North Coast Offshore Wind Workshop
September 14, 2020

Presented by:
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Photo credit: Maia Cheli
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

- ~1.8 GW (207 sq. mi)
- 150 MW (15 sq. mi)
- 50 MW (5 sq. mi)

North Coast Offshore Wind Study | 14 September 2020 | schatzcenter.org
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.
Capacity Factor

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%

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

Key Takeaways:
- Offshore wind increases local renewable energy generation.
- Reduces Humboldt County reliance on imports and natural gas.

Annual Energy Demand in Humboldt County With and Without Offshore Wind

<table>
<thead>
<tr>
<th>Energy, MWh/year</th>
<th>2030 Demand</th>
<th>50 MW Offshore</th>
<th>150 MW Offshore</th>
<th>1,800 MW Offshore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offshore wind, curtailed</td>
<td>800,000</td>
<td>600,000</td>
<td>1,000,000</td>
<td>1,400,000</td>
</tr>
<tr>
<td>Offshore wind, export</td>
<td>200,000</td>
<td>100,000</td>
<td>600,000</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Offshore wind, local use</td>
<td>200,000</td>
<td>100,000</td>
<td>600,000</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Import &amp; Humboldt Bay Generating Station</td>
<td>200,000</td>
<td>100,000</td>
<td>600,000</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Biomass, Scotia</td>
<td>100,000</td>
<td>50,000</td>
<td>150,000</td>
<td>300,000</td>
</tr>
<tr>
<td>Biomass, Fairhaven</td>
<td>100,000</td>
<td>50,000</td>
<td>150,000</td>
<td>300,000</td>
</tr>
</tbody>
</table>
## Energy Production Summary

<table>
<thead>
<tr>
<th></th>
<th>50 MW</th>
<th>150 MW</th>
<th>1,800 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of 12 MW turbines</td>
<td>4 turbines</td>
<td>12 turbines</td>
<td>153 turbines</td>
</tr>
<tr>
<td>Wind farm footprint area</td>
<td>5.3 sq. mi</td>
<td>15 sq. mi</td>
<td>210 sq. mi</td>
</tr>
<tr>
<td>Annual electricity production</td>
<td>200 GWh/yr</td>
<td>600 GWh/yr</td>
<td>7,500 GWh/yr</td>
</tr>
<tr>
<td>Annual electricity used locally</td>
<td>200 GWh/yr</td>
<td>340 GWh/yr</td>
<td>430 GWh/yr</td>
</tr>
<tr>
<td>Percent of Humboldt County’s load served</td>
<td>22%</td>
<td>38%</td>
<td>48%</td>
</tr>
</tbody>
</table>

California uses 200,000 GWh/yr
Humboldt uses 900 GWh/yr
Humboldt County Electricity System

Key Takeaways:
- Humboldt County transmission system is isolated and has existing generation to serve the regional load.
- There is limited transmission infrastructure into and out of the area.
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

500 kV transmission lines

115 kV transmission line

to Bridgeville
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

Key Takeaways:
- 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**

**Key Takeaways:**
- Cost increases with increasing scale of wind farm.
- Subsea cable is more expensive than overland routes.

<table>
<thead>
<tr>
<th>Transmission Type</th>
<th>Cost Estimate Range</th>
<th>Adjusted Cost Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overland</td>
<td>50 MW, 150 MW, 1,800 MW</td>
<td>1,800 MW</td>
</tr>
<tr>
<td>Subsea</td>
<td>50 MW, 150 MW, 1,800 MW</td>
<td>1,800 MW</td>
</tr>
</tbody>
</table>

* Adjusted Cost Estimate includes terrain and land acquisition and excavation adjustments.
Transmission Cost Comparison

Key Takeaways:
- Cost per MW decreases substantially for larger wind farms.

![Graph showing transmission cost comparison for different capacities and alternatives.](image)

* 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)

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

- Developing offshore wind will bring jobs and economic development to the region directly and indirectly.
- Jobs will be needed for planning, construction, operations, and maintenance.

Analysis done using the JEDI model.
The economic development and job creation estimates consider capital and operating expenses and make estimates of jobs creation and economic output.
Key Takeaways
• Projects at all scales will create a significant number of jobs.
• Larger projects create more jobs.
• Results for entire state of California.
• Economic output includes 25-year lifetime of the project

Key Takeaways
• 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.

![Graph showing Construction Phase Economic Output](Image)
Study collaboration and funding were provided by the U.S. Department of the Interior, Bureau of Ocean Energy Management, Renewable Energy Program, Washington, DC under Agreement Number M18AC00005.

Study collaboration and funding were provided by the California Natural Resources Agency, Ocean Protection Council, Agreement #C0304300

Study collaboration and funding were provided by the California Governor’s Office of Planning and Research, Grant Agreement OPR19100

Pacific Gas & Electric Company provided considerable cost-share to conduct the transmission planning analysis for this project.

Mott MacDonald provided engineering and consulting for the subsea cable corridor and hazards analysis.