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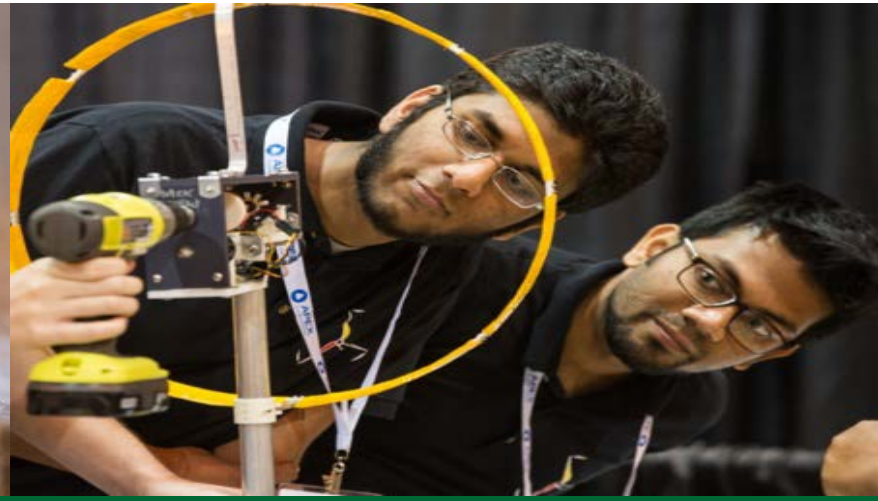
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Overview of Offshore Wind R&D supported by the DOE Wind Energy Technologies Office

Gary Norton

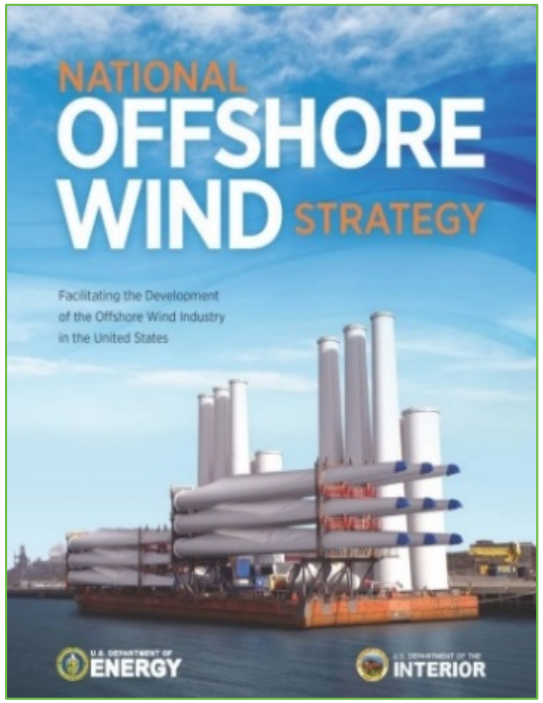
October 3, 2019



R&D Investments align with the National Offshore Wind Strategy

- Issued jointly with BOEM in 2016 as an update of 2011 strategy; input from industry, states and other stakeholders
- Over 30 DOE and DOI initiatives to address 7 action areas; three strategic themes

Strategic Themes	Action Areas
Reducing Technology Costs & Risks	1. Offshore Wind Power Resource & **Site Characterization** 2. Offshore Wind **Plant Technology Advancement** 3. Installation, Operation & Maintenance, & **Supply Chain** Solutions
Supporting Effective Stewardship	4. Ensuring Efficiency, Consistency & Clarity in the **Regulatory Process** 5. Managing Key **Environmental & Human Use** Concerns
Improving Understanding of the Benefits of Offshore Wind	6. Offshore Wind **Electricity Delivery & Grid Integration** 7. **Quantifying / Communicating** the Costs and Benefits of Offshore Wind



How? Directed national lab research; competitive awards; collaboration with Federal partners; communication and partnerships with stakeholders

Scientific Research Key to Cost-Reduction in Wind Plant Design & Operation

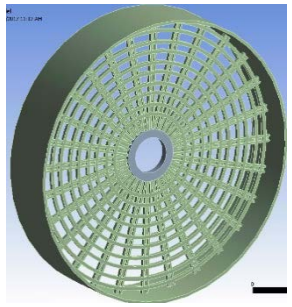
Ongoing collaborative research with laboratories, agencies and other research partners includes:

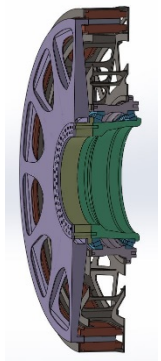
Wind Forecasting Improvement	Wake Dynamics	High Fidelity Modeling	Advanced Plant-Level Flow Controls	Integrated Systems Design and Analysis
Improve weather models and understanding of offshore atmosphere including mesoscale-microscale coupling	Quantify wake effects and dynamic interactions through experiments and field campaigns in collaboration with industry	Capture the physics and dynamics of turbines operating in turbulent wind and waves offshore, and in arrays	Develop plant flow control strategies that are capable of increasing energy capture, and mitigating loads	Modeling and optimization tools to streamline and automate system/plant level design

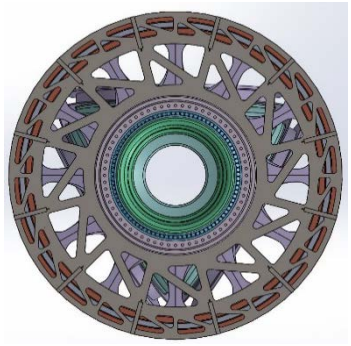
Recent Technology Innovation Awards

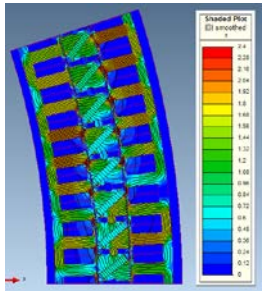
Ever larger turbines will require advanced generator designs that are highly efficient and relatively lightweight compared to current configurations

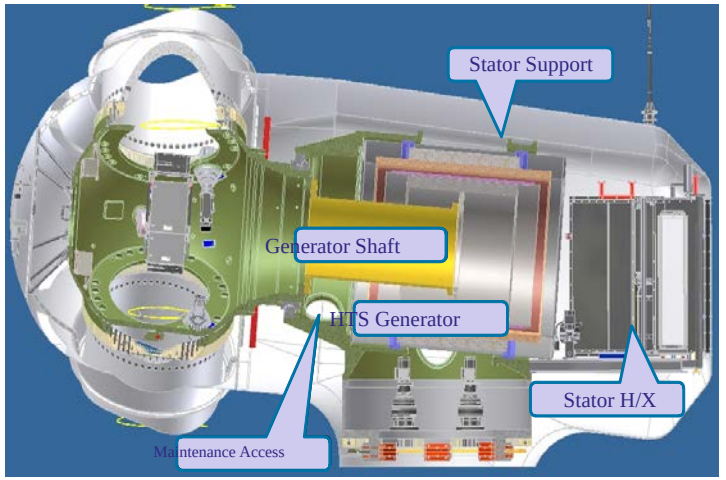
WEG Energy Corporation	Advanced Lightweight High Efficiency Permanent Magnet Direct Drive Generator for Wind Turbine Applications	Up to $7,500,000 in DOE funds each, plus >20% cost share
General Electric Company, GE Research	High Efficiency Ultra-Light Superconducting Generator for Offshore Wind	
American Superconductor Corporation	Advanced Next Generation High Efficiency Lightweight Wind Turbine Generator	











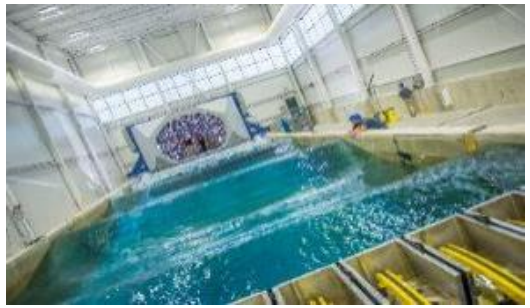
Upcoming Awards – Test Facilities

Funding opportunity announcement (FOA) for offshore wind R&D test facilities

FOA $7M for up to 14 projects to conduct testing in support of innovative offshore wind R&D utilizing existing national-level testing facilities. May include upgrades to existing facilities.

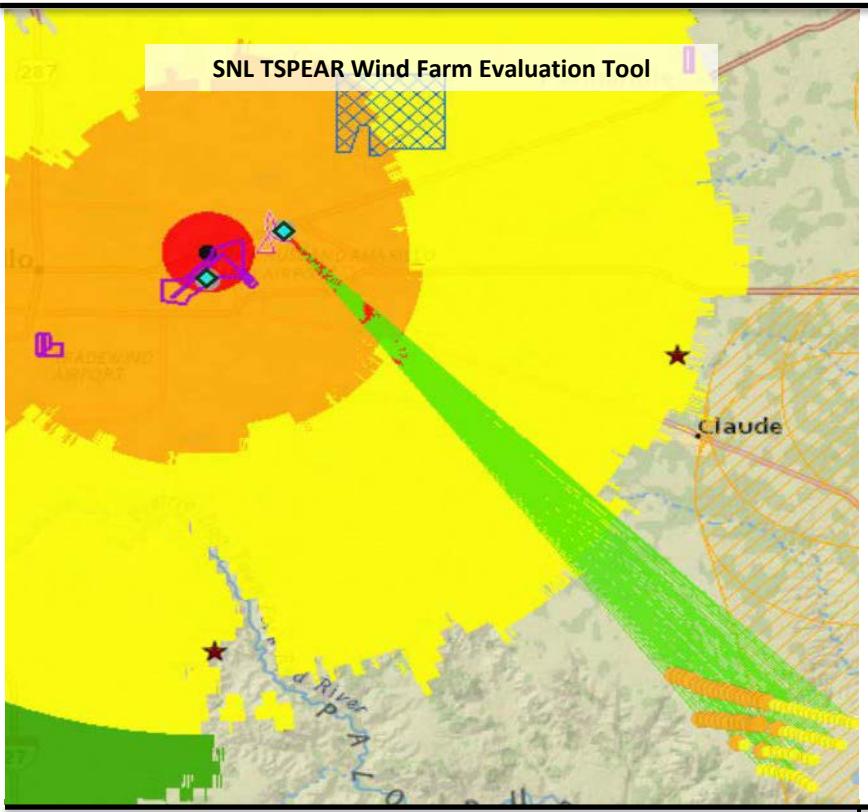
Timeframe Request for Information 7/30/2018 - Results included in FOA
Award announcements planned 10/2019

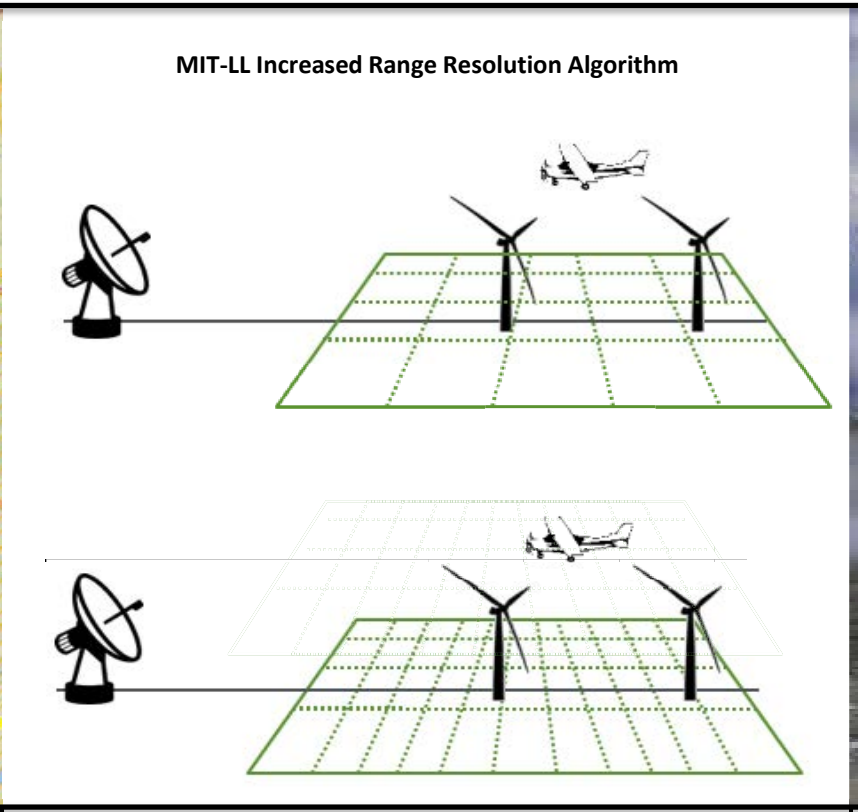
RFI responses and Congressional language helped inform FOA

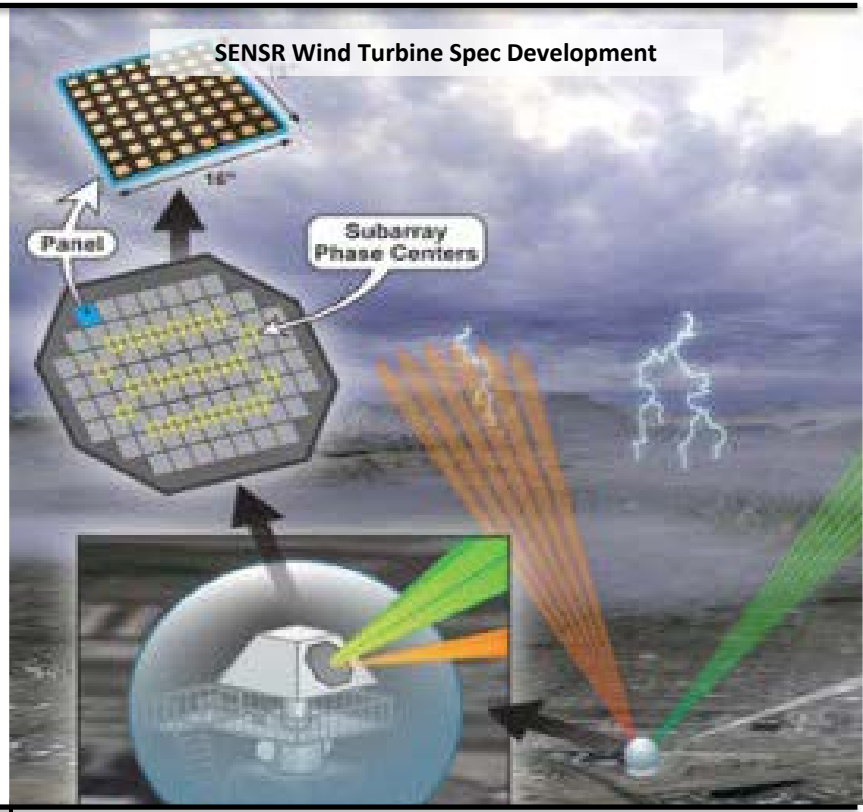



Wind Turbine Radar Interference Inter-Agency Working Group

DOE, DOD, DOI, FAA, NOAA and BOEM collaboration under MOU to: By 2025, eliminate wind turbine radar interference as an impact to critical radar missions, ensure the long-term resilience of radar operations in the presence of wind turbines, and remove radar interference as an impediment to future wind energy development.





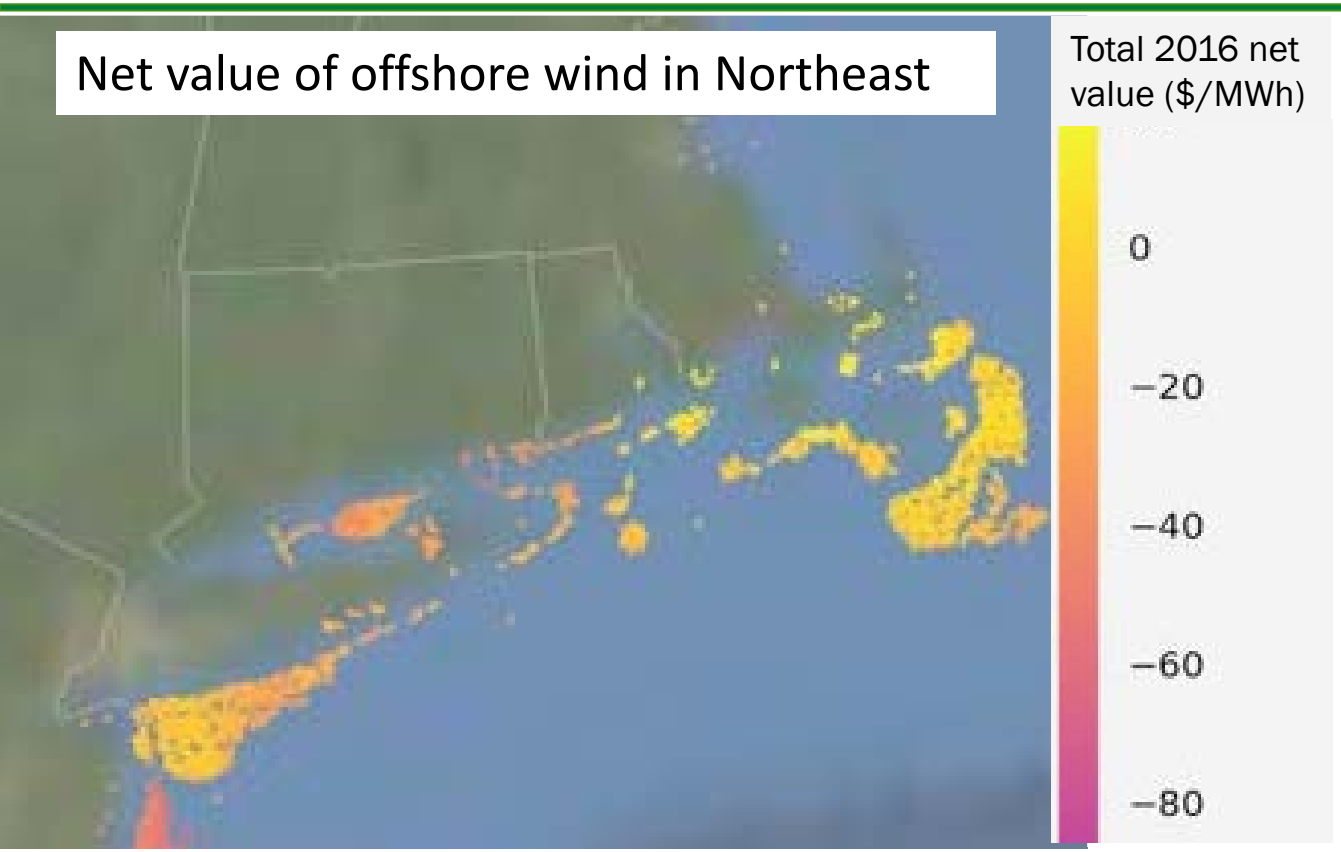


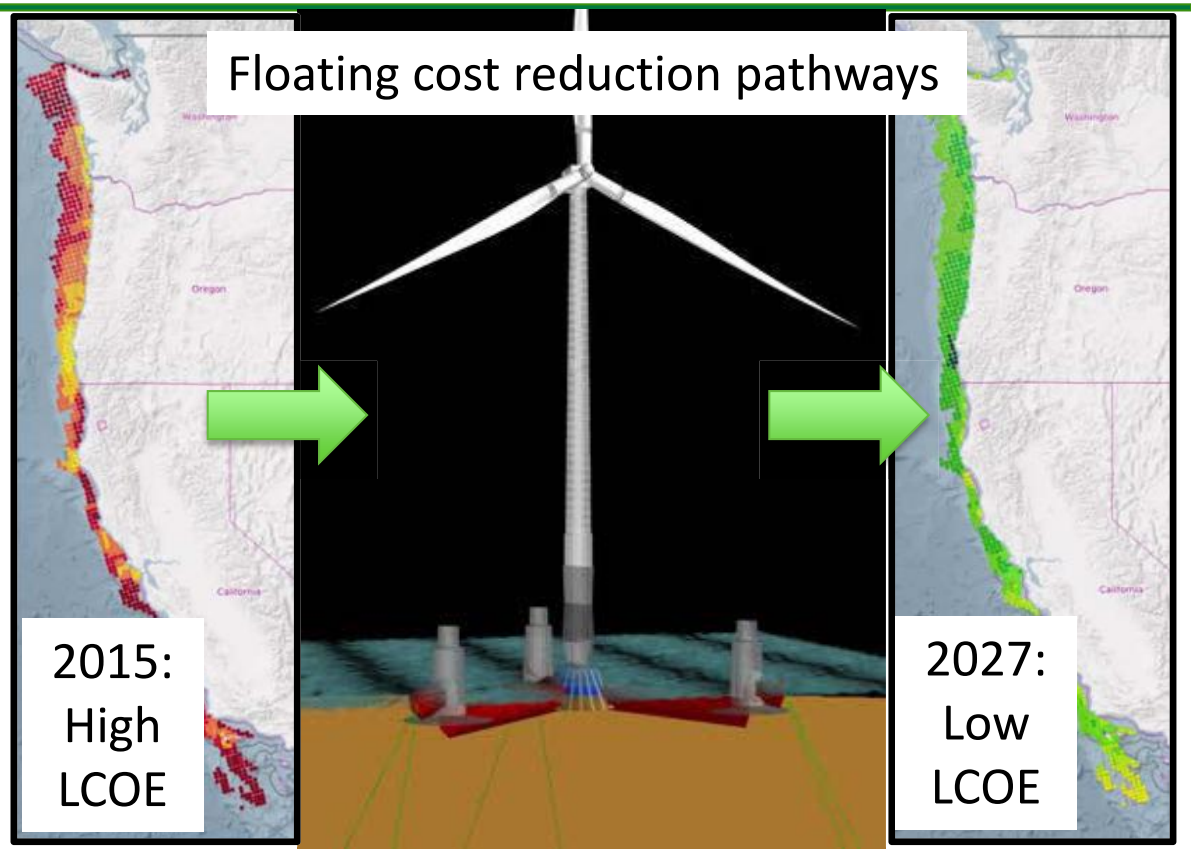
Strategic Theme 1:
Improve capacity to evaluate the impacts of wind energy on sensitive radars

Strategic Theme 2:
Develop mitigation measures to increase resilience of existing radars to wind turbines

Strategic Theme 3:
Encourage the development of next-generation radars resistant to wind turbine interference

Support for Analysis and Modeling by National Laboratories





Understanding technology trends, costs, and benefits:

- "Annual Cost of Energy Review"
- "Estimating the Value of Offshore Wind Along the US Eastern Coast"
- "An Assessment of the Economic Potential of Offshore Wind in the U.S. from 2015 to 2030 "

Identifying and evaluating technology improvement opportunities

- Floating offshore wind systems optimization studies
- Evaluating future cost reduction pathways
- Open source design and evaluation tools such as OpenFAST

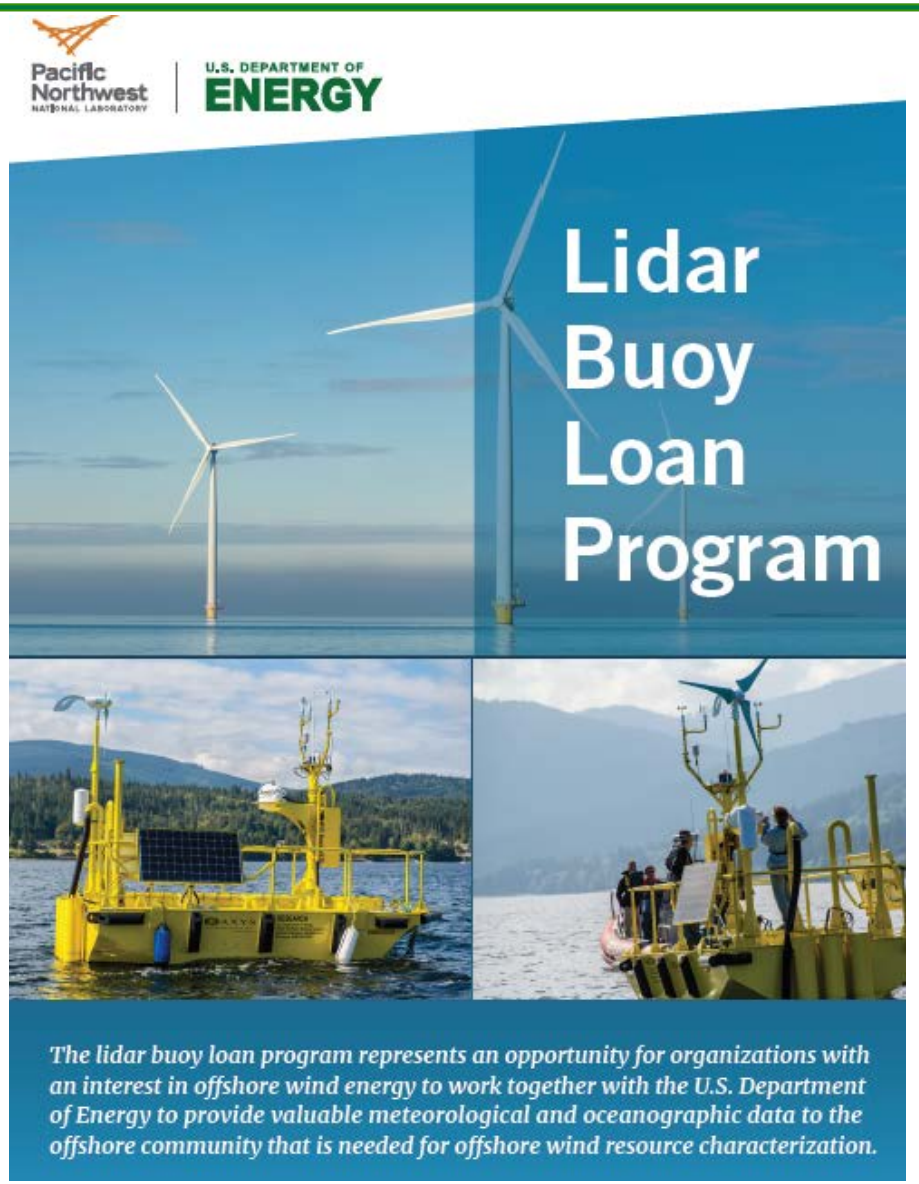
DOE's Resource Characterization Buoys

Deployment off central and northern coasts of California planned for 2020 in partnership with BOEM

(pending permitting process)

Two buoys for comprehensive meteorological and oceanographic measurements for offshore wind resource characterization including:

- Wind profile
- Near-surface wind speed and direction
- Near-surface air temperature, humidity, and pressure
- Solar radiation
- Waves (significant and maximum wave height, peak period, directional wave spectrum)
- Surface water temperature
- Water velocity profile
- Water temperature and conductivity

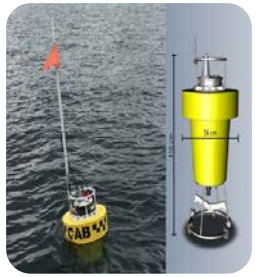


Approach to Mitigating Environmental Barriers

Objective: Reduce wildlife barriers to wind deployment by developing informed technical solutions to wildlife impacts

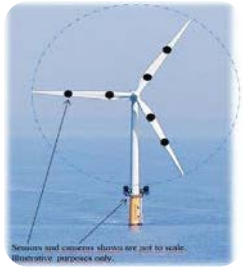
Data Collection and Experimentation	Conduct research to better understand species' exposure and the factors that drive risk in order to inform siting and mitigation solutions
Monitoring and Mitigation	Advance technologies or measures to reduce fatalities at wind energy facilities in an affordable manner
Information Synthesis and Sharing	Coordinate information synthesis and dissemination through collaboratives and information to reduce redundancy, make sense of disparate studies, and catalyze solution development.

Recent Environmental Monitoring Technology Awards



SMRU Consulting - Will develop a cost-effective, reliable network of easily deployed coastal buoys to monitor North Atlantic Right Whales around construction activities

Oregon State University - Will design, build and test an autonomous monitoring system to accurately detect avian and bat collisions with offshore wind turbines. The system will combine microphones and 360-degree cameras with analysis software to detect and verify impacts



WEST - Will further develop and test the WT Bird collision-detection system that combines turbine blade vibration sensors with cameras to quantify impacts

New Offshore Wind Initiative: Summary of Environmental Effects Research

- Summarize what we understand regarding environmental impacts based on global research to date
- Examine which of the high level findings are anticipated to be similar in U.S. waters with a focus on Mid-Atlantic, New England and West Coast.
- ID key areas where there may be knowledge gaps based on 1) our unique complement of species, 2) our legal/regulatory structure
- Summarize what is known regarding methodological effectiveness

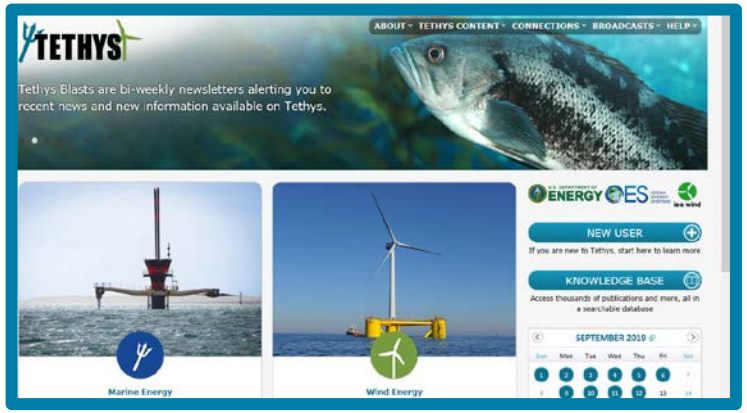
Note: Currently in planning stage - Seeking input from external stakeholders and welcome input on structuring the initiative so that is well-aligned with CA needs and priorities

Point of Contact is in attendance at the workshop: Bethany.Straw@nrel.gov

Key Offshore Wind Resources

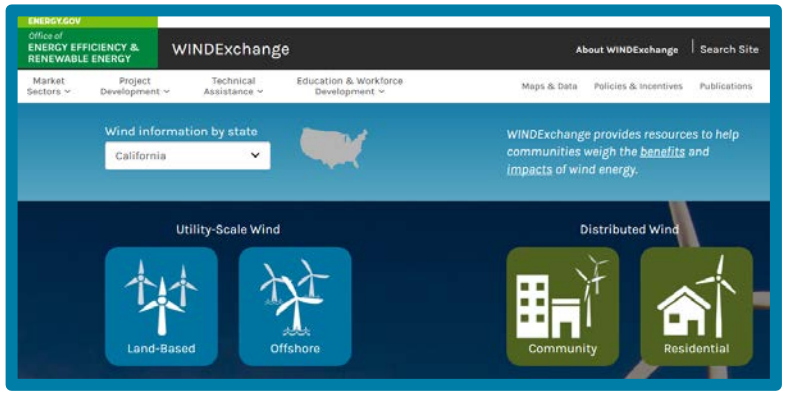
Tethys: A comprehensive searchable library designed to facilitate the exchange of information and data on the environmental effects of wind

https://tethys.pnnl.gov



Wind Exchange: Platform for stakeholder information on wind energy market sectors, state specific profiles and publications; newsletter; siting and project development information

https://windexchange.energy.gov/



Offshore Wind Technologies Market Report: Industry information through June, 2019; global market; all planned U.S. projects; lease areas; state policies; technology trends

https://www.energy.gov/eere/wind/downloads/2018-offshore-wind-market-report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Thank You!
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