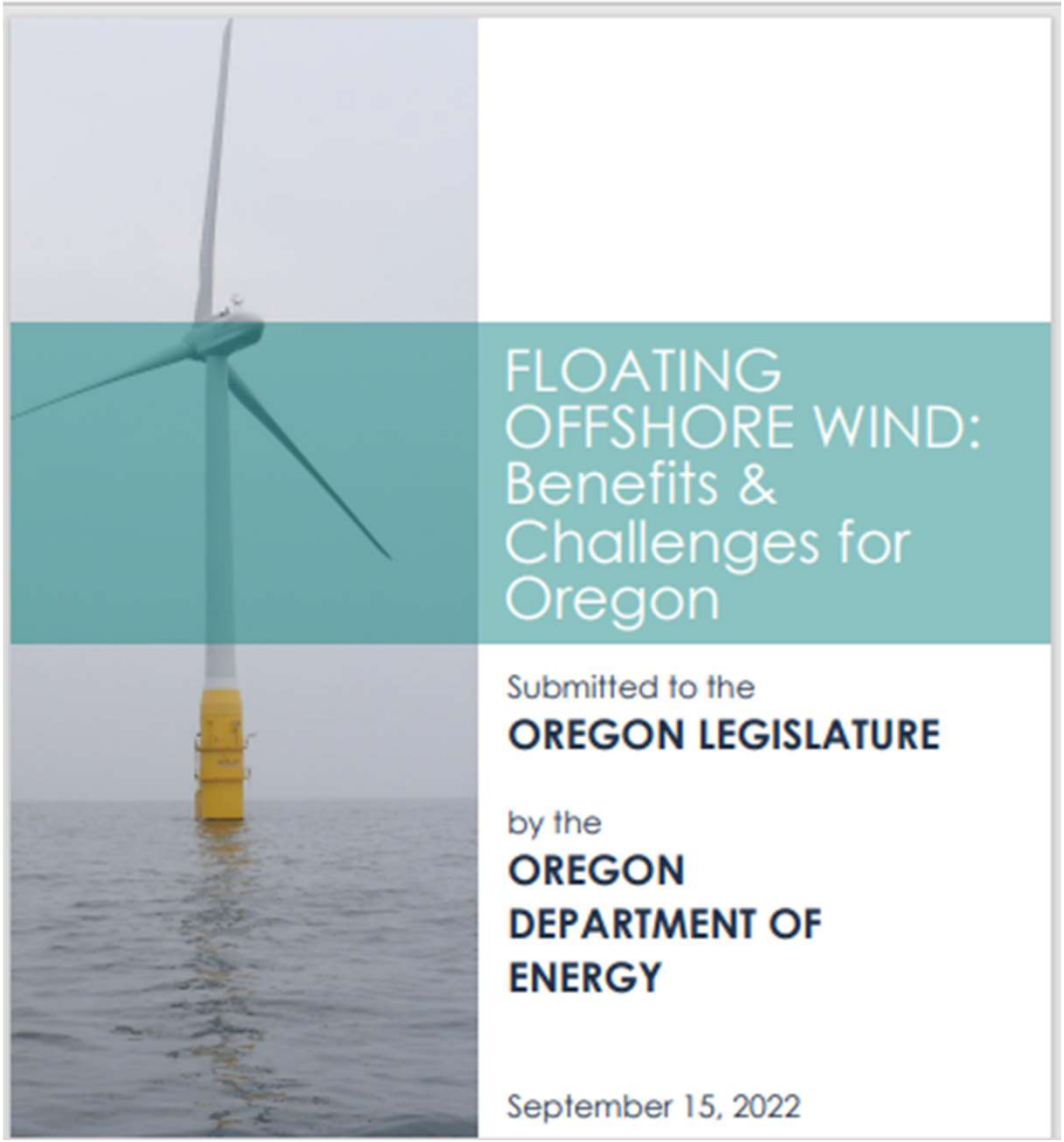
US DOE Goals for Pacific Coast Off-Shore Wind Development



US DOE goals:

- 15 GW by 2035
- 33 GW by 2050

Credit: PNNL and NREL



Oregon DOE published comprehensive report on benefits and challenges with interconnecting floating off-shore wind generation in Southern Oregon

https://www.oregon.gov/energy/Data-and-Reports/Documents/2022-Floating-Offshore-Wind-Report.pdf

Challenges with off-shore wind deployment

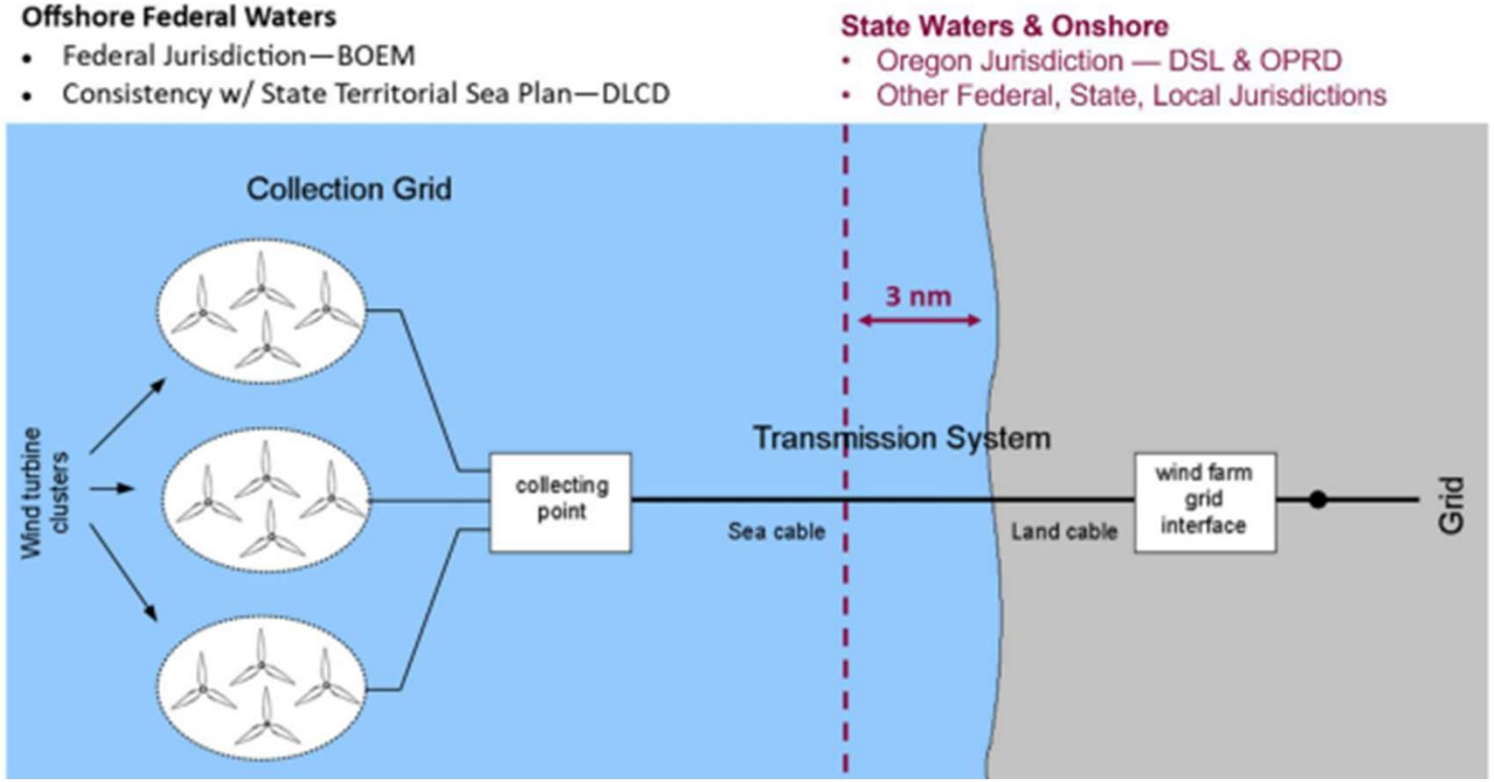
- Concern About Effects to Coastal Communities, Existing Industries, the Environment, and Cultural Resources
- Siting and Permitting Conflicts and Complexity
- Technology Readiness
- Port Infrastructure
- Power Offtake Agreements
- Transmission Grid

Leasing Off-Shore Wind Areas

US Bureau of Ocean Energy Management

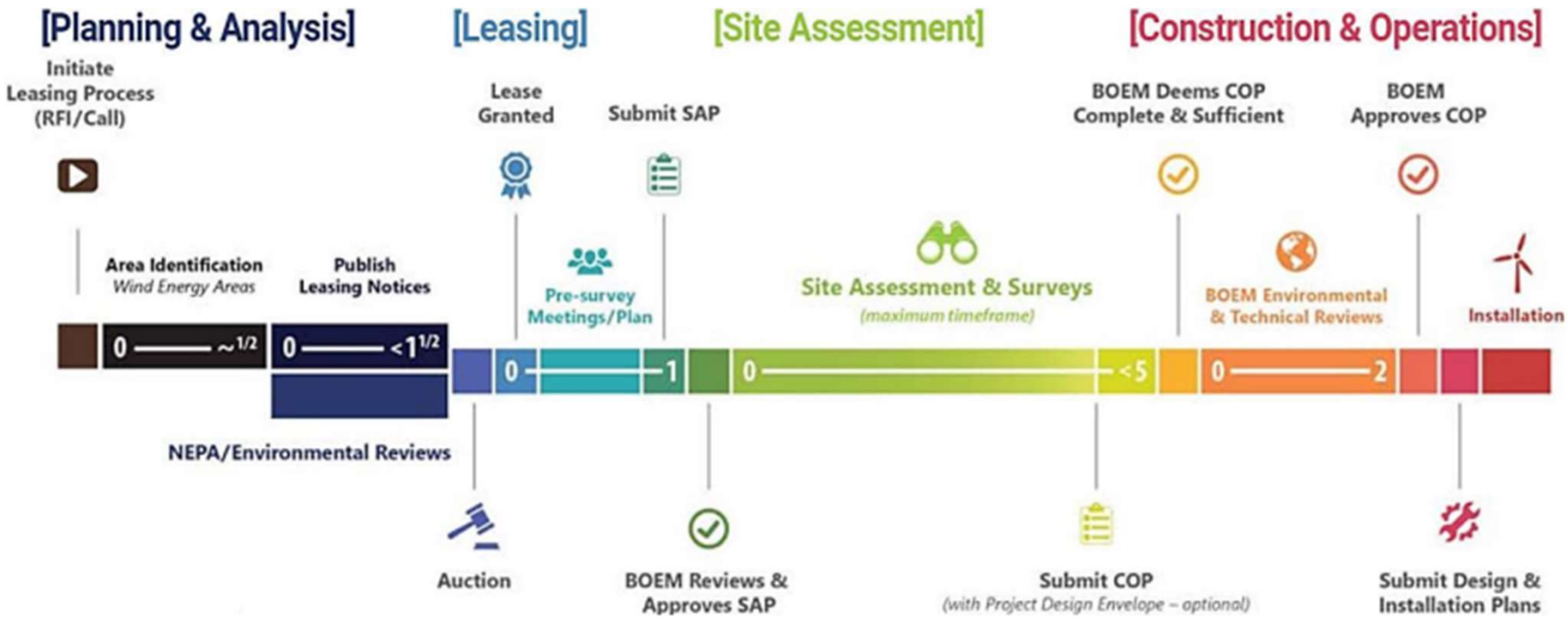
- https://www.boem.gov/renewable-energy
- BOEM is responsible for offshore renewable energy development in Federal waters
- BOEM conducts auctions, awards leases to develop off-shore resources, reviews and approves construction and operation plans

Wind Area Development



Credit: Oregon DOE

BOEM Off-Shore Wind Energy Authorization Process



Credit: BOEM

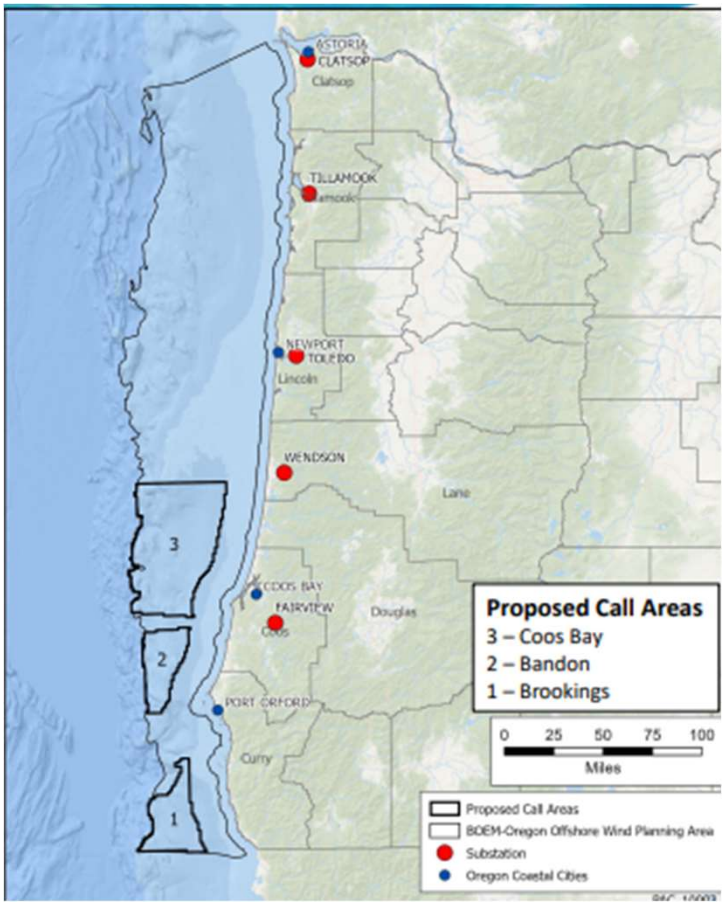
BOEM Leases in California

BOEM completed lease auctions in California – two leases in Northen California and three in Central California

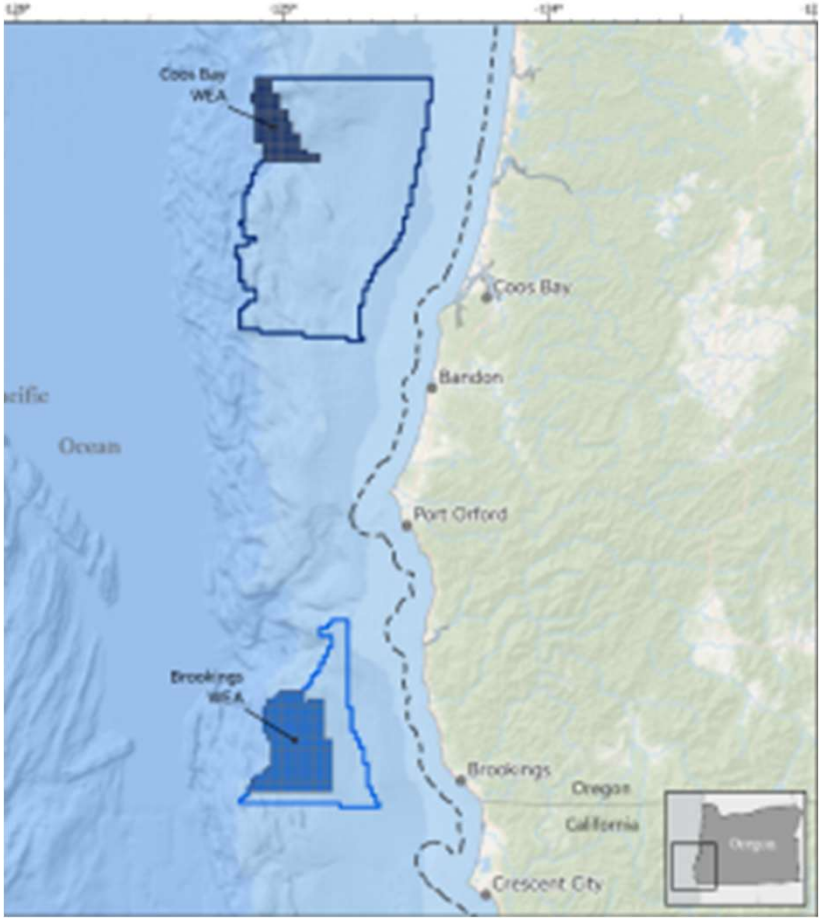
BOEM will conduct a regional environmental review of potential development activities on the five offshore wind lease areas off California's central and north coasts

BOEM's Public Process to Refine Wind Energy Areas

February 2022

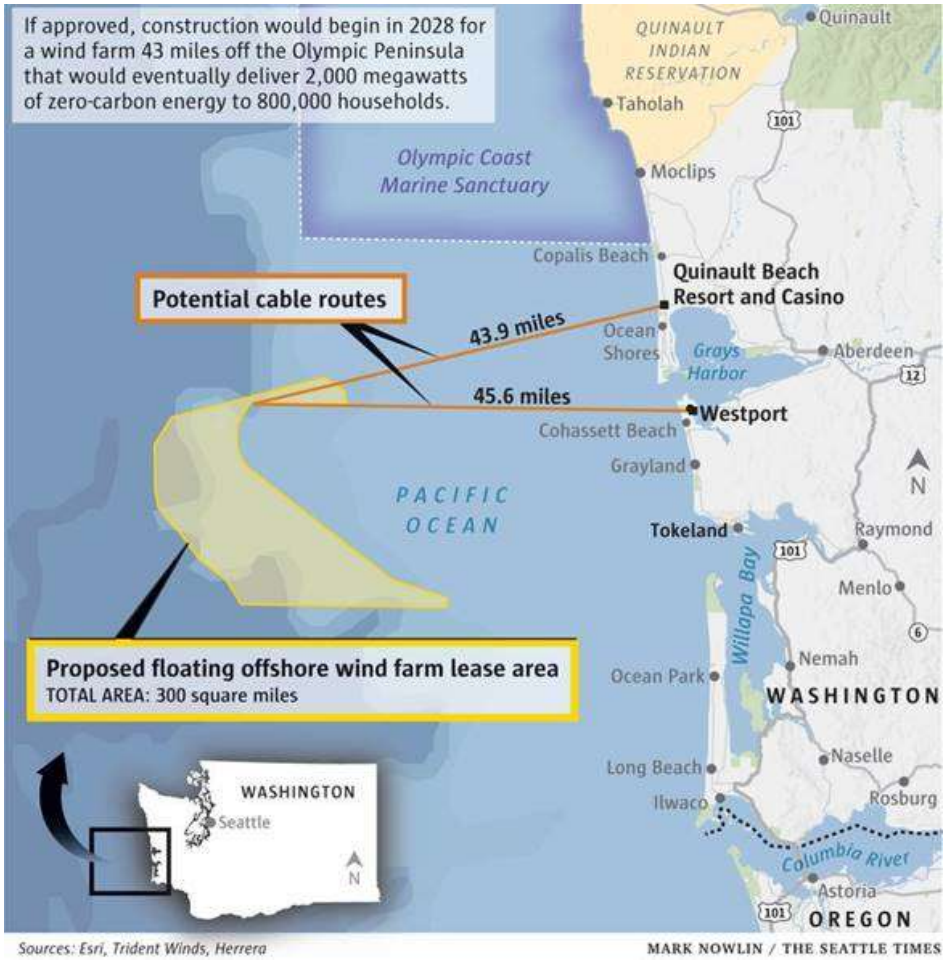


April 2024



BOEM has designated two final Wind Energy Areas (WEAs) off the Oregon coast, the Coos Bay WEA is 61,204 acres and located approximately 32 miles (mi) from shore. The Brookings WEA is 133,808 acres and approximately 18 mi off the coast. If fully developed, the Final WEAs could support 2.4 GW of energy production.

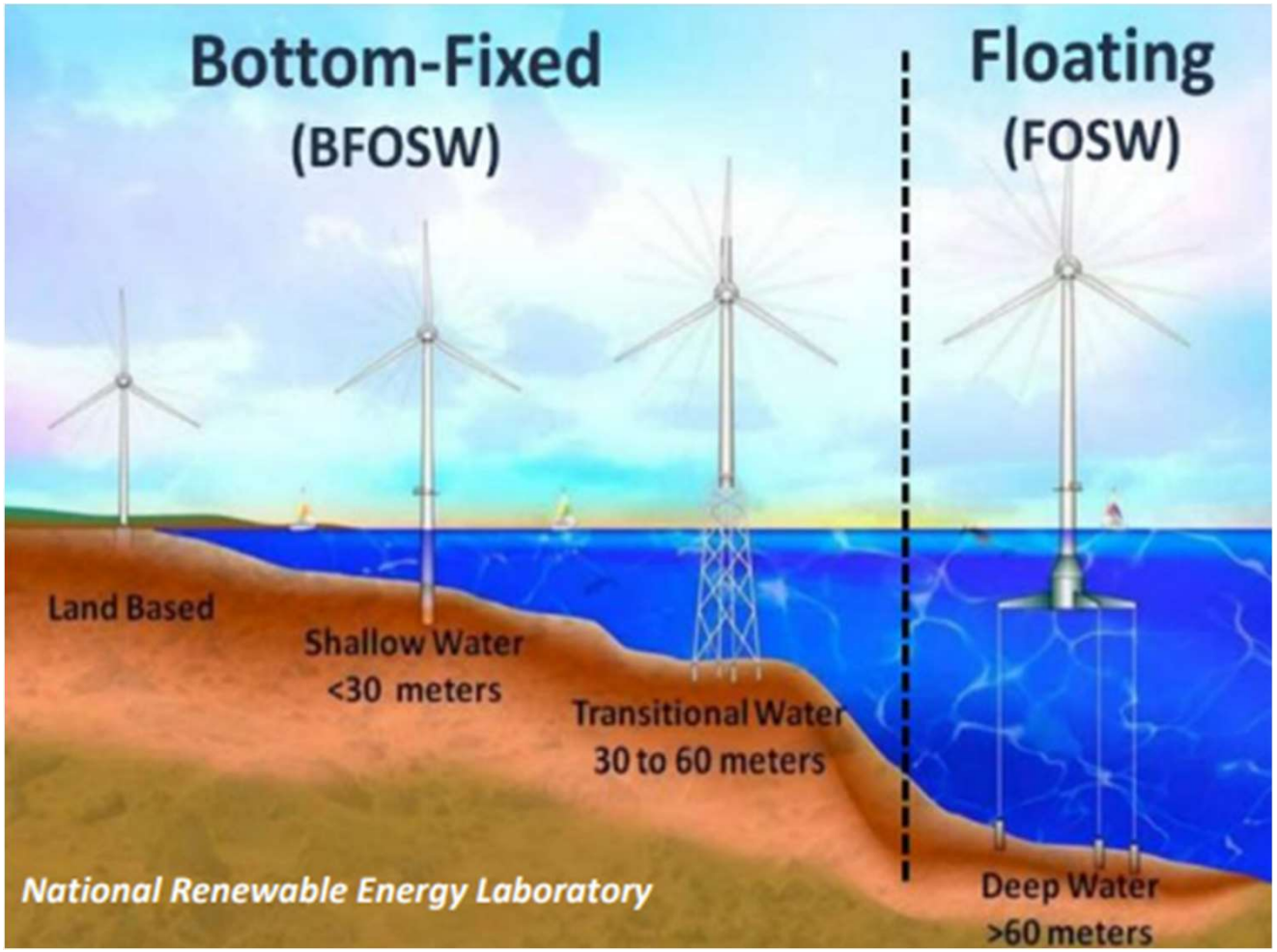
Washington Off-Shore Wind Proposal



- Trident Winds is seeking to develop 2,000 MW of off-shore wind off the coast of state of Washington
- Trident wind submitted unsolicited lease request to BOEM on April 12 2022:

  https://tridentwinds.com/portfolio-posts/trident-winds-submits-unsolicited-lease-request-for-developing-washington-states-first-floating-offshore-wind-project/
- Trident Winds performed studies to demonstrate the value of off-shore wind for serving peak loads in state of Washington

Technology



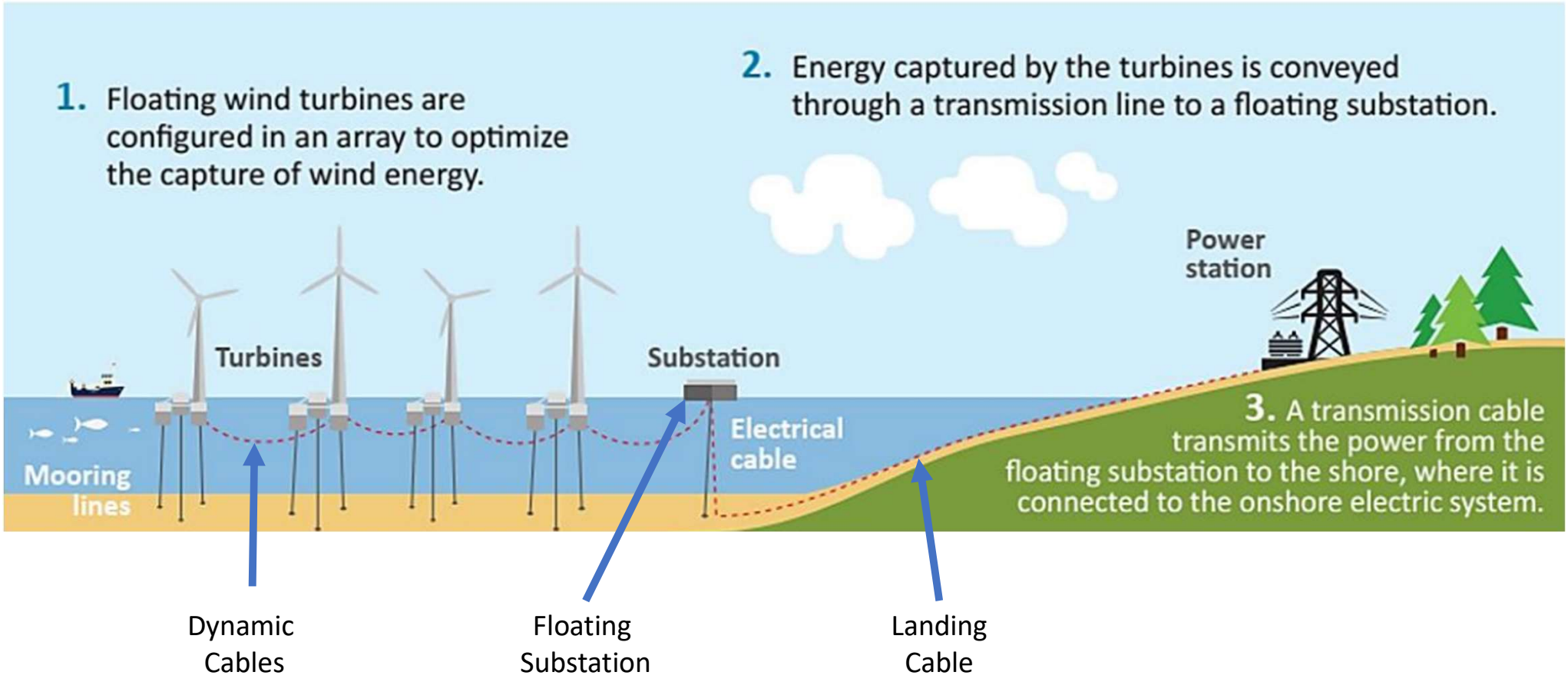
Coos Bay Wind Energy Area water depth is from 635 to 1,414 m

Brookings Wind Energy Area water depth is from 567 to 1,531 m

Credit: General Electric

Modern floating off-shore wind turbines:
15 MW, 18 to 20 MW planned
115.5m long blades
Sweep area 43,742m2 (or 6.5 football fields)

Floater structure:
Size of a baseball field (Dodger Stadium)



Credit: NREL and PNNL

Generation Interconnection

- Radial AC lines from floating AC substation to the land-based substation
  - Current approach
- Meshed off-shore AC network
  - Possible, commercial issues
- HVDC off-shore network
  - Requires technology advances

Port Infrastructure and Manufacturing

Port Infrastructure

California

The Port of Long Beach is planning Pier Wind, a $4.7 billion, 400-acre offshore wind turbine assembly terminal

Humboldt Bay Harbor received $426.7 million federal grant from US DOT to build a new marine terminal where turbines can be assembled and transported.

California introduced AB-2208 Offshore wind energy projects
The bill will place a $1 billion bond before voters to help pay for the expansion of ports for off-shore wind development aimed at helping ports build capacity to assemble, construct and transport wind turbines and other large equipment.

Port Infrastructure

Oregon

Manufacturer's need certainty in demand and stable pipeline of projects over 20-30 year horizon

Washington

The state wants to be a part of supply chain for off-shore wind

NREL West Coast Ports Strategy Study

https://www.nrel.gov/wind/west-coast-ports.html

Power Off-Takers

Power Off-Takers

California

- State of California Assembly Bill 1373 was signed into law: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202320240AB1373
- The new law permits the state to sign long-term contracts for the purchase of electricity from offshore wind facilities.

  "Certain generation resources require long development and permitting timelines and may be of such a scale that individual load-serving entities in California may not be able to secure these resources efficiently. AB 1373 now provides a mechanism that allows the California Department of Water Resources (CDWR) to centrally procure these resources upon specific findings by the California Public Utilities Commission (CPUC) that these eligible energy resources (like offshore wind) should be procured to meet the state's growing need for cost-effective resource diversity."

Power Off-Takers

Oregon

- PacifiCorp conducted a study to integrate 1GW of off-shore wind off Southern Oregon coast as a part of PacifiCorp's Integrated Resource Plan. The study found off-shore wind uneconomical at current costs
- Portland General Electric considered off-shore wind in their 2023 Integrated Resource Plan, the projects may become economical in 2030s

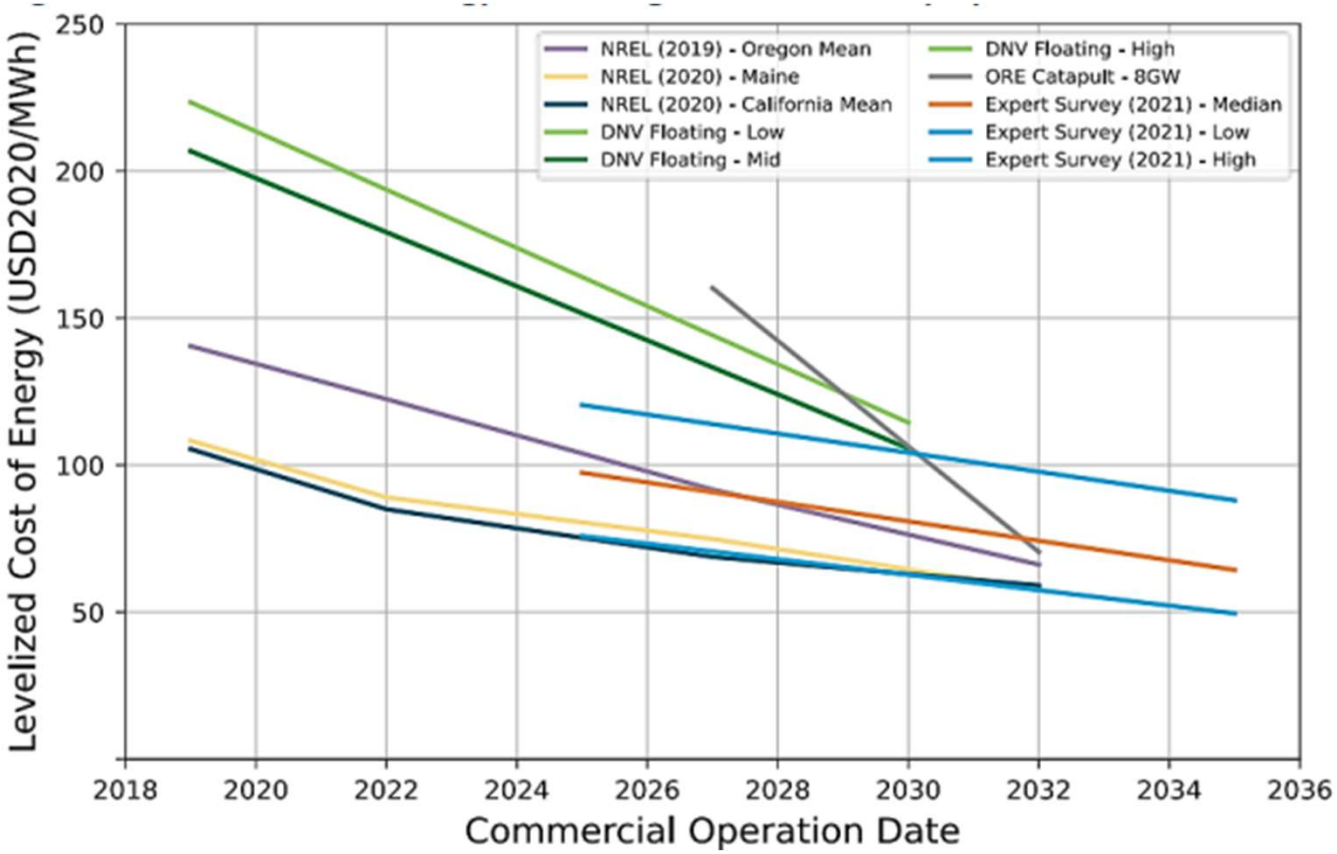
Washington

- Puget Sound Energy's preferred resource portfolio does not include off-shore wind

US DOE Off-Shore Floating Wind Shot™

- https://www.energy.gov/eere/wind/floating-offshore-wind-shot
- The Floating Offshore Wind Energy Shot seeks to reduce the cost of floating offshore wind energy by more than 70%, to $45 per megawatt-hour by 2035 for deep water sites far from shore:
  - Supporting development of cost-effective floating off-shore wind technologies
  - Scaling up domestic manufacturing capacity and supply chain development
  - Advancing transmission technologies to deliver power from off-shore wind sites to load centers
  - Promoting energy justice

Off-Shore Wind Cost (LCOE) Projections



Transmission Infrastructure

Large Scale Off-Shore Wind Integration

- Transmission system on Southern Oregon and Northern California Coast was designed for local load service, and includes lower voltage and low capacity lines
- Large scale integration of off-shore wind in Southern Oregon will require high capacity 500-kV EHV transmission to reliably interconnect the proposed generation and get power from the coast to load centers

- DOE, State Commissions, regional planning entities and transmission planners in the area have multiple undertaken studies to determine transmission system requirements for off-shore wind generation interconnection

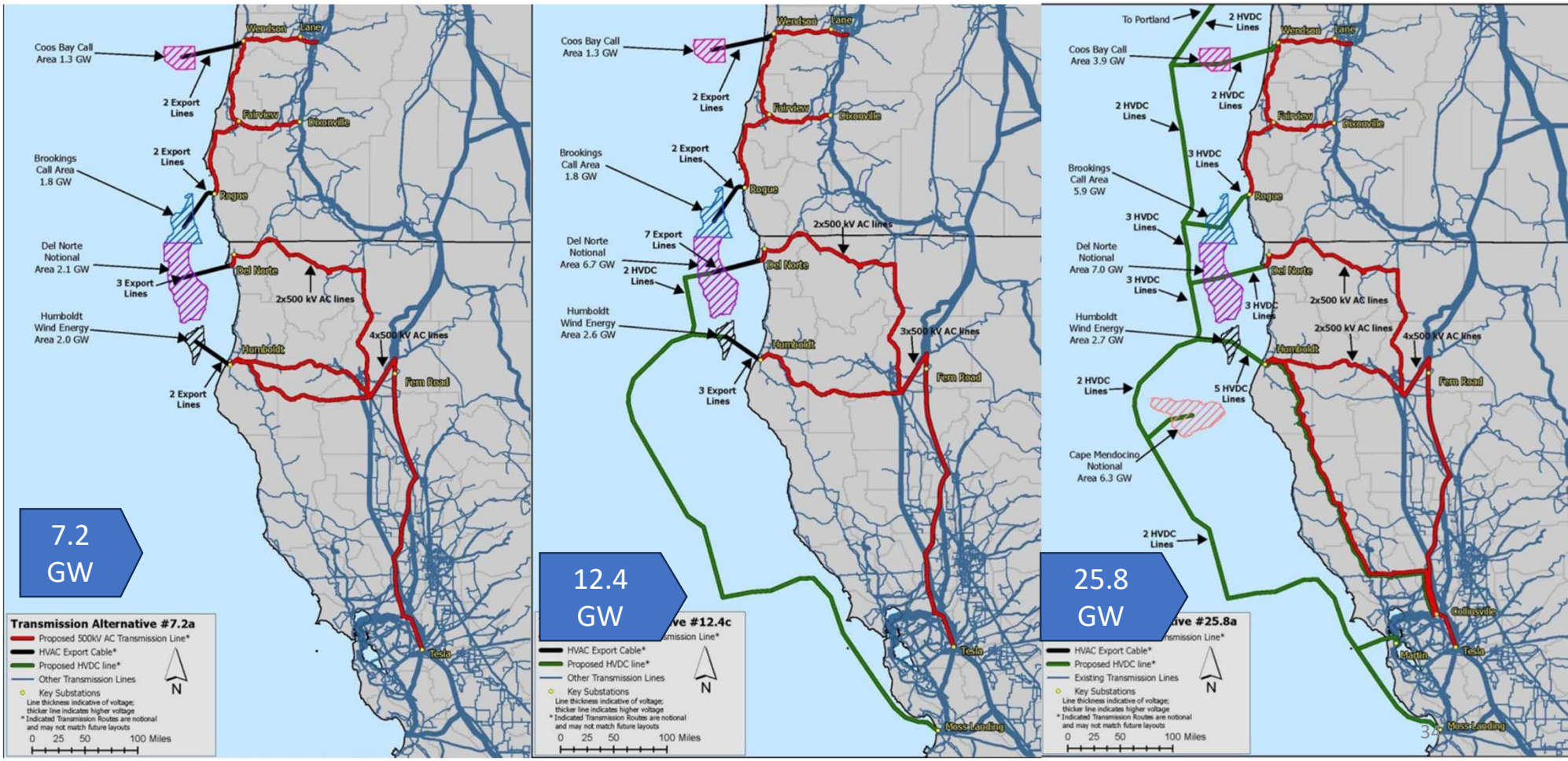
Inter-Regional Off-Shore Wind Transmission Studies

- DOE West Coast Off-Shore Wind Transmission Study led by PNNL and NREL
  - https://www.energy.gov/gdo/west-coast-offshore-wind-transmission-planning
  - https://www.pnnl.gov/projects/west-coast-offshore-wind-transmission-study
  - Resolve pathways for offshore wind generation and transmission development across the West Coast in support of state and federal clean energy goals through 2050 (33 GW by 2050)

- Schatz Energy Center
  - http://schatzcenter.org/pubs/2023-OSW-R2.pdf
  - Scalable plan to interconnect 7.2, 12.4 and 25.8 MW of offshore wind off the coast of Northern California and Southern Oregon
  - Reliability assessment, Economic analysis

- Northern Grid (regional transmission planning organization)
  - https://www.northerngrid.net/private-media/documents/2022_ESR_OSW_Approved.pdf
  - Request by Oregon DOE and Oregon PUC to perform reliability and economic studies to interconnect 3 GW of off-shore wind in Southern Oregon

Evolution of Transmission Topologies (credit Schatz Energy Center)



CAISO 2023-24 Transmission Plan

CAISO 2023-24 Transmission plan included off-shore wind resources:

- **Northern California – 1,607 MW base** and 8,045 MW sensitivity
- **Central California Morro Bay – 3,100 MW** base and 5,355 MW sensitivity

http://www.caiso.com/InitiativeDocuments/DRAFT_2023-2024_TransmissionPlan.pdf

CAISO plan includes:

- New Humboldt 500 kV substation, with a 500/115 kV transformer;
- Building approximately 260 mile HVDC line, initially operated as 500 kV AC line to interconnect Humboldt 500 kV to the Collinsville substation; Estimated cost of $1,913 – $2,740 million;
- Building approximately 140 mile, 500 kV AC line to interconnect Humboldt 500 kV to the Fern Road substation; Estimated cost of $980 – $1,400 million;
- A 115kV/115 kV phase shifting transformer (PST) and a 115 kV line from Humboldt 500 kV to existing Humboldt 115 kV substation. Estimated at $40 – $57 million.

The total estimated cost is $3.1B to $4.5 B with and estimated in-service date of 2035.

BPA Studies

BPA has several generation interconnection and transmission service requests in Southern Oregon

BPA Transmission Planning studied and developed a plan of service to deliver 2,600 MW from Southern Oregon to Portland metro area

BPA plan includes:

- New Fairview 500 kV substation, with a 500/230 kV transformer
- New Wendson 500-kV substation, with a 500/230-kV transformer
- 97-mile 500-kV lines Alvey – Fairview,
- 100-mile 500-kV line Lane – Wendson – Fairview

Stay Engaged

Useful Resources

Oregon DOE report
https://www.oregon.gov/energy/Data-and-Reports/Documents/2022-Floating-Offshore-Wind-Report.pdf

Bureau of Ocean Energy Management https://www.boem.gov/renewable-energy

US DOE Wind Technology Office https://www.energy.gov/eere/wind/wind-energy-technologies-office

US DOE West Coast Off-Shore Wind Transmission Study led by PNNL and NREL
https://www.pnnl.gov/projects/west-coast-offshore-wind-transmission-study

Schatz Energy Research Center https://schatzcenter.org/

Pacific Ocean Energy Trust https://pacificoceanenergy.org/