Energy Production, Delivery, and Economic Development



North Coast Offshore Wind Workshop September 14, 2020

> Presented by: Mark Severy, *Pacific Northwest National Laboratory*

> > Photo credit: Maia Cheli

Outline

Presentation Outline

- 1. Energy generation potential
- 2. Electricity delivery and transmission
- 3. Economic viability
- 4. Job creation and economic development

Main Findings and Key Points

Key Takeaways

- 1. Large Wind Resource: The north coast offshore wind resource is enormous and could support progress towards meeting California's climate and clean energy goals.
- 2. Limited Transmission: Transmission capacity is a major barrier for developing offshore wind on the north coast.
- 3. Economic Viability: Larger wind farms achieve lower costs of energy (economies of scale). Smaller, initial projects can be used to demonstrate the technology, but developers will likely want to see a pathway to larger projects to achieve economic viability.
- 4. Economic Development: Offshore wind has good potential to create a significant number of jobs in the region and elsewhere in California. A 150 MW wind farm would create approximately 3,000 construction jobs and 2,000 operational jobs.

Offshore Wind Resource



Time Series of Power Generation

Example Weekly Generation Profiles for 150 MW Offshore Wind Farm



Key Takeaways:

- Power generation varies from week to week, even within the same season.
- There are sustained times of maximum generation and low generation.

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Capacity Factor



Annual Energy Generation

Note: This *net* capacity factor includes losses and down time due to maintenance, weather events, line losses, wake effects, etc.

Key Takeaways:

- Across the entire year, offshore wind farms in northern California achieve a 50% capacity factor. Meaning they produce 50% of their maximum potential
- The capacity factor in Humboldt is among the best in the US because of the strong wind resource.
- This is favorable compared to the capacity factor of other renewables:
 - Land-based wind = 30% 40%
 - Solar = 15% 30%

Humboldt County Energy Demand



Energy Production Summary

	50 MW	150 MW	1,800 MW	
Number of 12 MW turbines	4 turbines	12 turbines	153 turbines	
Wind farm footprint area	5.3 sq. mi	15 sq. mi	210 sq. mi	California uses 200,000 GWh/yr Humboldt uses 900 GWh/yr
Annual electricity production	200 GWh/yr	600 GWh/yr	7,500 GWh/yr	
Annual electricity used locally	200 GWh/yr	340 GWh/yr	430 GWh/yr	
Percent of Humboldt County's load served	22%	38%	48%	

Humboldt County Electricity System



Humboldt County Electricity System



Key Takeaways:

- Major transmission corridors run north and south in California, connecting large generators and load centers.
- Development of offshore wind will likely require upgrades to the transmission lines, even at small scales.

Transmission Planning Study



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Transmission Planning Study

Transmission Planning Study

Conducted by PG&E

Scope of Work

- Recommend transmission upgrades for three scales of offshore wind development
- Provide high level cost estimate

Standard Assumptions

- Offshore wind generators are evaluated to provide full power at all times of the year
- Transmission upgrades built to eliminate overload, especially during peak summer and off-peak spring conditions
- No curtailment of offshore wind
- All existing generators operate at full capacity

Transmission Upgrades: 50 MW



<u>Key Takeaways:</u>

- Even for a small-scale offshore wind farm (50 MW), transmission upgrades are recommended to provide safety and redundancy on to existing transmission lines.
- The transmission costs at the small scale are disproportionately high compared to the large-scale, and an initial development should consider creative approaches to reduce transmission costs, such as storage or curtailment.

Transmission Upgrades: 1,800 MW



Key Takeaways:

- Large scale offshore wind developments have several options for transmission upgrades including overland or undersea.
- These upgrades can be constructed at a better value (\$/MW) than smaller scales.

Transmission Cost Comparison

Overland Transmission Cost Estimate Range Subsea Transmission Cost Estimate Range

Adjusted Cost Estimate



Transmission Cost Comparison

Overland Transmission Cost Estimate Range Subsea Transmission Cost Estimate Range

Adjusted Cost Estimate



Key Takeaways:

 Cost per MW decreases substantially for larger wind farms.

* The cost estimates per installed capacity align with past transmission projects in California

Economic Viability: LCOE



Economies of Scale

- Larger wind farms become more competitive in state electricity markets.
- Developers can start small but want a pathway to larger projects.
- Analysis by NREL indicates that prices will projects costs will continue to drop in the 2030s. (Musial et al., 2019)

Musial et al., 2019. Oregon Offshore Wind Site Feasibility and Cost Study https://www.nrel.gov/docs/fy20osti/74597.pdf

Notes: Modeled using single owner financing.

Assuming deployment in late 20

Includes port infrastructure development costs.

Costs do not include transmission upgrades.

Economic Development and Job Creation



Job Creation



Key Takeaways

- Projects at all scales will create a significant number of jobs.
- Larger projects create more jobs.

Economic Development



- Results for entire state of California.
- Economic output includes 25-year lifetime of the project

<u>Key Takeaways</u>

- A significant portion would occur in Humboldt.
- The economic output that is spent in Humboldt County depends on how much of the supply chain and assembly is done locally versus elsewhere in the state.

Key Takeaways

1. The offshore wind resource on the north coast is enormous.

A 1,800 MW wind farm in the Humboldt Call Area would produce 3.8% of California's electricity generation.

2. Transmission challenges are different depending on the scale of development.

- Smaller projects face disproportionately high transmission investment costs but may be an important first step for California offshore wind.

- Future, large-scale development would require significant investment and coordination at the state planning level.
- 3. Strategies need to be developed to reduce transmission costs for the first project.
- 4. Offshore wind provides an opportunity to bring a new industry to Humboldt County offering significant job and economic benefits.

Construction Phase Economic Output



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Photo credit: Maia Chel

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