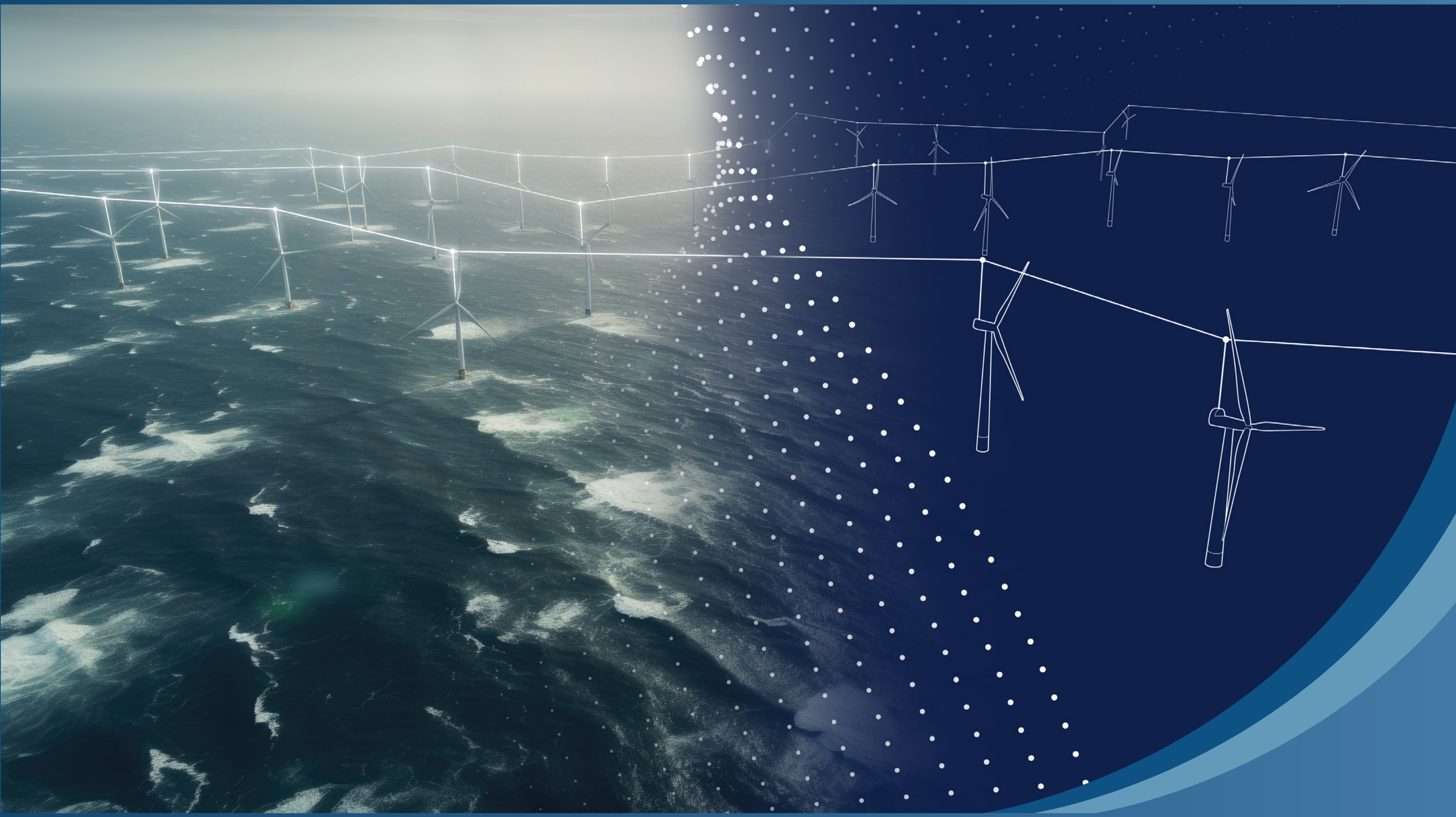
Metocean Measurement Data Management Analysis



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NEW YORK STATE | NYSERDA New York State Energy Research and Development Authority

NYSERDA's Promise to New Yorkers:

NYSERDA provides resources, expertise, and objective information so New Yorkers can make confident, informed energy decisions.

Our Vision:

New York is a global climate leader building a healthier future with thriving communities; homes and businesses powered by clean energy; and economic opportunities accessible to all New Yorkers.

Our Mission:

Advance clean energy innovation and investments to combat climate change, improving the health, resiliency, and prosperity of New Yorkers and delivering benefits equitably to all.

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Metocean Measurement Data Management and Analysis

Summary Report

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Notice

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Abstract

This report, prepared by DNV Energy USA, Inc. for the New York State Energy Research and Development Authority (NYSERDA), discusses a comprehensive metocean data collection campaign carried out in the New York Bight. The campaign involved deploying two floating lidar systems (FLS) to gather high-quality wind and wave data crucial for offshore wind project development. The collected data, spanning over two years, provided valuable insights into the wind resource potential and wave conditions in the region. This information significantly reduced the uncertainty for project developers, aiding in the planning and design of offshore wind farms. This report details the deployment process, data analysis, and the impact of the findings on the offshore wind industry, highlighting the importance of accurate metocean data in reducing project risks and supporting the responsible development of renewable energy resources. The net capacity factors estimated from the data are 48.9% for the Hudson Central area and 48.3% for the Hudson South area

Keywords

Metocean data, offshore wind, floating LiDAR, FLS, wind resource assessment, New York Bight, renewable energy, wind speed measurement, wave data, offshore wind development, NYSERDA, wind energy analysis, environmental monitoring, data management, wind turbine siting, and energy production estimation.

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Acronyms and Abbreviations

BOEM	Bureau of Ocean Energy Management
DNV	DNV Energy USA, Inc.
FLS	floating lidar system
IEA	International Energy Agency
kWh/year	kilowatt-hour per year
m	meter
m/s	meter per second
MW	megawatt
Narec	National Renewable Energy Centre
NOAA	National Oceanic and Atmospheric Administration
NOAH	Narec Offshore Anemometry Hub
OTS	Ocean Tech Services
OWA	Offshore Wind Accelerator
TGS	Tomlinson Geophysical Services Inc.

Background

Installing an offshore wind project follows years of assessment, analysis, design, and planning. The initial vision for the project evolves as developers acquire more information, gain a better understanding of site-specific factors, and as technologies and capabilities advance.

A critical part of the development process involves obtaining detailed knowledge of meteorological and oceanographic conditions, collectively called "metocean" conditions. This information is essential for the safe and efficient design and operation of offshore wind projects. Enhanced metocean characterization of the wind and wave environment increases design certainty, allowing for the refinement of critical project features such as layouts and component dimensions.

New York State is working diligently to develop offshore wind power responsibly and cost-effectively. Offshore wind is poised to become a significant source of renewable power for New York State, particularly on Long Island and in the New York City metropolitan area, where electric grid demand is greatest. To facilitate this progress, the New York State Energy Research and Development Authority (NYSERDA) contracted Ocean Tech Services (OTS) through competitive solicitation to supply and deploy two floating light detection and ranging buoys, known as floating lidars, in the New York Bight during the summer of 2019. DNV Energy USA, Inc. (DNV), was contracted to manage and analyze the collected data and to make it available to the public and all interested in offshore wind.[1]

1 What Was Done and Why

For all renewable energy projects, understanding the amount of the particular renewable resource at a specific location is crucial. The amount of renewable resources available at the site will determine how much energy the project could produce over its lifetime and facilitate assessment of the location's commercial viability.

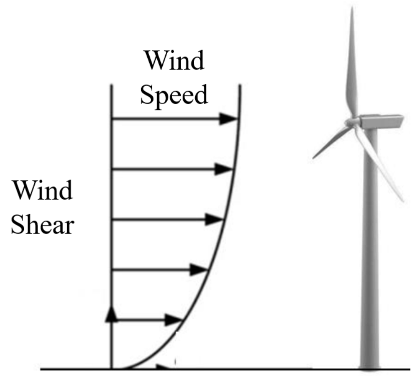
Various forms of instrumentation are deployed to measure quantities such as wind speed, solar irradiance, and other climatological conditions impacting energy production. Combined with long-term datasets, these measurements help determine the site's potential resource. While extensive oceanographic data are available through the National Oceanic and Atmospheric Administration's (NOAA) National Data Buoy Program, these measurements, collected near the ocean surface (approximately 3 meters [m] above sea level), do not reflect the wind speeds at the height of an offshore wind turbine. Although methodologies exist to estimate hub-height winds from near-surface measurements, they lack the accuracy energy project developers or financiers need to make an investment decision.

A unique aspect of offshore wind development in the U.S. is that potential locations fall under the authority of the Bureau of Ocean Energy Management (BOEM) under the U.S. Department of the Interior. Therefore, developers cannot privately purchase or lease land to collect such data as they would onshore. Furthermore, deploying oceanographic equipment incurs significant costs and requires years to collect data, both of which pose barriers for project developers seeking to acquire a lease. To address these significant barriers, NYSERDA deployed two floating lidars in the BOEM's New York Bight call areas to reduce project risk before the BOEM lease sale in 2022.

1.1 Existing In-Situ Meteorological Data Sources Are Insufficient

Accurate and precise wind farm energy analyses require high-quality data. Although wind speed models and data from oceanographic buoys near the New York Bight exist, in situ measurements provide projects with the most reliable risk reduction. NOAA's oceanographic buoys measure wind speed 3 m above the sea surface, whereas turbine blades operate over 200 m above sea level. Wind speed typically increases the further it is above the sea surface, which is called wind shear. Because of the inconsistent wind shear, accurate speed measurements close to the turbine's hub height and covering as much of the rotor's swept area as possible are essential. While onshore wind sites use meteorological towers with instruments at various heights, designing, building, permitting, and installing a fixed meteorological tower offshore is costly and time-consuming.

Figure 1. Wind Shear

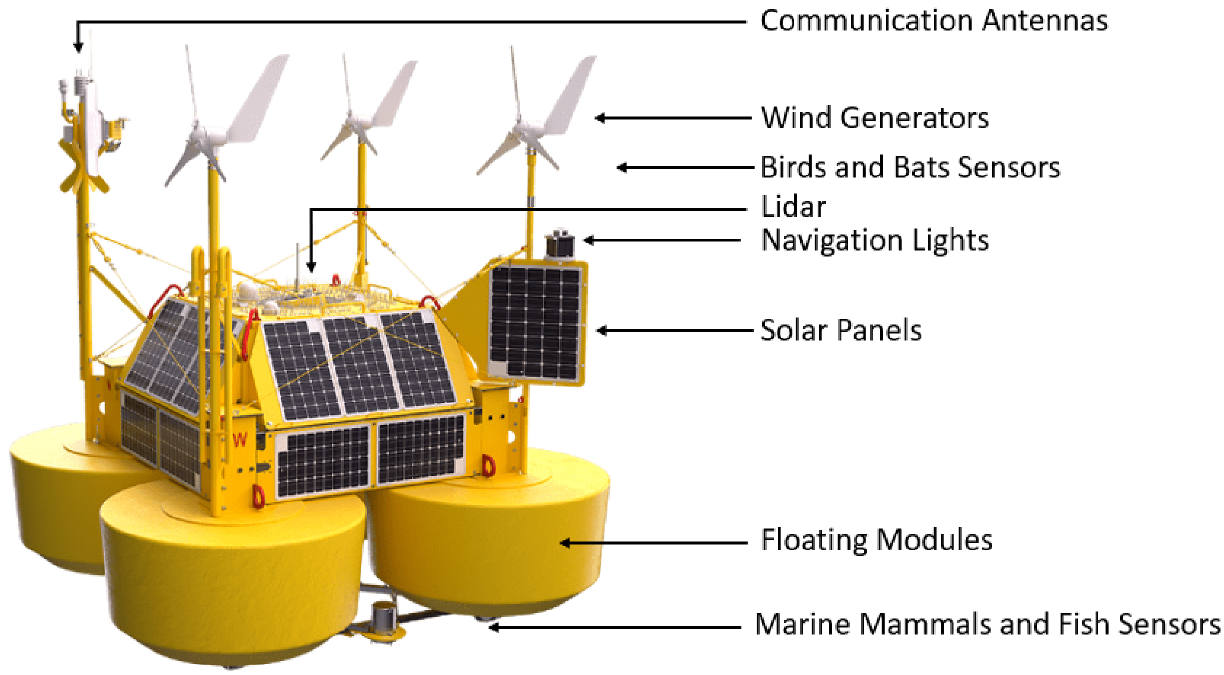


Over the past decade, the offshore wind industry has increasingly deployed floating lidar systems (FLSs) for data collection. The buoy, equipped with various sensors and measurement devices, uses lidar technology to capture wind speed data. The lidar emits a laser pulse, and the returning signals allow for calculating wind speed and direction at various heights above the device. The measurements extend up to 200 m high, reaching the hub height of an offshore wind turbine and covering a significant portion of the turbine's rotor-swept area.

An FLS offers the advantage of mobility, allowing it to be repositioned to achieve more spatial resolution in the data collection. Additionally, the buoy can accommodate extra metocean and environmental sensors, which capture site data necessary for designing and operating offshore wind projects. Various FLS units have undergone testing and calibration against fixed offshore meteorological towers in Europe to ensure reliability. Calibration and acceptance testing have confirmed that FLS units produce satisfactory wind speed data that meets "investment grade" standards.

For the NYSERDA New York Bight data campaign, the team deployed the EOLOS FLS-200 buoy. This buoy is outfitted with solar panels and small wind turbines to power the instrumentation and the communications system, enabling real-time data transmission to a data hub. Figure 1 illustrates the buoy's configuration and sensors.

Figure 2. EOLOS FLS-200—Floating Lidar System Deployed in the New York Bight



1.2 NYSERDA’s Floating Lidar, First High-Quality Dataset Available in U.S. Prelease Auction

One unique aspect of offshore wind development in the U.S. involves BOEM determining the ocean spaces suitable for offshore wind projects. Identifying and determining areas spans several years and requires extensive coordination and collaboration with states, federal agencies, and significant formal stakeholder engagement and feedback. After the area identification process is concluded, BOEM holds an auction for the lease areas. Securing a lease does not grant immediate rights to start constructing an offshore wind project; however, it allows the lessee to begin site evaluation and the permitting processes.

In contrast, other international markets may have a leasing body that initiates site characterization activities, such as deploying FLS buoys or conducting geophysical and geotechnical data campaigns. This approach gives energy project developers some assurance of a site’s commercial viability, a step not part of the U.S. leasing process. NYSERDA identified this gap and the lack of data as a significant barrier to developing the New York Bight and subsequently addressed the data gap.

1.3 Length of Campaign and Location of Deployments

In August and September 2019, after BOEM identified draft Wind Energy Areas, OTS, under contract with NYSERDA, deployed two EOLOS FLS-200 buoys in the New York Bight. Each buoy's intended campaign length was at least two years to capture seasonal variability. Before deployment, an independent assessment ensured that the buoys complied with the criteria outlined in the most recent Offshore Wind Accelerator (OWA) Roadmap for floating lidar technology, ver. 2,[2] the OWA Recommended Practices for Floating Lidar Systems,[3] and the International Energy Agency (IEA) Expert Group Report on Recommended Practices on FLS.[4] Following commissioning, acceptance testing occurred off the coast of the United Kingdom at the National Renewable Energy Centre (Narec) Offshore Anemometry Hub (NOAH) Offshore Met Tower. After shipment to the U.S., the buoys underwent final port acceptance tests in Avalon, NJ.

In September 2021, FLS E05, installed in the Hudson North Wind Energy Area, completed two full years of measurement. The buoy was returned to shore for maintenance and then redeployed for an additional year of measurement in the western part of the Hudson South Wind Energy Area (see Figure 3 for locations). This extended measurement campaign started in January 2022 and concluded in January 2023. In March 2022, FLS buoy E06, installed in the Hudson South Wind Energy Area, also completed two full years of measurement. In each case, the challenging offshore environment led to some equipment downtime, extending the data collection period. The FLS transmitted metocean data in near real-time, and all historical datasets are publicly available.[5]

Table 1. Floating Lidar System Deployment Timeframes

Buoy Reference	Deployment Name	Measurement Period
E05_N	Hudson North	August 2019 to September 2021
E06_S	Hudson South	September 2019 to March 2022
E05_SW	Hudson South Extension	January 2022 to January 2023

Figure 3. Deployment Locations

The grey and outlined areas represent the BOEM Offshore Wind Lease Areas

The FLS also offer a convenient platform for additional sensors to collect and record wildlife data. The environmental sensor package includes passive acoustic microphones for detecting vocalizations by birds and bats, nanotag receivers for tracking tagged birds and fish, and hydrophones for detecting vocalizations by marine mammals. Normandeau Associates conducts the wildlife data analysis, and their REMOTE data platform provides additional information, including the wildlife data itself.[6]

2 Lessons Learned and Impact

A strong knowledge of metocean conditions is essential for safe and efficient design and operation of offshore wind installations. Uncertainty in physical conditions increases development risk and offtake bid prices. Metocean characterization of the wind, wave, and ocean current environment enhances the certainty of development conditions. This information aids in planning activities such as refining project layout and turbine siting and key variables in lease auctions and offtakes. Therefore, an accurate forecast of wind speeds at a potential site is critical for assessing a location's viability.

2.1 Summary of the New York Bight Wind Resource

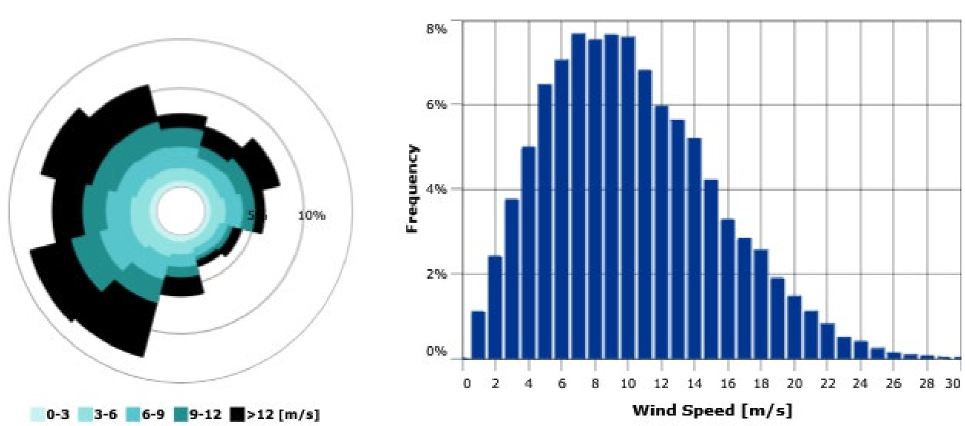
Historically, onshore wind power projects consider a 7-meter per second (m/s) average annual wind speed as the minimum for economic feasibility. Onshore sites with wind speeds of 8 m/s to 9 m/s represent excellent opportunities, while speeds above 9 m/s, although rare, are considered exceptional.

Data from the FLS collected in the New York Bight reveal a robust offshore wind resource, with average annual wind speeds of 10 m/s or at anticipated turbine hub heights of 140 m or more. This wind resource (the equivalent of fuel to an offshore wind project) positions the New York Bight as a top contender along the U.S. Atlantic coast.

Table 2. Wind Resource Summary

Area	140 m Wind Speed [m/s]	155 m Wind Speed [m/s]	165 m Wind Speed [m/s]
Hudson Central	10.1	10.2	10.3
Hudson South	10.0	10.1	10.2

Figure 4. Wind Resource Summary



2.2 Turning the Wind into Electricity

Estimating electricity production from a wind speed forecast requires data analysis, calculations, and a combination of assumptions and industry experience. A critical component of this energy assessment work is the turbine power curve, which indicates the amount of power a specific turbine model is expected to produce at various wind speeds. Most turbines generate electricity at wind speeds ranging from 3 m/s to 25 m/s.

Analysts derive a gross energy estimate by comparing the wind resource data with the turbine power curve. "Gross" refers to a theoretical ideal condition without considering outside impacts. Analysts must factor in external environmental conditions, mechanical and electrical losses inherent in the design, and other nonideal phenomena to determine a net energy estimate.

Using the wind resource data collected by the FLS, DNV estimated the potential electricity production for a theoretical offshore wind project at two locations in the New York Bight.

Table 3. Energy Production Estimation

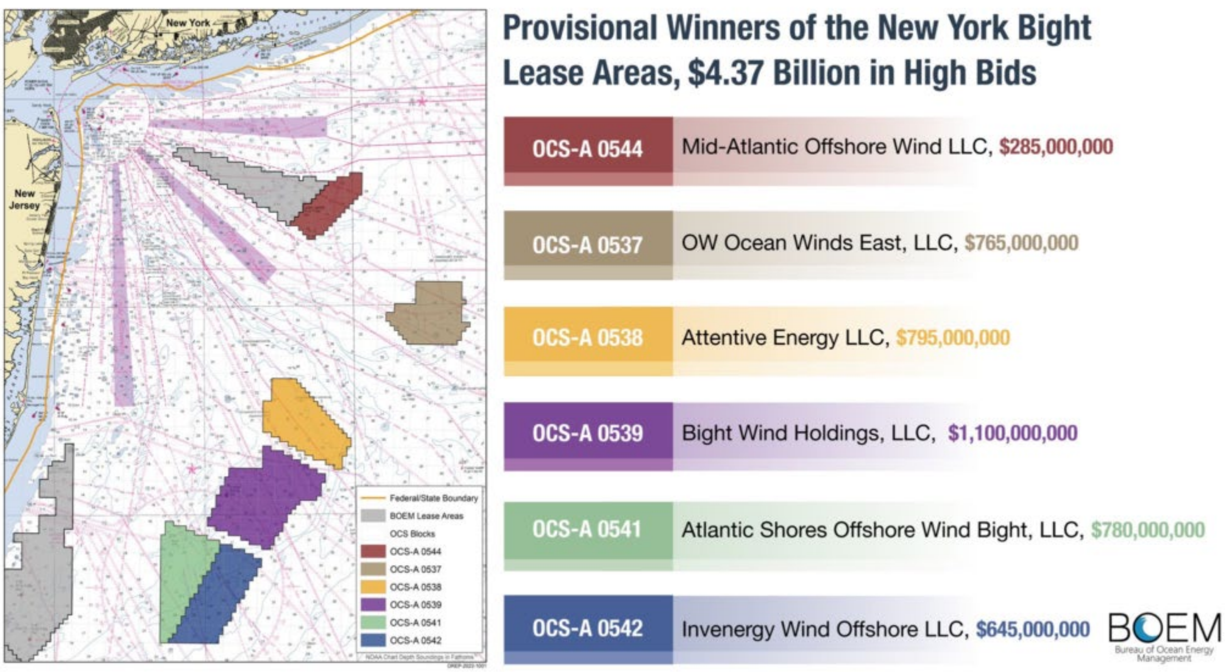
Area	measure	Units	Single 14 MW Turbine	Generic Windfarm: (62) 14 MW Turbines
Hudson Central	Gross energy	GWh/yr	71.6	4,438
	Net energy	GWh/yr	60.0	3,723
	Equivalent NY households		8,350	518,000
Hudson South	Gross energy	GWh/yr	70.7	4,384
	Net energy	GWh/yr	59.3	3,675
	Equivalent NY households		8,250	511,000

In addition to the wind resource information, the FLS also collected wave height data, which is crucial for designing an offshore wind project, particularly the turbine and substation foundations. The wave data did not reveal significant concerns for development.

2.3 How Project Developers Used These Results

On February 23, 2022, the auction for six New York Bight offshore wind lease areas began. This auction was the most competitive offshore wind lease auction in the U.S., featuring the highest number of bidders and lease prices. The two-day auction set a record as the highest-grossing competitive offshore energy lease sale in history, surpassing even oil and gas lease sales. Project developers acquired the six New York Bight offshore wind lease areas for $4.37 billion.

Figure 5. Provisional Winners of the New York Bight Lease Areas



Securing a lease does not grant the lessee the right to start constructing an offshore wind project immediately; instead, it allows only the beginning of a site evaluation and the permitting processes. Therefore, obtaining a lease involves a degree of uncertainty because no guarantee exists that the project will be approved for construction or prove commercially viable. The data NYSERDA's FLSs collected provided auction bidders with significant certainty regarding the wind resource of the New York Bight lease areas and the corresponding potential for electricity production. This certainty is crucial for assessing the overall commercial viability of a project site. Without this wind resource certainty, the auctions might not have attracted so much interest from potential developers.

"The NYSERDA FLS datasets were an important factor in Avangrid's preauction assessment of New York Bight lease areas. The high quality of data allowed for the validation of our internal modeling, significantly reducing our level of uncertainty regarding the region."

— Lou Bowers, Lead Meteorologist, Avangrid

2.4 How the Industry Is Building on Lessons Learned

BOEM continues to plan for future offshore wind lease auctions along the Atlantic and Pacific coasts and in the Gulf of Mexico. These regions face a similar metocean data gap. No other state agency or regulator has replicated NYSERDA's success with FLSs. However, the private company Tomlinson Geophysical Services Inc. (TGS) has introduced "…a multi-client business model to the industry for offshore measurement campaigns, specifically for deploying floating lidar buoys. This model ensures that the cost of acquiring measurements is greatly reduced and makes critical wind and metocean measurements available much earlier in the development process, often well before lease round auctions."

Greg Lampman, who led NYSERDA's FLS initiative, comments on the importance of publicly available data to de-risk offshore wind development:

> The responsible and cost-effective development of a new industry, like offshore wind, requires innovative thinking that maximizes opportunities to better understand our ocean environment. Collectively, we have a chance to build transparency and data-sharing into the foundation of offshore wind development in the U.S. New York State['s] taking the opportunity to deploy a metocean platform to collect and share not just meteorological and oceanographic information, but wildlife data as well, sets an example for others to follow. It reduces costs, improves understanding of our ocean environment, and empowers stakeholders, resulting in better outcomes for everyone.

2.5 Where Can Those Interested Find the Data and Reports

The raw data collected and DNV's energy assessment and analysis have been made publicly available online. This data is valuable for academics, research institutes, industry professionals, and the general public.[7]

Endnotes

[1] DNV, 2024, Resource Panorama Public Data, Website, accessed June 2024. https://oswbuoysny.resourcepanorama.dnv.com/overview

[2] Carbon Trust. 2018. “OWA Roadmap for the Commercial Acceptance of Floating LiDAR Technology,” ver. 2, October.

[3] Carbon Trust. 2016. “OWA-Recommended Practices for Floating Lidar Systems.” Issue 1.0, October.

[4] International Energy Agency (IEA) Wind. 2017. “Expert Group Report on Recommended Practices, 18. Floating Lidar Systems, First Edition.”

[5] DNV, 2024, Resource Panorama Public Data, Website, accessed June 2024. https://oswbuoysny.resourcepanorama.dnv.com

[6] Normandeau Associates. 2021. "Data prepared for New York State Energy Research and Development Authority. Metocean Buoy Wildlife Sensors Deployed in Support of Offshore Wind Energy." https://remote.normandeau.com/nys_buoy_overview.php

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