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Floating Offshore Wind Energy Technology and Cost Trends

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Golden, Colorado

IEPR Workshop - Offshore Wind
Thursday, October 3, 2019 – 10:00 AM
California Public Utilities Commission
505 Van Ness Avenue, San Francisco, CA 94102

Business Case for Floating Offshore Wind

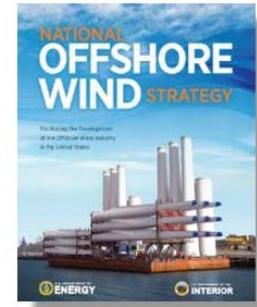
- **Resource Abundance:** 58% of U.S. OSW resource is > 60 meters
- **Reduce Siting Conflicts:** Major siting conflicts are likely to be reduced in deeper water, which tends to be farther from shore
- **Wind Vision:** Floating technology may be needed to achieve targets for 86 GW OSW per DOE/DOI strategy (e.g. Pacific)
- **Cost Reduction Potential:** Cost models have shown that floating wind technology has the potential to achieve the same cost (or lower) as fixed bottom OSW by 2030
- **Rapid Global Industry Pace:** The pace of floating technology advancement has been accelerating world-wide
- **Consistent Policy:** Floating OSW, expected to be commercialized within the next decade, can support an “all of the above” U.S. energy policy
- **National Leadership:** There is a significant economic opportunity in establishing national leadership in floating OSW technology

2015



<http://energy.gov/eere/wind/downloads/wind-vision-new-era-wind-power-united-states>

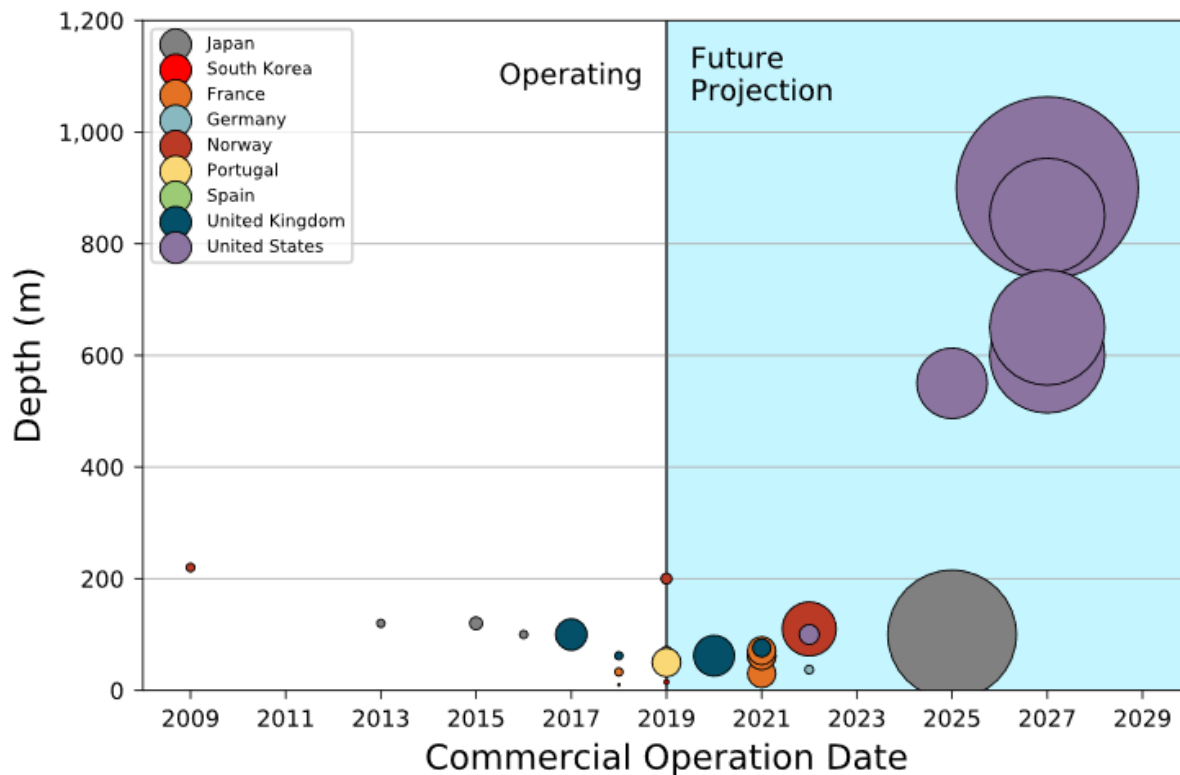
2016



<http://energy.gov/sites/prod/files/2016/09/f33/National-Offshore-Wind-Strategy-report-09082016.pdf>

Floating Offshore Wind Pipeline

- 8 floating offshore wind projects globally represent 46 MW of installed capacity.
- 5 projects (37 MW) are in Europe and 3 projects (9 MW) are in Asia.
- 14 projects with approximately 200 MW under construction, have achieved financial close or regulatory approval.
- In 2018 the global pipeline for floating offshore wind reached 4,883 MW



Commercialization Path for Floating Wind Energy



Photo: Equinor
Scotland
30 MW 5 Turbines –
Credit: Walt Musial



Proof of Concept Phase

2009 to 2016

6 full-scale prototypes totaling about
20-MW
2 - 7 MW turbines



Pre-commercial Phase

2017 to 2023

Multi-turbine commercial arrays
14 projects
totaling over 200-MW



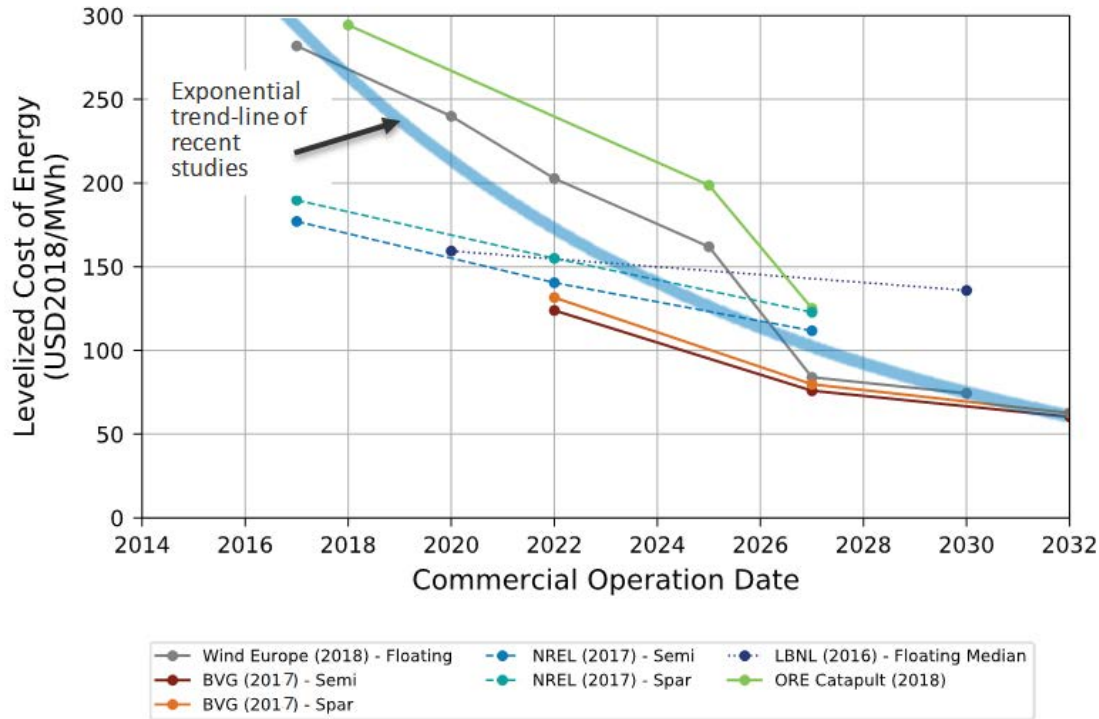
Commercial Floating Arrays

2024 and beyond

400 MW+ arrays proposed
Principle Power – Hawaii/California
Progression - Hawaii
Equinor - TBD
Trident Wind - California
Dyfed/Kantanes – United Kingdom

Current Floating Offshore Costs

Selected Floating Offshore Wind LCOE Trajectories

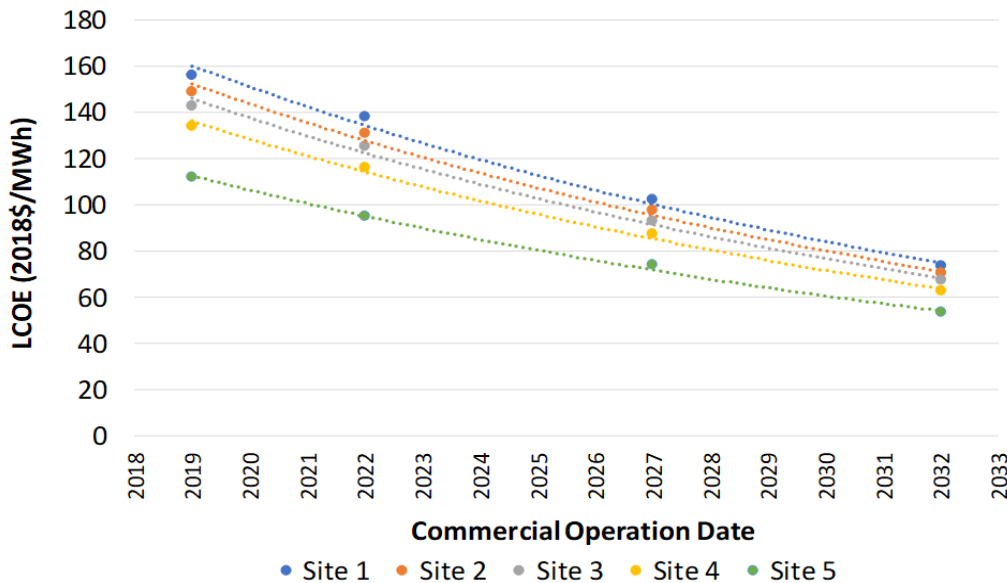
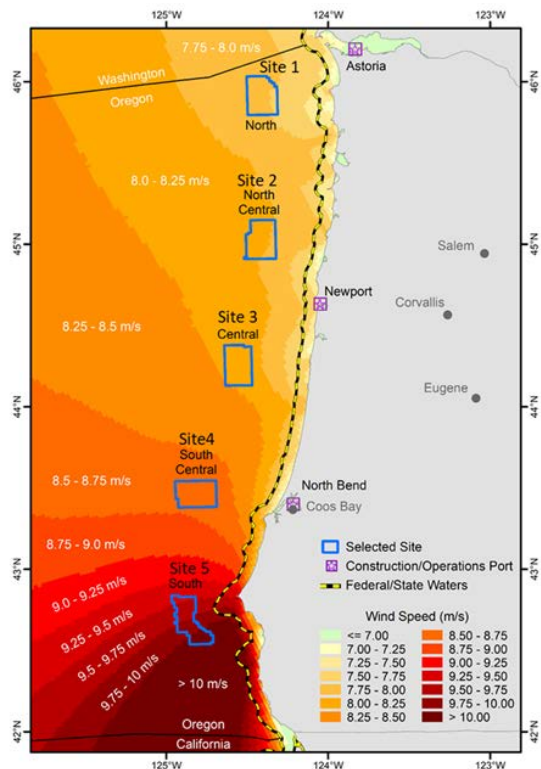


- Floating cost estimates are declining rapidly as new information is obtained
 - › NREL (2016) study for CA estimated \$100/MWh by 2030
 - › BVG and Wind Europe (2018) estimate costs near \$70/MWh by 2030
 - › New NREL modeling will deliver similar estimates
 - › Primary cost drivers:
 - Larger turbines – 12MW to 15 MW
 - Lower turbine prices
 - Lower finance costs
 - Integrated stable substructures
 - Quayside commissioning
 - Reduced cable costs

Musial, W; Beiter, P., Spitsen, p., Nunemaker, J., Gevorgian, V. 2019. “2018 Offshore Wind Technologies Market Report”, U.S. Department of Energy Report, August 2019.

<https://www.energy.gov/eere/wind/2018-wind-market-reports#offshore>

Oregon Cost Study Results – Sept 2019



- Funded by the Bureau of Ocean Energy Management
- Hypothetical sites have not been vetted by ocean user communities
- Only cost and geo-spatial factors were considered
- By 2032 – costs may drop below \$60/MWh in some locations

Musial W., Beiter P., Nunemaker J., Heimiller D., Ahmann J., and Busch J.
 “Oregon Offshore Wind Site Feasibility and Cost Study” NREL September 2019

Thank you for listening – questions?

Trip to Block Island Wind Farm – Oct 1, 2016

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National Renewable Energy Laboratory
<https://www.nrel.gov/about/nwtc.html>



Photo Credit : Dennis Schroeder-NREL