Lidar Buoy Program

The lidar buoy program facilitates meteorological and oceanographic data collection using validated methods to support the U.S. offshore wind industry.

Pacific Northwest National Laboratory (PNNL) manages several lidar buoys for offshore wind resource characterization on behalf of the U.S. Department of Energy's Wind Energy Technologies Office (WETO). WETO oversees a large portion of the nation's offshore wind research to advance the scientific understanding of offshore wind and help industry advance offshore wind plant technology.

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 instrument on each buoy is a wind profiling lidar that provides wind information up to 250 meters above the sea surface—where offshore wind turbines would be located. The lidars received an independent performance validation in 2020 documenting that the offshore lidars received Stage 2 (pre-commercial) certification in compliance with the recommended practices of the International Energy Agency (IEA) Wind Technology Collaboration Programme.

The buoys are equipped with advanced scientific instrumentation, including the following:
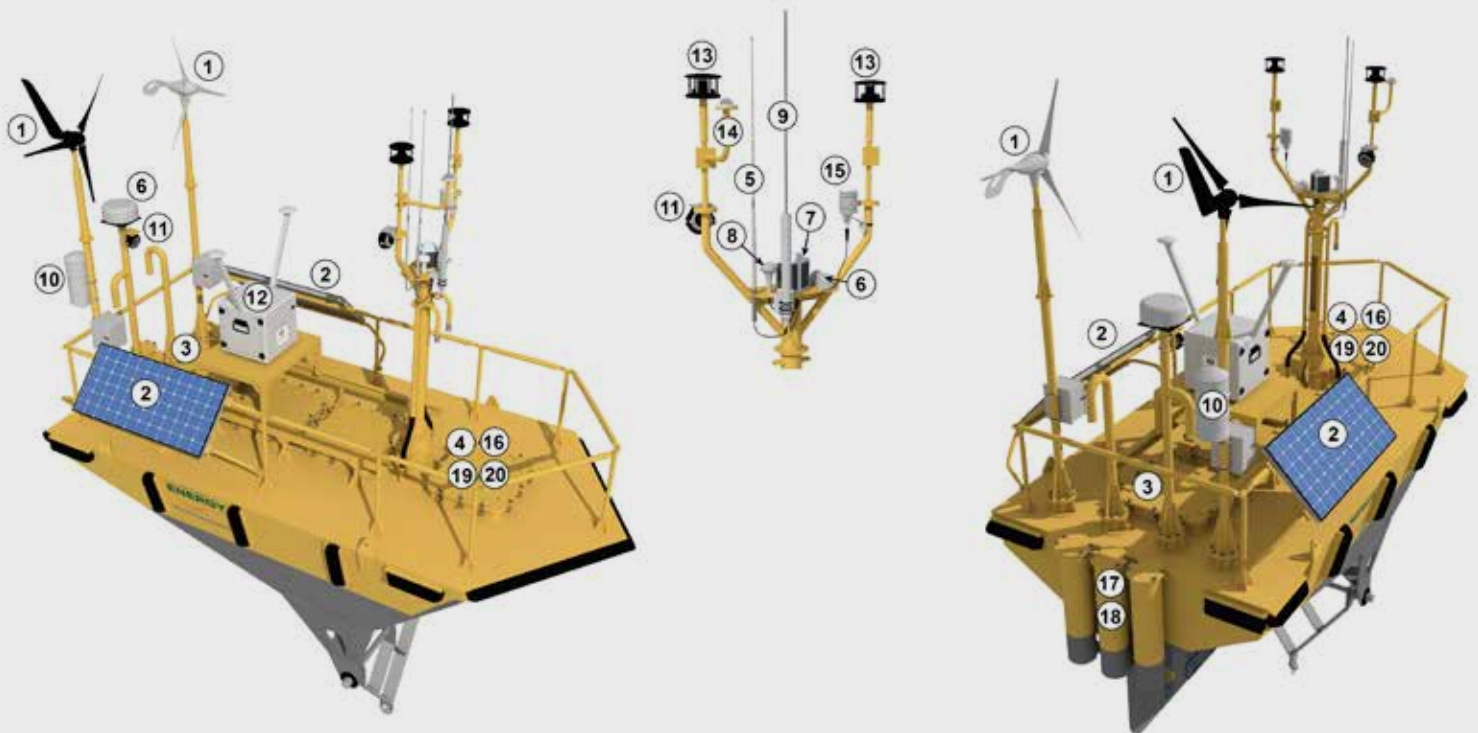
Power, Data, Communication, & Navigation
1. Wind turbine generators
2. Solar panels
3. Diesel generator (in compartment)
4. Data loggers (in compartment)
5. Cellular antenna
6. Satellite antenna
7. Navigation light
8. AIS GPS antenna
9. AIS VHF antenna
10. Radar reflector
11. Security cameras

Meteorological
12. Wind profile
13. Wind speed & direction
14. Solar radiation
15. Air temperature & relative humidity
16. Barometric pressure (in compartment)

Oceanographic
17. Water velocity profile (in moonpool)
18. Salinity and water temperature (in moonpool)
19. Wave spectrum (in compartment)
20. Water temperature (in compartment)
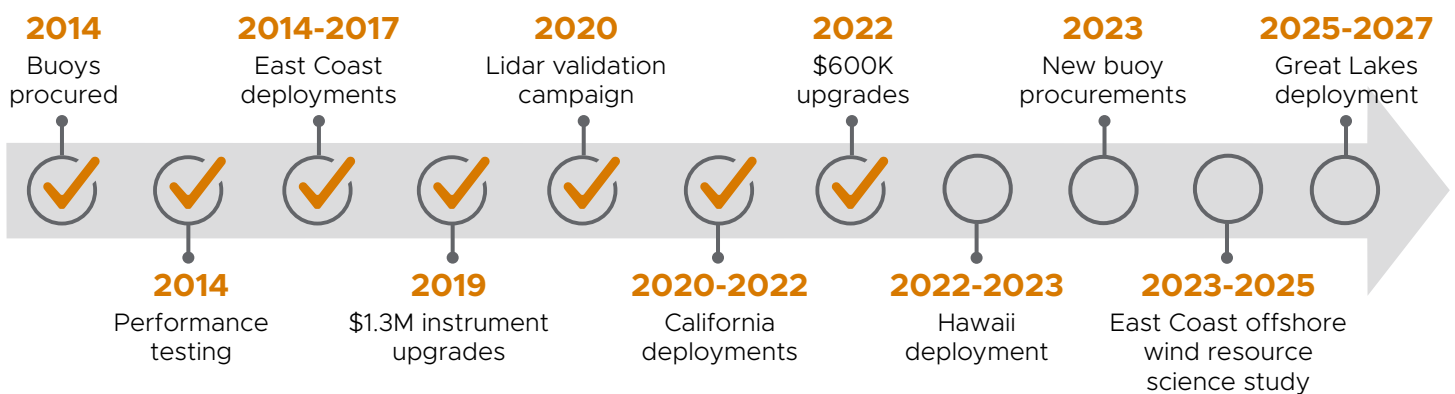
BUOY LOAN PROGRAM

PNNL administers a buoy loan program through which the buoys may be loaned to qualified parties for the purpose of acquiring wind resource characterization and oceanographic data in areas of interest for offshore wind energy development in the U.S. The program represents an opportunity for WETO and organizations with an interest in offshore wind energy to work together, providing valuable and focused offshore data to the wind energy community in high-priority locations.

Organizations that want to use the buoys for their research should submit an application to the buoy loan program for evaluation. Selected applicants will be invited to negotiate loan agreements.

BUOY ACTIVITY

The lidar buoys have been deployed on the East Coast (Virginia and New Jersey), California, and Hawaii to support U.S. offshore wind development. The buoys have undergone performance testing, significant upgrades, and a lidar verification campaign, as shown in the timeline below.

2014
Buoys procured

2014-2017
East Coast deployments

2020
Lidar validation campaign

2022
$600K upgrades

2023
New buoy procurements

2025-2027
Great Lakes deployment

2014
Performance testing

2019
$1.3M instrument upgrades

2020-2022
California deployments

2022-2023
Hawaii deployment

2023-2025
East Coast offshore wind resource science study

ANALYZING BUOY DATA

Buoy data are used to validate wind models, improve the understanding of air-sea interactions, and reduce uncertainty and risk in characterizing offshore wind resources. Data analysis includes:

Wind profile: The lidar measures wind speed and direction at heights where future wind turbine blades would be located. Measurements are used to predict the power production and inform the engineering design of future wind turbines.

Near-surface measurements: Meteorological and oceanographic measurements near the surface allow scientists to understand the physical conditions that drive weather patterns offshore. Near surface meteorological and lidar measurements are used to validate and improve atmospheric models.

Sea state: The buoy monitors the wave conditions and measures the current down to 200 m below the surface. These measurements provide the basis for the design of turbine foundations and moorings and allow the maritime industry to predict when they could safely install or service a wind farm.

DATA ACCESS

The collection and dissemination of buoy data for the benefit of the public and industry is critical to the program. Data obtained from lidar buoy deployments are stored in the Wind Data Hub, which is managed by PNNL data management and computer scientists.

THE PORTAL IS DESIGNED TO:

collect, store, curate, catalog, preserve, and disseminate the massive amounts of experimental and computational results generated by wind research.

collect   store   curate

catalog   preserve   disseminate

The system provides the wind research community with secure, timely, easy, and open access to the wind data, including laboratory, field, benchmark modeling, and offshore wind data.

ABOUT PACIFIC NORTHWEST NATIONAL LABORATORY

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.

Contact:

Alicia M. Mahon, Ph.D., PMP
Wind Energy Program Manager
Pacific Northwest National Laboratory
509.375.6943
alicia.mahon@pnnl.gov