Preparing for a Wind Revolution

Integrated Site Characterization Reduces Project Risk

By Andrew Cooper • Elena Starchenko

The United States is primed for an offshore wind energy boom. Falling costs, technology advancements and state policies are driving investments in this burgeoning industry all along the Eastern Seaboard. While the Block Island Wind Farm in Rhode Island is the only U.S. wind farm in operation today, 15 active offshore wind leases in various stages of development promise to provide more than 25 GW of clean, renewable energy to Atlantic coastal states over the next couple of decades.

In addition to offshore oil and gas projects, the Bureau of Ocean Energy Management (BOEM) is responsible for overseeing offshore wind lease activities in federal waters. A fundamental piece of that oversight is site characterization, which details surface and subsurface conditions to help identify and mitigate potential geohazards in the lease area, and inform the design, construction and installation of wind turbine foundations, cabling and related infrastructure.

Drawing on nearly 40 years of delivering site characterization services to BOEM standards in support of oil and gas development, Fugro has, for the last 11 years, provided similar services to offshore wind farm customers in support of their development activities. Along the way, the company has acquired regional expertise on the Atlantic Outer Continental Shelf (OCS), while implementing technology innovations and process improvements designed to increase safety, reduce carbon footprint and accelerate project schedules.

Geophysical Data for Engineering Insights And Hazards Identification

The Atlantic OCS is described by BOEM as a “frontier region,” due to the lack of knowledge regarding the area’s geologic makeup compared to mature development areas such as the Gulf of Mexico. This absence of information makes geophysical campaigns critically important to the engineering phase of projects, providing information about site conditions, geologic constraints and geohazards. Standard data sets collected include bathymetry, side scan sonar, high-resolution seismic and magnetometry. Traditionally, bathymetry data are acquired using high-resolution multibeam echosounder systems from a
geophysical survey vessel. The resulting water depth and seafloor elevation data are used to inform a wide range of design parameters, such as structure height; seabed conditions, such as sand waves; and geohazards and anthropogenic hazards, such as boulders and shipwrecks. To augment vessel-based data collection, Fugro has developed two specialized platforms: Fugro RAMMS (Rapid Airborne Multibeam Mapping System) and the FAS-900 (Fugro Autonomous Surveyor 900).

RAMMS is a next-generation airborne LiDAR mapping system that delivers industry-leading depth penetration and point densities for fast and accurate bathymetry in nearshore and coastal waters. Lightweight and compact, the system can operate either from small aircraft of opportunity or uncrewed aerial vehicles. The FAS-900 is an uncrewed surface vessel that can collect multibeam echosounder data in full autonomy, semi-autonomy, or by remote control in offshore and coastal waters. In addition to improving data collection rates, these systems help improve project safety and sustainability by limiting the number of crew needed in the field and significantly reducing fuel demands.

For additional insight into seafloor conditions and potential hazards, Fugro relies on side scan sonar technology. Acquired by geophysical vessel, side scan sonar generates an acoustic picture of the seafloor by measuring the amplitude of the backscattered return signals. The collected data are rendered to provide a photo-like image of the seafloor, which can be used to identify sediment type, hard-bottom areas, rock outcrops and boulder zones. This latter feature is particularly important in the North Atlantic, where boulders abound as the result of past glacial processes.

To improve the accuracy and efficiency of boulder zone mapping, Fugro is applying a machine-learning solution for side scan sonar data interpretation. The method identifies boulders, maps their footprints, and determines length, width and height. This approach improves accuracy and efficiency, and effectively maps targets in boulder zones. A boulder data set is created that provides a quantifiable means of determining boulder population densities that can be highly valuable in cable routing, assessing the probability of encountering boulders during cable installation, foundation installation or leg penetration of installation vessels.

Shallow penetrating seismic technology is used to further characterize the seafloor, imaging the shallow subsurface to inform activities such as foundation design and cable burial. Fugro has developed a proprietary method for using 2D and 3D seismic to perform subsurface boulder mapping. The approach relies on plane wave disruption theory to isolate, map and characterize seismic diffractions in the subsurface to identify higher and lower risk areas within the survey area for siting wind turbines and scoping the geotechnical site investigation.

Boulders are not the only concern when it comes to mapping lease areas in the Atlantic. Unexploded ordnance (UXO) is a major concern in the Atlantic, which was a munitions dumping ground along the East Coast until 1972. To identify these hazards, Fugro is using its Geowing system, which can detect even low-ferrous UXO items in challenging marine environments. The system collects high-resolution magnetic data using a two-row configuration that allows the data to be analyzed as gradiometer, which has proven superior to traditional magnetometer methods. The Geowing identifies other ferrous objects in addition to UXO, including abandoned ships, pipelines and other marine debris.

**Geotechnical Data for Safe, Cost-Effective Design**

After conducting geophysical surveys for offshore wind, Fugro performs preliminary geotechnical site investigations to ground-truth the developing ground model. This is then used to inform the positions of wind turbines, interarray cables and proposed export cable routes, and a subsequent detailed geotechnical site investigation provides site-specific data for engineering design of wind turbine foundations (e.g., jackets and monopiles) and optimal methods for cable installation (e.g., jet-plowing and trenching). High-quality data allow conservatism to be removed from the engineering design, which translates to significant material and cost savings.

To acquire high-quality in-situ data in offshore wind farm areas, Fugro operates a piezocone penetration test.
an electric motor that applies more than twice the power of a crane on board any offshore platform. The HPC contains an identical drive system. Special clamping blocks improve the force transmission to the PCPT rod, resulting in efficient PCPT processing during surveys, monitoring and planning operations, and providing survey solutions. The geotechnical campaign is followed by a large in-house laboratory program that includes advanced testing to characterize ground conditions by determining soil strength and strain properties, dynamic soil properties, and detailed ground layering. Fugro’s onshore laboratory in the U.S., one of the largest private geotechnical laboratories in the world, has recently doubled its advanced soil testing capacity for triaxial and cyclic simple shear testing to meet the growing demand from offshore wind projects.

Incorporating Remote Technologies for Efficiency Gains

Fugro is committed to increasing remote and automated technologies into its business practice as a way of increasing efficiency, improving communication and meeting sustainability goals. The company’s Office Assisted Remote Services (OARS) is one such example. OARS is a cloud-based system that enables qualified staff in strategically located command centers to perform offshore survey tasks as if they were physically on board the work vessel. The technology is currently being used for navigation and positioning, survey data acquisition, PCPT processing during surveys, monitoring and planning operations, and providing survey solutions.

Another major challenge in the project development phase is sorting through endless data types. Seismic data, daily progress reports, borehole logs, in-situ tests, locations, laboratory documents, project data and reports are often stored in multiple systems. To resolve this data management issue, Fugro has developed an interactive web-based GIS tool that provides clients with 24-hr. ac-

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cess to a single repository of project data. The interactive digital platform is hosted in the cloud and allows clients to observe key project information such as vessel tracking, geophysical and geotechnical progress, UXO, archaeology, obstruction, and environmental permitting clearance and approvals.

Data are available in a centralized location easily accessible from various devices, which is used to obtain the latest ground model and field work progress. This remote access helps to reduce project schedules and costs. Powered by a Microsoft SharePoint environment, a project can be tracked from award to report delivery. With this tool, the entire project team can seamlessly search, update and share files. It provides near-real-time soil data to inform project decisions sooner, including the rerouting of export and interarray cables due to geohazards and obstructions, siting wind turbine generator locations, and informing foundation design considerations.

Field Examples

Given the large size of lease areas and the desired information about seafloor conditions in the region, site characterization projects tend to require extensive survey coverage with work phased over multiple field seasons to support varying stages of development. Fugro’s projects often include multiple geophysical and geotechnical vessels operating simultaneously within a single lease area and are managed from the company’s U.S. Center of Expertise for Renewable Projects, located in Norfolk, Virginia. In 2020 alone, the company is supporting six different offshore wind projects in the region. Work on one of these originally began in 2017 with a reconnaissance survey, meant to provide an initial site framework and geologic model. In 2018 and 2019, Fugro returned to the site to perform export cable route studies. Offshore investigations were completed this year, capturing the full complexity of the site.

Conclusion

The Atlantic OCS is the starting point for offshore wind-based energy projects in the U.S. By adapting proven strategies for delivering integrated site characterization services to the specific needs of offshore wind clients in the region, Fugro is helping to ensure responsible stewardship of natural resources and the sustainable development of large capital assets in the marine environment.

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