Offshore Wind Initiatives at the U.S. Department of Energy

The Block Island Wind Farm, the first U.S. offshore wind farm represents the launch of an industry that has the potential to contribute significantly to a clean, affordable, and secure energy mix.

Photo by Dennis Schroeder / NREL

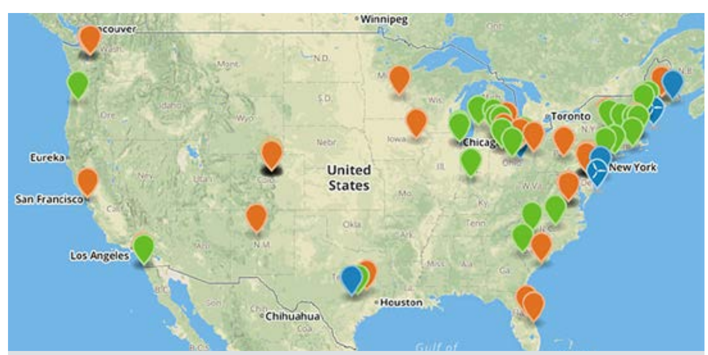
U.S. Offshore Wind Sets Sail

Coastal and Great Lakes states account for nearly 80% of U.S. electricity demand, and the winds off the shores of these coastal load centers have a technical resource potential twice as large as the nation's current electricity use. With the costs of offshore wind energy falling globally and the first U.S. offshore wind farm installed off the coast of Block Island, Rhode Island in 2016, offshore wind has the potential to contribute significantly to a clean, affordable, and secure national energy mix.

To support the development of a world-class offshore wind industry, the U.S. Department of Energy (DOE) has been supporting a broad portfolio of offshore wind research, development, and demonstration projects since 2011 and released a new National Offshore Wind Strategy jointly with the U.S. Department of the Interior (DOI) in 2016.

Research, Development, and Demonstration Projects

DOE has allocated over $200 million to offshore wind research and development projects for technology development and market barrier removal, as well as advanced technology demonstration. DOE-funded offshore wind technology development projects focused on developing the engineering modeling and analysis tools needed to reduce costs and designing the next generation of offshore wind technologies including optimized turbines and foundations. DOE also invested funds from the Recovery Act in a large-scale wind turbine blade testing facility in Massachusetts and in a drivetrain testing facility in South Carolina. DOE also invests in projects to mitigate market barriers that limit the deployment of offshore wind. These barriers include those related to integrating offshore wind energy into existing grid infrastructure, limiting the extent to which offshore wind turbines interact with avian and aquatic life, and ensuring that the construction of wind power is feasible through the study of our nation's available ports, vessels, and supply chain infrastructure. DOE's two highly instrumented wind resource characterization buoys provide long-term offshore wind profile data to support research needs.

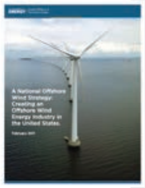


DOE's offshore wind research, development, and demonstration projects are focused in three areas: technology development (orange), market acceleration (green), and advanced technology demonstration (blue). For a full list of DOE-funded projects, see *http://www.energy.gov/eere/wind/downloads/offshore-wind-projects*.

2009 2010 2011 2012 2013 2014 2015 2016

Recovery Act Funding of Test Facilities

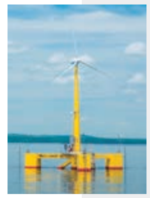
DeepCWind Consortium



First National Offshore Wind Strategy

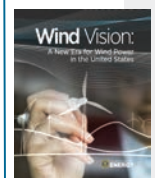
Technology & Market Barrier Funding Opportunities

Advanced Technology Demonstration Projects Initiated

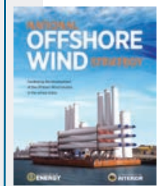


Deployment of UMaine VolturnUS Prototype

DOE Lidar Buoys



Wind Vision Report



Joint National Offshore Wind Strategy

Advanced Technology Demonstration Projects

The flagship of DOE's offshore wind portfolio is the $168 million advanced technology demonstration program, which features innovative offshore wind technologies that have yet to be deployed on a commercial scale. These demonstration projects have innovative features and are among the first of their kind making their way through state and federal permitting, approval, and grid interconnection processes in the United States, and are providing valuable technological advances and lessons that will benefit the development of the nation's offshore wind industry for years to come.

Fishermen's Energy's Atlantic City Windfarm

- **Technology:** Six 4-megawatt (MW) turbines on domestically produced twisted jacket foundations
- **Location:** Three miles off the coast of Atlantic City, New Jersey, in state waters
- **Innovation:** With foundation developer Keystone Engineering, demonstrated a new access ladder that is rotated 90 degrees, allowing workers to safely side step onto the ladder.

  Will act as an at-sea laboratory to investigate interactions between turbines, test new control systems, and provide information about potential environmental impacts of offshore wind.

Lake Erie Energy Development Corporation's (LEEDCo's) Icebreaker project

- **Technology:** Six 3.45-MW turbines on Mono Bucket foundations
- **Location:** Eight miles off the coast of Cleveland in Lake Erie
- **Innovation:** Mono Bucket foundation will reduce installation time, costs, and environmental impacts compared to traditional foundations that require pile driving.

  Addressing technical challenges unique to the Great Lakes including weak soil conditions and surface ice accumulation.

University of Maine's New England Aqua Ventus I

- **Technology:** Two 6-MW turbines on floating concrete semisubmersible VolturnUS foundations
- **Location:** Test site off of Monhegan Island, Maine
- **Innovation:** Floating platform would be suitable for the nearly 60% of U.S. offshore wind resource that is in deep water, where traditional foundations are not feasible.

  Leveraging earlier 1:8-scale prototype deployment; focus on commercial-scale manufacturing of the foundation, leading to reduced internal steel requirements.

National Offshore Wind Strategy

On September 9, 2016, DOE and DOI released the *National Offshore Wind Strategy: Facilitating the Development of the Offshore Wind Industry in the United States*, a jointly produced report informed by extensive stakeholder input. The strategy details the current state of offshore wind in the United States, presents the actions and innovations needed to reduce deployment costs and timelines, and provides a roadmap to support the growth and success of the industry.

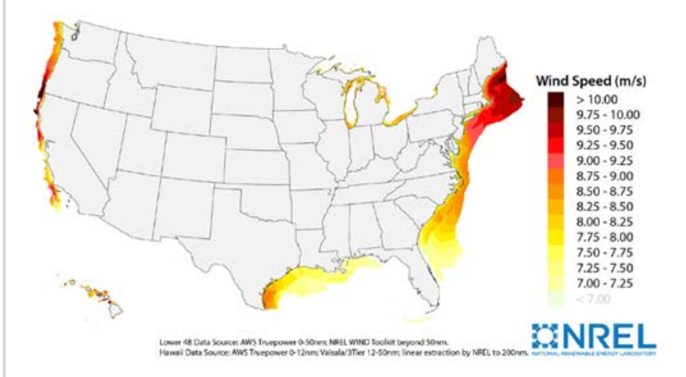
Offshore Wind Represents a Significant Opportunity for the Nation

The *National Offshore Wind Strategy* accounts for progress made since the first offshore wind strategy released in 2011 and builds off of the *Wind Vision* released by DOE in 2015. The *Wind Vision* assessed the potential economic, environmental, and social benefits of a scenario in which U.S. wind power (land-based and offshore combined) supplies 10% of the nation's electrical demand in 2020, 20% in 2030, and 35% in 2050. Achieving the *Wind Vision* study scenario deployment level of 86 GW of offshore wind energy by 2050 would reduce greenhouse gas emissions by 1.8%, decrease electric-sector water consumption by 5%, and create 160,000 gross jobs in coastal regions.

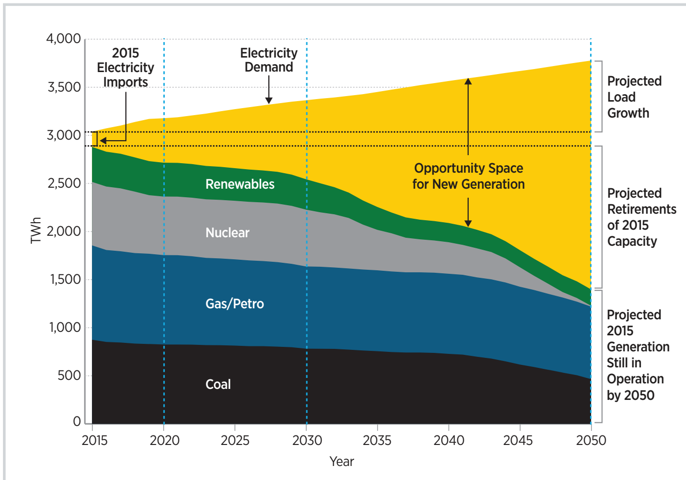
Today, a technical potential of 2,058 gigawatts (GW) of offshore wind resource capacity or 7,200 terawatt-hours of electricity generation is accessible in U.S. waters using existing technology, which is roughly double the current electric generating capacity in the United States.[1]

As the existing fleet of electric-generating units ages and retires and the demand for electricity continues to increase, there is a growing need for new generation, which could be met partially by offshore wind.[2]

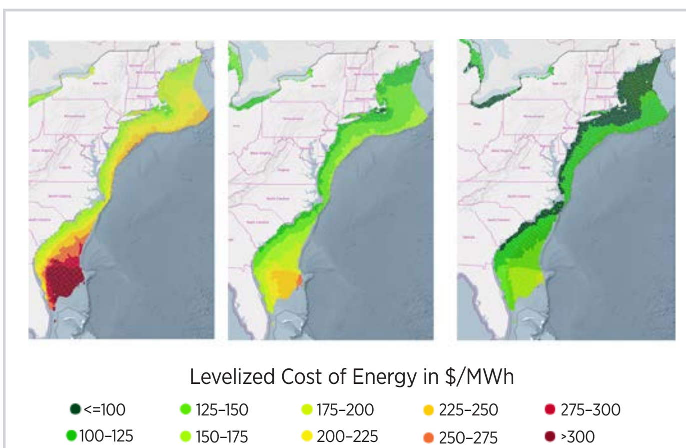
Through technology improvements, efficiencies gained through economies of scale, and deployment experience, offshore industry cost models now show credible scenarios for cost reductions below $100 per megawatt-hour (MWh) at many sites in the United States by 2030.[3]



Offshore wind speeds at 100-meter heights with technology and competing use exclusions applied for calculating the technical resource potential.



Scheduled and age-based retirements and load growth create opportunity for new offshore wind generation in coastal regions.



Geospatial cost variable maps of levelized cost of electricity for Atlantic regions for project financial close dates of 2013, 2020, and 2025.

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1 Read the report: *2016 Offshore Wind Energy Resource Assessment for the United States* (NREL/TP-5000-66599), National Renewable Energy Laboratory, *http://www.nrel.gov/docs/fy16osti/66599.pdf*, or read the blog at *http://energy.gov/eere/articles/computing-america-s-offshore-wind-energy-potential*.

2 *Quantifying the Opportunity Space for Future Electricity Generation: An Application to Offshore Wind Energy in the United States* (NREL/TP-6A20-66522), National Renewable Energy Laboratory, *http://www.nrel.gov/docs/fy16osti/66522.pdf*.

3 *A Spatial-Economic Cost-Reduction Pathway Analysis for U.S. Offshore Wind Energy Development* 2015–2030 (NREL/TP-6A20-66579), National Renewable Energy Laboratory, *http://www.nrel.gov/docs/fy16osti/66579.pdf*.

Key Challenges Remain

Realizing the benefits of offshore wind development will require overcoming critical challenges across three strategic themes, which are further broken down into action areas:

- Reduce technology costs and risks through resource and site characterization, plant technology advancement, and installation, operation and maintenance, and supply chain solutions.
- Support effective stewardship by managing key environmental and human use concerns.
- Increase understanding of the benefits and improve market conditions for investment in offshore wind by evaluating offshore wind electricity delivery and grid integration and by quantifying and communicating the costs and benefits of offshore wind.

Federal Offshore Wind Strategy

The *National Offshore Wind Strategy* identifies specific actions that DOE and DOI can take over the next five years to address key challenges facing the industry. The table below lists actions that DOE plans to take to reduce the cost of energy through technological advancement and to create the conditions necessary to increase deployment by reducing market barriers.

Action Area	Actions for DOE
Offshore wind power resource and site characterization	▪ Support Site Characterization Data Collection Guidance ▪ Gather and Disseminate U.S. Metocean and Geological Data ▪ Validate Innovative Site Characterization Methods
Offshore wind plant technology advancement	▪ Demonstrate Advanced Offshore Wind Technology ▪ Advance Partnerships to Address Unique U.S. Offshore Challenges ▪ Improve Reliability of Offshore Wind Systems ▪ Develop Offshore Wind Energy Design Standards
Installation, operation and maintenance, and supply chain solutions	▪ Support a Regularly Updated U.S. Supply Chain Inventory ▪ Evaluate Supply Chain Bottlenecks, Costs, Risks, and Future Scenarios
Managing key environmental and human use concerns	▪ Collect Environmental Impact Data and Support Testing of Monitoring and Mitigation Technologies at First-Generation Projects ▪ Synthesize Environmental Impact Data and Develop Predictive Models ▪ Evaluate and Support Mitigation of Unique Impacts of Offshore Wind on Coastal Radar Systems and Other Federal Missions ▪ Support Social Science to Understand the Drivers of Opposition and Acceptance of Offshore Wind Farms ▪ Aggregate and Disseminate Environmental Information
Offshore wind electricity delivery and grid integration	▪ Analyze Optimized Offshore Wind Grid Architectures ▪ Analyze State and Regional Offshore Wind Integration Strategies
Quantifying and communicating the costs and benefits of offshore wind	▪ Quantify Offshore Wind Social and Environmental Costs and Benefits ▪ Quantify Offshore Wind Electricity Market Costs and Benefits ▪ Communicate the Costs and Benefits of Offshore Wind

U.S. DEPARTMENT OF ENERGY
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For more information, visit energy.gov/eere/wind

DOE/EE-1486 • October 2016