RESOURCE &TECH

NOVEMBER 14–15 | AUSTIN, TX

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# Lidar Buoy Facility: U.S. DOE Open-Source Buoy Platform for Testing New Offshore Instruments

## OBJECTIVE

The U.S. Department of Energy has designed and fabricated a **new open-source buoy platform**, called the instrumentation test buoy. The new buoy has the same instruments as the existing lidar buoy fleet but with expanded capabilities and flexibility to integrate new instruments for testing. The mission of the new buoy will be to evaluate the performance of new offshore sensors in the field.

## OPEN-SOURCE BUOY

Open-access software will be made publicly available, in particular

- **Data logging** → All Campbell Scientific data logger codes for instruments and buoy control.
- **Design and Control architecture** → Drawings of the buoy and software to control the buoy power, communication, and operations.
- **Communication** → Software to automatically transfer data from the buoy to a remote server via Satellite/Wi-Fi.

## INSTRUMENT TESTING

Tentative plans to test the below instruments in 2-3 years:

- ✓ Atmospheric thermodynamic profilers,
- ✓ Remote sensing lidars,
- ✓ Radiometers and Ceilometers,
- ✓ Precipitation, lightning, etc.,
- ✓ Wildlife tracking/monitoring (avian radars, Yagi Antenna etc.),
- ✓ Testing power devices, such as wave energy converters
- ✓ SageNode – Edge computer and ML within an interconnected cyberinfrastructure, spanning multiple major science instruments and wind farms

## DESIGN CONSIDERATIONS

**Power**

- ➢ Renewables support base buoy load
- ➢ Extra ~ 500 W available for test instrumentation
- ➢ Diesel generator as backup power supply for base load, may be relied on for extra capacity

**Space and Mounting Locations**

- ➢ Additional mounting options for instrumentation on mast, via moonpools, and on deck
- ➢ Internal compartment space for additional electronics, power needs

**Communications**

- ➢ Short range – WiFi for connectivity with nearby vessel
- ➢ Long range – 5G for deployments in cell range, Iridium for farther offshore

**Position and Safety** – AIS, navigation light, GPS watch circle alarms, independent asset tracker, cameras (IR)

**Data Logging**

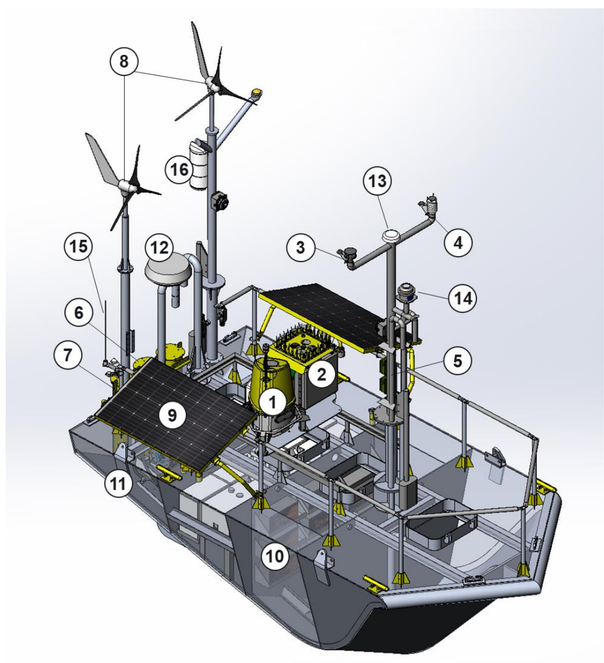
- ➢ Built around Campbell Scientific CR1000X and Industrial PC
- ➢ On-board data processing to minimize transmission requirements
  - ✓ Configurable to user-selected averaging intervals for individual sensors, such as taking 1 Hz data and saving as 10-min averages
  - ✓ Save raw and processed data
- ➢ Minimum 3 TB onboard data storage (replaceable when deployed) to support at least 12 months of data acquisition

**Software**

- ➢ Data collection and instrument control software completely accessible and able to be modified by the user
- ➢ Seamless addition of new sensors or modification of data processing code
- ➢ Remote system controls to adjust sensor parameters as needed during data collection campaign

**Scientific Sensors**

1. ZX 300M LiDAR
2. Windcube v2.1 LiDAR
3. Gil ultrasonic anemometer
4. Vaisala WXT 536:
   - Wind speed
   - Wind direction
   - Temperature
   - Relative humidity
   - Barometric pressure
   - Precipitation
5. Wildlife Acoustics bird and bat recorders (SM4)
6. Nortek Signature 250 AD2CP
7. Seabird Electronics 37 SMP CTD




**Power**

8. (2) SuperWind 350 turbines
9. (2) 320 W Renogy solar panels
10. (8) Lithium-ion phosphate batteries providing 24VDC
11. 5 kW diesel generator, 160 gallons capacity

**Navigation/ Communication**

12. Thales Vessel link Iridium comms
13. Pep-link 5G and Wi-Fi router
14. Navigation light
15. AIS antenna
16. Radar reflector


*(Top) Schematic of the DOE test buoy with all key scientific sensors, power sources, and communication devices. (bottom) Buoy currently under testing at Fall River, MA. Additional Industry sensors added to the buoy for testing.*

## TEST YOUR SENSORS

The test buoy was designed to accommodate a range of future sensors both above and below water and have additional electric power, mounting locations, and data storage. The buoy will be the first open-source buoy, where in the buoy architecture, control system, designs, communication protocols will be made publicly available.

Current Location for testing is at the Air-Sea Interaction Tower near Martha's Vineyard. Ongoing testing of the below industry sensors on the buoy:

*a)* *Heitronics* Infrared Radiation Thermometer for Skin Sea Surface Temperature,
*b)* *SeaView* Systems wave sensor,
*c)* *Campbell Scientific - Apogee* - Infrared Radiometer with Standard Field of View

A report detailing the performance of these systems against the reference will be published.

PNNL lidar-buoy-program

## ACKNOWLEDGEMENTS

The authors would like to thank the Wind Data Hub team for making the Lidar Buoy field campaign data publicly available. The authors would also like to thank Ocean Technical Services, AXYS Technologies, and Science Applications International Corporation (SAIC) for partnering with PNNL on various buoy deployments. PNNL is operated for DOE by the Battelle Memorial Institute under Contract DE-AC05-76RLO1830.

## REFERENCES

DOE A2e Wind Data Hub for data access.

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