PNNL-26071, Rev. 1

Department of Energy Lidar Buoy Loan Program Description

September 2020

AM Gorton
WJ Shaw
MA Severy

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Pacific Northwest National Laboratory
Richland, Washington 99354

Acronyms and Abbreviations

ADCP	acoustic doppler current profiler
BOEM	Bureau of Ocean Energy Management
CF	compact flash
CTD	conductivity, temperature, depth
DAS	data acquisition system
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
FGW e.V.	Fördergesellschaft Windenergie und andere Erneuerbare Energien
IEA	International Energy Agency
IMU	inertial measurement unit
IPC	industrial personal computer
MCRL	Marine and Coastal Research Laboratory
OCS	outer continental shelf
PNNL	Pacific Northwest National Laboratory
R&D	research and development

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1.0 Introduction

The U.S. Department of Energy (DOE) owns two AXYS WindSentinel™ buoys (Buoys #120 and #130) that collect a comprehensive set of meteorological and oceanographic (metocean) data to support resource characterization for wind energy offshore. The two buoys were delivered to DOE's Pacific Northwest National Laboratory (PNNL) in September 2014. After acceptance testing and initial performance testing and evaluation at PNNL's Marine and Coastal Research Laboratory (MCRL) in Sequim, Washington, the buoys were deployed off the U.S. East Coast, off the coasts of Virginia and New Jersey through 2017. In 2019, the buoys underwent $1.3M in upgrades, including upgrades to their wind profiling lidar systems. In 2020, the upgraded lidars received an independent performance validation (pictured in Figure 1.1), documenting that the offshore lidar validation campaign and data analysis were performed in compliance with the roadmap towards commercial acceptance published by the Carbon Trust. Beginning in September 2020, the buoys were deployed off the coast of California in partnership with the Bureau of Ocean Energy Management (BOEM) through September 2021. Data from the buoys are available to the public through the DOE-managed Data Archive and Portal online at https://a2e.energy.gov/data.

In response to a number of inquiries and unsolicited proposals, DOE's Wind Energy Technologies Office has implemented a program, managed by PNNL, to lend the buoys to qualified parties for the purpose of acquiring wind resource characterization data in areas of interest for offshore wind energy development. This document describes the buoys, the scope of the loans, the process of how borrowers will be selected, and the schedule for implementation of this program, including completing current deployments.

Figure 1.1. One of two DOE lidar buoys undergoing a lidar validation campaign

1.1 Buoy Context: The National Offshore Wind Strategy

The National Offshore Wind Strategy (Gilman et al., 2016) identified key strategic areas in which DOE and the U.S. Department of the Interior (DOI) could collaboratively act to support the development of the U.S. offshore wind industry. The National Offshore Wind Strategy reflects input provided by stakeholders through workshops and comments and is organized around several strategic themes. Each theme identifies current gaps in information or support needed by the U.S. offshore wind industry and actions the agencies can take to fill them.

Deployment of the buoys helps address the strategic theme titled “Reducing Costs and Technical Risks”. Within this theme, the following knowledge gaps were identified (Gilman et al., 2016, pg. 26-27):

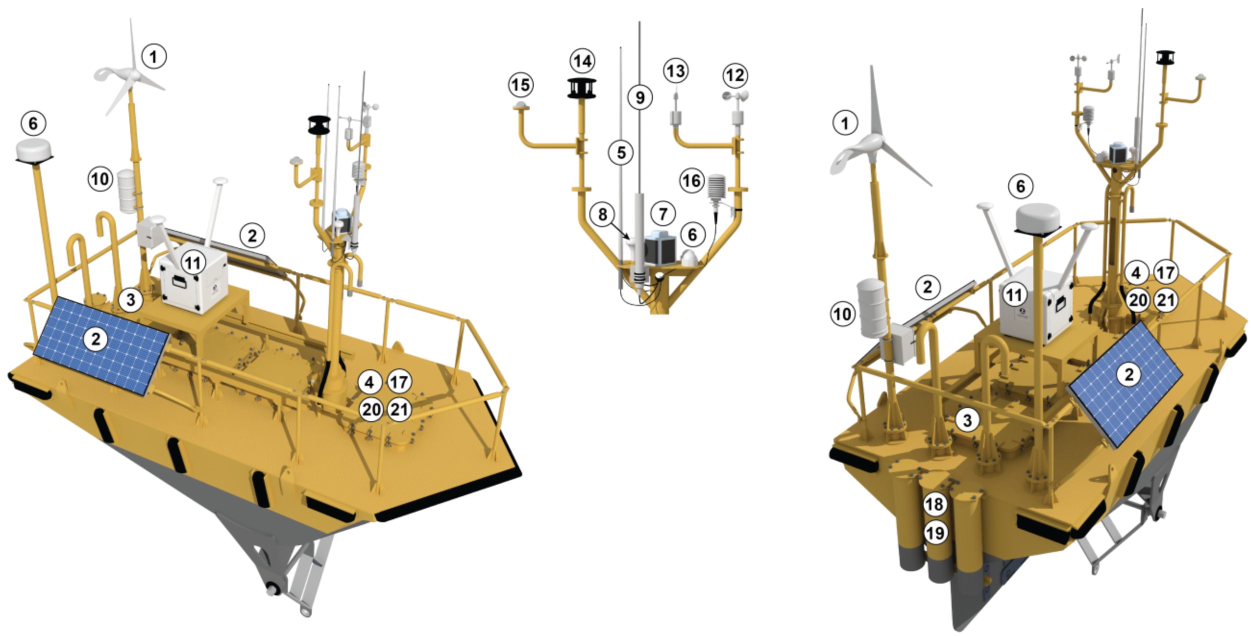
- **Collecting Metocean Data through Validated Methods:** The U.S. Outer Continental Shelf (OCS) and the Great Lakes have very limited observations supporting wind energy because of the difficulty of making such observations in the harsh marine environment. The first full-year observations of winds at hub-height in the OCS were provided by these buoys. The lack of data creates uncertainty in siting, design criteria, projected performance, and regulation, and this uncertainty ultimately increases the cost of energy. Traditional meteorological towers are very expensive in the offshore environment; buoys offer a much less expensive path to obtaining key wind resource information. If formally validated and accepted by the financial community, the buoys also offer a cost-effective path to bankable pre-construction resource assessments.
- **Standardizing Metocean and Geophysical and Geotechnical Data Collection Methods:** Under DOI requirements, certain metocean data are required to be submitted as part of the Facility Design report for each project. Existing DOI requirements for metocean data collection are general and allow a wide variety of data collection methods. Through experience with buoy data collection, DOE can support the development of standard data collection guidelines that would help provide consistency in project designs and help developers determine the effort required to provide the data.
- **Understanding Intraplant Flows**: The impact on reliability and annual energy production of disturbed wind flows within wind plants, including turbulent wakes, is not yet well understood and yet has a potentially significant effect on the cost of energy. The offshore environment for these flows is different from the onshore environment because of the dynamic nature of the ocean surface and the presence of unique coastal circulations. Accurate modeling of intraplant flows requires good characterization of the inflow conditions, and the DOE buoys can provide direct measurements of this inflow and the associated ocean conditions.

To address these gaps, DOE is committed to support both the development of standards for data collection and the metocean data collection. The buoys play a key role in these activities.

1.2 Buoy Description

The lidar buoys collect a comprehensive set of atmospheric and oceanographic measurements needed for offshore wind resource characterization. The centerpiece of the instrumentation suite for each buoy is a motion-corrected lidar system that can provide profiles of the wind speed and direction from the surface up to 250 m above the sea surface. In addition to a lidar, each buoy collects ocean temperature, salinity, current, and wave data as well as near-surface air temperature, humidity, and wind speed and direction. Meteorological and oceanographic instruments on the two buoys are identical and are described in Figure 1.2 and Table 1.1.

The system provides flexibility for user definition and control of averaging intervals for all instrumentation. In general, observations can be recorded at the highest rate available for each instrument to allow maximum flexibility in subsequent analyses. In most cases, this is a sampling rate of at least once per second.



Power, Data, Communication, & Navigation

1. Turbine
2. Solar panels
3. Diesel generator (compartment)
4. Data loggers (compartment)
5. Cellular antenna
6. Satellite antenna
7. Navigation light
8. AIS GPS antenna
9. AIS VHF antenna
10. Radar reflector

Meteorological

11. Wind profile
12. Wind speed (cup anemometer)
13. Wind direction
14. Wind speed & direction (ultrasonic anemometer)
15. Solar radiation
16. Air temperature & relative humidity
17. Barometric pressure (compartment)

Oceanographic

18. Water velocity profile (moonpool)
19. Salinity & water temperature (moonpool)
20. Wave spectrum (compartment)
21. Water temperature (compartment)

Figure 1.2. Lidar buoy instrumentation schematic

Table 1.1. Lidar buoy metrological and oceanographic instruments

Sensor Type	Manufacturer	Model	Reference in Figure 1.2
Wind profiling lidar	Leosphere	Windcube 866	11
Cup anemometer	Vector Instruments	A100R	12
Wind vane	Vector Instruments	WP200	13
Ultrasonic anemometer	Gill	Windsonic	14
Pyranometer	Licor	LI-200	15
Temperature, Relative Humidity	Rotronic	MP101A	16
Barometer	RM Young	61302V	17

Sensor Type	Manufacturer	Model	Reference in Figure 1.2
Acoustic Doppler Current Profiler (ADCP)	Nortek	Signature 250	18
Conductivity, Temperature, Depth (CTD)	Seabird	SBE 37SMP-1j-2-3c	19
Directional Wave Sensor	AXYS	TRIAXYS NW III	20
Water Temperature	AXYS	YSI	21
Tilt/Compass	MicroStrain	3DM GX3 25	NA
Tilt/Compass	MicroStrain	3DM GX5 45	NA

The data acquisition system for the lidar buoys is shown in Figure 1.3. Data collection on each buoy is managed by an industrial personal computer (IPC) that integrates data collected from the two AXYS Watchman500 data loggers, Campbell Scientific data logger, and Windcube lidar. Raw data and 10-minute averaged data are stored on compact flash (CF) cards onboard the Watchman500 and Campbell Scientific data loggers. The data are transferred to shore via cellular (high-bandwidth) communications when close to shore or satellite (low bandwidth) communications. Complete data recovery requires physically exchanging the CF card during regular maintenance visits to the buoy. Each lidar buoy has extensive documentation of all of its systems, including metocean sensors, power, data collection, communications, and safety.

Each buoy is also equipped with a wind turbine, solar panels, and a diesel backup generator. The wind turbine and the solar systems provide the basic power for operations while the backup generator serves as a stop-gap source.

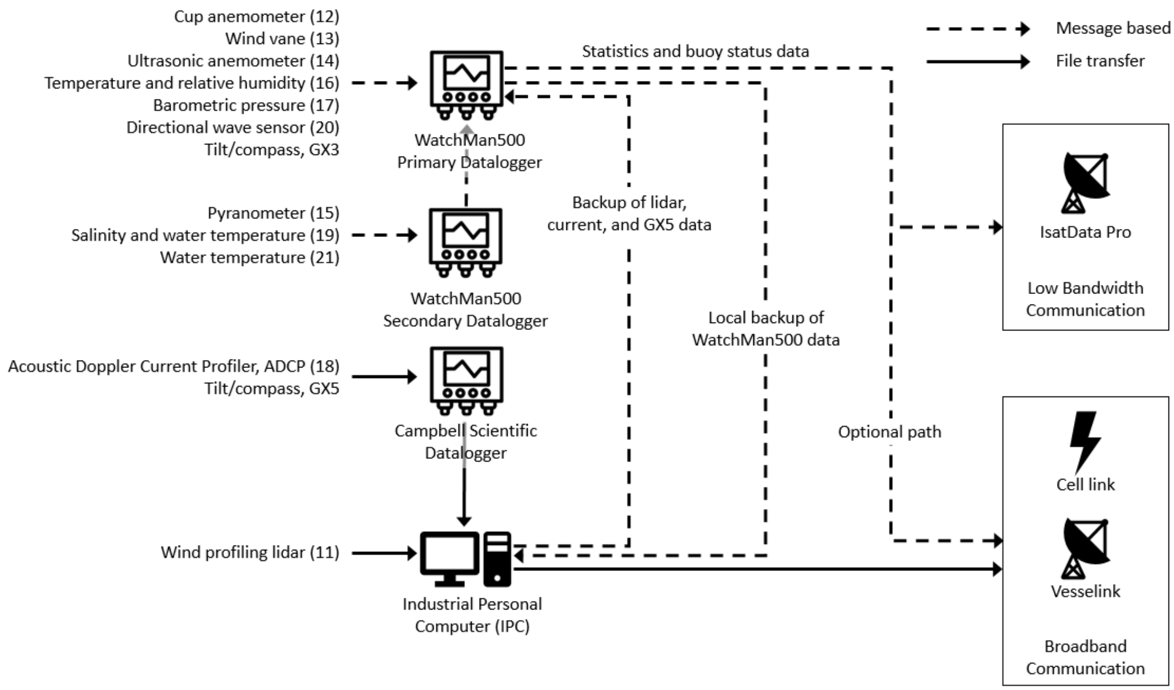


Figure 1.3. Lidar buoy data acquisition system

1.3 Lidar Validation

Verifying the readings from the lidar buoys before each deployment helps evaluate the accuracy and uncertainty of the subsequent wind resource measurements. Guidelines for validating the performance of floating lidar systems are described in two documents published by the Carbon Trust including their Roadmap for Commercial Acceptance of Floating Lidar Technology (2018) and a set of Recommended Practices for Floating Lidar Systems (2016), which was later published by the International Energy Agency (IEA) Wind (2017).

The validation process involves each lidar buoy being deployed near a trusted reference source for comparison (Carbon Trust 2018). The lidar must collect measurements across a range of wind conditions including low and high wind speeds that can be evaluated against the reference source.[1] A typical validation process can take between four and eight weeks in order to capture enough measurements across the required wind speed range.

The decision to conduct a pre- or post-deployment validation depends on the goals and use case for the lidar buoy measurements. Validation of the lidar buoy prior to a commercial wind resource assessment may be more important than validation for preliminary offshore wind speed data collection because data collected for a commercial deployment need to have a greater degree of certainty. The additional step of a pre-deployment and/or post-deployment validation will add cost and time to the overall wind speed measurement campaign and should be made at the discretion of the user.

IEA Wind (2017) recommends performing a pre-deployment validation test within 12 months prior to the deployment of a lidar buoy for a wind resource assessment. Further, the Technical Guidelines for Determination of Wind Potential and Energy Yield, published by Fördergesellschaft Windenergie und andere Erneuerbare Energien (FGW e.V., 2017), recommend that validation of a remote sensing device should occur at least every two years. IEA Wind's recommendations state that a post-deployment verification is typically unnecessary but may be appropriate if there is reasonable concern about the measurement accuracy during the deployment (IEA Wind 2018). Although not included IEA Wind recommended practices, a post-deployment validation may be the best practice following a wind resource assessment (DVN GL, personal communication, 19 Dec 2019).

1.4 Buoy Timeline

The buoys have been deployed at DOE's direction in different regions of the U.S. to collect hub-height offshore wind data in support of the U.S. offshore wind industry. The data collected by the buoys represent the first publicly available multi-seasonal hub-height data to be collected in U.S. coastal waters. The buoys consequently provide an important new opportunity to characterize the wind resource using observations in regions targeted for wind development.

Since their procurement in 2014, the buoys have been through deployments on the U.S. East Coast and West Coast and undergone several upgrades (Figure 1.4). The history of buoy deployments and upgrades are described in the following subsections.

[1] See Carbon Trust (2018) page 38 for the data coverage requirements.

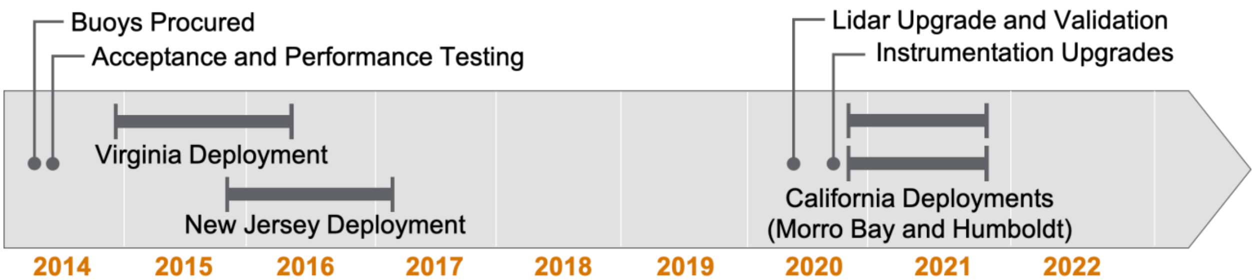


Figure 1.4. Timeline of buoy deployments and upgrades.

1.4.1 Procurement, Acceptance, and Performance Testing

Two AXYS WindSentinel™ buoys were procured in 2014 and underwent acceptance and performance testing at PNNL's MCRL, in Sequim, Washington. The goal of the performance testing was to assess the performance of all sensors, power systems, and communications links with the buoys deployed in a location representative of a real operational environment. Wind data collected from the buoys were compared to a meteorological station near the New Dungeness lighthouse (Sequim, Washington), which is operated and maintained by the New Dungeness Lighthouse Association. General sea state conditions as observed by the buoys were compared to the National Oceanographic and Atmospheric Administration New Dungeness buoy (Station 46088) in the vicinity of the deployment location.

1.4.2 East Coast Deployments

In December 2014, one buoy was deployed 42 km off the coast of Virginia. Subsequently in November 2015, the second buoy was deployed 5 km off the coast of New Jersey. Each buoy collected over a year's worth of continuous meteorological and oceanographic data on the U.S. East Coast.

Data availability from oceanographic and surface meteorological sensors at both sites was nearly 100% throughout the year with the exception of the conductivity sensor, which experienced biofouling after seven months of deployment and requires a more frequent maintenance interval (Shaw et al. 2018). Lidar measurements at lower elevations up to 110 m met the Carbon Trust's (2013) recommendation for 85% data recovery, while measurements from the highest two range gates at 130 m and 150 m elevation had lower availability due to a low signal strength at these heights (Shaw et al. 2018).

A comprehensive analysis of data collected from both buoys conducted by Shaw et al. (2020) describe the general characteristics of wind and sea state and provide detailed analysis of the buoy performance and vertical wind speed profile.

Both buoys displayed a strong dependence between the wind shear and the atmospheric stability, as indicated by the air-to-sea temperature difference (Shaw et al. 2018). The wind shear was significantly higher when the air temperature was greater than the sea temperature.

Initial analysis of wind speed data from the Virginia deployment showed an apparent maximum in the wind speed profile at 90 m height with lower wind speeds at 110 m, 130 m, and 150 m (Newsom 2016). The decrease in wind speeds at higher elevations appeared to be a negative measurement bias that was consequence of weak signal strength at upper elevations. Newsom (2016) applied stronger filtering criteria to the measurements in order to correct the bias. As a result of these findings, PNNL upgraded the lidar to a more powerful system, as described below.

1.4.3 Lidar Upgrade and Validation

In 2019, the lidar system was upgraded on both buoys to improve measurement accuracy and reliability at the upper elevation ranges of the lidar. The Vindicator III lidars used during the Virginia and New Jersey deployments were replaced with Leosphere Windcube-866 lidars on both buoys.

After installation on the buoys, the performance of the new lidar units was verified using the recommended practices described by IEA Wind (2017). The buoys were deployed offshore near Martha's Vineyard, Massachusetts for eight weeks to compare their measurements against a validated lidar system on the Air-Sea Interaction Tower, which is operated by the Woods Hole Oceanographic Institute. The independent verification reports for each buoy are available upon request.

1.4.4 Instrumentation Upgrades

Following the lidar validation campaign, the buoys underwent additional upgrades in preparation for deployments in California during 2020 and 2021. Additional upgrades included:

- The ADCPs on both buoys were upgraded from Nortek Aquadop Profilers (400 kHz; 90 m profiling range) to Nortek Signature250 Current Profilers (250 kHz; 200 m profiling range) to increase the profiling depth.
- One of the cup anemometers on each buoy was also upgraded to a Gill ultrasonic anemometer to provide a more robust complementary measurement to the remaining cup anemometer and wind vane wind sensors.
- The buoys' inertial measurement units (IMUs), Microstrain 3DM GX3 25, were replaced with new units (same model), while an additional IMU, Microstrain 3DM GX5 25, was integrated with each buoy to provide enhanced attitude and heading information to support an analysis of turbulence extracted from the lidar data.
- The buoys' data architecture was redesigned to include an IPC that integrates data collected from the two AXYS Watchman500 data loggers, Campbell Scientific data logger, and Windcube lidar (Figure 1.2).

1.4.5 West Coast Deployments

The buoys have been deployed off the California cost in partnership with BOEM from September 2020 through September 2021. One buoy was deployed within the Morro Bay Call Area offshore central California (Buoy #130) (BOEM 2018a); the other buoy was deployed within the Humboldt Call Area off the coast of northern California (Buoy #120) (BOEM 2018b). The measurements from the buoys are used to characterize the wind and oceanographic conditions near potential locations for offshore wind lease areas.

1.4.6 Future Deployments

After the buoys are recovered from the California deployments in fall 2021, the next planned deployment by DOE is anticipated to begin sometime in late 2022 or early 2023 on the East Coast.

2.0 Buoy Loan Program

2.1 Loan Program Overview

2.1.1 Loan Program Objectives

Both the wind industry and the research and development (R&D) community have indicated that the lack of wind resource data offshore is a significant barrier to the development of offshore wind energy in the U.S. DOE has made a significant investment in lidar buoys in an effort to reduce this barrier. The investment to deploy the buoys is also significant. The buoy loan program represents an opportunity for organizations with an interest in offshore wind energy and DOE to work together both to provide valuable offshore data to the community as a whole and to focus the data collection on areas of acknowledged high priority. The objectives of this program are to do the following:

- Keep the buoys mostly at sea, collecting data valuable to the wind energy industry
- Provide excellent resource characterization through multiple seasons at each deployment site
- Provide free access to all data collected by the buoys to the wind industry, research communities, and any other interested parties
- Operate the program in a way that is responsive both to industry data needs and to DOE programmatic objectives
- Structure the buoy loan program so that it is sustainable and beneficial for the lifetime of the buoys

2.2 Loan Program Framework

DOE will proactively work with interested parties to enable the loan of its lidar buoys. The loan program framework is based on the assumption that borrowing partners will deploy the buoys for approximately one year to support data collection and analysis over an annual weather cycle. Partners will assume complete responsibility for the funding, pre-deployment lidar verification, deployment logistics, maintenance, and safe retrieval of each buoy while its loan is active. Borrowers will be required to return the buoy to DOE in the same functional condition in which they received it. DOE will not provide funds to the borrowers of the buoys to support their proposed deployment.

DOE may periodically announce opportunities through a public Request for Applications. Interested qualified parties will be encouraged to prepare applications for consideration by DOE. Applications will be reviewed, scored, and the selected partner will be invited to negotiate bailment agreements for the loan.

2.3 Application Process

2.3.1 Request for Applications

Periodically DOE may initiate a Request for Applications from potential partners. The timing of subsequent solicitations will depend on the agreements negotiated in the first round; however, the anticipated duration of the agreements is expected to be a year. The solicitations will be scheduled to allow adequate time to prepare and process applications, select partners, confirm site selection, perform designs and permitting, conduct pre-deployment lidar verification, and other upfront activities.

Applicants will be required to provide a proposal that addresses three critical areas:

- Pre-qualification
- Project scope and benefit
- Buoy deployment plan

Proposals will be reviewed by the applicant selection team and graded based on the criteria described in this plan. The selected partner will be notified, and bailment negotiations will occur. If an agreement cannot be reached, the next ranked qualified applicant on the list will be engaged. Specific instructions regarding application content will be provided in the Request for Applications. The sections that follow provide a general description of information that applicants will need to provide.

2.3.2 Application Content

2.3.2.1 Pre-Qualification Requirements

PNNL anticipates that the lease-free loan of a buoy to be of significant benefit to partners with an interest in offshore wind energy. At the same time, executing a successful deployment requires substantial resources on the part of the borrower. The pre-qualification requirements represent the critical elements demonstrating sufficient resources that must be met before the application can be considered to be viable. The pre-qualification requirements are described in more detail below. If an applicant does not meet the pre-qualification requirements, the proposal will not be considered further. The following elements constitute the pre-qualification requirements:

- **Demonstration of ability to fund the full lifecycle of the project**: This implies the ability of the applicant to articulate the costs associated with critical components of the deployment including pre-deployment design and permitting; deployment, operation and maintenance, and recovery; restoration work post-deployment; and realistic contingencies for the anticipated site. Cost estimates will be credible if based on substantial comparable experience or credible consultation. The applicant will be required to demonstrate resources adequate to cover these costs.

- **Demonstration of technical ability to support operations**: The applicant must demonstrate in-house expertise and resources sufficient to execute the deployment, or alternatively, specifically identify contracting options for filling this role.

- **Agreement to share all data from the deployment**: The buoys are federally funded resources; therefore, applicants must confirm that they will share all data collected during the deployment with DOE for eventual public dissemination either directly via buoy communications or within a week following the physical recovery of data storage cards. This includes data collected from any instruments provided by the borrower. Data from native buoy instrumentation should be provided as soon as it is available. The data must be provided in a mutually agreeable standard format. Applicants may negotiate specific information management terms for business reasons as part of agreements (e.g., data in the DOE archive may be withheld from public dissemination for a reasonable and mutually agreed time following recovery of the buoy).

2.3.2.2 Project Scope and Benefit

This section of the application provides the justification for the loan. The applicant will address the following in their project proposal:

- **Objectives**: Discuss the objectives of the deployment and why the data are needed. The application should state how the data will advance the development of U.S. offshore wind energy and how the deployment supports the National Offshore Wind Strategy.

- **Description of Proposed Deployment Site**: Provide information describing the proposed deployment location, duration, and how the information supports the stated objectives. The applicant should also note any synergies with other resource characterization efforts.

- **Technical Discussion**: Provide a detailed description of how the data will be used, noting technical problems to be addressed and providing details of how they plan to use the buoy data to address these.

- **Technical and Logistical Qualifications**: Provide evidence of the applicant team's technical experience and ability to effectively use the data as well as evidence of the ability to manage the logistics of deployment.

- **Dissemination of Results**: Description of how the borrower will disseminate the results of the use of the buoy data for the benefit of the offshore wind energy community.

2.3.2.3 Buoy Deployment Plan

The Buoy Deployment Plan submittal is the applicant's opportunity to demonstrate completeness of understanding of the scope, risks, logistics, and requirements of a buoy deployment. The plan shall cover the following topics in detail:

- Partner organization and stakeholders
- Site selection
    - Selection criteria
    - Permitting requirements and strategy
    - Mooring design process
- Buoy communications systems setup and operation
- Deployment logistics
    - Pre-deployment lidar verification plan
    - Elements of deployment staff and contractor responsibilities
    - Monitoring of buoy health
    - Maintenance approach
    - Retrieval, repair, and turnover to DOE
    - Health and Safety
- Data management plan
    - Data acquisition
    - Security
    - Analysis
    - Dissemination to DOE and PNNL
- Emergency response plan
- Project management plan
    - Project organization
    - Work breakdown structure
    - Schedule

    - Budget
    - Reporting

- Other issues specific to this proposed deployment

The subject plan shall also include relevant assumptions and technical bases to demonstrate understanding of the scope and support budget and schedule estimates.

The applicant should expect to revise the Buoy Deployment Plan if selected pending bailment agreement and review and comment by stakeholders. The final revised plan may be required to close out bailment negotiations.

2.4 Partner Selection Criteria

Consistent with buoy loan objectives, the loan program will be managed so that is responsive both to the wind industry and DOE programmatic objectives. DOE will retain discretion in the selection of partners. In addition to programmatic needs, partners will be selected according to the qualifications and criteria described below. Proposals to use the buoys should directly address the following criteria and will be evaluated and ranked on that basis.

2.4.1 Pre-Qualification Criteria

Borrower applications shall include a confirmation and rational basis for meeting the pre-qualification criteria. If these criteria are not met, the application will not be considered further. The pre-qualification criteria are:

- Demonstration of ability to fund full lifecycle of project including:
    - Pre-deployment design and permitting
    - Deployment, operations and maintenance throughout the deployment
    - Restoration of buoy to full functionality after deployment as defined by a reference checklist to be provided with the Request for Application
- Contingency proportional to risks (unless otherwise noted assume minimum of 20% of total project cost)
- Demonstration of technical ability to support operations
- Confirmation of willingness to share all data from the deployment (regardless of originating instrument) in a format readily discernable to DOE and public users
    - If needed, data collected on the buoy can be embargoed for a mutually agreed period; however, they must ultimately be made public
    - Derivative data from privately funded analysis of the observations collected on the buoy do not need to be made public or provided to the archive

Once the pre-qualification criteria are confirmed to be met, the source selection team will review and consider the proposals based on the following application criteria. If the applicant cannot meet all the basic entrance criteria, the application is not evaluated further.

2.4.2 Application Criteria

2.4.2.1 Qualifications of Applicant

- Adequacy of applicant's Deployment Plan
  - Completeness of plan
  - Site selection relative to DOE objectives
  - Sound permitting strategy, including realistic timelines
  - Plans to actively monitor, operate, and maintain the buoy
  - Data management: plans to provide timely and safe transfer of all data, including those on the physically retrieved CF cards, to the DOE archive (via PNNL)
  - Resource, contract, and staffing plans to perform scope of work: demonstrate ability to provide necessary resources
- Experience
  - Qualifications of technical science team
  - Subcontracting experience and capabilities
  - Qualifications of deployment, operations, maintenance, and logistics teams

2.4.2.2 Technical Value

- Compatibility with DOE R&D objectives
  - Degree to which proposed use and analysis supports the aims of the Wind Program's Wind Vision and the National Offshore Wind Strategy
  - Degree to which the proposed deployment site is relevant to offshore wind energy development
  - Degree to which the proposed deployment fills significant data gaps
- Mix of research and resource assessment
  - Degree to which the proposed use addresses technical metocean issues as well as providing essential developer data
- Plans for sharing technical results. DOE places value on providing information to the public.
  - Plan and mechanisms for informing the public

- Plan and mechanisms for informing industry and the research community

2.4.2.3 Timelines

- Interest and ability to deploy for a full year or more in the same location. DOE will consider other deployment durations as long as there is compelling justification consistent with DOE objectives.

- Flexibility relative to DOE timelines and priorities

2.5 Partner Selection

Each application that is considered responsive (i.e., meets minimum pre-qualification criteria) will be considered by a partner selection team composed of the following individuals:

- Program Manager, DOE Wind Energy Technologies Office
- Offshore Wind Team Lead, DOE Wind Energy Technologies Office
- Buoy Deployment Project Manager, PNNL
- Buoy Deployment Principal Investigator, PNNL
- Contracts Representative, PNNL

The selection team will work to build consensus; however, the DOE program manager will have the final selection authority. The selection team will evaluate (score and weight) each application based on the effectiveness in meeting DOE programmatic objectives as described above.

3.0 Implementation

3.1 Work Breakdown Structure for Buoy Loan Management

The following sections describe the structure for PNNL's management of the buoy loan program.

3.1.1 Near-Term Buoy Deployment Program Scope

Near-term scope is aligned with completing the buoy deployments off California in partnership with BOEM. Near-term work scope is organized according to the following categories:

- Buoy #120 (deployed in Humboldt Call Area beginning September 2020)
    - Complete one-year deployment
    - Monitor buoy status
    - Collect and disseminate near-real-time data
    - Recover raw data from CF cards during maintenance visits
    - Recover buoy to shore and secure
    - Inspect and repair. Make ready and fully functional to support next deployment and transition to third party.
- Buoy #130 (deployed in Morro Bay Call Area beginning September 2020)
    - Complete one-year deployment
    - Monitor buoy status
    - Collect and disseminate near-real-time data
    - Recover raw data from CF cards during maintenance visits
    - Recover buoy to shore and secure
    - Inspect and repair. Make ready and fully functional to support next deployment and transition to third party.

3.1.2 Long-Term Buoy Deployment Program Scope

Long-term scope is aligned with overseeing the buoy deployment lifecycle for both buoys (#120 and #130). This includes facilitating the initial transition and deployments under the loan program; oversight of operations, maintenance, and data acquisition; pre-planning and contracting to support seamless transition to new partners; oversight of retrieval and maintenance, and transition to follow-on partners. The longer-term work scope is organized according to the following categories for each buoy:

- Pre-deployment preparation (borrower)
- Buoy deployment (borrower)
- Deployment oversight and data support (PNNL)
- Preparation for next deployment: solicitation and review of applications, partner selection, negotiations, final agreement (PNNL)

3.2 Critical Schedule Considerations

Figure 3.1 represents a notional schedule from 2020 through 2023. The near-term schedule depends on buoy recovery and repair schedule after the California deployments and DOE's future plans for use. The duration of repairs is estimated based on assumed replacement part lead times.

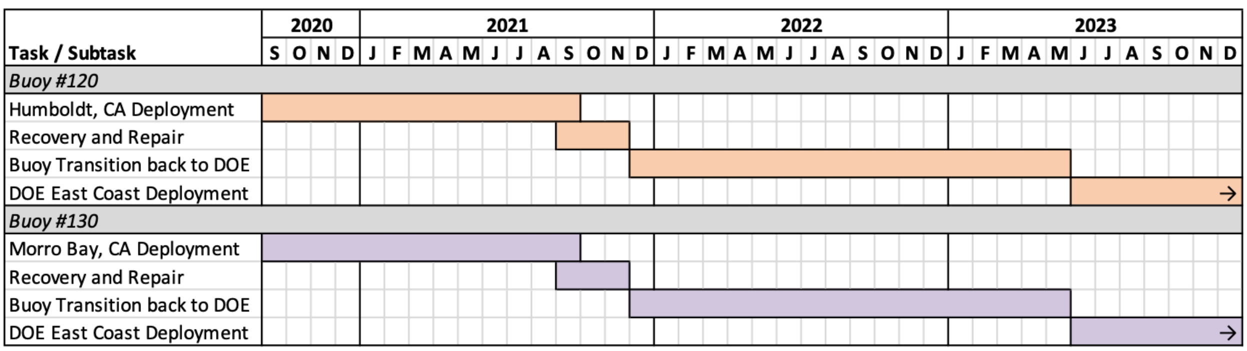


Figure 3.1. Notional schedule for buoys through 2023, subject to change

It is acknowledged that buoys are easier to deploy in fair weather which typically aligns with the spring and summer, depending on location. The target duration of one year on station makes it difficult to cycle through deployments such that all installation activities are within this window. After each deployment the buoy will require inspection, repair, and maintenance funded by the borrowing entity. In addition, the buoy will be transitioned to the new borrower and transported to the new location where it will be staged and deployed. This transition time between deployments may range between one and four months depending on circumstances. This uncertainty will be managed during the bailment negotiations for each buoy. Each deployment negotiation will include an assessment of optimal timing to sustain efficient deployment and transition to future users.

3.2.1 Bailment Agreement

A bailment agreement will be used as the contract mechanism to document agreement with the partners. Under the bailment agreement, the partner (i.e. bailee) will agree to serve as primary caretaker of the buoy for the duration of the agreement and will agree to manage, operate, and maintain the buoy per manufacturer requirements. The agreement will also spell out liability and insurance commitments. Specific requirements will be clearly defined in the Request for Application.

A statement of work will be issued with the Request for Application. The candidate partner applications will be required to describe how the buoy will be managed to meet statement of work requirements.

3.2.2 Transition of Buoy to Partner

A system checklist will be used to document the transition of the buoy from one entity to another. The transition process will include verifying the condition and operability of the buoy prior to turn over. The receiving organization will review documentation and perform inspections to verify the as delivered condition. Once the checklist is filled out, all parties will sign off to indicate the completion of the transition. Mutually agreeable action items may be identified and managed by one or both parties. PNNL will facilitate the transition process on DOE's behalf.

3.2.3 Deployment Preparation

The partner selected will prepare for deployment by completing site selection activities, preparing designs, and seeking permits. PNNL subject matter experts may be called upon to review partner submittals during this period. PNNL may also participate in inspections and readiness reviews if called out by the statement of work.

3.2.4 Pre-Deployment Lidar Validation

A pre-deployment validation ensures that the floating lidar system making accurate measurements. IEA Wind (2017) recommends performing a pre-deployment validation test of the floating lidar system within the 12-months prior to deployment for wind resource assessments. Validation testing involves deployment of the buoy for four to eight weeks near a trusted reference system to compare the measurement accuracy (IEA Wind 2018).

The choice to conduct a pre-deployment validation is made at the discretion of the partner depending on their use case and requirements. The partner is responsible for the logistics and costs of pre-deployment lidar validation testing. If the partner plans to perform a pre-deployment lidar validation, the timeline and costs must be reasonable included in their application. In addition, the results of the validation become part of the publicly available data record for the borrowed buoy.

3.2.5 Deployment, Operations, and Maintenance

The deployment, daily operations, and maintenance will be performed by the partner in accordance with the statement of work, permits, and manufacturer documentation. The bailment agreement (and supporting documents such as a statement of work) will also include specific requirements for operations and maintenance.

3.2.6 Monthly Monitoring and Reporting

The statement of work will include requirements for partners to provide monthly reports on buoy status and system health. The statement of work will also include provisions for emergency response.

3.2.7 Data and Information Sharing

The collection and dissemination of buoy data for the benefit of the public and industry is critical to the program. Data will be made available for use through the following mechanisms:

- PNNL will implement and confirm data collection configuration of buoys prior to deployment
- The system will be configured to save raw 1-second data to the onboard CF cards. These CF cards will be recovered by the buoy loan partner on a 6-month basis (typically performed as part of the 6- month maintenance interval).
- PNNL will work with partners to post all data online through the DOE's Data Archive and Portal for public access

3.2.8 End-of-Deployment Maintenance and Repair

At deployment completion, the selected partner will repair and restore the buoy to fully functional condition as verified by an acceptance checklist reviewed and signed off on by PNNL and the bailee. The beginning and end transitions will be managed through inspection and review and will be documented on a checklist. It is anticipated that the partner in possession of the buoy will be required to perform repairs to restore the buoy to fully functional condition after the deployment. Options for this repair will be negotiated with the bailment agreement; however, the responsibility for the repair costs will reside with the partner.

Ideally, the transition from one user to the next can be implemented seamlessly without intermediate custody. In certain circumstances, it may be necessary for PNNL to take possession of the buoy between campaigns.

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