

# WIND ENERGY

@PNNL

Enabling wind energy  
innovation and integration



## CAPABILITIES

Wind Resource Characterization

Environmental Monitoring and  
Wind-Wildlife Impacts

Community Values and Ocean Co-Use

Wind Systems Integration

Wind Data Management

Distributed Wind



# WIND ENERGY

Wind energy represents more than 10 percent of the nation's electricity mix, making it the largest source of renewable power generation in the United States. This energy source enables many states to meet their renewable energy goals. However, implementing wind energy comes with challenges, such as cost-effective grid integration and risks to wildlife and the surrounding environment.

Pacific Northwest National Laboratory (PNNL) partners with the Department of Energy (DOE) Wind Energy Technologies Office (WETO) to meet its two-fold mission:

- Enable the innovations needed to advance the nation's wind energy systems
- Address wind energy market and deployment barriers (e.g., siting and environmental impacts for offshore and land-based power)

## WHAT WE DO

**PNNL's research focuses on six key capabilities:**

### Wind Resource Characterization

---

*Providing and improving wind resource data to reduce project uncertainty, advance forecasting, and reduce costs*

Through observational data collection, simulation, and testing based on improved and more accurate wind data, PNNL is bringing model parameters to greater certainty. With more confidence in the model forecasts, the power industry can better integrate wind power into the electric grid as a more affordable and clean energy source.

### Environmental Monitoring and Wind-Wildlife Impacts

---

*Increasing understanding of wind-wildlife interactions and developing monitoring technologies to mitigate environmental risk*

Wind technologies, such as spinning turbine blades, may pose risks to nearby wildlife. PNNL helps mitigate this risk by curating, synthesizing, and disseminating research findings needed to inform wind siting in the United States. We also conduct underlying research and development to inform, develop, and test monitoring technologies designed to minimize the impact of operational wind facilities on wildlife species of concern.

### Community Values and Ocean Co-use

---

*Exploring community values and concerns with offshore wind energy to facilitate equitable ocean co-use*

PNNL leads community-engaged offshore wind research to enable the development of new strategies, holistic approaches and tools, and timely data products that integrate community values into offshore wind development. Knowledge and project products will inform partnerships with DOE, the Bureau of Ocean Energy Management, state and local governments, tribes, regional and local planning groups, developers, and other stakeholders engaging communities in offshore wind projects.

### Wind Systems Integration

---

*Enabling cost-effective, reliable, and resilient energy systems operation with increasing wind energy contributions*

PNNL is a leader in developing and deploying methods at a system scale to assess requirements for capacity and grid support services. PNNL researchers consider a range of meteorological conditions, equipment de-rates, and operational dynamics due to resilience threats that inform new planning and operational models. These capabilities inform the technoeconomic valuation of wind energy and guide reliable decarbonization.

### Wind Data Management

---

*Collecting, storing, curating, cataloging, preserving, and disseminating results generated by wind energy research through the Wind Data Hub portal ([a2e.energy.gov](http://a2e.energy.gov))*

PNNL leads the development of a wind data repository that provides researchers, wind plant owners, consultants, and wind turbine owners with secure, timely, easy, and open access to all laboratory, field,



PNNL's ThermalTracker-3D technology is a stereo-vision solution for evaluating flight tracks of birds and bats around wind turbines. (Photo by Werner Stocum, NREL)





GW 87/1500 turbines in Ohio (Photo courtesy of One Energy Enterprises LLC)

benchmark model, and offshore data produced by WETO-funded research. This data helps wind plant owners and consultants make decisions about where to locate wind turbines, optimize energy production from wind, and evaluate wake effects from wind plants.

## Distributed Wind

*Making wind technology a more affordable, accessible, and compatible distributed energy resource option*

PNNL's distributed wind research advances wind energy technology as a distributed energy resource to contribute maximum societal, economic, and power system benefits. Through market analyses, PNNL provides key information to help stakeholders understand and access market opportunities and inform distributed wind industry research and development needs. We also collaborate with stakeholders to ease the integration of distributed wind into microgrids, isolated grids, distribution networks, and hybrid power plants and systems by improving valuation and power system modeling techniques, developing advanced turbine control capabilities, and providing tools to increase the resilience of distributed wind infrastructure.

## PROJECT SPOTLIGHTS

### West Coast Offshore Wind Transmission Study

PNNL is leading a study in collaboration with the National Renewable Energy Laboratory to examine how the nation can expand transmission to harness power from floating offshore wind for West Coast communities. The findings will be used to address transmission constraints that currently limit offshore wind development in the deep waters of the Pacific Ocean, while supporting grid reliability, resilience, and ocean co-use through 2050.



The study will leverage part of the \$100 million in DOE funding provided under the Inflation Reduction Act for offshore wind and interregional transmission analysis. The study also supports the Floating Offshore Wind Shot, which was launched by DOE and other departments in 2022 to reduce the cost of floating offshore wind energy by more than 70 percent and deploy 15 gigawatts by 2035.

## Lidar Buoy Program



PNNL manages lidar buoys for offshore wind resource characterization on behalf of WETO. Using atmospheric and oceanographic measurement capabilities, the lidar buoys capture data—such as wind speed and direction at multiple heights—using wind profiling lidar, air and sea surface temperatures, ocean current speeds and directions, and wave heights and directions.

The centerpiece of each buoy is a wind profiling lidar that provides wind measurements up to 250 meters above the sea surface, where the winds are most relevant to offshore turbines. Buoy data is used to validate wind models, improve the understanding of air-sea interactions, and reduce uncertainty and risk in characterizing offshore wind resources.



Department of Energy lidar buoy deployed off Morro Bay, California. (Photo by AXYS Technologies and PNNL)



## **PACIFIC NORTHWEST NATIONAL LABORATORY**

draws on signature capabilities in chemistry, Earth sciences, and data analytics to advance scientific discovery and create solutions to the nation's toughest challenges in energy resiliency and national security. Founded in 1965, PNNL is operated by Battelle for the Department of Energy's Office of Science. DOE's Office of Science is the single largest supporter of basic research in the physical sciences in the United States and is working to address some of the most pressing challenges of our time.



**For more information about PNNL's wind energy capabilities, contact:**

**Alicia M. Mahon, PhD, PMP**

Wind Energy Program Manager  
Operational Systems Engineering  
Group Leader  
alicia.mahon@pnnl.gov | (509) 375-6943

U.S. DEPARTMENT OF  
**ENERGY**

PNNL-SA\_192881

PNNL researchers lead students on a wind farm tour as part of the laboratory's Pathway Summer School for the Department of Energy Office of Science's Reaching a New Energy Sciences Workforce (RENEW) initiative. RENEW is an immersive program that introduces students to PNNL teams that conduct research in renewable energy science.