Floating Offshore Wind Study

Public Meeting 2

April 7, 2022

OREGON DEPARTMENT OF ENERGY

Leading Oregon to a safe, equitable, clean, and sustainable energy future.

Our Mission

The Oregon Department of Energy helps Oregonians make informed decisions and maintain a resilient and affordable energy system. We advance solutions to shape an equitable clean energy transition, protect the environment and public health, and responsibly balance energy needs and impacts for current and future generations.

What We Do

On behalf of Oregonians across the state, the Oregon Department of Energy achieves its mission by providing:

- A Central Repository of Energy Data, Information, and Analysis
- A Venue for Problem-Solving Oregon's Energy Challenges
- Energy Education and Technical Assistance
- Regulation and Oversight
- Energy Programs and Activities

AGENDA

- Welcome & Logistics
  - Opening Remarks - Oregon Rep. David Brock Smith
- Review Comments Received & Hear Additional Feedback
  - 100% Clean Targets
  - Floating Offshore Wind Technologies
  - State and Regional Reliability & Resilience

    ~ 11:10 a.m. Break (10 min)
  - Transmission Infrastructure

    ~ 12:05 p.m. Lunch (30 min)
  - Energy Markets
  - Draft Literature Review
- Next Steps
- Closing Comments / Q & A

HOW THIS MEETING WILL BE FACILITATED

Panelists and Attendees

- **Panelists** – ODOE Staff sharing common themes and Guest Presenters sharing specific information about some topics.
- **Attendees** – Time is reserved for attendee feedback & discussion on each topic, and at the end of today's agenda during closing comments and Q&A.

Community Agreements:

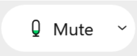
- Be present and ready to learn.
- Be respectful to others.
- Learning happens outside of our comfort zones.
- Listen to learn first, and to supply information or perspectives second.
- Thank you for being flexible and patient around any technology needs or changes.
- If you need something at this meeting, please ask for it!
- Technical issues or questions: Contact **"Host"** in the chat.

OPTIONS TO PROVIDE FEEDBACK

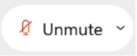
- Feedback Today - For anyone wishing to provide feedback about topics, please ask your question or provide your comment in the chat **or** with "raise hand" feature in WebEx.
  - Note: Priority may need to be given to organizations listed in the bill to share information and help answer specific questions within their expertise.
- In Chat – Request topic by topic feedback in the chat (we will pause at each topic to review comments and questions shared in the chat)
- 2 weeks for additional written feedback after today meeting – please submit by April 22.

USING WEBEX

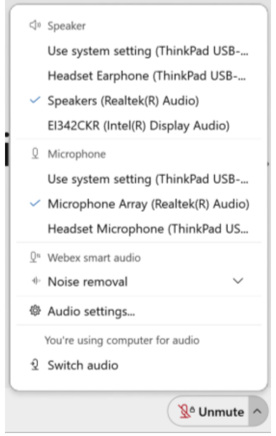
Audio Options



Microphone On



Microphone Off

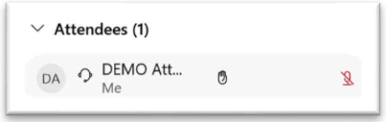


You can check Speaker and Microphone settings by clicking the arrow next to Mute/Unmute.

Second Raise Hand Option

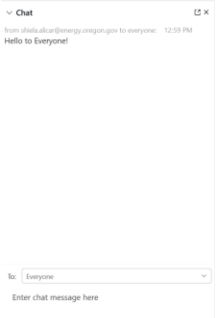
You can also click on the hand next to your name in the Participant list to raise your hand.

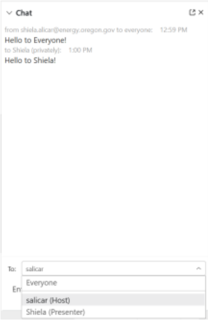
Click on Lower hand when you are done.



Chat

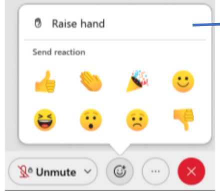
You can chat to Everyone in the meeting.



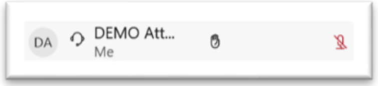


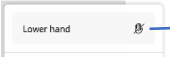
You can send a private message to the Host or Presenter (or all Panelists when there is a Panel).

Reactions



Click to Raise your hand.





Click on Lower hand when you are done.

WHAT IS HB 3375?

- "Whereas statements" - Recognize the merits of studying FOSW
  - Vast potential, BOEM activity, decarbonization, other benefits & challenges

- Describes Oregon goal to plan for up to 3 GW of FOSW by 2030
  - "Goal to plan" only – doesn't direct how to plan
  - Directs ODOE to report on benefits & challenges

- Does not commit to deployment targets
  - Unlike NY
    - State commitment to a target of 9 GW by 2035
  - Unlike CA
    - AB 525 directs CEC to develop a state plan
    - CEC plan will identify a capacity target

ODOE'S CORE ELEMENTS OF HB 3375

1. Literature Review

- Review studies and reports relevant to benefits & challenges of FOSW

2. Stakeholder Feedback

- Several state, regional and national entities listed in bill to consult
- Additional stakeholders identified by ODOE, including those from BOEM Task Force
- Develop topical questions based on lit. review to prompt stakeholder feedback

3. Public Remote Meetings

- Convene at least two public remote meetings with stakeholders

4. Report to Legislature by 9/15/2022

- Summarize key findings from literature review and stakeholder feedback, including opportunities for future study and engagement

https://www.oregon.gov/energy/energy-oregon/Pages/fosw.aspx

State, Regional, National Entities

Entities Listed in HB 3375

- Oregon Department of Land Conservation and Development (DLCD)
- Oregon Business Development Department (Business Oregon)
- Oregon Department of Fish and Wildlife (ODFW)
- Oregon Public Utilities Commission (OPUC)
- Northwest Power and Conservation Council (NWPCC)
- Bonneville Power Administration (BPA)
- Bureau of Ocean Energy Management (BOEM)
- National Renewable Energy Laboratory (NREL)
- Pacific Northwest National Laboratory (PNNL)
- US Department of Defense (DoD)

TIMELINE FOR IMPLEMENTATION

Data Gathering & Engagement

Jan
- **1/19:** Lit. Review and Qs on Website
- **1/20:** Stakeholder Kick-Off Mtg.

Feb
- **2/18:** Initial Feedback Due

Mar
- **3/10:** Public Meeting #1
- **3/25:** Additional Feedback Due

April
- **4/7:** Public Meeting #2
- **4/22:** Additional Feedback Due

Report Drafting & Submission

May
- **5/11:** Public Meeting #3
- **5/27:** Additional Feedback Due
- Begin Drafting Report

Jun

Jul
- Share draft findings

Aug

Sep
- **9/15:** Submit Report to Legislature

TOPICS FOR PUBLIC MEETINGS

Public Meeting #1

March 10, 2022
9:30 a.m. – 2 p.m.

- Siting and Permitting
- Port Infrastructure & Sea Vessels
- Economic Development
- Equity
- Local Reliability & Resilience

Public Meeting #2

April 7, 2022
9:30 a.m. – 2 p.m.

- 100% Clean Energy Targets
- Technologies
- Transmission Infrastructure
- Energy Markets
- State & Regional Reliability

https://www.oregon.gov/energy/energy-oregon/Pages/fosw.aspx

TOPICS FOR PUBLIC MEETINGS

Public Meeting #3
In-Person & Online

May 11, 2022
5:30 p.m. – 6:45 p.m.
The Mill Casino
Coos Bay, Oregon

- Overview of Preliminary Findings
- Public Comment

https://www.oregon.gov/energy/energy-oregon/Pages/fosw.aspx

REVIEW OF FEEDBACK & ADDITIONAL INPUT

- Comment review slides focus on common themes of feedback we received.

- Goals are to help synthesize our understanding of information and perspectives shared in this study process accurately in a summary report to the Legislature (**not** to reconcile opposing perspectives).

- Additional Input Today:
  - Do you have information or a perspective that differs from common themes?
  - Would you emphasize something differently?
  - Is there something missing?

Objective:

To gather and synthesize a range of information and perspectives on the benefits and challenges of integrating up to 3 GW of FOSW into Oregon's electric grid to inform a summary of key findings in a report to the Legislature, including opportunities for future study and engagement.

FEEDBACK RECEIVED

- 22 different commenters submitted feedback from a variety of perspectives, including:
  - Members of the public
  - Ports
  - Fisheries
  - State Agencies
  - NGOs
  - Utilities and transmission providers
  - Developers and supply chain
  - Research consortiums and national labs

- Feedback received can be viewed at the following link:
  - https://odoe.powerappsportals.us/en-US/fosw/foswview/

100% Clean Targets
(30 minutes)

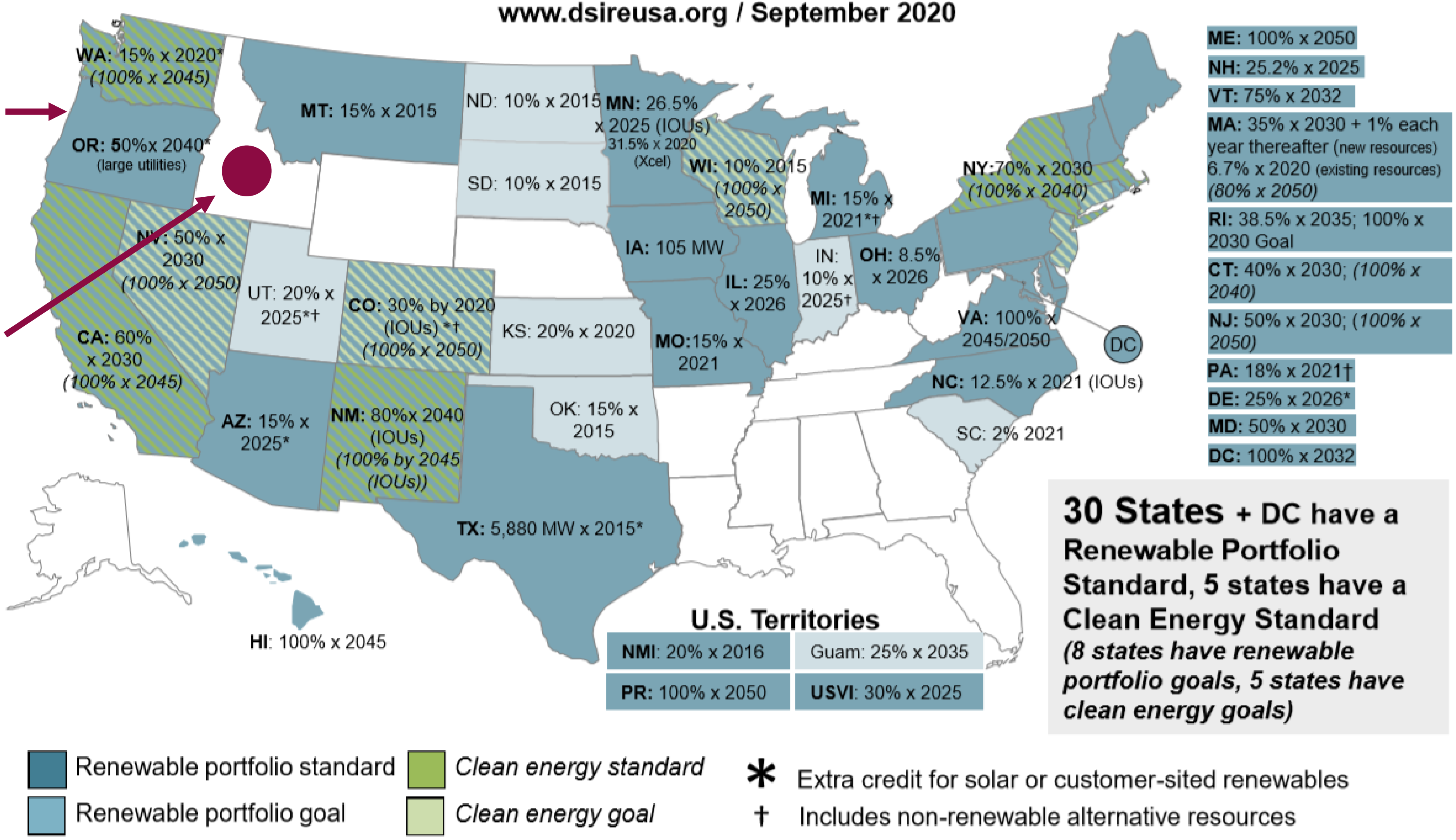
- Overview of Targets and Existing Analysis
- Overview of Feedback Received
- Time for Additional Feedback

Renewable & Clean Energy Standards

www.dsireusa.org / September 2020

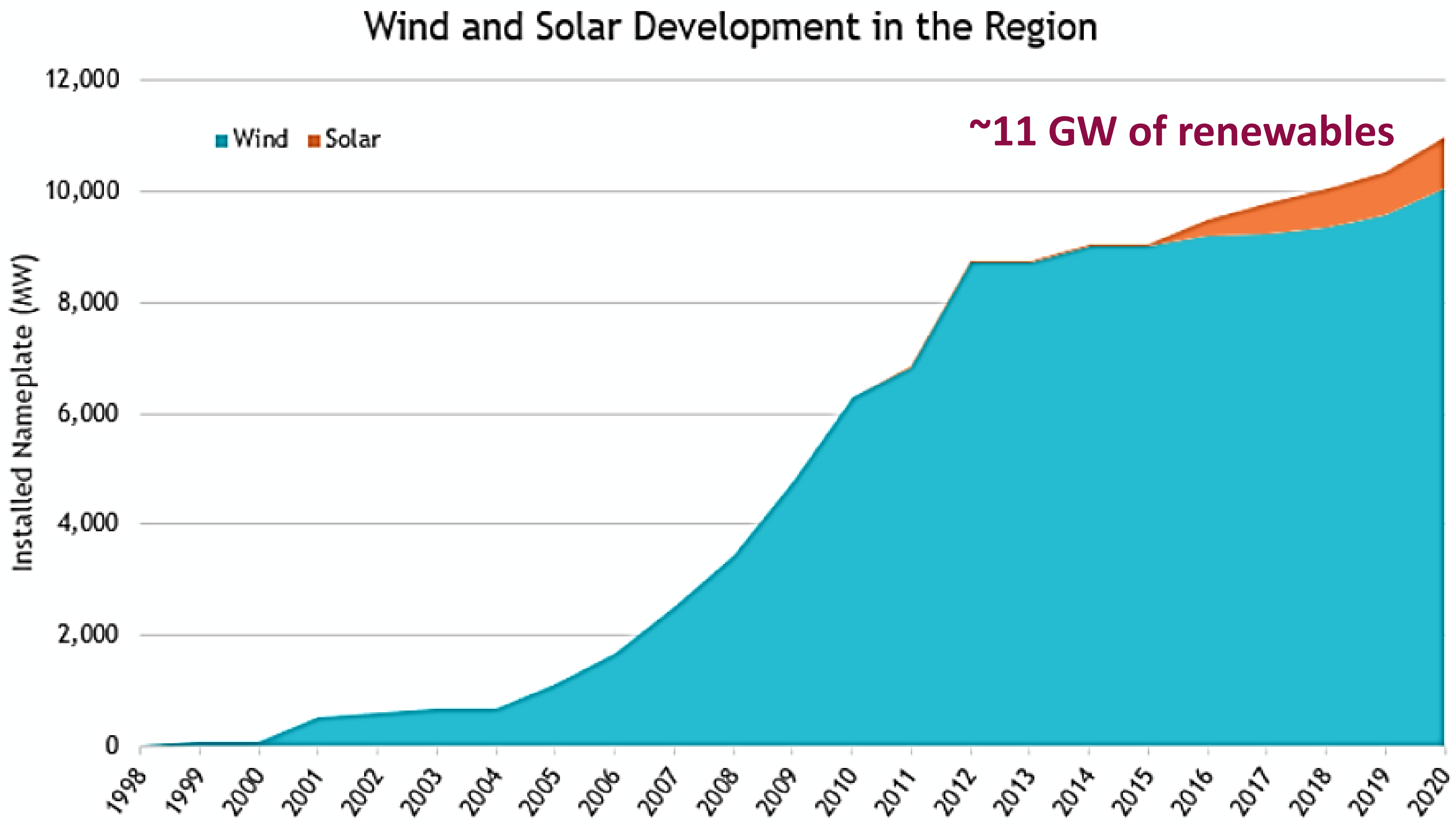
Oregon now
100% Clean by 2040
HB 2021 (2021)

Idaho Power & Avista
100% Clean by 2045



Oregon and many other states are looking for clean energy.

SCALE OF EXISTING RENEWABLES: PNW



Source, Slide 3

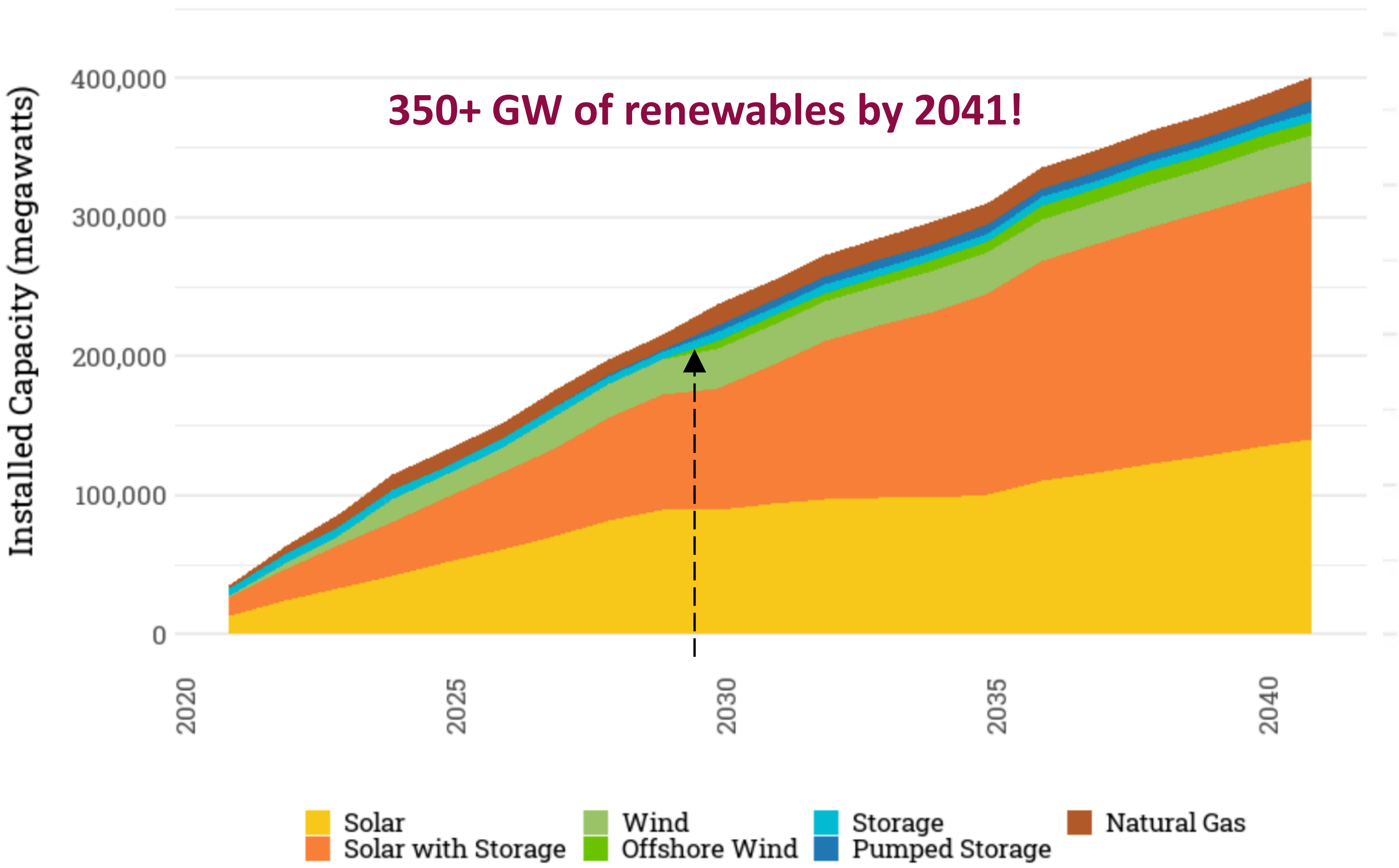
THE 2021 NORTHWEST POWER PLAN
FOR A SECURE & AFFORDABLE ENERGY FUTURE

Wind & Solar in the PNW Developed to date:

Approximately 10,000 MW of wind, with solar increasing in recent years.

Lots of Onshore Wind, How Much More?

SCALE OF NEED FOR NEW RENEWABLES: WEST-WIDE



THE 2021 NORTHWEST POWER PLAN
FOR A SECURE & AFFORDABLE ENERGY FUTURE

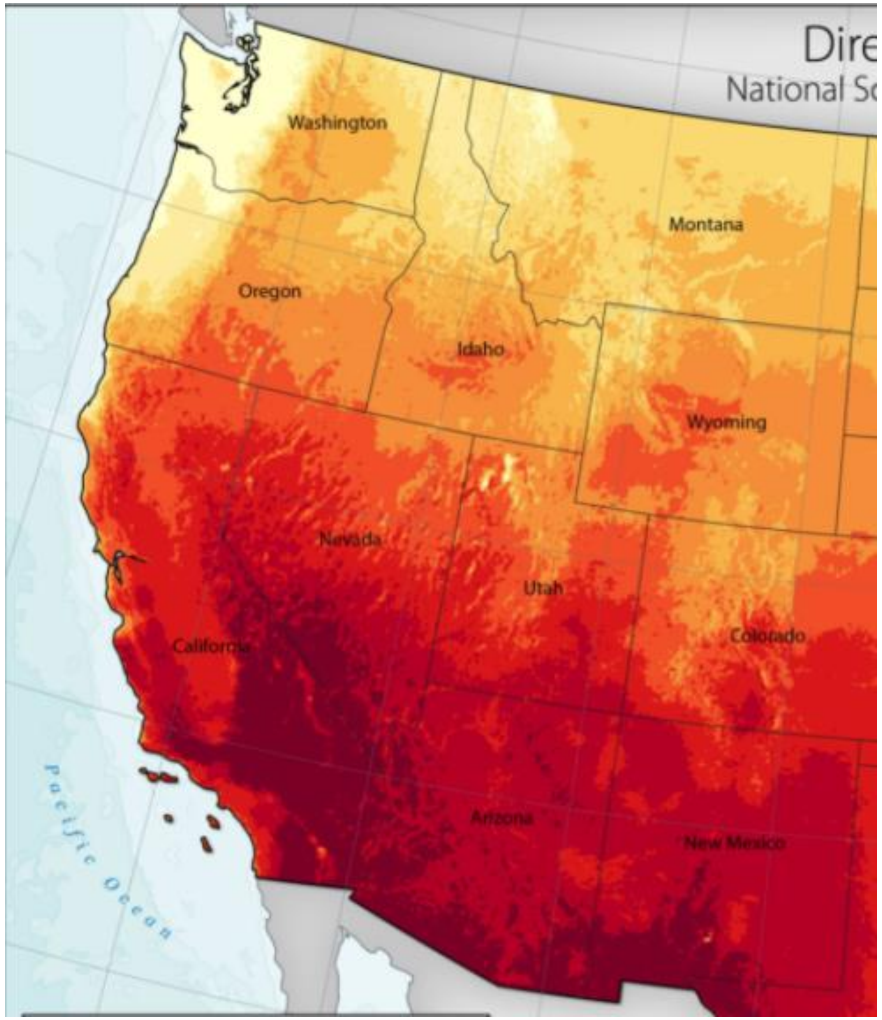
West-wide Projection: Baseline projection for what will be required across western states to meet clean energy targets

Source, p. 51

Can It All Get Built In Time?

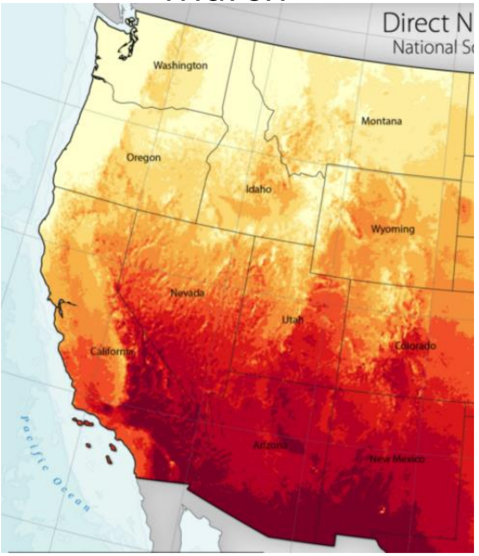
NEED FOR DIVERSITY: **WEST-WIDE - SOLAR**

Annual - Average Solar Output



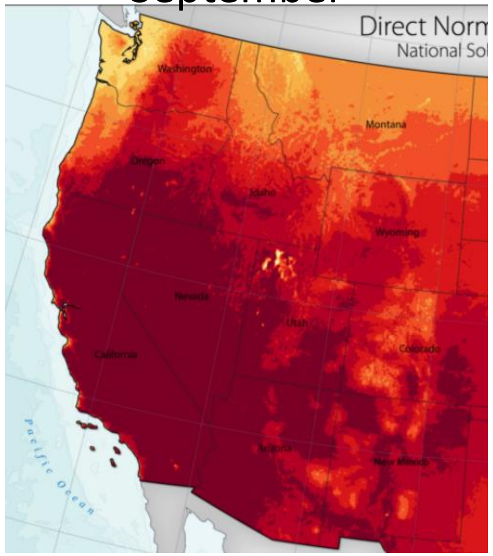
January

March



July

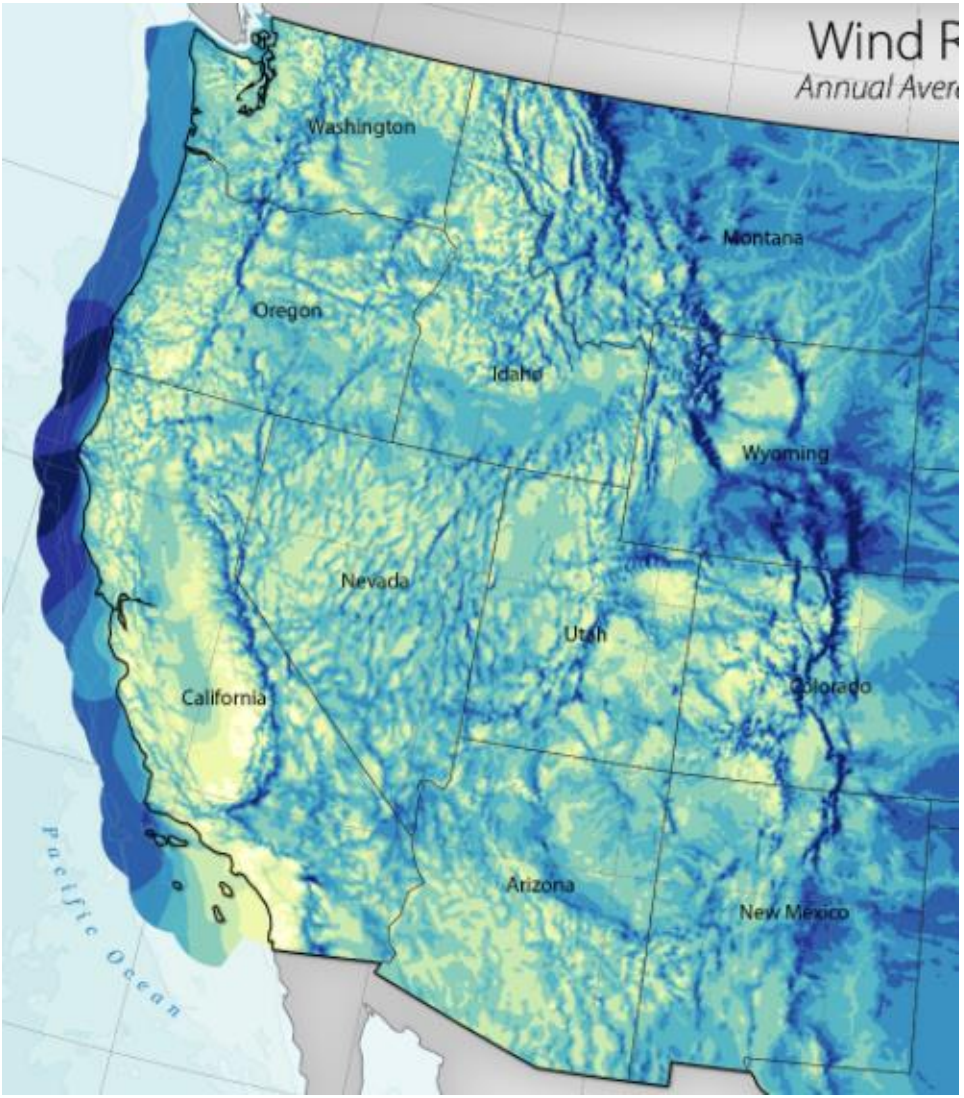
September



Source: https://www.nrel.gov/gis/solar-resource-maps.html
Sengupta, M., Y. Xie, A. Lopez, A. Habte, G. Maclaurin, and J. Shelby. 2018.
"[The National Solar Radiation Data Base (NSRDB)](#)." *Renewable and Sustainable Energy Reviews* 89 (June): 51-60.

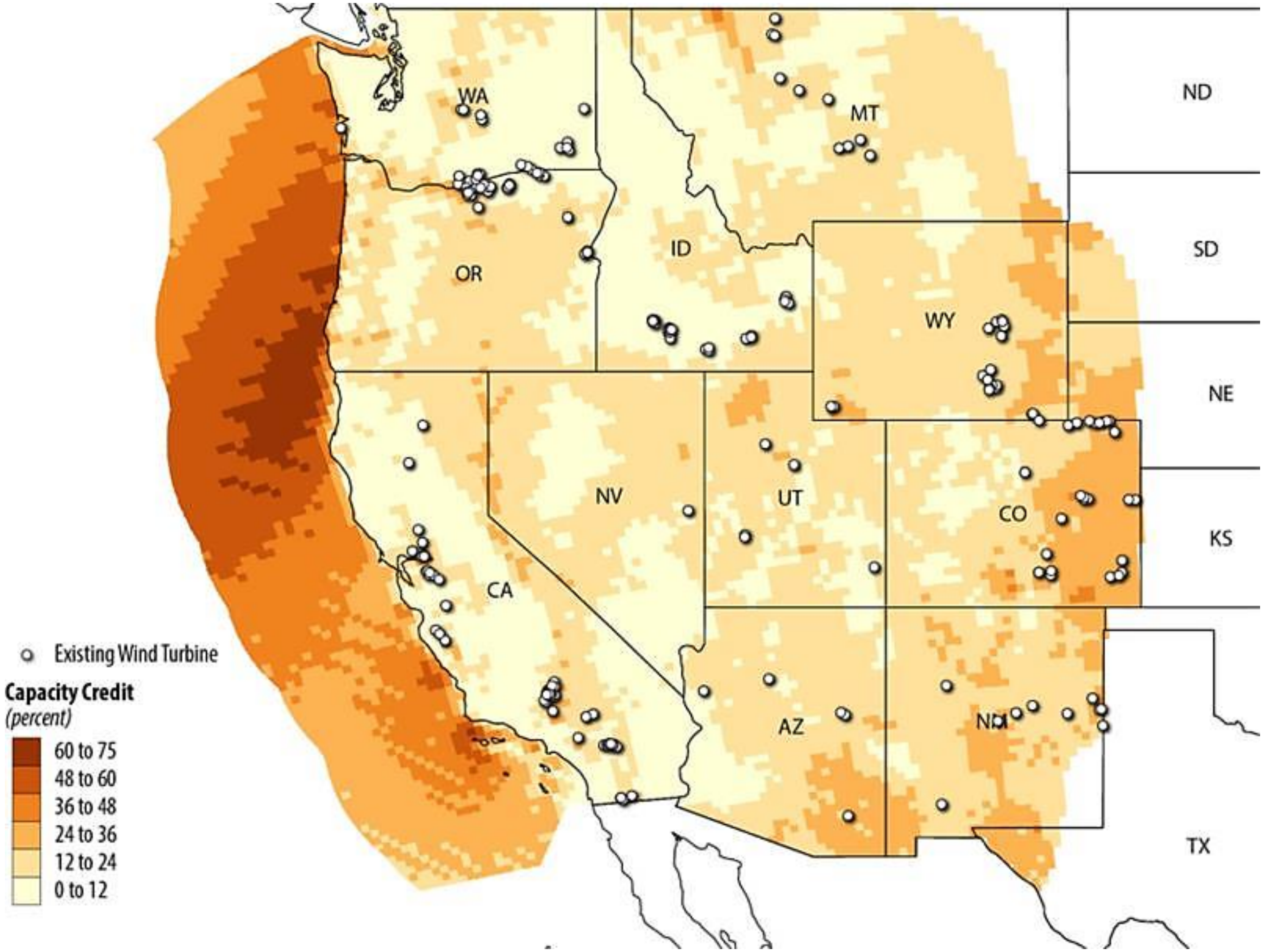
NEED FOR DIVERSITY: **WEST-WIDE - WIND**

Annual - Average Wind Speed



Source: https://www.nrel.gov/gis/wind-resource-maps.html

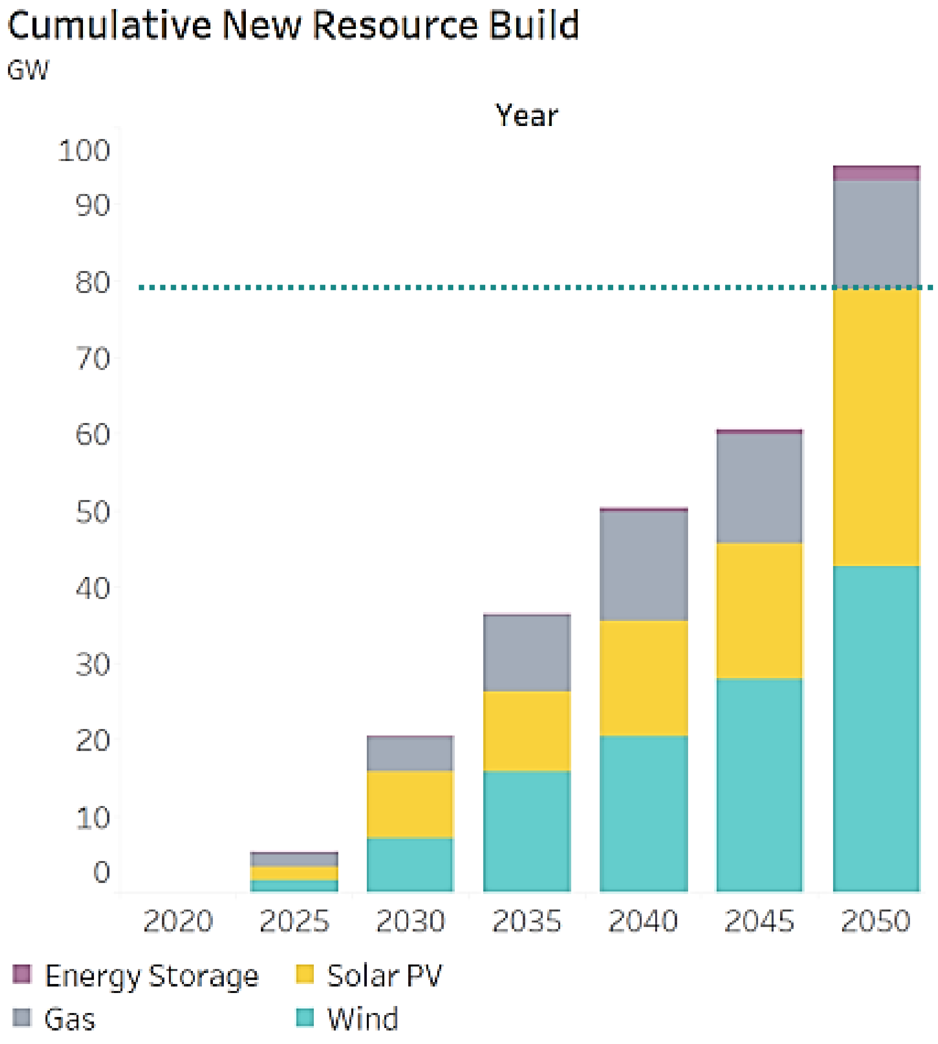
Estimated Capacity Credit & Existing Projects



Source: https://onlinelibrary.wiley.com/doi/full/10.1002/we.2620

Economy-Wide Clean Pathway Studies: PNW

PNW Clean Pathways Study (2019)

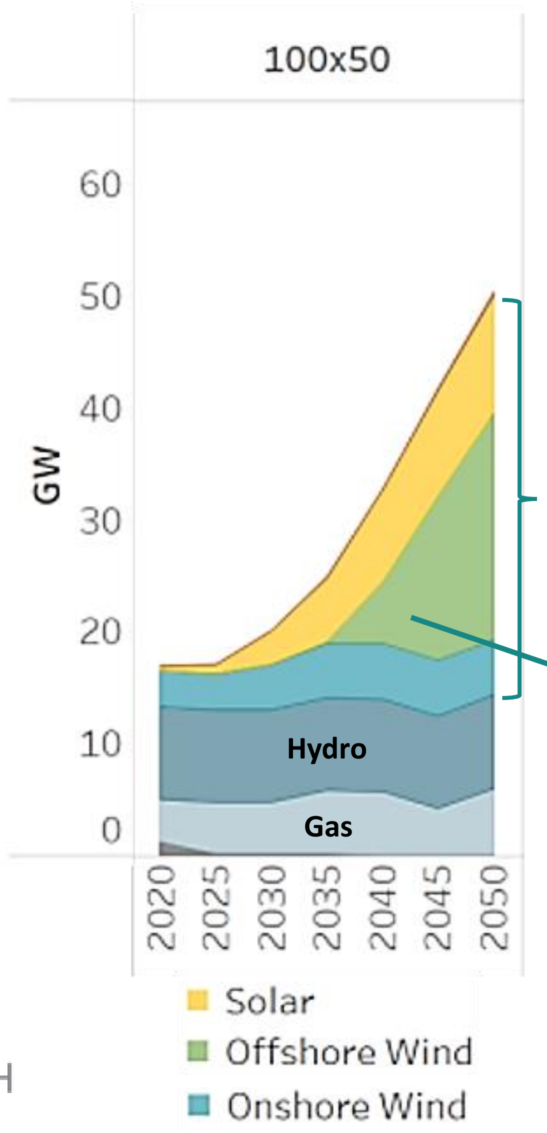


PNW
80 GW
Wind
& Solar
By 2050

Source: Northwest Deep Decarbonization Pathways Study, May 2019, Evolved Energy Research, pg. 73.

EVOLVED ENERGY RESEARCH

Oregon Clean Pathways Study (2021)



Oregon
35 GW
Wind
& Solar
By 2050

20 GW
FOSW
2035-50

Source: Oregon Clean Energy Pathways Study, June 2021, Evolved Energy Research, pg. 39.

100% Clean Targets

Key Takeaways

1) <u>Tremendous scale of new renewables</u> necessary for Oregon and rest of the West
2) <u>Diversity of new renewables</u> necessary to optimize costs & impacts, and to ensure reliable energy systems.
3) <u>Transmission expansion</u> necessary to achieve and optimize the scale & diversity of new renewable build-out.
4) <u>Offshore wind can help optimize all the above</u> – the scale & diversity of new renewables, and the scale of transmission expansion.

100% Clean Targets

Refresh of Key Topics

(1) FOSW Contribution to 100% Clean

(#) → Question Number from Prompting Question Document

100% Clean Targets

Themes from Comments

- FOSW is critical for meeting Oregon climate goals.
- Studies show GWs of new renewables needed for 100% Clean and OSW can contribute.
- FOSW will balance well with solar and contribute to the region’s winter peak energy needs.
- FOSW could be part of the solution to help Oregon and surrounding states meet their climate and clean energy goals.
- Some amount of FOSW can play a role in 100% clean assuming minimal impacts to the environment and ocean ecology.

Source

100% Clean Targets

Themes from Comments

- FOSW represents a great “replacement resource” at GW-scale for regional fossil-fuel and hydro projects that may be retired.

- FOSW projected to serve a diversity role in economy-wide decarbonization.
    - Helping to support load growth for end-use electricity and the production of clean fuels for non-electric sectors.

- FOSW in the ocean offers benefits to optimize the amount of land used for solar and wind development on land.

Source

100% Clean Targets

Opportunity for Additional Feedback

- Information or perspectives that differ from common feedback?
- Provide elaboration or emphasis?
- Topics for future study or engagement?
- New thoughts?

FOSW Technologies
(25 minutes)

- Overview of FOSW Technologies
  - NREL
- Overview of Feedback Received
- Time for Additional Feedback

State of Floating Offshore Wind Technology

Patrick Duffy| Wind Engineer |National Renewable Energy Laboratory
Offshore Wind Briefing for ODOE
April 7, 2022

Presentation Outline

Floating Offshore Wind Overview

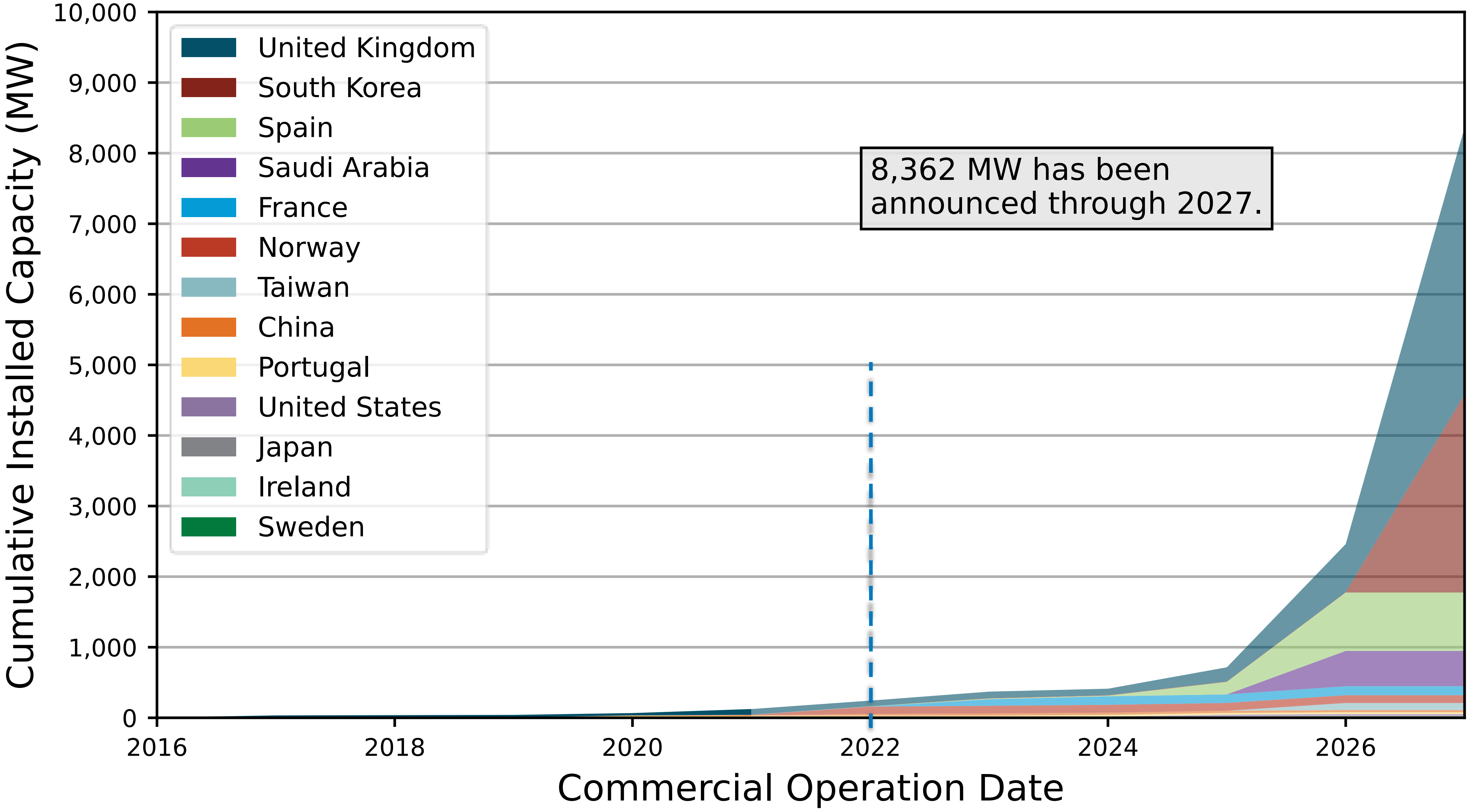
World’s Largest Floating Wind Plant: 50-MW Kincardine

- Kincardine floating wind farm was completed in 2021.
- Five, 9.5-MW Vestas turbines mounted on steel semi-submersibles substructures – Principle Power Inc.
- Located 15-kilometers off Aberdeen, Scotland.
- New largest: Hywind Tampen, an 88 MW wind farm under construction in Norway in 2022

Kincardine 50-MW Floating Offshore Wind Plant

Photo: courtesy of Principle Power Inc.

Projected Floating Offshore Wind Capacity

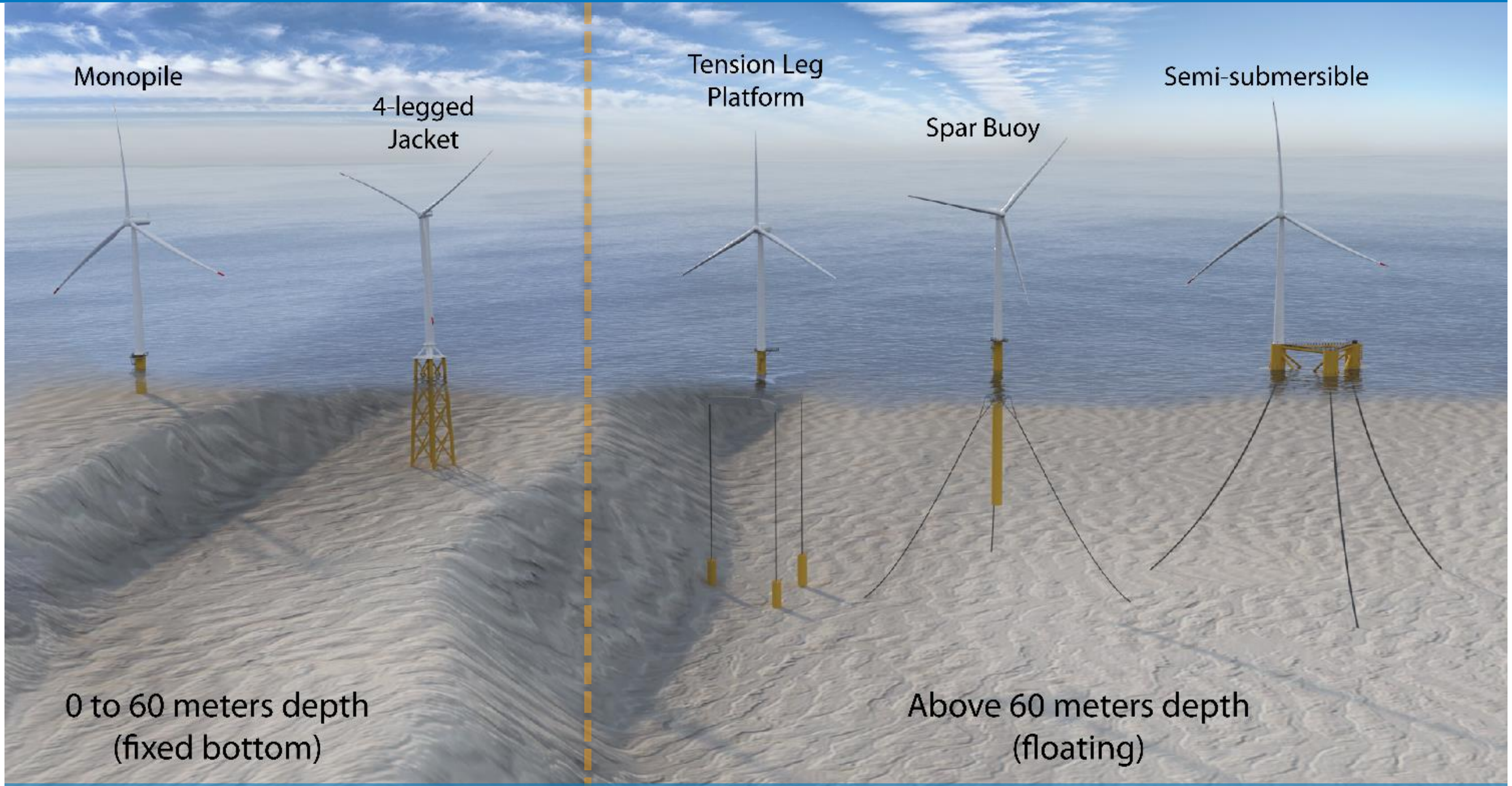


Most Offshore Wind Deployment has been on Fixed-bottom Support Structures

Leading Offshore Wind Countries
(Installed Capacity)
17,399 MW added in 2021

China	13,790 MW
United Kingdom	1,855 MW
Vietnam	634 MW
Denmark	605 MW
The Netherlands	402 MW
Taiwan	109 MW

Figures current as of 5 Apr 2022



Offshore Turbine Substructure Type Depends on Water Depth

Fixed Bottom
50,500 MW Installed

Floating Offshore Wind
123 MW Installed

The future floating wind energy market may be bigger than the fixed-bottom market

Characteristics of Basic Floating Platform Types

- **Spar:** Achieves stability through ballast (weight) installed below its main buoyancy tank
  - Challenges: Deep drafts limit port access

- **Semisubmersible:** Achieves static stability by distributing buoyancy widely at the water plane
  - Challenges: Higher exposure to waves; more structure above the waterline

- **Tension-leg platform (TLP):** Achieves static stability through mooring line tension with a submerged buoyancy tank
  - Challenges: Unstable during assembly; high vertical load moorings.

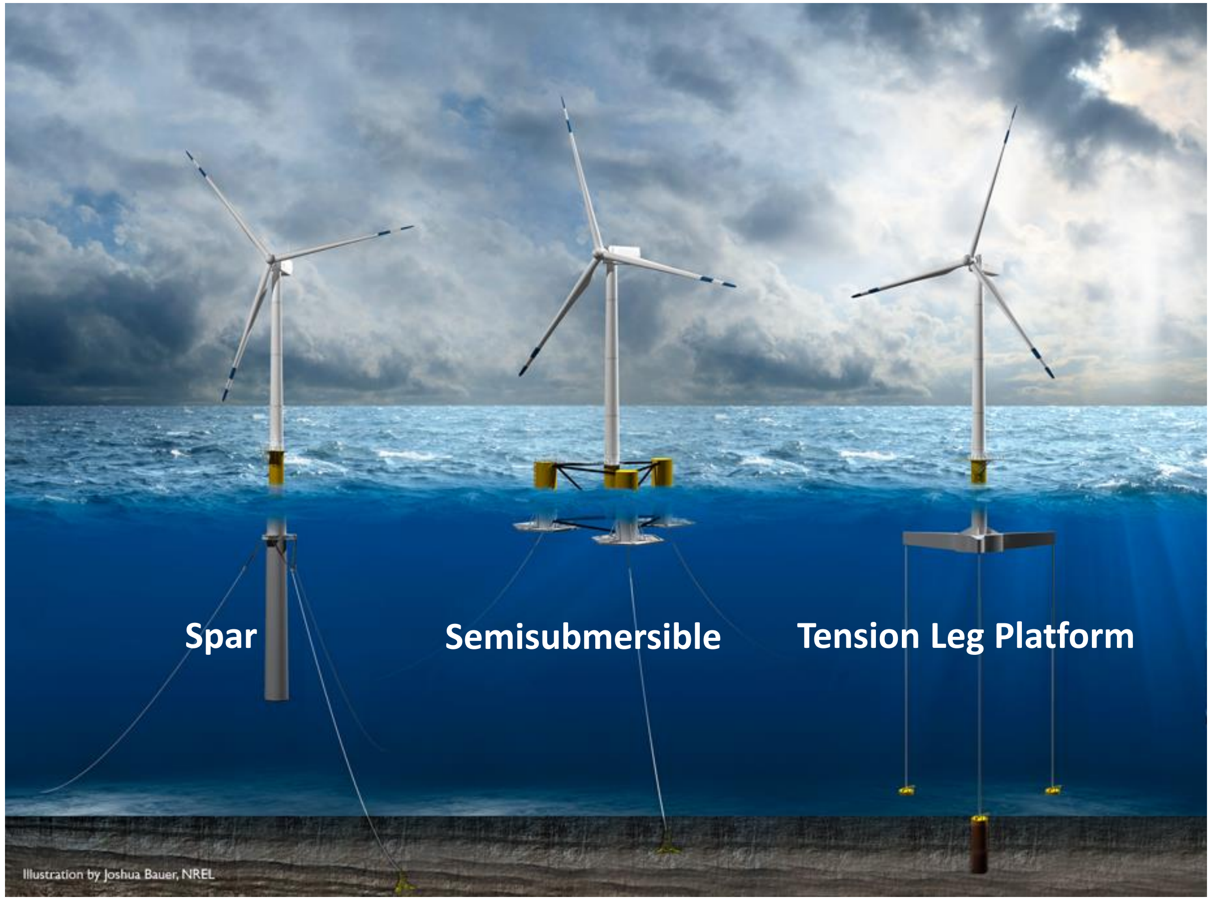


Figure credit: NREL

Offshore Wind Cost Modeling

Oregon Offshore Wind – Levelized Cost of Energy

- Recent NREL study calculated floating offshore wind costs (LCOE) in Oregon
- Observe strong north-south variations mainly driven by:
  - Wind speed distribution
  - Distance from shore
- By 2032, **LCOE is expected to range between $75/MWh in the north and $50/MWh** in the south.

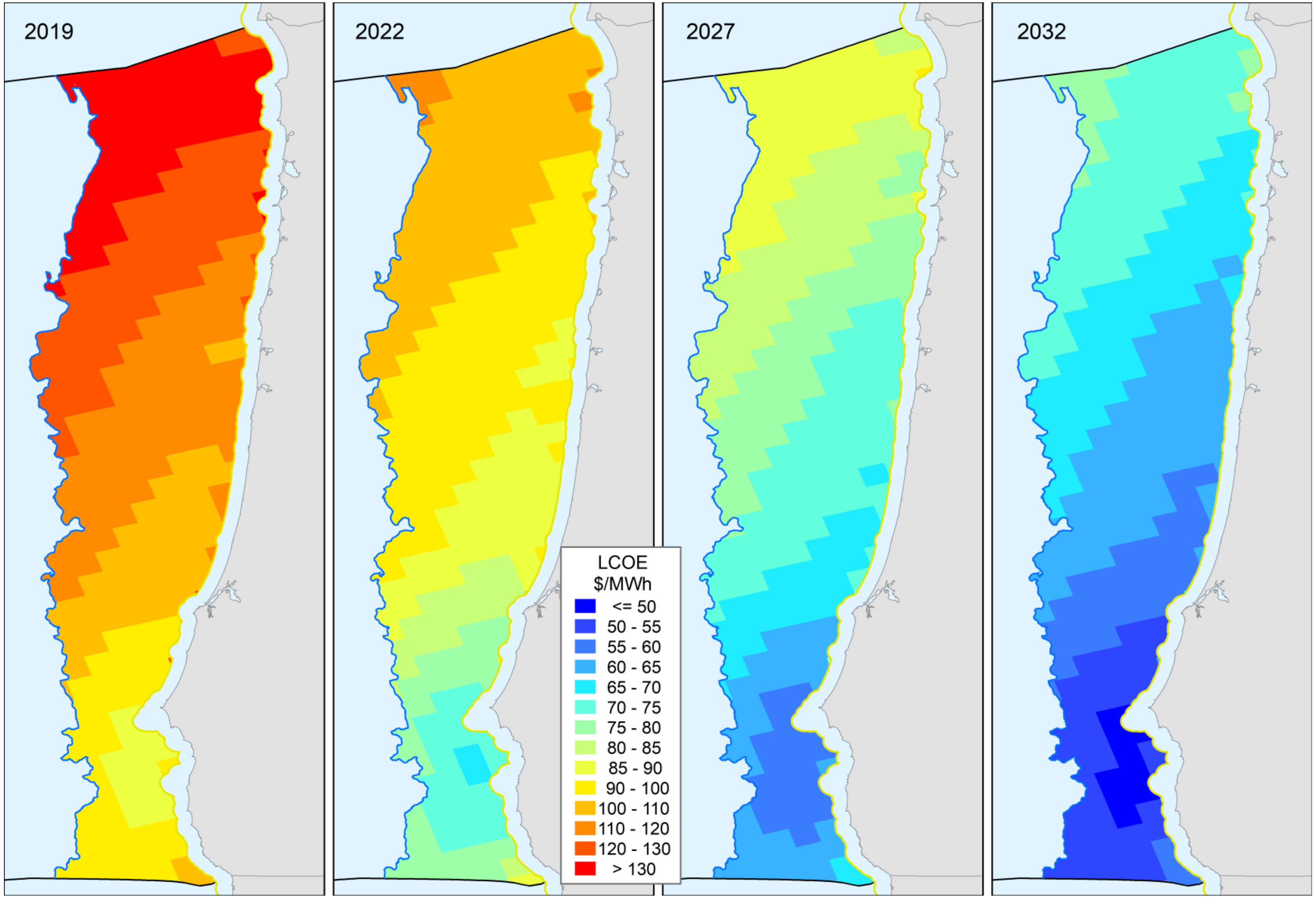
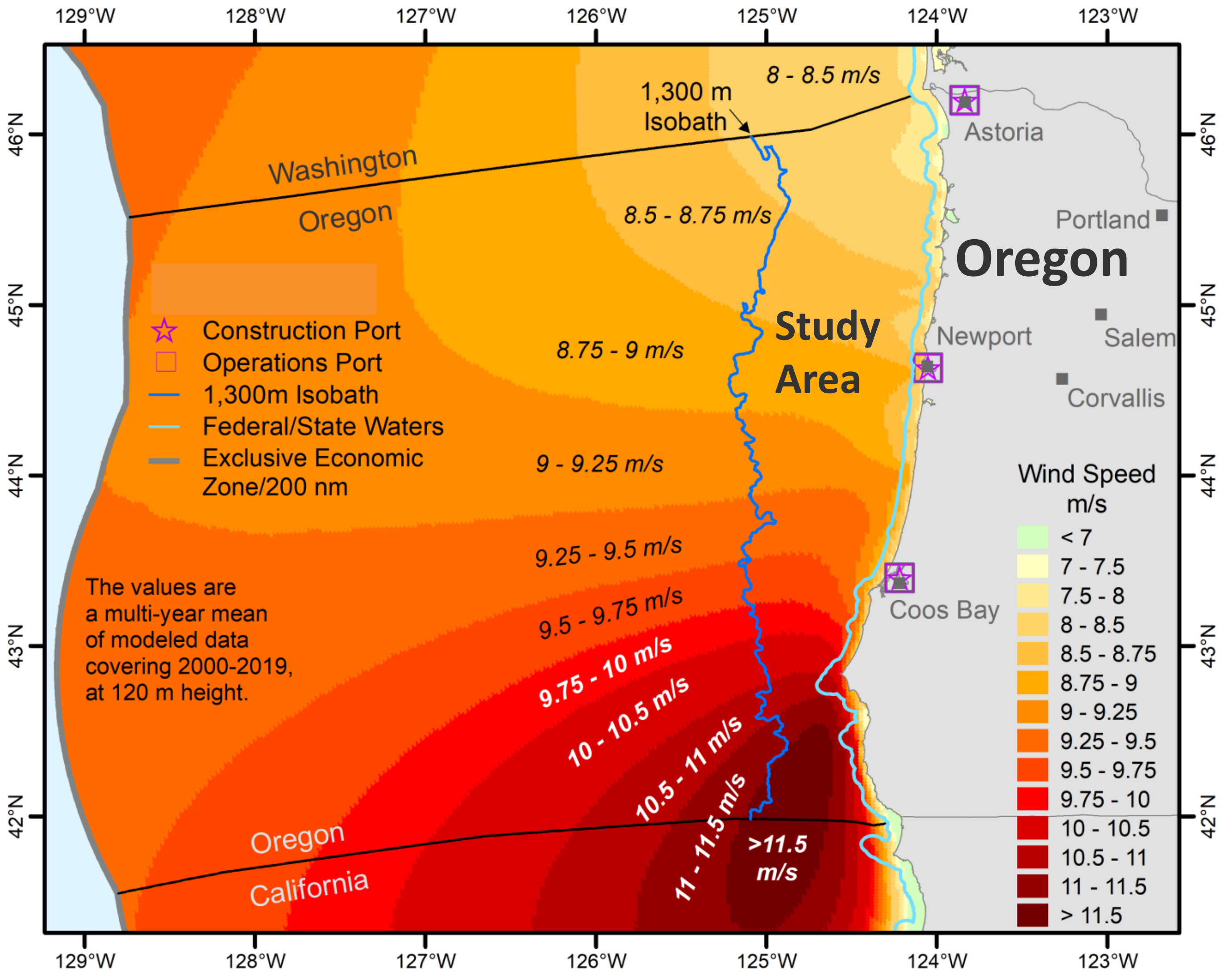


Image source: NREL

New Oregon Offshore Wind Resource Dataset

- New OR-WA20 offshore wind dataset produced a 120-m wind resource map (see figure) using 20 years of modeled data
- Best assessment of offshore wind resources in the Pacific Northwest to date
- **Validation against measured data from floating LIDAR is an important next step**
- The data shows a strong north/south gradient (8 m/s to 11 m/s), with the best wind resources being in the south.



Wind Resource Offshore Oregon – source NREL

What Lowers Offshore Wind Costs?

- Technology improvements (**larger turbines**, better control algorithms, improvements in materials, digitalization)
- Increasing plant size due to economies of scale
- Maturing supply chains
- Industrialization and serial production
- Increased competition
- Lower risk (from tech/industry maturity)
- Note: port and bulk transmission upgrade costs are not included in the LCOE numbers on slide 8

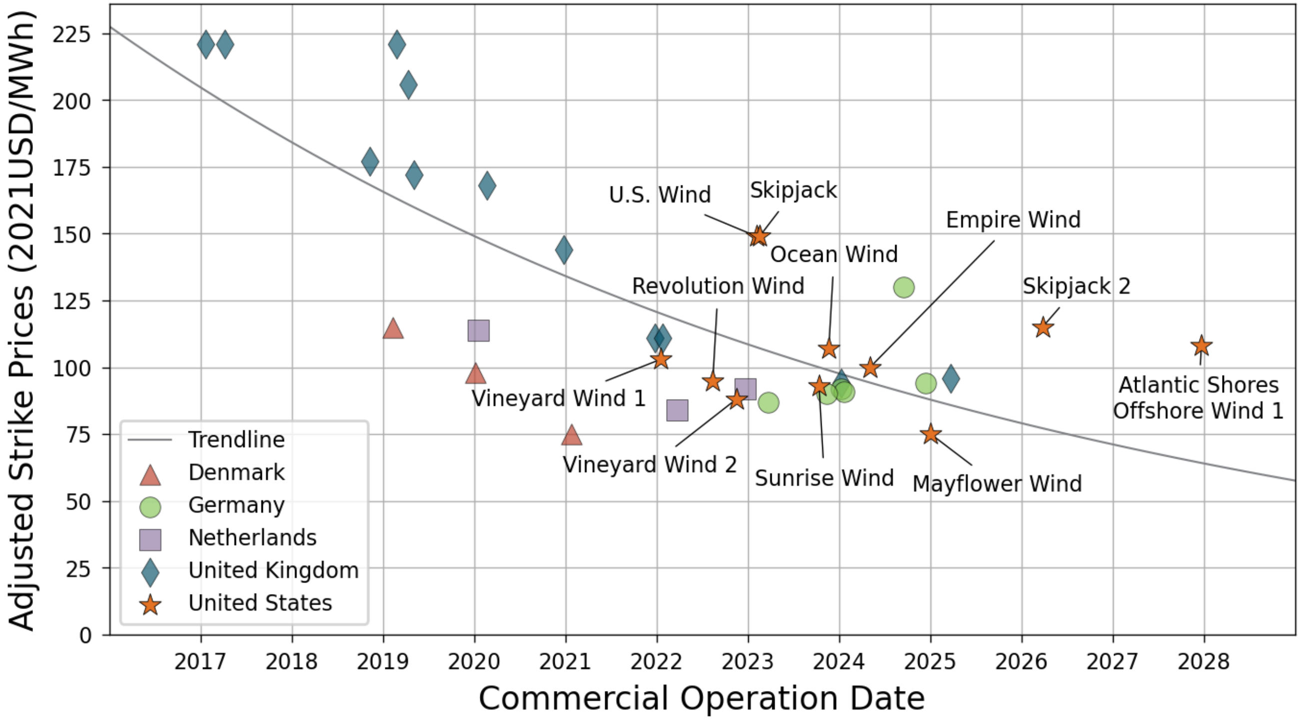


Image source: NREL

Key Takeaways

- Floating offshore wind is in the early stages of deployment, but will leverage knowledge from the global fixed-bottom offshore wind industry
  - Floating expected to grow exponentially by 2027
- Different floating substructure technologies are competing, and will likely benefit from rapid innovation as the industry grows
- NREL estimates that LCOE for floating offshore wind in Oregon could range from $75/MWh in the north to $50/MWh in the south by 2032
- The best wind resource is in Southern Oregon
- Factors like turbine size, economies of scale, maturing supply chains, and industrial production of floating offshore wind turbines are helping to lower costs
- A marshalling port to serve offshore wind deployment and service the wind farms would likely be needed
- Significant economic benefits may be available with Oregon offshore wind energy

References

1. Beiter, P., W. Musial, P. Duffy, A. Cooperman, M. Shields, D. Heimiller, and M. Optis. 2020. *The Cost of Floating Offshore Wind Energy in California Between 2019 and 2032*. National Renewable Energy Laboratory (NREL). NREL/TP-5000-77384. https://www.nrel.gov/docs/fy21osti/77384.pdf .
2. Draxl, C., A. Clifton, B.M. Hodge, and J. McCaa. 2015. "The Wind Integration National Dataset (WIND) Toolkit." *Applied Energy* 151 (1 August 2015): 355–66. https://doi.org/10.1016/j.apenergy.2015.03.121 .
3. Gaertner, E., J. Rinker, L. Sethuraman, F. Zahle, B. Anderson, G. Barter, N. Abbas. 2020. *Definition of the IEA 15-Megawatt Offshore Reference Wind*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5000-75698. https://www.nrel.gov/docs/fy20osti/75698.pdf.
4. Hundleby, G., K. Freeman, A. Logan, and C. Frost. 2017. "Floating Offshore: 55 Technology Innovations That Will Have Greater Impact on Reducing the Cost of Electricity from European Floating Offshore Wind Farms." KiC InnoEnergy and BVG Associates. Accessed September 24, 2021. http://www.innoenergy.com/new-floating-offshore-wind-report-55-technology-innovations-that-will-impact-the-lcoe-in-floating-offshore-wind-farms/.
5. Musial, W., P. Beiter, J. Nunemaker, D. Heimiller, J. Ahmann, and J. Busch. 2019. *Oregon Offshore Wind Site Feasibility and Cost Study*. National Renewable Energy Laboratory (NREL). NREL/TP-5000-74597. https://www.nrel.gov/docs/fy20osti/74597.pdf.
6. Musial, W., P. Beiter, P. Spitsen, M. Shields, A. Cooperman, R. Hammond, J. Nunemaker, V. Gevorgian. 2020. *2019 Offshore Wind Technologies Market Update*. Washington, D.C.: U.S. Department of Energy. https://www.nrel.gov/docs/fy21osti/77411.pdf.
7. Novacheck, J., and M. Schwarz. 2021. Oregon Offshore Wind Grid Integration Analysis. Golden, CO: National Renewable Energy Laboratory https://www.nrel.gov/docs/fy22osti/81244.pdf
8. NREL. 2021. FLORIS. Version 2.3.0. https://github.com/NREL/floris.
9. Optis, M., A. Rybchuk, N. Bodini, M. Rossol, and W. Musial. 2020. *2020 Offshore Wind Resource Assessment for the California Pacific Outer Continental Shelf*. National Renewable Energy Laboratory. NREL/TP-5000-77642. https://www.nrel.gov/docs/fy21osti/77642.pdf .
10. Shields, M., P. Beiter, J. Nunemaker, A. Cooperman, and P. Duffy. 2021. Impacts of turbine and plant upsizing on the levelized cost of energy for offshore wind. *Applied Energy* 298: 117-189. https://doi.org/10.1016/j.apenergy.2021.117189.

Carpe Ventum!

Thank you

www.nrel.gov

patrick.duffy@nrel.gov

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the U.S. Department of the Interior, Bureau of Ocean Energy Management, Pacific OCS Region, through Interagency Agreement M19PG00025 with the DOE National Renewable Energy Laboratory. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government.

NREL Transforming ENERGY

FOSW Technologies

Refresh of Key Topics

FOSW Turbines

(9) Turbine Size

(10) Technical Limitations

FOSW Platforms/Anchoring Systems

(11) Overall Costs

(12) Costs by Platform Type

(13) Platforms for Oregon

(14) Innovative Designs

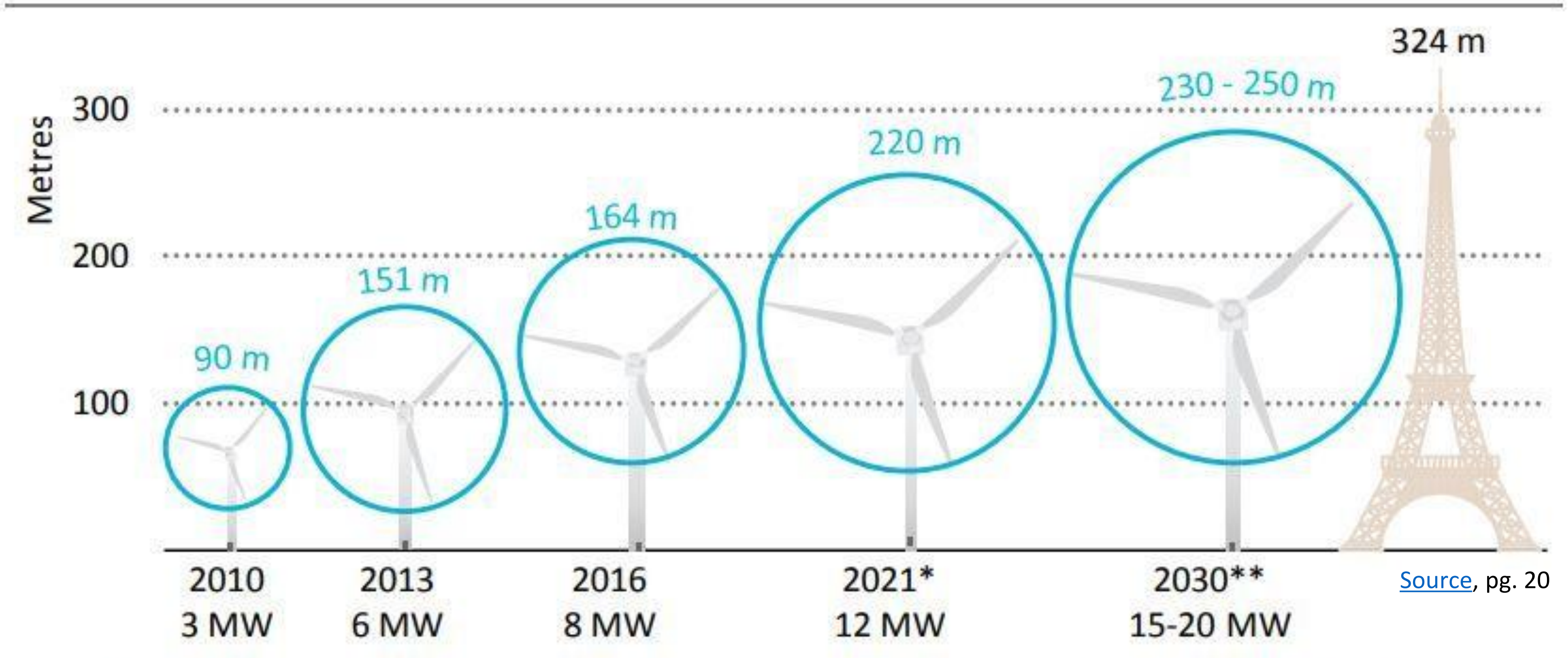
(#) → Question Number from Prompting Question Document

FOSW Technologies - Turbines

Themes from Comments

Turbine Size:

- Size is significant contributor to overall project economics.
- Upscaling is essential, 15 MW turbines already in development.
- R&D projects underway to develop cost-effective designs to address upscaling and domestic supply chain hurdles.



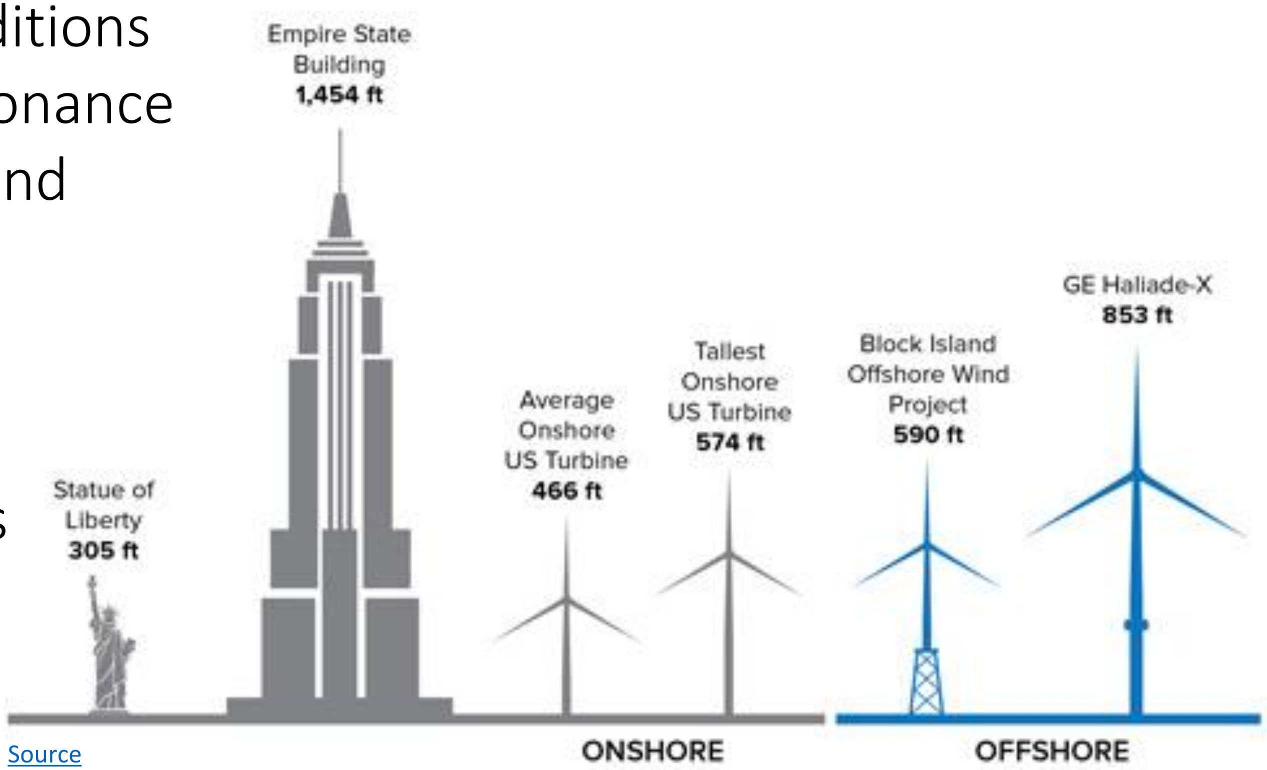
Source, pg. 20

FOSW Technologies - Turbines

Themes from Comments

Technical Limitations:

- Limits could be driven by manufacturing and port infrastructure.
- No physical limits preventing commercial viability of 20 MW turbines.
- Large rotors may introduce new physical conditions related to wake interactions and dynamic resonance interactions between slow rotating turbines and floating substructures.
- Need for more research to understand how floating turbines with six degrees of freedom behave under various atmospheric conditions and extreme storm and seismic events.
- Blade tip height could cause concern from FAA or DoD.



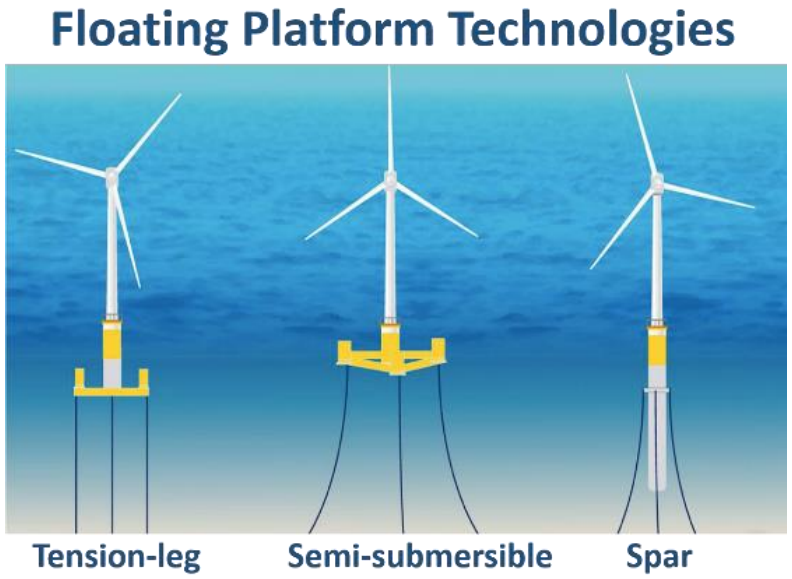
Source

FOSW Technologies - Platforms

Themes from Comments

Overall Costs:

- Cost reductions rely on serial production.
- Upscaling identified as critical to support larger turbines.



Cost by Platform Type:

- Dozens of platforms to chose from, every project requires a site-specific evaluation that will influence type and costs.

Platforms for Oregon:

- FOSW will be installed at depth ranging from 500 m to 1300 m.
- Deeper the water, the larger the anchor circle, which reduces density of arrays.
- More efficient designs can: shrink footprint, reduce ocean conflicts, minimize costs, and expedite installation.
- Designs need to withstand earthquakes and seismically induced soil liquefaction.

FOSW Technologies

Opportunity for Additional Feedback

- Information or perspectives that differ from common feedback?
- Provide elaboration or emphasis?
- Topics for future study or engagement?
- New thoughts?

State and Regional Reliability & Resilience
(30 minutes)

- Overview of PNNL Study on FOSW Generation and Transmission
    - PNNL
- Overview of Feedback Received
- Time for Additional Feedback

Pacific Northwest NATIONAL LABORATORY

Oregon Offshore Wind Energy: Reliability & Resilience Considerations

April 7, 2022

Travis C. Douville, PE

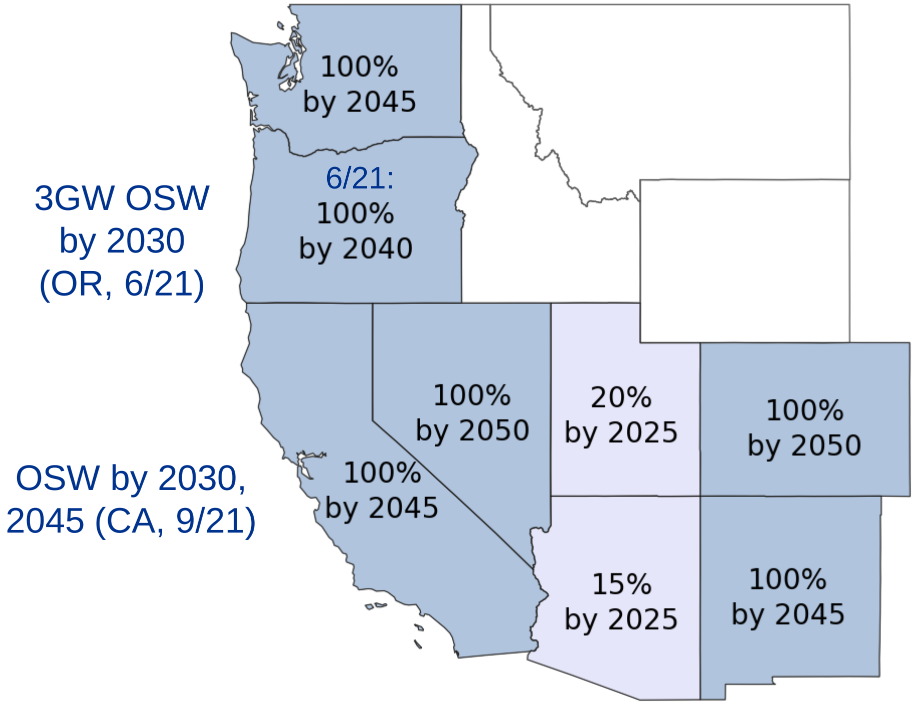
U.S. DEPARTMENT OF ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy

[1] Douville & Bhatnagar (2021)

Clean energy policy acceleration in West

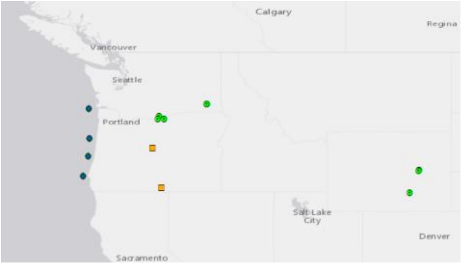
Current electricity decarbonization commitments pose paradigm shifts in grid design and operation

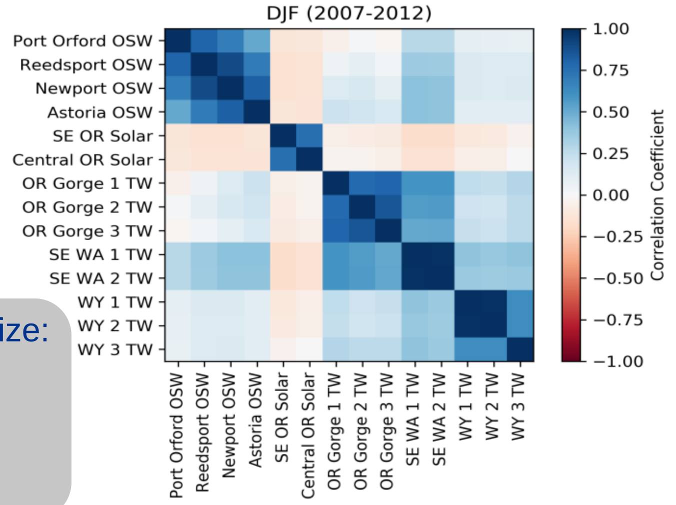


Most of the clean energy goals in the Western Interconnection will be met through variable renewable energy (VRE) resources

At these scales, VRE challenges resource adequacy and grid reliability and resilience

The role for OSW? VRE characteristics to inform scale/siting[1]





Geographic, generator diversity to optimize:

- Correlation with (net) load
- Correlation with (future) VRE
- Capacity factor
- Power flows

In practice, current grid capacity to inform scale/siting[1]

OR HB3375 → 2 GW

Total OSW Capacity	Curtailment (%)			
	Port Orford	Reedsport	Newport	Asto
1 GW	0.2	0.1	0.0	0.
2 GW	2.0	7.2	0.2	3.
3 GW	20.5	28.1	10.3	14.
4 GW	36.8	42.2	26.1	30
5 GW	47.3	51.5	37.3	40.

Resource/Load Complementarity

Variable Renewable Energy (VRE) study:

+8 “terrestrial” wind (TW) locations

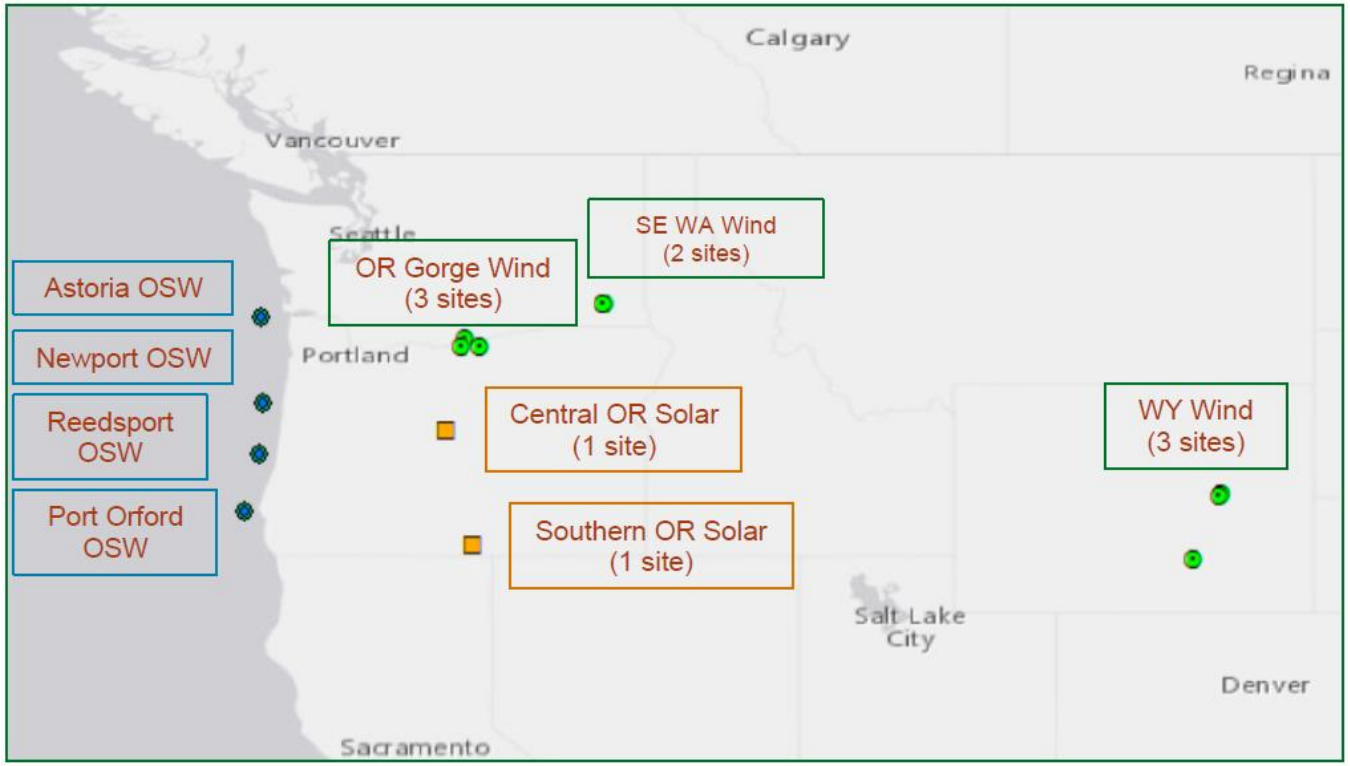
- 100m wind speeds from WindToolkit

+2 solar farms (OR Solar Dashboard)

- Hourly DNI, GHI data from National Solar Radiation Database (NSRDB)
- Reedsport and Port Orford are closest to BOEM draft call areas.

Hourly correlations $r_{x,y}$ computed by season

Complementarity holds implications to reliability and resilience selection of correlated resources may reduce the need for energy storage and may preserve hydropower flexibility

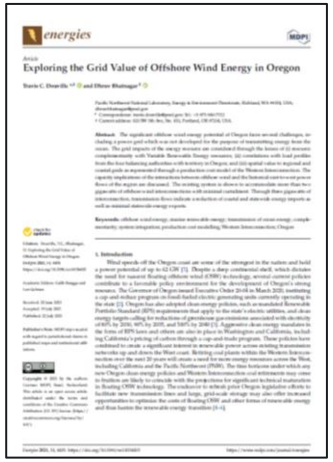


$$r_{x,y} = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2}\sqrt{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}}$$

(VRE) Resource Complementarity

1. *r*(OSW, Gorge TW) ~ -0.2 (summer), -0.13 (spring)
   - OSW could help balance Gorge, SE WA wind in the summer
2. *r*(OSW, OR solar) ~ -0.15 (winter)
   - OSW could complement OR solar to help meet regional peak loads
3. *r*(TW, OR solar) ~ -0.2 (summer) > *r*(OSW, OR solar) ~ 0 (summer)
   - OSW does not complement solar as well as TW in the summer

Load Complementarity


energies

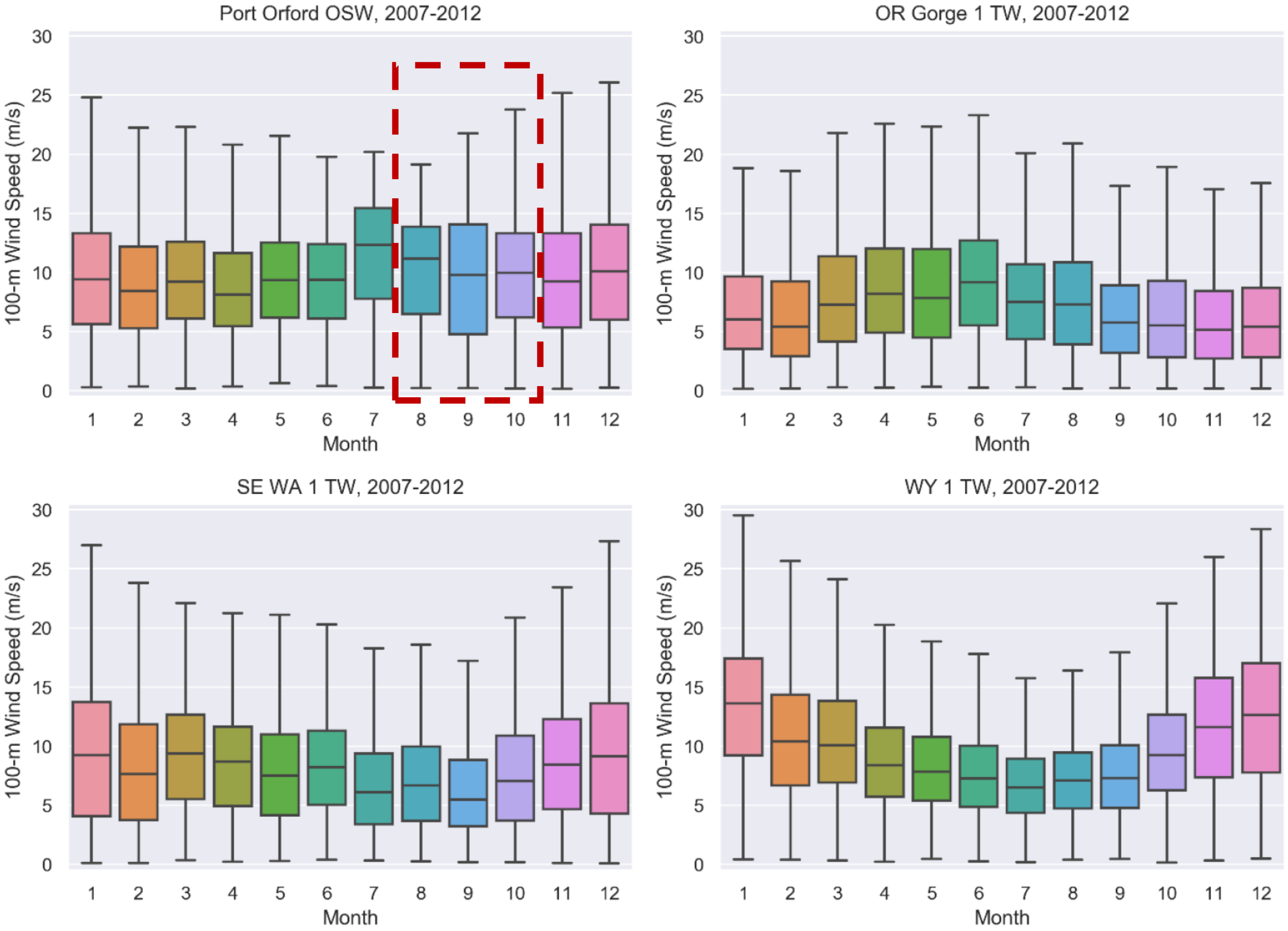
Exploring the Grid Value of Offshore Wind Energy in Oregon

[1] Douville & Bhatnagar (2021)

1. *r*(OR solar, load) ~ 0.4 (summer)
   - Solar load complementarity exceeds all other VRE
2. *r*(OSW, load) ~ 0.15 (winter)
   - OSW may help balance loads during regional peaks driven by heating
3. *r*(OSW, load) ~ 0.17 (summer), 0.18 (spring)
   - In general, OSW complements load better than TW through the year

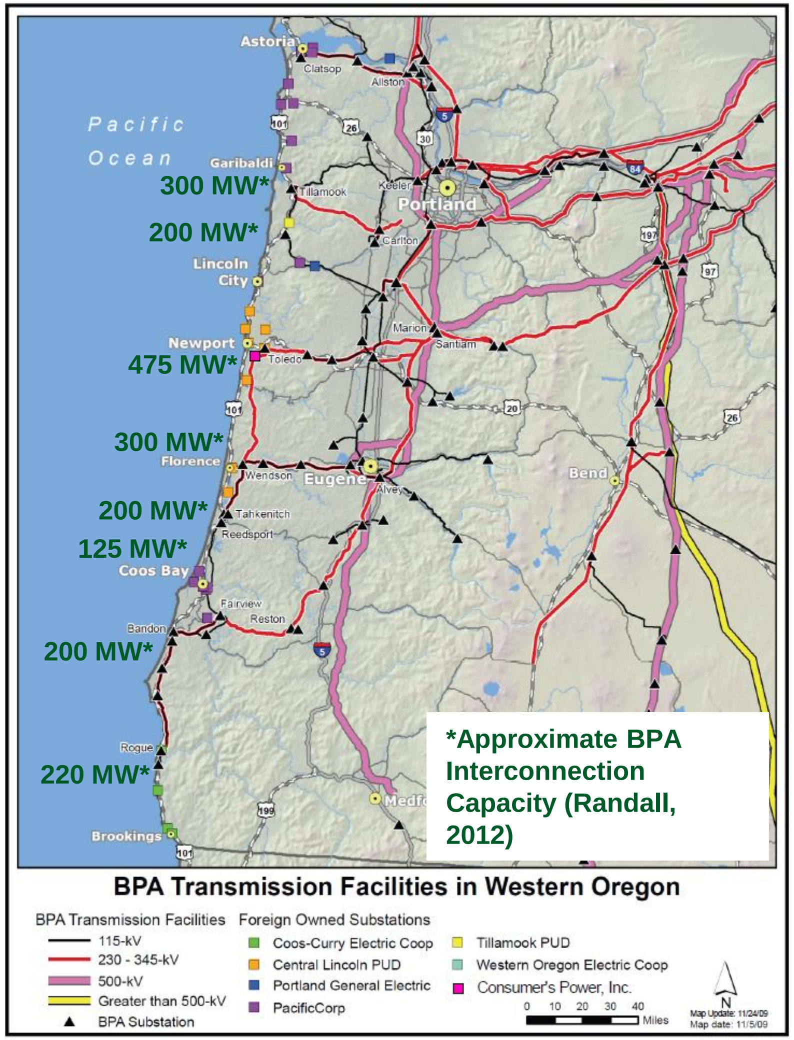
Resource Complementarity—Hydro

- Late summer constraints:
  - Depletion of water resource
  - Increase in river temperatures mean that the river must flow to preserve habitat
  - Hydropower flexibility is reduced
- OSW holds a more consistent production profile through the summer than TW resources



Locational Reliability and Resilience Value

- Power Quality. Injection from modern offshore WTGs may stabilize coastal grids
  - Distributed active power injection for frequency response and regulation
  - Reactive power for voltage regulation
  - Fault ride-through
  - Many of these capabilities recently demo'd (CAISO, 2020)
- Resilience benefits at coast and system-wide
  - Avoided costs of outages
  - Reductions in backup systems
  - Loads which can be served by resilient power, including disaster response
  - N-S transmission alternatives (e.g., Bootleg fire 7/2021)
- Reduce power transmission to OR coast
  - Serving 1GW of coastal load frees up transmission to serve additional inland loads



Pacific Energy Ventures (2009)

PNNL 2020 OR OSW Study

Key Findings

- **Regional transmission may be able to carry significant OSW contributions (2-3 GW) with minimal transmission investment and limited power export**
- **OSW power flows would relieve historic transmission flows**
  - OSW frees east-to-west transmission which may assist additional VRE transmission
  - Coastal loads could be served largely by OSW
- **OSW naturally complements loads better than Northwest onshore wind**
- **OSW could complement regional clean energy sources**
  - Consistency of OSW speeds in late summer may benefit constrained hydropower
  - OSW could help hydropower balance Gorge wind

Future Work

Resource adequacy analysis, power flow simulations (i.e., steady state, short circuit, and dynamic), and production cost modelling (>3 GW) of various generation and transmission concepts in future states of the WECC

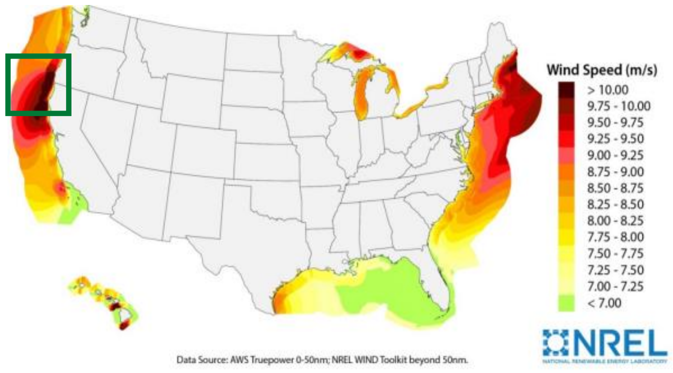
NOWRDC/BOEM Extension

Current study is poised to inform state and federal efforts along the CA/OR Outer Continental Shelf

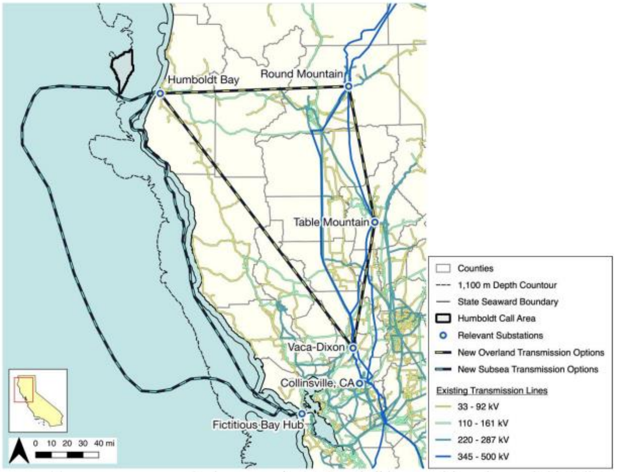
An Offshore Wind Energy Development Strategy to Maximize Electrical System Benefits in Southern Oregon and Northern California

- 18-month effort
- Optimization of generation footprints for system value
- Evaluation of three conceptual transmission scenarios among:
  - Incremental land-based transmission upgrades
  - New high voltage land-based transmission, or
  - Offshore high voltage transmission
- Guided by 11-member POET[1] Industry Advisory Board
- Extension in-work to evaluate Bay Area power flows

Outcomes:
1. A system valuation methodology for concept prioritization
2. System dispatch and power flow simulations of three large-scale transmission concepts
3. Identification of mechanisms to further optimize system value



Musial, et. al (2016)



Severy, et. al (2020)

[1] *Pacific Ocean Energy Trust*

Pacific Northwest NATIONAL LABORATORY

Thank you

References (1 of 2)

Beiter, P., Lau, J., Novacheck, J., Yu, Q., Stephen, G., Jorgenson, J., Musial, W., & Lantz, E. (2020). *The Potential Impact of Offshore Wind Energy on a Future Power System in the U.S. Northeast* (Report No. NREL/TP-5000-74191). National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy20osti/74191.pdf

Beiter, P., Musial, W., Kilcher, L., Maness, M., & Smith, A. (2017). *An Assessment of the Economic Potential of Offshore Wind in the United States from 2015 to 2030* (Report No. NREL/TP-6A20-67675). National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy17osti/67675.pdf

Collier, Robert, Sanderson Hull, Oluwafemi Sawyerr, Shenshen Li, Manohar Mogadali, Dan Mullen, and Arne Olson. (2019). California Offshore Wind: Workforce Impacts and Grid Integration. Center for Labor Research and Education, University of California, Berkeley. http://laborcenter.berkeley.edu/offshore-wind-workforce-grid.

Denholm, P., Sun, Y., & Mai, T. (2019). An Introduction to Grid Services: Concepts, Technical Requirements, and Provision from Wind (Report No. NREL/TP-6A20-72578). National Renewable Energy Laboratory. nrel.gov/docs/fy19osti/72578.pdf

Douville, T. C., & Bhatnagar, D. (2021). Exploring the Grid Value of Offshore Wind Energy in Oregon. *Energies*, *14*(15), 4435. doi:10.3390/en14154435

Froese, M. (2018). Offshore wind industry heading out to deeper water. *Windpower.* https://www.windpowerengineering.com/offshore-wind-industry-heading-out-to-deeper-water/

ISO New England (ISO-NE) (2016). *2015 Economic Study Evaluation of Offshore Wind Deployment*. http://www.iso-ne.com/static-assets/documents/2016/09/2015_economic_study_offshore_wind_development_final.docx

Jorgenson, J., Awara, S., Stephen, G., & Mai, T. (2021). A systematic evaluation of wind's capacity credit in the Western United States. *Wind Energy*, we.2620. https://doi.org/10.1002/we.2620

LiVecchi, A., Copping, A., Jenne, D., Gorton, A., Preus, R., Gill, G., Robichaud, R., Green, R., Geerlofs, S., Gore, S., Hume, D., McShane, W., Schmaus, C., Spence, H. (2019). *Powering the Blue Economy; Exploring Opportunities for Marine Renewable Energy in Maritime Markets*. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Washington, D.C.

Mills, A., D. Millstein, S. Jeong, L. Lavin, R. Wiser, M. Bolinger (2018). Estimating the Value of Offshore Wind Along the United States' Eastern Coast. *Environmental Research Letters*, *13*(2018), 1-12. https://doi.org/10.1088/1748-9326/aada62

References (2 of 2)

Mongird, K. & Barrows, S. (2021). The Value of Distributed Wind: A Valuation Framework (Report No. PNNL-31127). Pacific Northwest National Laboratory. https://doi.org/10.2172/1777484

Musial W, D Heimiller, P Beiter, G Scott, and C Draxl. 2016. *2016 Offshore Wind Energy Resource Assessment for the United States* (Technical Report). Golden, CO: National Renewable Energy Laboratory. NREL/TP-5000-66599. http://www.nrel.gov/docs/fy16osti/66599.pdf

Novacheck, J. & Schwartz, M. (in press). Oregon offshore wind grid integration analysis. National Renewable Energy Laboratory.

Pacific Energy Ventures. (2009). Utility Market Initiative: Integrating Oregon Wave Energy into the Northwest Power Grid. Oregon Wave Energy Trust.

Randall, C. (2012, September 27). *Generation Interconnection to BPA's Transmission System on the Oregon Coast* [Conference presentation]. 7th Ocean Renewable Energy Conference, Portland, OR.

Sheridan L, Krishnamurthy R, Gorton A, Shaw W, and Newsom, J. 2020. "Validation of reanalysis-based offshore wind resource characterization using lidar buoy observations." *Marine Technology Society Journal 54*(6). https://doi.org/10.4031/MTSJ.54.6.13

Severy, M. & Jacobson, A. (2020). Interconnection Constraints and Pathways. In M. Severy, Z. Alva, G. Chapman, M. Cheli, T. Garcia, C. Ortega, N. Salas, A. Younes, J. Zoellick, & A. Jacobson (Eds.) California North Coast Offshore Wind Studies. Humboldt, CA: Schatz Energy Research Center. schatzcenter.org/pubs/2020-OSW-R8.pdf .

Younes, A., Severy, M., Chamberlin, C., Guerrero, I., & Alstone, P. (2020). Electricity Market Revenue Study. In M. Severy, Z. Alva, G. Chapman, M. Cheli, T. Garcia, C. Ortega, N. Salas, A. Younes, J. Zoellick, & A. Jacobson (Eds.) *California North Coast Offshore Wind Studies*. Humboldt, CA: Schatz Energy Research Center. schatzcenter.org/pubs/2020-OSW-R7.pdf.

State and Regional Reliability & Resilience

Refresh of Key Topics

(1) Reliability for a 100% Clean Power Grid

(7) Transmission Power Supply Reliability

(8) Power System Resilience

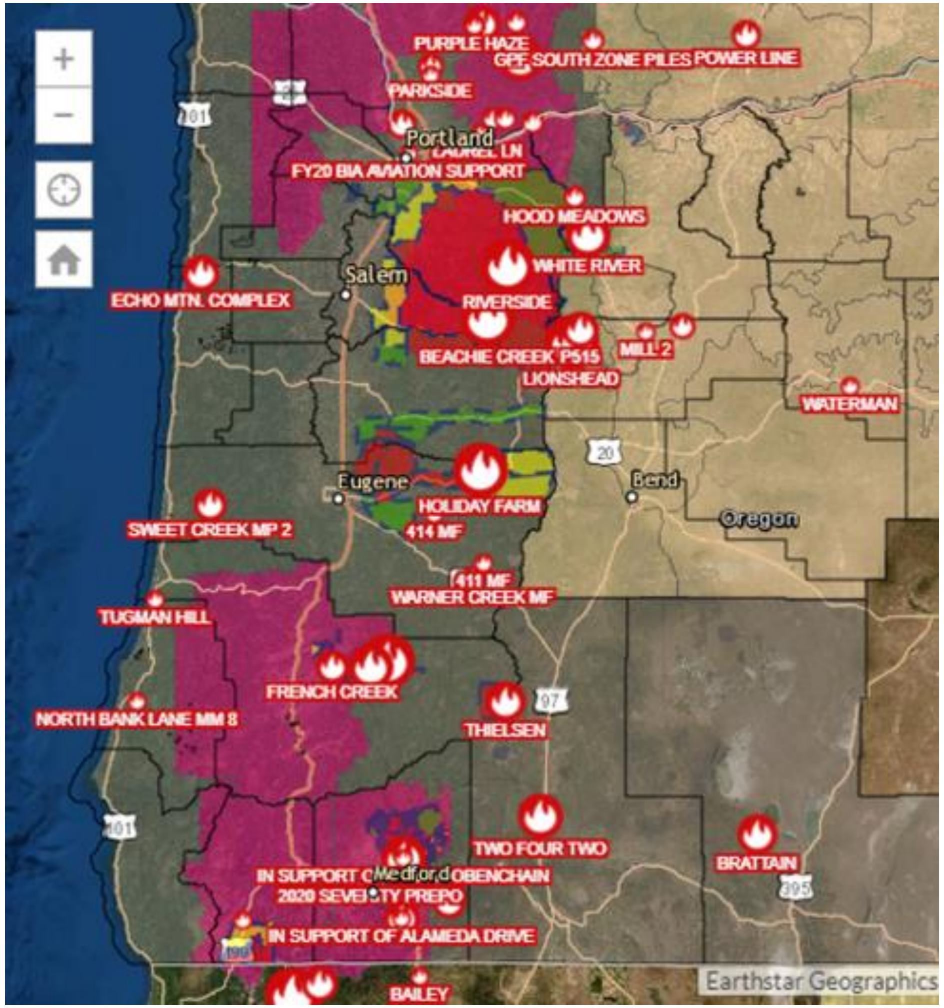
(#) → Question Number from [Prompting Question Document]

State and Regional Reliability & Resilience

Themes from Comments

- FOSW generation profile is complementary to solar and provides resource diversity.
- Also offers locational diversity to balance power flows and reduce reliance on other transmission pathways.
- FOSW can bolster reliability - need to explore transmission expansion necessary to deliver reliability benefits.
- Transmission solutions that reduce reliance on E-W transmission pathways and provide alternate N-S pathways to those that can be constrained and disrupted due to wildfires can enhance resilience.

Snapshot from [Oregon RAPTOR]() at 7 a.m. Friday, Sept. 11, 2020



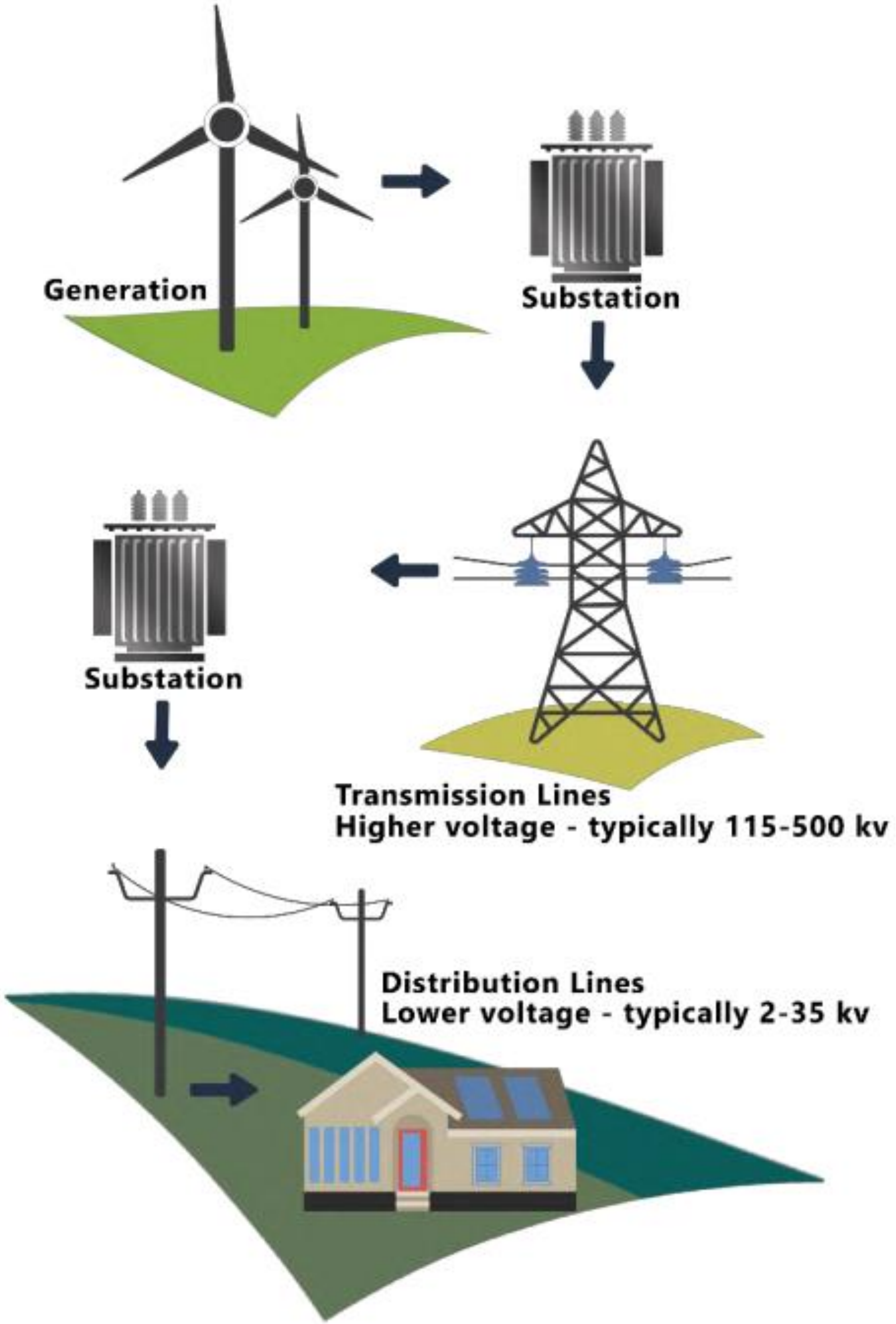
Opportunity for Additional Feedback

- Information or perspectives that differ from common feedback?
- Provide elaboration or emphasis?
- Topics for future study or engagement?
- New thoughts?


BREAK
10 minutes

Transmission Infrastructure for FOSW (45 minutes)

- Overview of NREL Study on FOSW Generation and Transmission
  - NREL
- NorthernGrid Transmission Analysis
- Overview of Feedback Received
- Time for Additional Feedback



NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Evaluating the Impact of Oregon Offshore Wind

Josh Novacheck and Marty Schwarz

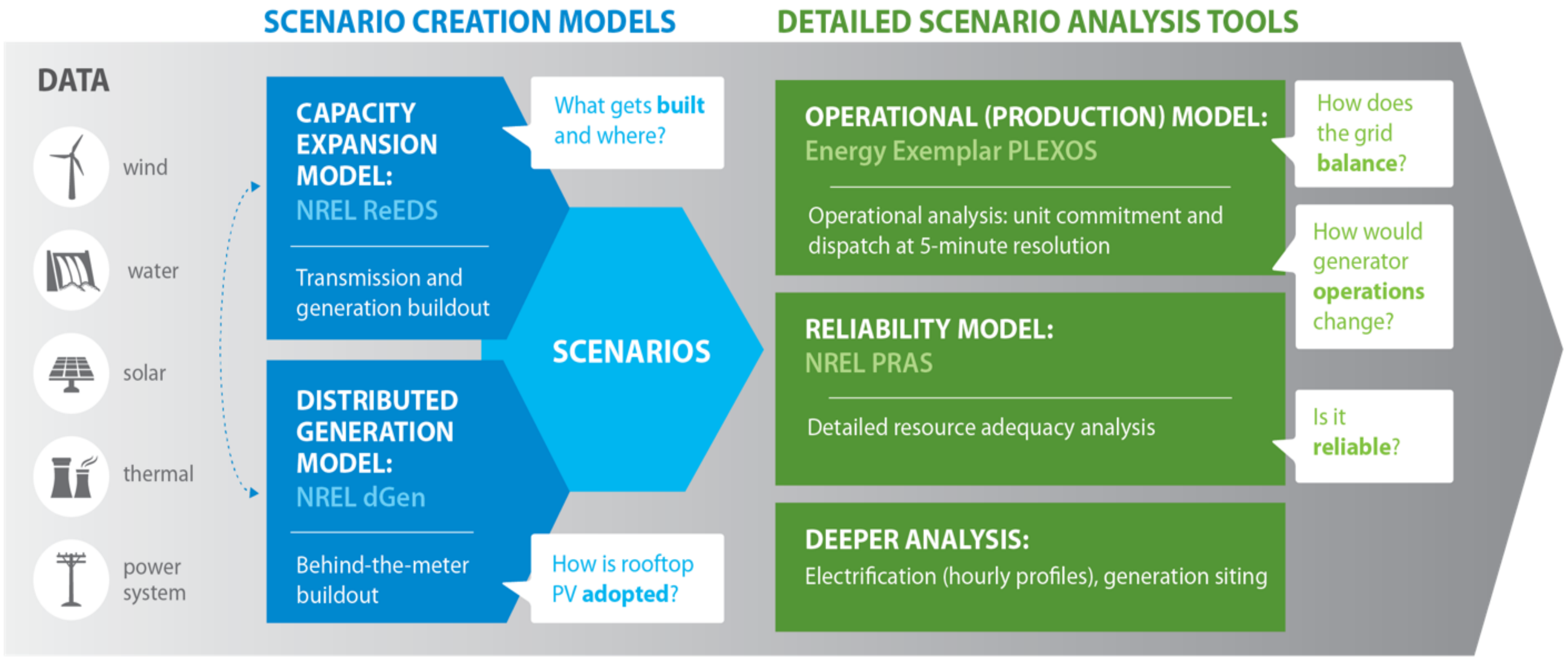
Report published October, 2021

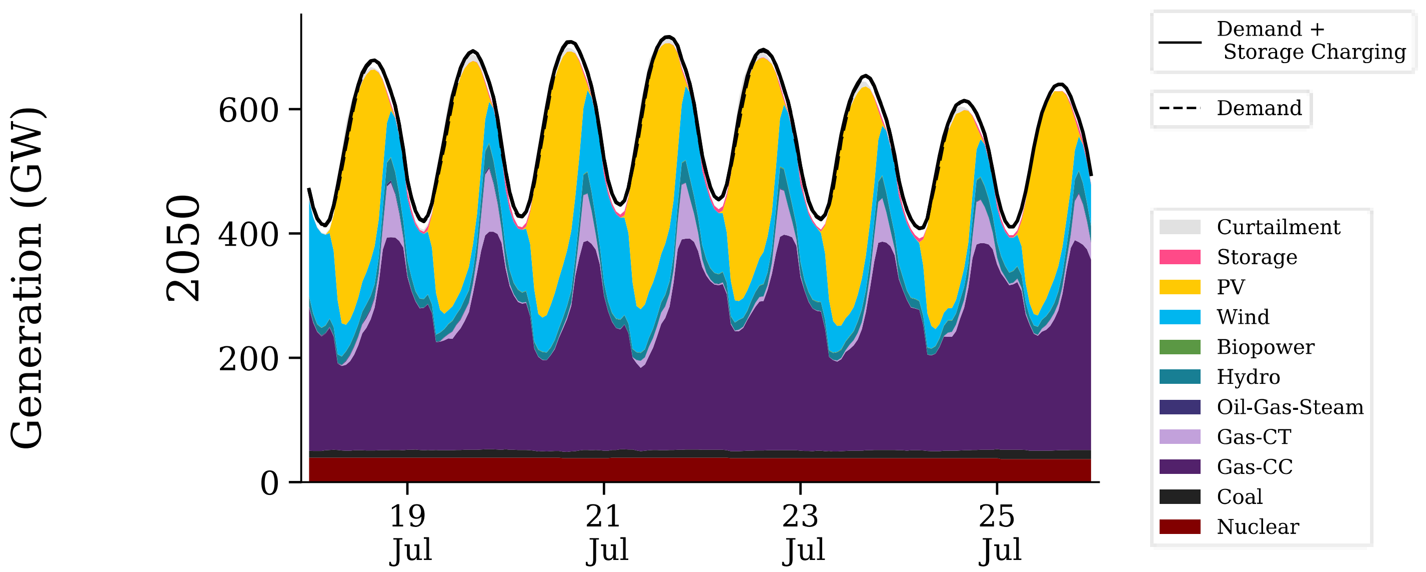
This work was authored by staff from the Alliance for Sustainable Energy, LLC, the manager and operator of the National Renewable Energy Laboratory for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308.

The presentation is available from the Bureau of Ocean Energy Management by referencing OCS Study BOEM 2021-064. The presentation may be downloaded from BOEM's Completed Environmental & Technical Studies - Pacific webpage at http://www.boem.gov/Pacific-Completed-Studies.

This study was funded by the U.S. Department of the Interior, Bureau of Ocean Energy Management through Interagency Agreement M19PG00025 with the U.S. Department of Energy.

Study Objectives





Using high resolution data sets and modeling developed through past studies, explore value and impact of Offshore Wind integration into Oregon's power system.

Five scenario dimensions

1. **Offshore wind penetration**: Base (0GW), Mid (2.6 GW), or High (5GW)

2. **WECC infrastructure year**: Current grid (~22% Wind/Solar penetration by generation), or future system (~46% Wind/Solar) based on past NREL studies.

3. **Trans-coastal range transmission expansion**: no expansion, or expansion along trans-coastal corridors to avoid congestion with 5 GW of offshore wind.

4. **Co-located energy storage**: no storage, or co-located storage at the onshore point of interconnection. The storage systems are sized at 10% of the associated offshore wind plant power, and 24-hour duration.

5. **Historical year:** The 2012 historical weather year was run for all scenario combinations. We ran 7 historical weather years (2007-2013) for three select scenario combinations.

Analytical Scope: *Western Oregon (West of the Cascade Range), Eastern Oregon, and the full Western Interconnection*

Key Findings

Summary of Findings

Finding 1: Existing system can support up to 2.6 GW of offshore wind

Finding 2: Offshore wind grid value exceeds its LCOE

Finding 3: Transmission congestion is main driver of offshore wind curtailment

Finding 4: Offshore wind reduces flow on cross-Cascade transmission

Finding 5: Offshore wind can serve over 84% of coastal Oregon loads

Finding 6: Offshore wind allows for more optimal hydropower dispatch

Finding 7: OSW increases current OR to CA transmission exports

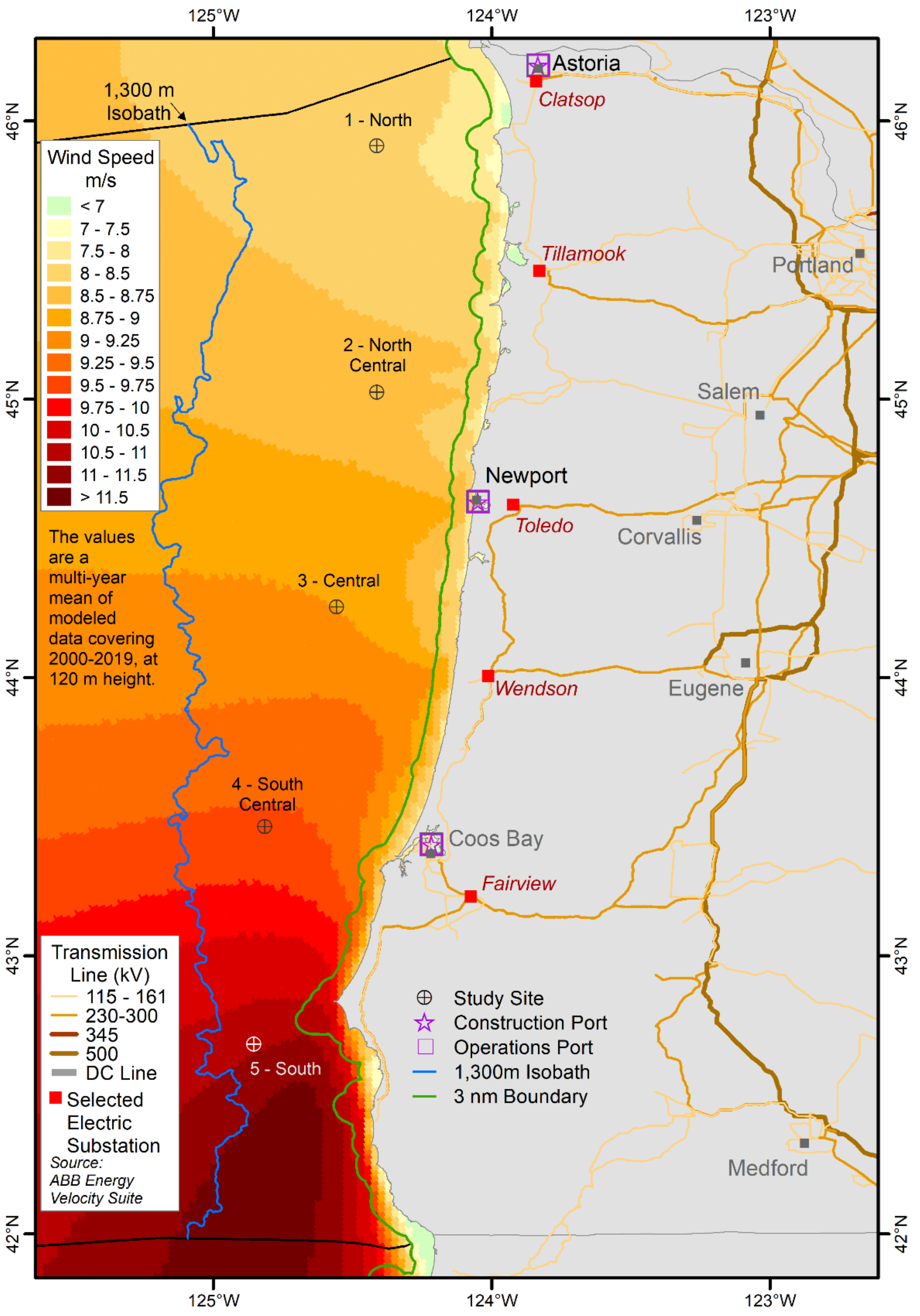
Finding 8: Batteries smooth short periods of low OSW

Finding 1: Existing system may support up to 2.6 GW of offshore wind

Offshore Wind Point of Interconnection	Max Nameplate Capacity (MW)	Max Injected power* (MW)
Clatsop (1-North)	361	301
Tillamook (2-North Central)	553	461
Toledo (3-Central)	156	130
Wendson (4-South Central)	613	512
Fairview (5-South)	941	785
Total	**2625**	**2189**

- The offshore wind capacity is not evenly distributed amongst coastal substations, rather the capacities were chosen based the ratings of the of associated trans-coastal transmission lines.
- Southern sites were maximized for their superior capacity factor.
- Might find less than 2.6 GW can fit once more detailed transmission engineering studies are done.

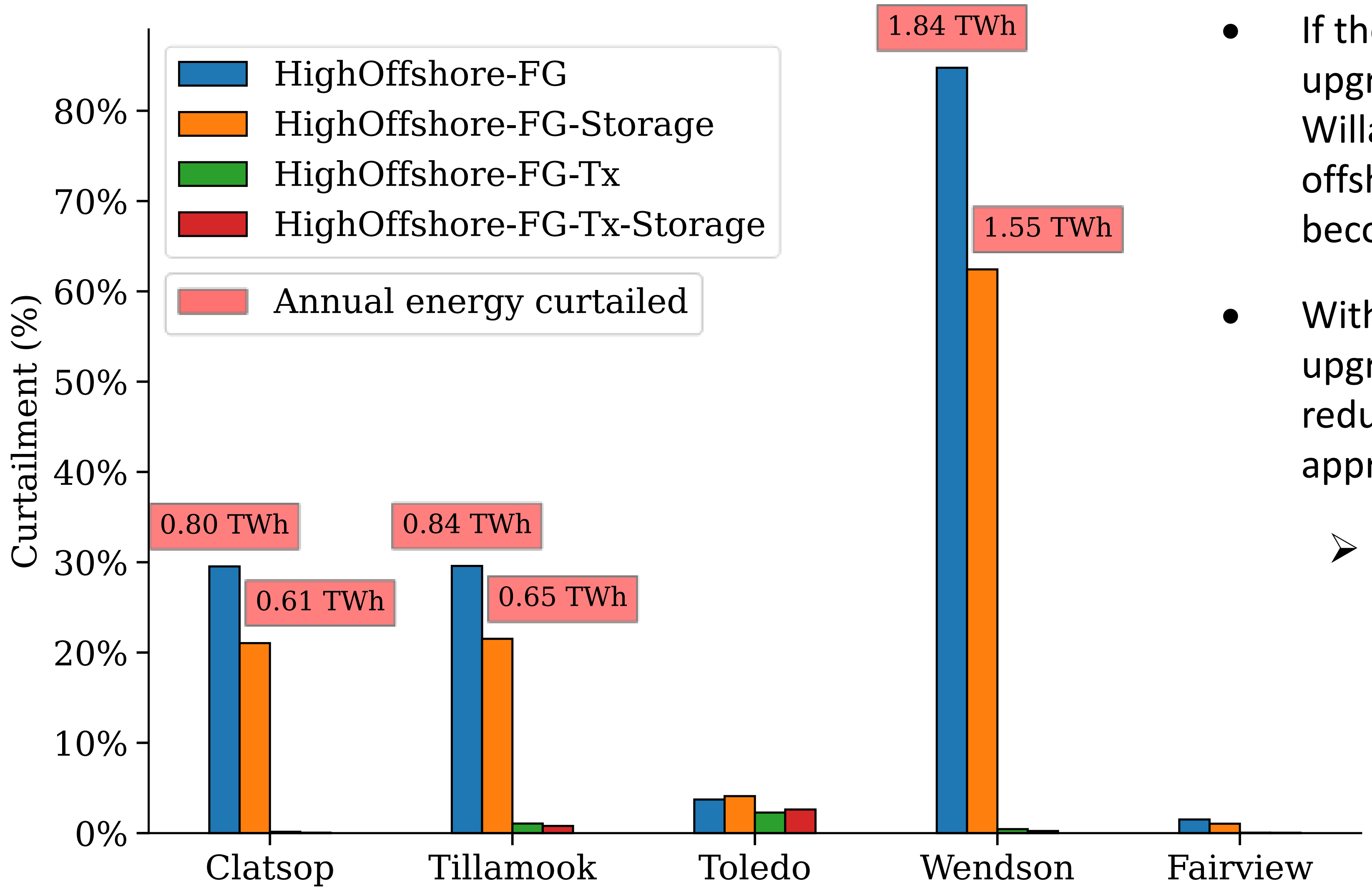
*Due to internal loses, max injected power is 83.4% of nameplate.



Caveats to Finding 1

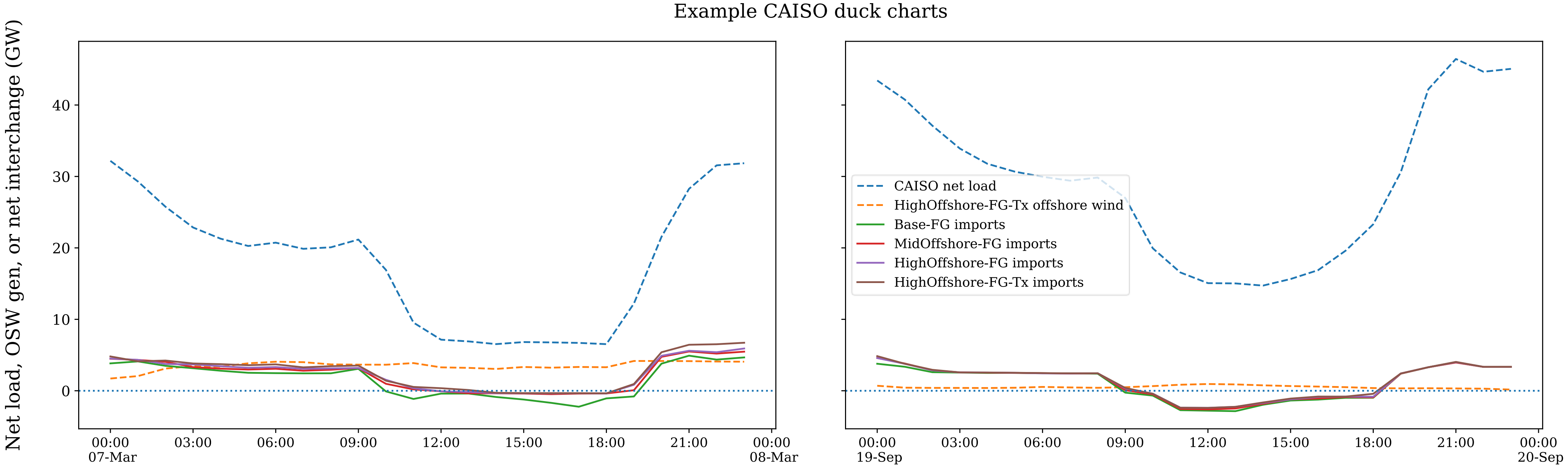
- Detailed power flow analysis is needed to refine the distribution of offshore wind, the total offshore wind capacity, and identify small upgrades to the trans-coastal system.
- This study does not capture the barriers to smaller scale transmission between the offshore wind turbines and the high voltage coastal substations, like right-of-way and reactive power support
- The southern sites included in this study have higher average wind speeds than the northern sites, but they are also farther from existing coastal substations. If the cost of the undersea transmission was studied, trade-offs between the cost of interconnection and capacity factor might be discovered.
- The offshore wind locations used in this study do not represent the results of a comprehensive siting study.
- As this study is not a comprehensive power flow or resource adequacy analysis, it does not capture line outage contingencies.

Finding 3: Trans-coastal transmission congestion is the main driver of offshore wind curtailment, when OSW penetration >2.6 GW



- If the trans-coastal transmission is upgraded, power can be delivered into the Willamette Valley and curtailment of offshore wind off the coast of Oregon becomes minimal.
- Without trans-coastal transmission upgrades, co-located energy storage can reduce offshore wind curtailment by approximately 15%.
    - ➢ More detailed investigation of storage sizing could help determine the full curtailment and congestion management value of co-located storage.

Finding 7: OSW increases exports from Oregon to serve evening net load peak in California (i.e., duck curve), but further contribution is limited by congestion



- With high OSW generation, OR to CA exports increase at all hours of the day relative to the 0 GW OSW base case, particularly during CA net load peak in evening. Little change in OR to CA exports, on days with low OSW generation.
- Interstate transmission congestion limits the ability for OSW to help in 41% of the evening ramps in the year. During 17% of the evening ramps, this congestion is not present in the 0 GW base case.
- OSW capacity factor during CAISO's summer evening net load peaks is 52% and 49% in the 2.6 and 5 GW scenarios, respectively.

References

- Beiter, Philipp, Jessica Lau, Joshua Novacheck, Qing Yu, Gord Stephen, Jennie Jorgenson, Walter Musial, and Eric Lantz. 2020. *The Potential Impact of Offshore Wind Energy on a Future Power System in the U.S. Northeast*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5000-74191. nrel.gov/docs/fy20osti/74191.pdf.
- Brinkman, Gregory, Dominique Bain, Grant Buster, Caroline Draxl, Paritosh Das, Jonathan Ho, Eduardo Ibanez, et al. 2021. *The North American Renewable Integration Study: A U.S. Perspective.* Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-79224. https://www.nrel.gov/docs/fy21osti/79224.pdf
- CAISO (2012). Annual Report on Market Issues and Performance. Folsom, CA. Accessed May 2, 2014: http://www.caiso.com/Documents/2012AnnualReport-MarketIssue-Performance.pdf
- Denholm, Paul, Matthew O'Connell, Gregory Brinkman, and Jennie Jorgenson. 2015. *Overgeneration from Solar Energy in California: A Field Guide to the Duck Chart.* NREL/TP-6A20-65023. https://www.nrel.gov/docs/fy16osti/65023.pdf
- Douville, Travis, Dhruv Bhatnagar, Rebecca O'Neil, and Kendall Mongird. 2020. Exploring the Grid Value Potential of Offshore Wind Energy in Oregon. PNNL/AC05-76RL01830/BOEM Interagency Agreement M17PG00047.
- Frew, Bethany, Brian Sergi, Paul Denholm, Wesley Cole, Nathaniel Gates, Daniel Levie, Robert Margolis. 2021. The curtailment paradox in the transition to high solar power systems. Joule, Volume 5, Issue 5. Pages 1143-1167, ISSN 2542-4351. https://doi.org/10.1016/j.joule.2021.03.021. https://www.sciencedirect.com/science/article/pii/S2542435121001446
- **Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. 2021. *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide, Interim Estimates under Executive Order 13990.* https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf**
- Jorgenson, Jennie, Sarah Awara, Gord Stephen, Trieu Mai. 2021. *A systematic evaluation of wind's capacity credit in the Western United States.* Wind Energy. https://doi.org/10.1002/we.2620
- Lazard. 2020. *LAZARD'S LEVELIZED COST OF ENERGY ANALYSIS—VERSION 14.0.* https://www.lazard.com/media/451419/lazards-levelized-cost-of-energy-version-140.pdf
- Mills, Andrew, R. Wiser. 2012. An Evaluation of Solar Valuation Methods Used in Utility Planning and Procurement Processes. LBNL-5933E. Berkeley, CA: Ernest Orlando Lawrence Berkeley National Laboratory. Accessed May 2, 2014: http://emp.lbl.gov/sites/all/files/lbnl-5933e_0.pdf
- Mills, Andrew, Dev Millstein, Seongeun Jeong, Luke Lavin, Ryan Wiser, and Mark Bolinger. 2018. *Estimating the Value of Offshore Wind Along the United States' Eastern Coast. Environ. Res. Lett.* 13 094013. 10.1088/1748-9326/aada62
- **Musial, Walter, Philipp Beiter, Jake Nunemaker, Donna Heimiller, Josh Ahmann, and Jason Busch. 2019. Oregon Offshore Wind Site Feasibility and Cost Study. NREL/TP-5000-74597. nrel.gov/docs/fy20osti/74597.pdf.**
- Novacheck, Josh, Sharp, Justin, Schwarz, Marty, Donohoo-Vallett, Paul, Tzavelis, Zach, Buster, Grant, and Rossol, Michael. 2021 (Forthcoming). *The Evolving Role of Extreme Weather Events in the U.S. Power System with High Variable Generation Penetrations.* Golden, CO: National Renewable Energy Laboratory.
- Optis, Mike, Alex Rybchuk, Nicola Bodini, Michael Rossol, and Walter Musial. 2020. *2020 Offshore Wind Resource Assessment for the California Pacific Outer Continental Shelf*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5000-77642. https://www.nrel.gov/docs/fy21osti/77642.pdf.
- Roger Collanton, Ivancovich Anthony, Pinjuv Jordan. 2021. Order Instituting Rulemaking to Oversee the Resource Adequacy Program, Consider Program Refinements, and Establish Forward Resource Adequacy Procurement Obligations:Track 3B.1 Proposals of the California Independent System Operator Corporation.
- System Advisor Model Version 2020.11.29 (SAM 2020.11.29). National Renewable Energy Laboratory. Golden, CO. Accessed December 27, 2020. https://sam.nrel.gov .

Thank you!

Joshua.Novacheck@nrel.gov

Marty.Schwarz@nrel.gov

www.nrel.gov

This work was authored by staff from the Alliance for Sustainable Energy, LLC, the manager and operator of the National Renewable Energy Laboratory for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308.

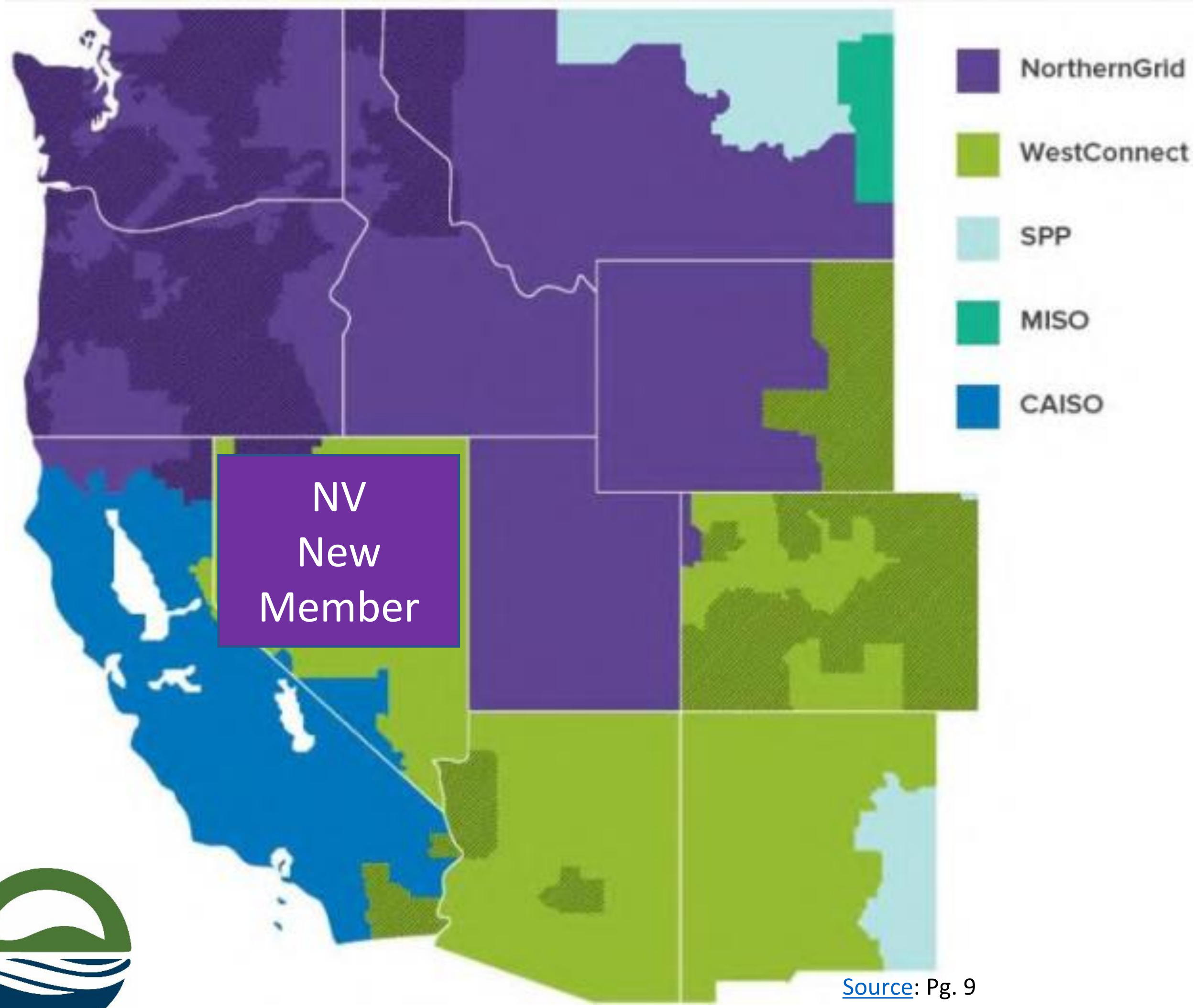
The presentation is available from the Bureau of Ocean Energy Management by referencing OCS Study BOEM 2021-064. The presentation may be downloaded from BOEM's Completed Environmental & Technical Studies - Pacific webpage at http://www.boem.gov/Pacific-Completed-Studies.

This study was funded by the U.S. Department of the Interior, Bureau of Ocean Energy Management through Interagency Agreement M19PG00025 with the U.S. Department of Energy.

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Additional FOSW Transmission Analysis

NorthernGrid - Regional Transmission Planning



Source: Pg. 9

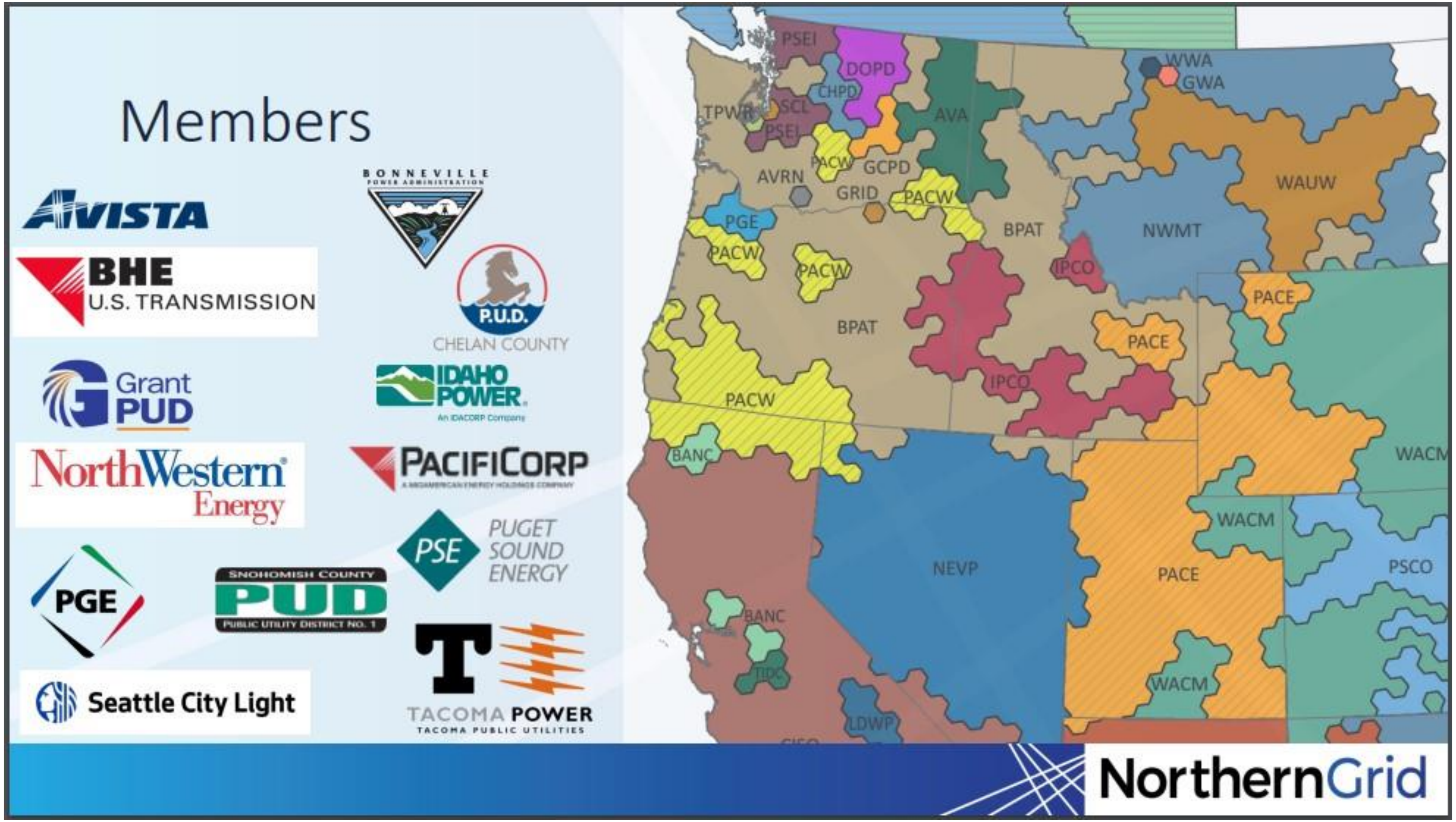
NorthernGrid

- PNW-Intermountain Regional Transmission Planning Entity
  - FERC Order 1000 Regional Transmission Planning Compliance
- NG Members
  - BPA, PacifiCorp, PGE, Idaho Power, Puget Sound Energy, Avista, etc.
- NG States Committee
  - State Gov't representatives from: OR, WA, ID, MT, WY, UT, NV

2022-23 Transmission Planning Cycle

- FOSW transmission study request submitted by Oregon representatives from States Committee
  - OPUC & ODOE

Additional FOSW Transmission Analysis



[Source](#): Pg. 3

Additional Transmission Analysis

Oregon FOSW Transmission Study Request

Oregon Request to NorthernGrid to Study (3) Scenarios

- TBD if request will be accepted and studied

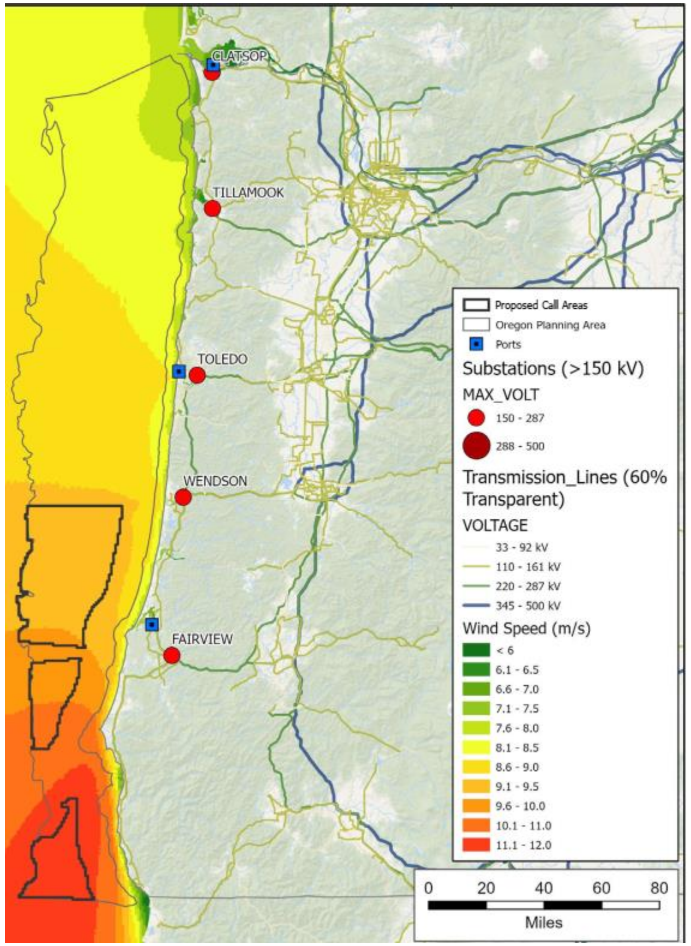
Scenario 1: 1.5 GW

Scenario 2: 3 GW

Scenario 3: 10 GW

- All scenarios propose to interconnect portions of the total FOSW nameplate capacity to the Fairview and Wendson substations. *(Or proximate substations that could provide more economical solutions)*

BOEM Call Areas



NREL Study Results

Offshore Wind Point of Interconnection (POI)	Max Capacity (MW)
Clatsop	361
Tillamook	553
Toledo	156
Wendson	613
Fairview	941
Total	**2,625**

Source: Pg. 8

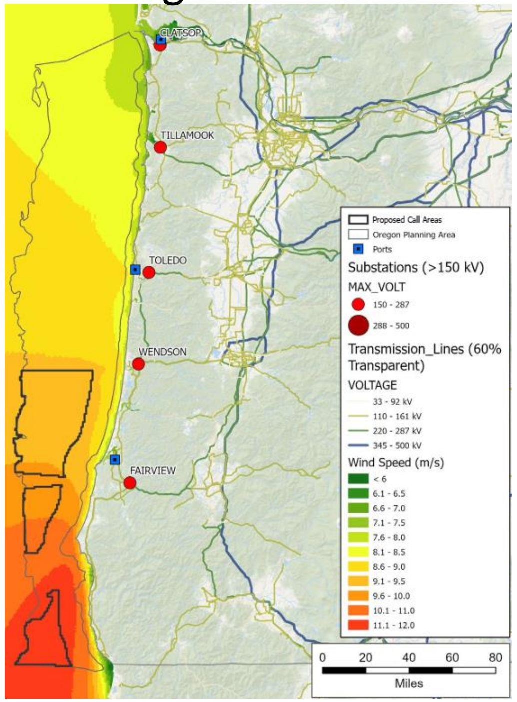
In-Process Transmission Analysis

CA/OR Transmission Analysis

Department of Defense (DoD) – Office of Local Defense Community Cooperation (OLDCC):

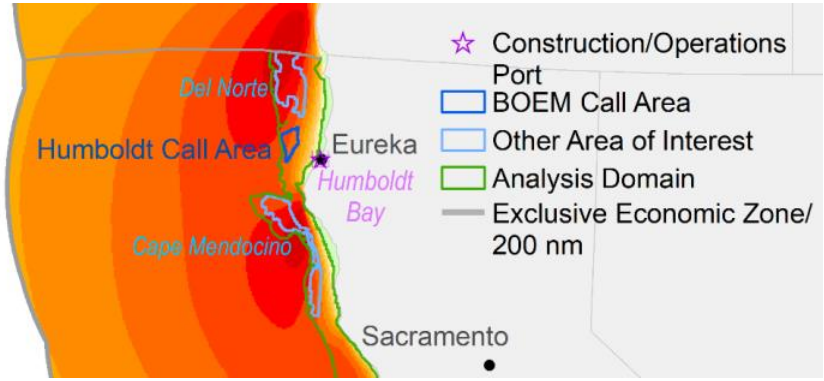
- Planning and coordination supporting potential FOSW development in Northern California and Southern Oregon.
- Intended to prevent incompatible energy project encroachment within critical DoD operational areas.
- Grant to California Energy Commission (CEC) to evaluate existing transmission infrastructure, capacity, limitations and opportunities.
- ODOE partnering with DoD/CEC on initiative.

S. Oregon Call Areas



Source: Pg. 8

N. California Call Area



Source: Pg. 20

Transmission Infrastructure

Refresh of Key Topics

(23) Economies of Scale

(24) Offshore Transmission Configurations

(25) Existing Transmission Limitations

(26) Costs and Barriers

(27) Onshore Upgrades

(28) Co-locating Storage

(29) State & Regional Benefits

(30) Subsea Backbone Transmission

(31) Optimizing Transmission

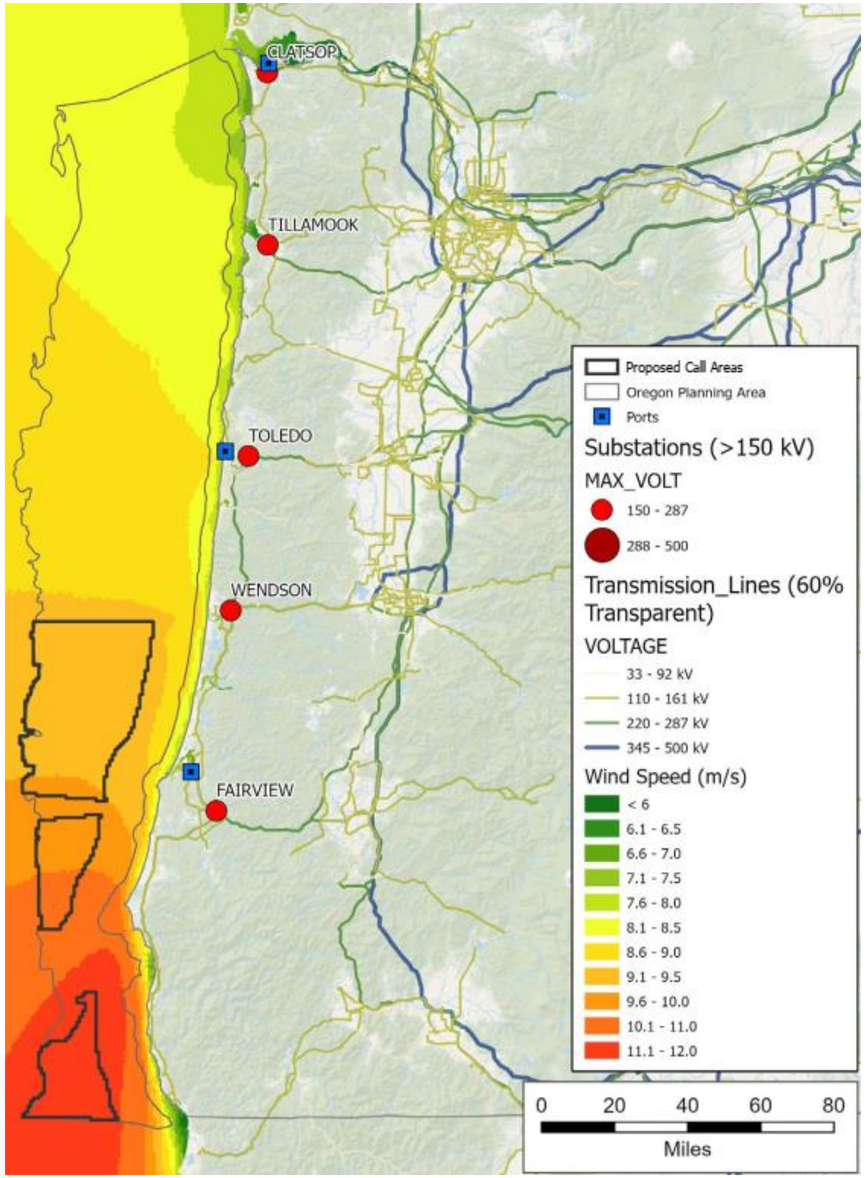
(#) → Question Number from Prompting Question Document

Transmission Infrastructure

Themes from Comments

Existing Transmission Limits:

- Completed studies indicate existing onshore transmission infrastructure could potentially accommodate ~2 GW of FOSW across multiple coastal interconnections – distributed up and down a wide range of the entire Oregon Coast.
  - Studies based on economic dispatch and physical transmission limits.
  - Need additional studies to account for reliability metrics and available contract capacity for transmission service.



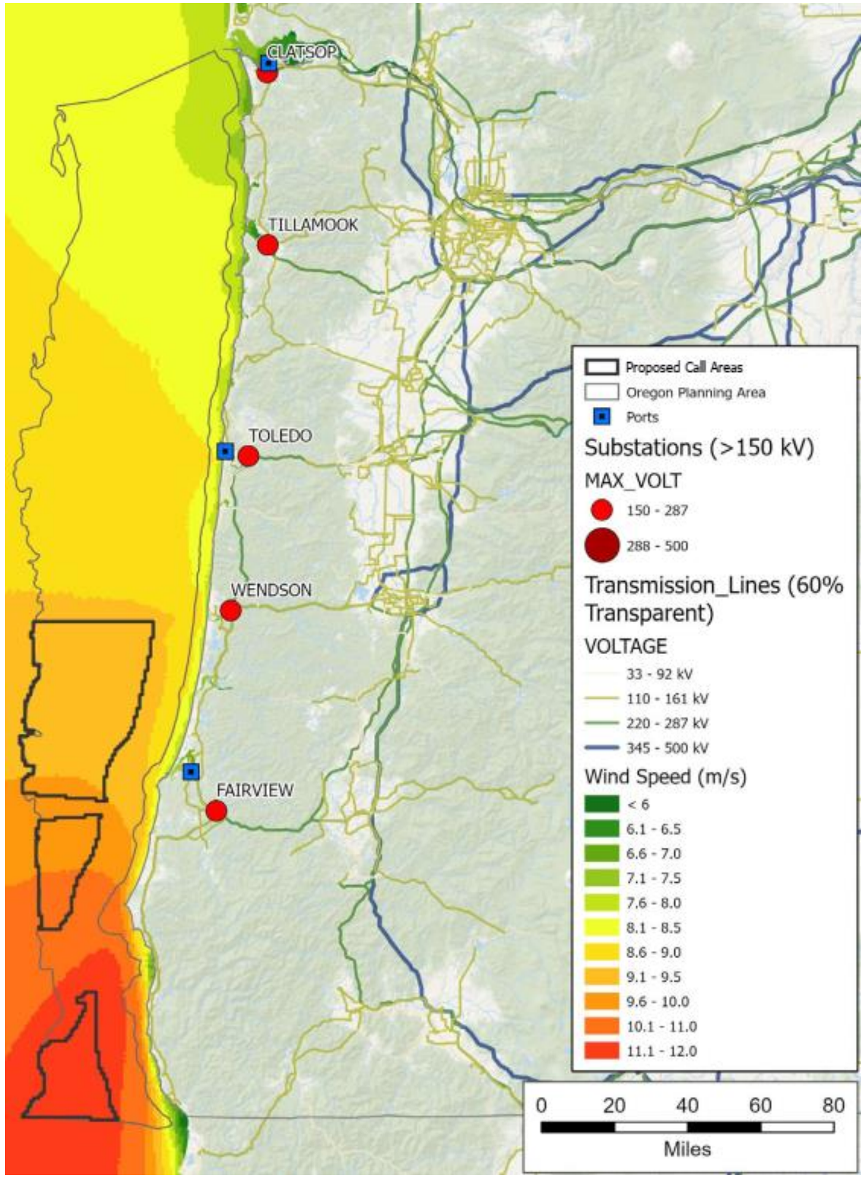
Source: Pg. 8

Transmission Infrastructure

Themes from Comments

Existing Transmission Limits, Upgrades, and Costs:

- No single point of interconnection (POI) can currently accommodate 2 GW w/o significant transmission upgrades.
    - As little as 500 MW of FOSW could result in substantial transmission upgrades – potentially costing millions of dollars.
- Additional reliability studies could show 2 GW across multiple POIs would also require significant upgrades – potentially costing billions of dollars.
- Transmission expansion is costly and has long lead times to plan, permit, design, and build – billions of dollars and 10-15 years before construction can begin.



Source: Pg. 8

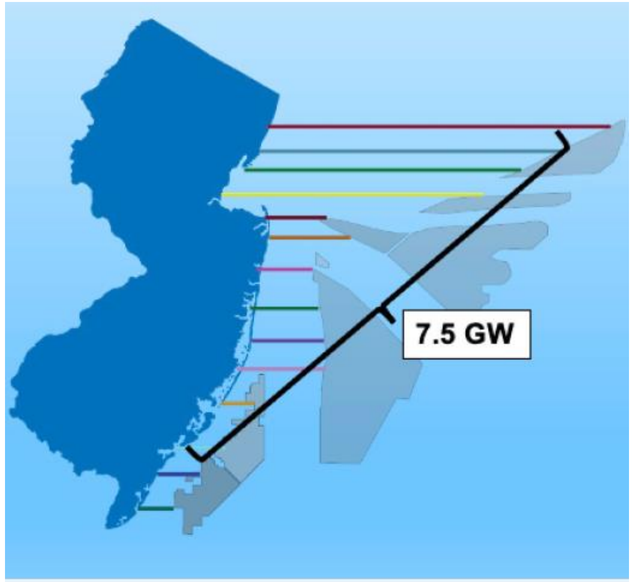
Transmission Infrastructure

Themes from Comments

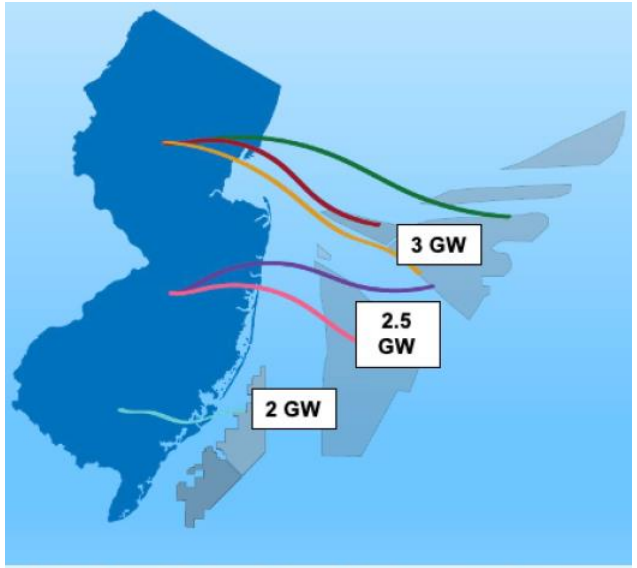
Benefits, Economies of Scale, and Optimization:

- Transmission expansion can provide regional benefits to optimize location and scale of renewable deployments, enhance transfer capacities, and bolster reliability.
- Optimization and collaborative regional efforts are critical to reducing costs and impacts and maximizing benefits.
    - Early FOSW projects could individually pursue radial, offshore transmission lines (similar to East Coast) to target most attractive onshore POIs.
    - Subsequent radial lines could be sub-optimal to minimizing impacts and achieving economies of scale at least-cost, least-risk.
    - Challenge is optimizing the number and location of onshore connections to maximize reliability while minimizing the costs and impacts of a large number of radial transmission lines.

East Coast Example



A SINGLE LINE TO EACH WIND FARM



A PLANNED-OUT SYSTEM CONNECTING MULTIPLE WIND FARMS

Source: Pg. 52

Transmission Infrastructure

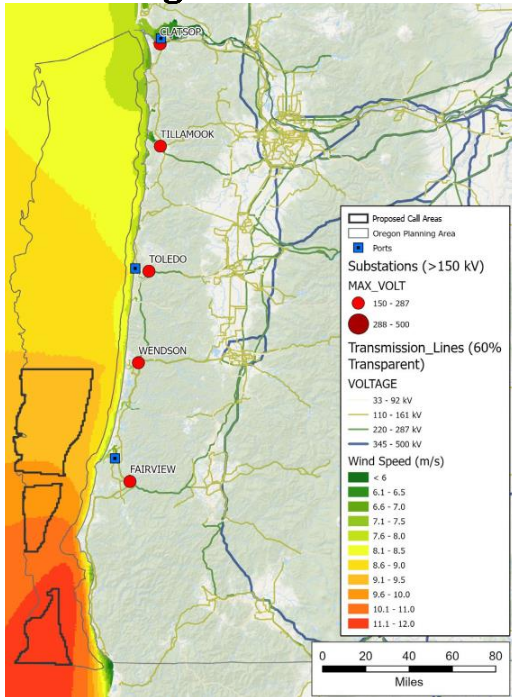
Themes from Comments

Configurations for Economies of Scale:

- Transmission solutions should be scaled to accommodate larger scales of scales of FOSW
  - Studies projecting dozens of GWs of FOSW between by 2050 to meet grid and economy-wide decarbonization goals.
  - Various offshore configurations should be studied, including "mesh" networks and subsea HVDC lines.

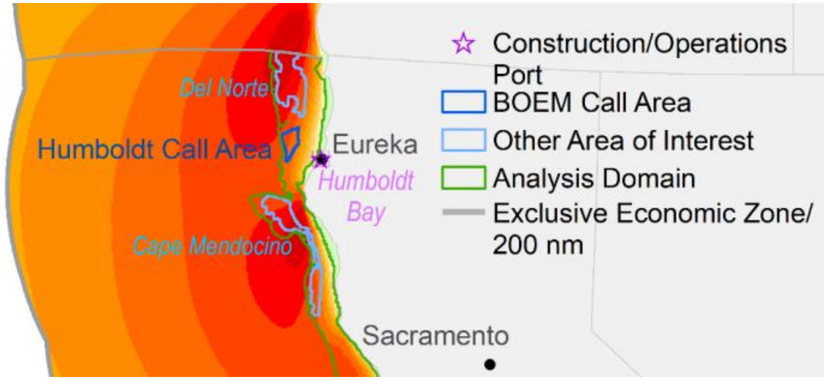
- Optimal configurations could require transmission solutions that span S. Oregon and N. California, and BOEM Call Areas adjacent to S. Oregon and N. California.

S. Oregon Call Areas



Source: Pg. 8

N. California Call Area



Source: Pg. 20

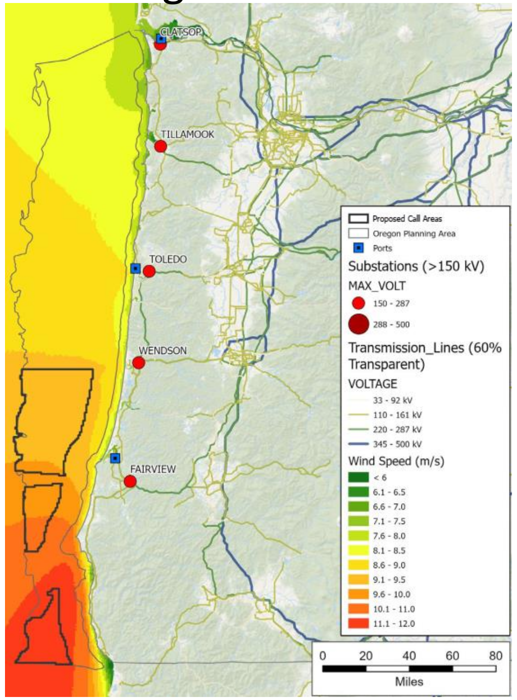
Transmission Infrastructure

Themes from Comments

Regional Collaboration for Optimizing & Achieving Economies of Scale:

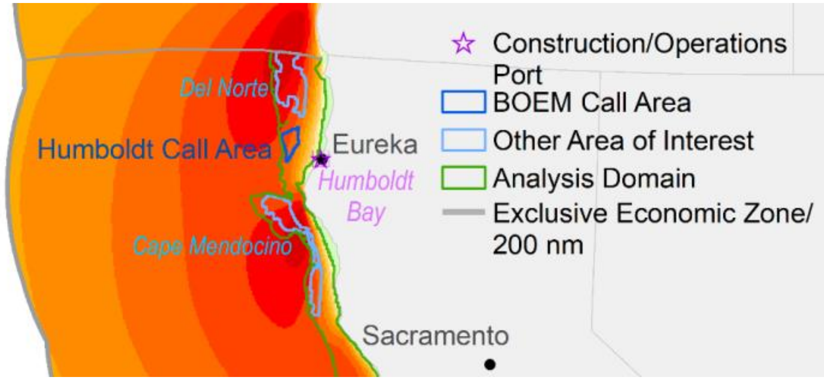
- Regional collaboration to proactively plan and design offshore transmission configurations and onshore transmission expansion necessary to accommodate future energy needs of Oregon and other western states.
    - PNW coordination with NorthernGrid, BPA, PacifiCorp, and others.
    - Interregional coordination with California and potentially other transmission planning regions.

S. Oregon Call Areas



Source: Pg. 8

N. California Call Area



Source: Pg. 20

Transmission Infrastructure

Opportunity for Additional Feedback

- Information or perspectives that differ from common feedback?
- Provide elaboration or emphasis?
- Topics for future study or engagement?
- New thoughts?

LUNCH BREAK

30 minutes

Energy Markets & RTO
(45 minutes)

- Update on Oregon IOU Activities for Assessing FOSW & Hydrogen (H2)
  - OPUC

- Overview of Feedback Received

- Time for Additional Feedback

Oregon Investor-Owned Utilities

Assessing Potential for FOSW & Hydrogen (H2)

PacifiCorp

2022 RFP

- Sensitivity analysis for floating offshore wind, with parameters to be discussed during the RFP process.

2023 IRP

- Including FOSW proxy resources for modeling analysis.
- IRP leadup process including a discussion of H2 production as a flexible load.

Transmission

- Identify transmission cost estimates to inform IRP modeling of FOSW proxy resources.
- Additional transmission studies for FOSW have been requested to inform potential regional transmission system upgrades.

For more info on H2 -
Please follow the in-process ODOE Renewable Hydrogen Study

Oregon Investor-Owned Utilities

Assessing Potential for FOSW & Hydrogen (H2)

PGE

Next IRP

- Floating offshore wind to be considered as a potential proxy resource.

Current RFP

- Potential FOSW and/or flexible H2 load sensitivity.

For more info on H2 -
Please follow the in-process ODOE Renewable Hydrogen Study

Oregon Investor-Owned Utilities

Assessing Potential for Hydrogen (H2)

NWN

2018 IRP

- Included H2 (Power to Gas located at Mist storage) as a supply-side resource for modeling analysis.
- H2 not selected as part of the preferred portfolio.

2022 IRP

- Including H2 as a supply-side resource for modeling analysis.
- IRP development process is ongoing. Modeling details not yet finalized.

For more info on H2 -
Please follow the in-process ODOE Renewable Hydrogen Study

Energy Markets & RTO

Refresh of Key Topics

Investors/Purchaser (Offtakers)

(33) Sharing the Output

(34) Barriers to Cooperative Offtake Arrangements

(35) Out-of-State Offtakers

(36) First Mover Advantage

Regional Transmission Organization

(37) General Effects of an RTO

(38) Transmission Planning

(39) Value of Regional Analysis

(40) Regionalization Pre-Requisite

(#) → Question Number from Prompting Question Document

Energy Markets & RTO

Themes from Comments

Offtakers – Sharing Output and Out-of-State Offtakers:

- GW scales of FOSW likely too costly and risky for a single, moderately sized utility to procure.
- Multiple Oregon offtakers are necessary, with potential for Washington and California offtakers as well.
  - Hydrogen producers could also be offtakers, potentially mitigating some amount of transmission expansion.
- Even with out-of-state offtakers, FOSW would likely provide local Oregon benefits in the form on increased power quality & reliability, port development, and direct and indirect economic development from jobs and tax revenue.

Source

Energy Markets & RTO

Themes from Comments

Offtakers – Barriers to Multiple Offtakers:

- PNW public power entities (COUs) served by inexpensive hydropower from BPA and may not be near-term offtakers.

- Multitude of disparate utility resource planning processes in Oregon (several IOUs, and many COUs), and multitude of state regulatory processes across the PNW region's bi-lateral market structure make cooperative offtake challenging.

Source

Energy Markets & RTO

Themes from Comments

First-mover Advantages:

- First-mover and near-term procurement could result in advantages such as:
    - Avoiding over investment in generation and transmission resources with sub-optimal diversity values.
    - Targeting high-value POIs with radial transmission lines.
    - Momentum for industry supply-chain development, and economic development.

Source

Energy Markets & RTO

Themes from Comments

Regional Cooperation for FOSW:

- Due to offshore location in Federal waters, FOSW has a regional and interregional nature.
- Regional analysis can target optimal locations and scales for FOSW and associated transmission expansion.
- Regional coordination is possible under current bi-lateral market structure is utilities are flexible in planning and procurement activities.
- Immediate regional coordination may not be necessary for initial FOSW projects, but will be increasingly critical for subsequent projects.

Source

Energy Markets & RTO

Themes from Comments

RTO Benefits for Regional Cooperation:

- RTOs provide regional dispatch optimization.
- RTOs conduct collective, region-wide resource planning to provide optimal system benefits for least-cost, least-risk.
- RTOs conduct region-wide cost allocation and can apportion value of FOSW and transmission across local and regional utilities.
    - This would help enable investment partnerships for larger scales of FOSW and transmission projects.

Source

Energy Markets & RTO

Opportunity for Additional Feedback

- Information or perspectives that differ from common feedback?
- Provide elaboration or emphasis?
- Topics for future study or engagement?
- New thoughts?

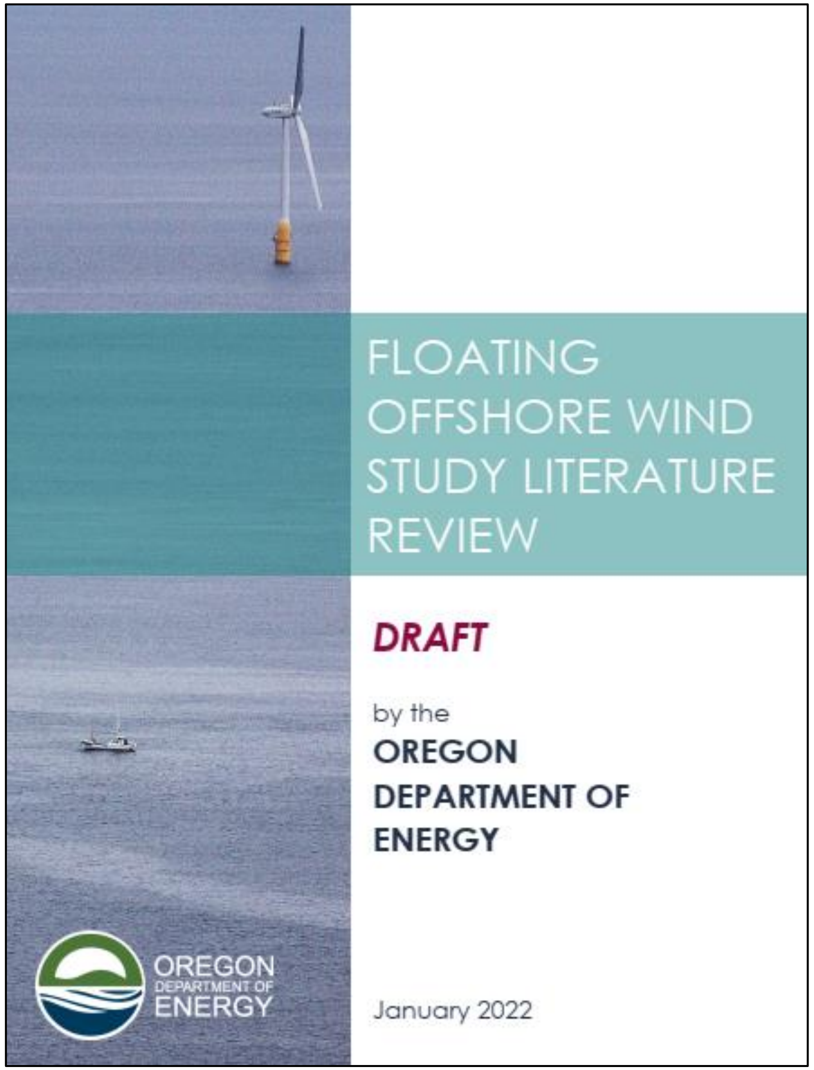
Draft Literature Review
(10 minutes)

DRAFT LITERATURE REVIEW

Refresh of Key Questions

(46) Additional Key Topics Missing?

(47) Errors or Inconsistencies?



(#) → Question Number from Prompting Question Document

DRAFT LITERATURE REVIEW

Themes from Comments

- Ideas for Additional Topics for Report:
  - Community engagement in coastal communities, with a focus on tribal, frontline, BIPOC, and fishing communities.

- Errors or Inconsistencies:
  - None

- Other:
  - Suggestions for turbines to have radar reflectors, lighting, and bright colors to prevent vessels collisions - and to assess subsea hazards.

DRAFT LITERATURE REVIEW

Call for Additional Feedback

- Information or perspectives that differ from common feedback?
- Provide elaboration or emphasis?
- Topics for future study or engagement?
- New thoughts?

Next Steps & Additional Feedback

(5 minutes)

WEB PORTAL FOR SUBMITTING FEEDBACK

https://odoe.powerappsportals.us/en-US/fosw

Floating Offshore Wind Study

Thank you for your interest in providing feedback to the Oregon Department of Energy regarding its Floating Offshore Wind Study, directed by House Bill 3375.

ODOE's Objective

To gather and synthesize a range of information and perspectives on the benefits and challenges of integrating up to 3 gigawatts of floating offshore wind (FOSW) into Oregon's electric grid to inform a summary of key findings in a report to the Legislature, including opportunities for future study and engagement.

Feedback & Prompting Questions

To support participation, we provided background information available on **ODOE's FOSW Study website**, including a draft literature review report and links to additional information. In addition, we created a **two-page document** that summarizes the study process and provides a timeline of study phases.

Initial feedback was gathered with the help of **prompting questions** that were developed based on key topics identified in the draft literature review report, including reliability, state renewable energy goals, jobs, equity and resilience.

Feedback received plays a critical role in helping the state have a better understanding of stakeholder perspectives on key topics relating to the potential for integrating large-scale deployments of FOSW into Oregon's electric grid.

Please Read

Instructions for Additional Feedback Relating to Public Meeting 1

During the public meeting on March 10, 2022, initial feedback related to five key topics and the Department's draft literature review was discussed.

- **Siting & Permitting**
- **Port Infrastructure & Sea Vessels**
- **Economic Development**
- **Equity**
- **Local Reliability & Resilience**

On the pages ahead you find general questions asking for any additional feedback relating to the **prompting questions** about these topics. Given the technical nature of these questions and that some stakeholders have more data and analysis to address some of these questions than others, it is not required to answer every question.

Required Fields

Next

Will **save** where you are, but it doesn't **submit.**

Note that * denotes Required Fields.

Contact Information

First Name *

Last Name *

Organization Name

Organization Type

Email Address *

Phone Number

Provide a telephone number

Street 1

Street 2

City

State

OR

Zip/Postal Code *

Previous | Next

Instructions ✔ | Contact Information | Siting & Permitting | Port Infrastructure & Sea Vessels | Economic Development | Equity | Local Reliability & Resilience | Attach File (Optional) | Submit

Floating Offshore Wind Study

You have completed the comment process.

You may review or modify your comments by using the '**Previous**' button to return to prior pages.

Once you are satisfied with your comments, plase click on the '**Submit**' button at the bottom of this page.

If you have questions or run into technical issues with the form, please reach out to: Jason Sierman.

To complete your feedback, you must click **Submit** on Final Screen

Previou Submit

Instructions ✔ | Contact Information ✔ | Siting & Permitting ✔ | Port Infrastructure & Sea Vessels ✔

Economic Development ✔ | Equity ✔ | Local Reliability & Resilience ✔ | Attach File (Optional) ✔ | Submit

TIMELINE FOR IMPLEMENTATION

Data Gathering & Engagement

- **2/18:** Initial Feedback Due
- **4/7:** Public Meeting #2
- **4/22:** Additional Feedback Due

Jan → Feb → Mar → April

- **1/19:** Lit. Review and Qs on Website
- **1/20:** Stakeholder Kick-Off Mtg.
- **3/10:** Public Meeting #1
- **3/25:** Additional Feedback Due

Report Drafting & Submission

- **5/11:** Public Meeting #3
- **5/27:** Additional Feedback Due
- Share Draft Findings
- **9/15:** Submit Report to Legislature

May → Jun → Jul → Aug → Sep

- Begin Drafting Report

TOPICS FOR PUBLIC MEETINGS

Public Meeting #3
In-Person & Online

May 11, 2022
5:30 p.m. – 6:45 p.m.
The Mill Casino
Coos Bay, Oregon

- Overview of Preliminary Findings
- Public Comment

https://www.oregon.gov/energy/energy-oregon/Pages/fosw.aspx

OREGON DEPARTMENT OF ENERGY

Q & A Time

Contact information:

Jason.Sierman@energy.oregon.gov