XOCEAN®

Offshore Wind Farm Surveys using Uncrewed Surface Vessels (USVs)

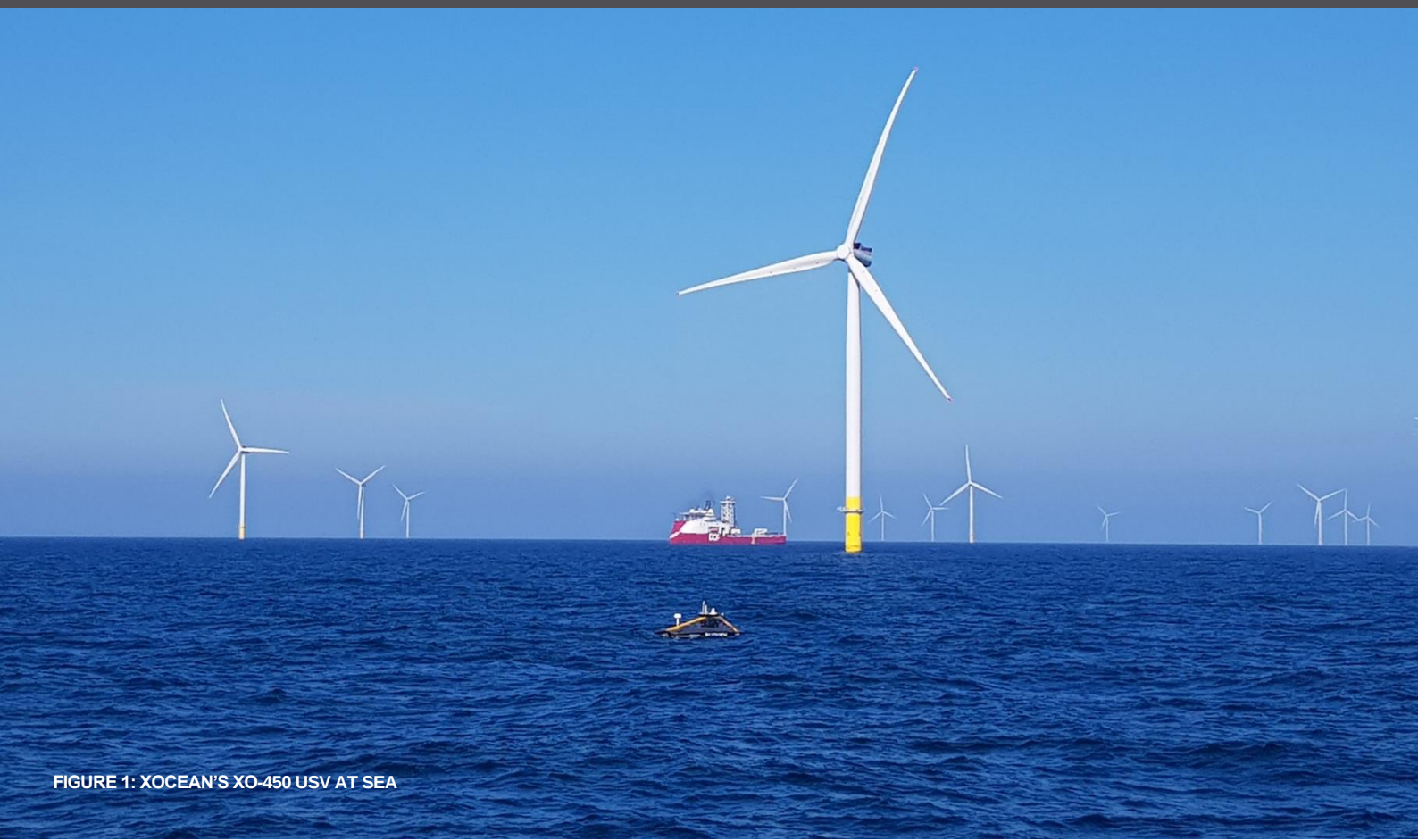

FIGURE 1: XOCEAN'S XO-450 USV AT SEA

Offshore Wind Farm Surveys using Uncrewed Surface Vessels (USVs)

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About XOCEAN

Using Uncrewed Surface Vessels (USVs), XOCEAN provides turnkey data collection services to surveyors, companies and agencies. From mapping the seabed to environmental monitoring, our platform offers a safe, economic and carbon neutral solution to collecting ocean data.

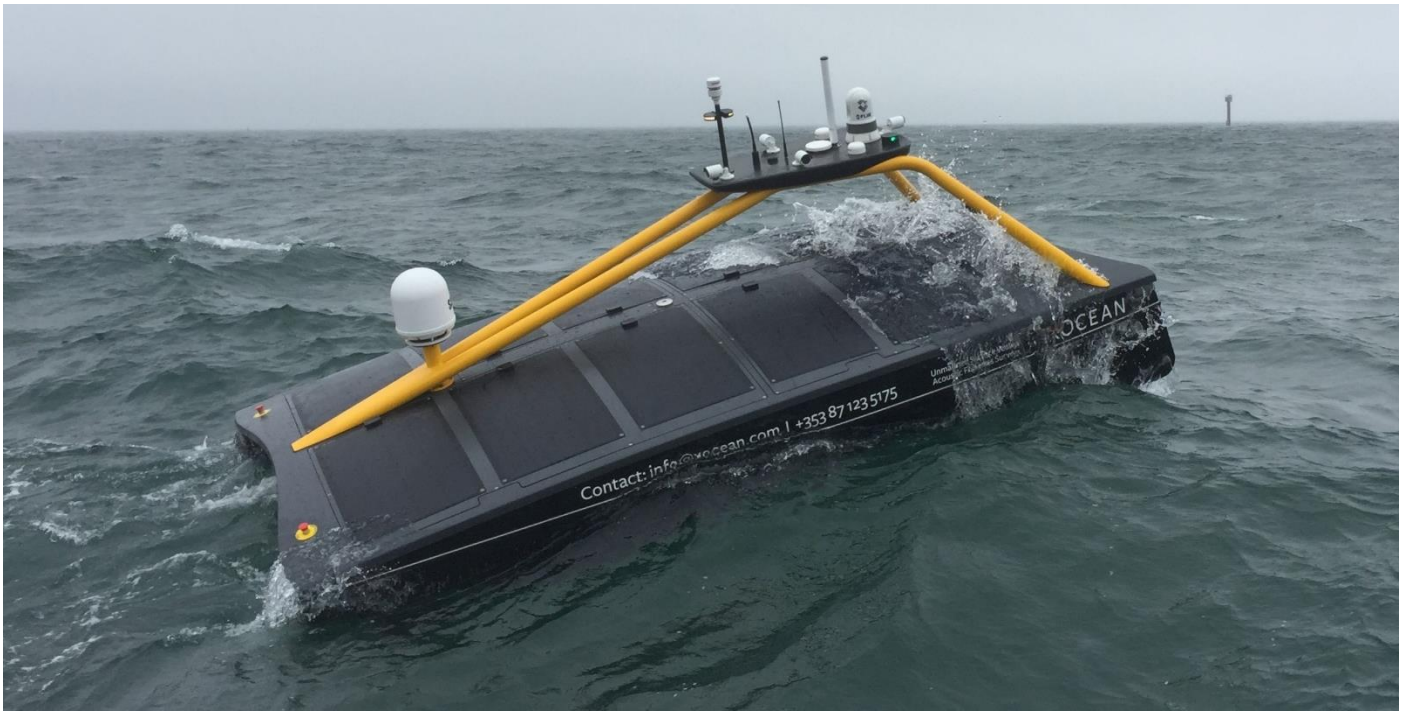

FIGURE 2: XOCEAN'S XO-450 UNCREWED SURFACE VESSEL (USV)

Introduction

Using an Uncrewed Surface Vessel (USV), XOCEAN recently conducted a site investigation on the Ørsted Hornsea One Offshore Wind Farm in the UK. Hornsea One Offshore Windfarm is a 1.2 GW offshore windfarm, using 7 megawatt (MW), 190 metres tall wind turbines, located off the East Coast of the United Kingdom, located approximately 120 km offshore in the North Sea.

The purpose of the survey was to demonstrate the ability of XOCEAN's XO-450 USV platform to monitor scour around wind turbine generator (WTG) foundations and the cable depth of burial of inter-array cables.

The USV conducted the offshore operation in three-and-a-half-days, mobilising from Bridlington Harbour in Yorkshire. The vessel was launched and recovered from shore, approximately 120 kilometres from the offshore surveying location.

Mission in Numbers

0 accidents, incidents or near misses	0 Hours Technical Downtime	610 Exposure Hours	42 Litres Fuel Used 112 Kg CO_2 Offset	229 Nautical Miles Travelled	70 Gigabytes Of Data Collected

FIGURE 3: MISSION IN NUMBERS

Survey System

XOCEAN fitted the XO-450 USV with the following survey system:

- R2Sonic 2024 Broadband Multibeam Sonar
- Innomar SES2000 Standard Parametric Echosounder (PES)
- Applanix POS MV Wavemaster II Inertial Navigation System
- Valeport SWiFT Sound Velocity Profiler
- QPS Qinsy Acquisition Software

Safe & Carbon Neutral

The vessel was slipway launched in Bridlington from where it was accompanied out of the harbour with an operator on an accompanying support vessel steering the USV using a remote manual controller. Once clear of the harbour environment, control was handed over to a team of remote USV Pilots based in XOCEAN's control room in Ireland. Via a broadband satellite connection, the USV Pilots managed both the USV navigation and the survey system control until the vessel returned to Bridlington.

During the 3.5 days at sea no HSE accidents, incidents or near misses occurred. The USV incorporates a hybrid power system with ultra-low emissions. During the project the USV itself used just 42 litres of diesel, this fuel use plus that used in transporting the system to Bridlington was offset by XOCEAN resulting in a fully carbon neutral operation.

FIGURE 4: XO-450 ROAD TRANSPORT

Survey Operations

The USV completed the survey activities in site conditions of up to 1.9m max wave heights, providing accurate and high-resolution seabed data from both the sensors mounted on the USV, in 30m water depth.

The USV completed a box-in pattern around the selected WTG foundation, multiple passes along each cable route, and completed a series of short crosslines across each cable in both directions. During survey operations, a Valeport Swift SVP attached to the onboard automated winch collected Sound Velocity Profiles.

Multibeam Echo Sounder (MBES) Data

The bathymetry was gridded to 0.2m resolution, as shown in the images below, as well as MBES point clouds. The bathymetry images highlight sand wave features present, and the 'spud-can' depressions left following the Jack-up vessel created during construction

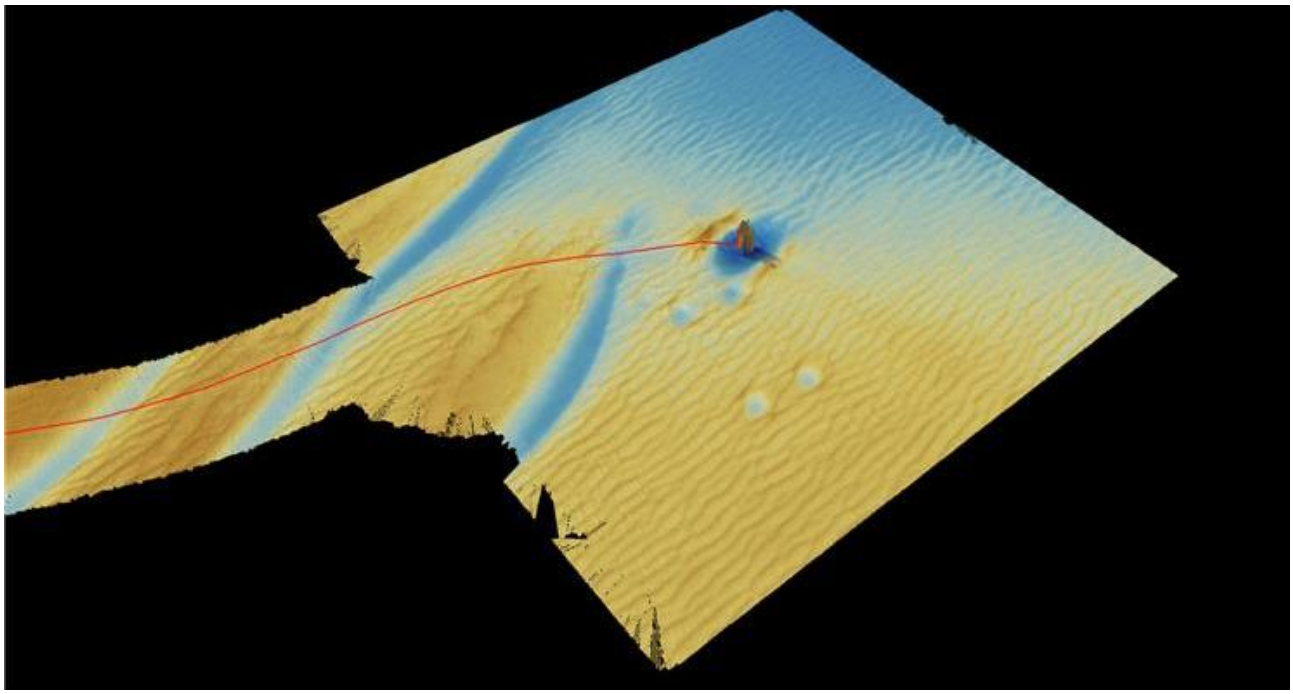

FIGURE 5: BATHYMETRY GRIDDED AT 0.2M RESOLUTION

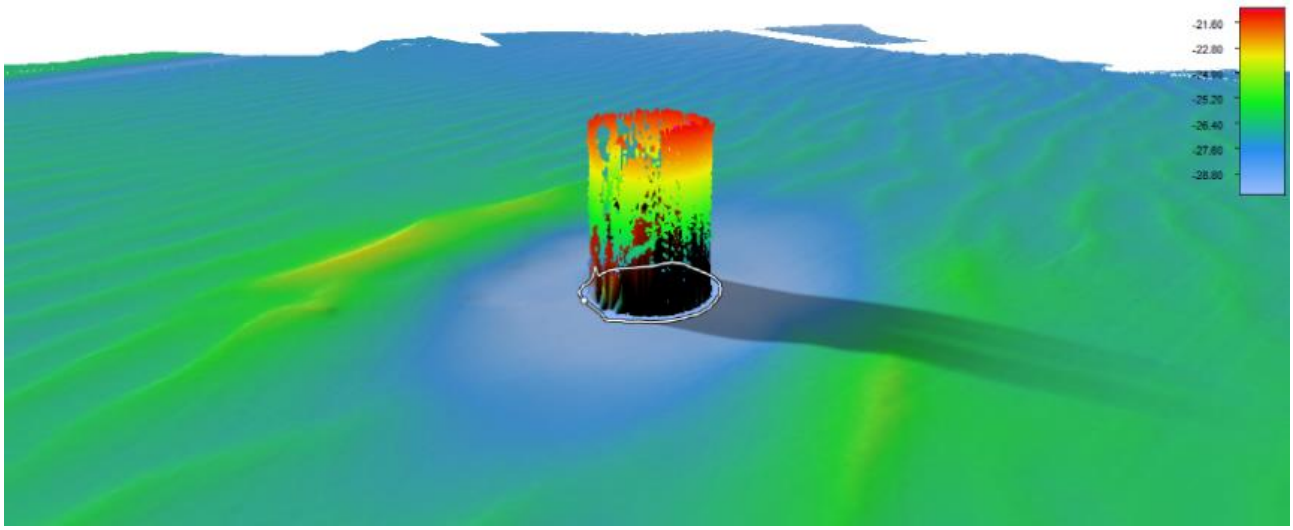

FIGURE 6: MULTIBEAM ECHO SOUNDER (MBES) POINT CLOUD

Sub Bottom Profiler (SBP) Data

As well as collecting high-resolution multibeam data, the USV was equipped with an Innomar SES2000 Standard Sub Bottom Profiler (SBP). During survey operations, data was collected in wave conditions of up 1.5m Hs on site. The recorded data records provided excellent resolution and penetration at 12kHz, showing that the system is suitable for carrying out cable depth of lowering surveys.

To validate the performance of the system to detect small diameter buried cables, the USV surveyed each cross line in both directions. This methodology delivered 70% identification along the cable routes, and the corresponding detections were, on average, within 0.05m of each other. When Ørsted's Site Investigation team compared the results from the depth of lowering survey with the 'as-built' data for each cable, they found a significant correlation.

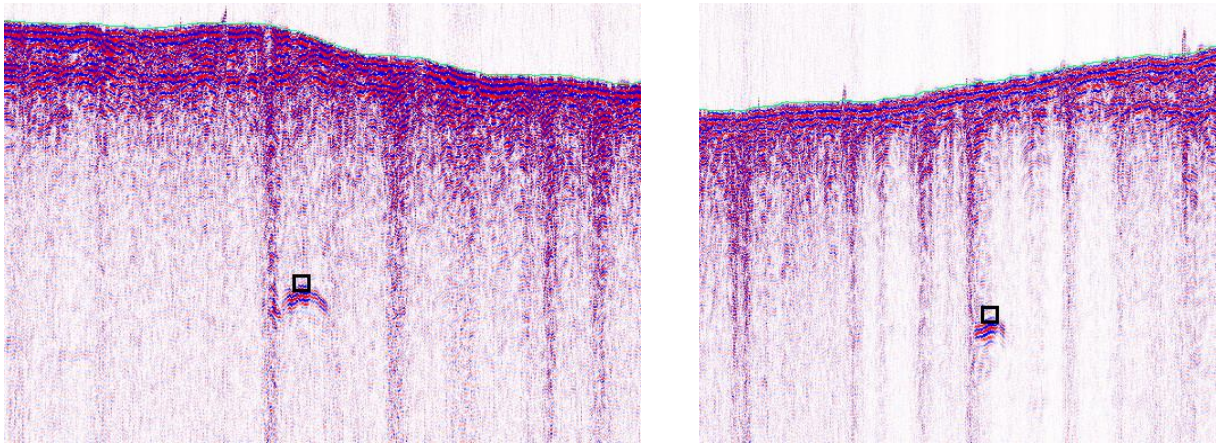

FIGURE 7: SUB BOTTOM PROFILER (SBP) BURIED CABLE DETECTION

The mission was supported by HydroFix, who provided Geophysical support services for both acquisition and processing.

Conclusions

Overall the results provided from the operation satisfied the technical requirements for this type of survey activity. The mission showed that the XO-450 USV can successfully use an Innomar SES2000 Standard, alongside a MBES, to perform offshore survey activities.

Kevin Harnett, XOCEAN's Chief Commercial Officer, says: "*This was an important development in the sensor integration onboard an XO-450 for XOCEAN, and it was fantastic to provide this site investigation for Ørsted. This mission demonstrated how uncrewed systems can deliver safe, cost effective and low carbon solutions within the Renewable Energy sector*."

This sensor configuration is not only applicable to depth of burial type surveys. The Innomar SES2000 Standard PES has the ability to provide up to 50m penetration, depending on the sediment type, making this an excellent tool for surveying the sub-seabed for geophysical ground modelling. The combination of being able to complete survey operations with a versatile PES and the highly transportable, weather capable XO-450 USV, offers a great solution to conduct geophysical surveys globally.

FIGURE 8: XOCEAN'S XO-450 UNCREWED SURFACE VESSEL (USV)