Policy for Offshore Renewable Energy Data Surveying and Analysis

November 30th, 2023

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Preface

Gathering, analysing, and effectively applying data is a key to successful Offshore Renewable Energy (ORE) development. Ireland has the benefit of the INFOMAR programme which has provided basic geophysical data about much of Ireland's maritime territory. However, *advanced* geophysical, geotechnical and metocean surveys and analysis, along with surveys of birds, bats, and mammals, are required to enable the identification of Offshore Wind farm sites and their development. This work is at the heart of marine spatial planning and is complex, time consuming and costly. It requires both specialist expertise and equipment, much of which is not readily available 'inhouse' to the public sector.

This paper examines the data steps required to enable ORE (and examines the technology involved) and sets out practical suggestions for policymakers to improve on all aspects of ORE data gathering, analysis and application. It highlights the urgent need for the Department of Environment, Climate and Communications to establish a working group of ORE data *experts* to advise on the data standards, capacities and practices needed to enable Ireland's ORE targets to be met.

The cumulative impact of the steps recommended in this Paper should be to reduce the impact of surveying on fishers, improve the quality and accessibility of data relevant to ORE, improve support to policymakers and, finally, facilitate deployment of consented wind farms at a faster pace than is likely under current arrangements.

Summary of Views and Recommendations

A minimum data baseline is required for the DMAP site(s) to be chosen prior to auction and a realistic timeline for establishing this should be set. The full requirements of early-stage geophysical data will likely not be provided by INFOMAR as currently constituted for all planned DMAP sites. Project developers or the State will likely still need to undertake multiple geophysical etc survey campaigns to fill data gaps.

ORE project developers are concerned at the friction that can arise with fishers over surveys. Moreover, ORE interests want data to be collected and analysed to appropriate international standards and in as efficient a way as possible.

There is little to no industry role in the public data collection exercise. There is also little to no metadata on the data quality, calibration, validation. The Marine Institute has long term data sets but it is spatially sparse in places and quality is inconsistent in many datasets.

Data gathering – regardless of sponsor, State or private – should be confined, where practical, to finalising DMAP selection and, second, to identifying and preparing a chosen site(s) for development. Data standards and data quality requirements vary between the publicly available data and that required by ORE developers.

An expert group – with appropriate technically qualified individuals from both State agencies and from industry - should be established by the Department of Environment, Climate and Communications (DECC) to:

- Review and report on the data currently available in respect of the likely/possible DMAPs under Phases 2 and beyond
- Recommend a course of action to
    - 'Sweat' (i.e., engage in deep analysis of) the current information to enable early action on DMAP/site(s) determination
    - 'Fill' any gaps in the data with data already collected by industry or, where this is not possible, with new data collected in appropriately designed campaigns in consultation with industry.
    - Where necessary, contract specialist firms to undertake the work with preference given to Irish service providers where possible

- Recommend the appropriate standards and quality targets in respect of all data gathering and analyses

The Marine Institute should be tasked with co-ordinating this approach and acting as the repository for all data gathered and analysed. This may require extra resources at the Institute and may be partially dealt with by deliberations underway at present at the Seafood ORE Working Group. Survey standards should be set in consultation with industry and under the guidance of the expert group referred to above. In addition, where industry provides data (existing or new) to inform DMAPs, an appropriate means of compensation should be considered.

Industry would be minded to engage with DECC on a pricing model to access the data. Two key requirements would have to be met from industry's perspective: a reasonable and negotiated price mechanism and achievement of agreed, high standards in both the collection and the analysis of data coupled with ongoing consultation and engagement with industry.

Three further issues for discussion between industry and DECC are, first, how the legal responsibility for the integrity of data supplied by the State about specific development sites will be dealt with. Second, what should the scope be for alterations to ORESS bid prices in light of issues identified post ORESS by developers in respect of State-identified sites. Finally, Ireland has at least three leading data survey and analysis companies – Green Rebel Marine, Techworks Marine and xOcean. Public procurement of contractor data survey and analysis must enable Irish companies to compete

The MRIA urges DECC to work with DETE to establish clear alignment on how publicly issued tenders for work in the ORE sector will encourage participation from indigenous Irish companies - this should be encouraged as a primary aim to deliver sustainable economic benefit to Irish-based companies.

Baseline data sets should be subject ongoing appropriate monitoring to see the effects/impacts, if any, of activities in the DMAPs (including effects/impacts which would not necessarily arise from ORE).

1. Introduction

This paper was drawn up by a MRIA expert working group[1] to address issues which arise from the vital part which data gathering, and analysis plays in selecting Offshore Renewable Energy (ORE) sites within ORE Designated Maritime Area Plans (DMAPs).

Data collected and analysed to an appropriate standard enables better planning, which ultimately saves money, creates cheaper electricity, and causes less impact to the environment. Currently, the State cannot provide sufficient seabed information to achieve this.

2. Background

INFOMAR

The development of ORE today would not be possible without the pioneering work of Government agencies in surveying the seabed.

Ireland has undertaken deep-water hydrographic and geophysical survey operations to designate its maritime territory since 1996. Originally conducted by the Petroleum Affairs Division of today's Department of Environment, Climate and Communications (DECC), the findings reinforced the need for a comprehensive assessment of the entire Irish seabed. The Geological Survey Ireland (GSI)-managed Irish National Seabed Survey (INSS, 2000-2006) followed, an ambitious but successful programme to survey Ireland's entire deep-water territory beyond the 200m water depth. To further leverage national interests and coastal and shelf-based development opportunities, INFOMAR evolved naturally as the follow-on national seabed survey initiative as a joint venture between the GSI and the Marine Institute.

[1] Members of MRIA ORE Data Advisory Group: Dr Jared Peters, Director of Survey Division at Green Rebel Marine; Kevin Harnett, COO XOCEAN; Charlotte O' Kelly, CEO Techworks Marine and Director of the Marine Institute; John Breslin, CEO BlueWise Marine, Ruairi Hand, consenting manager Simply Blue Group; Patricia Comiskey, Simply Blue Group; Peter Coyle, MRIA (Chair of the Group)

INFOMAR was initiated to survey the remaining shelf and coastal waters between 2006 to 2026 and to deliver a baseline bathymetry data set to underpin the future management of Ireland's marine resource.

ORE's immediate issues

While recognising the contribution made by INFOMAR and its predecessors, technology has changed since its inception and, of course, the recent inauguration of Irish ORE has generated new demands, including the need for different survey standards to be achieved in some instances and for different forms of surveys.

Government policy is to move quickly to a planned approach to ORE development, starting with Phase 2.1. The intention is to run the Phase 2.1 ORESS auction in advance of surveying by developers but not by the State, who plan a short survey prior to auction (which is likely to be of minimal value) of the associated, Southern, DMAP. That being the case, it is important that a MINIMUM DATA BASELINE IS DETERMINED FOR THE DMAP SITE(S) TO BE CHOSEN PRIOR TO AUCTION AND A REALISTIC TIMELINE FOR ESTABLISHING THIS SHOULD BE SET. Hopefully, the inefficiencies and complexity historically associated with consenting data collection and analysis will be mitigated as the Maritime Area Planning Act and MARA mature.

The fishing community is disturbed by the perceived frequency and repetitive nature of surveys by project developers, often covering the same general area, and the perceived impact on fishing stocks and on the fishing community's freedom to fish while surveys are ongoing. Frequency of surveys is a particular issue with Phase 1 and all projects which will be in relatively shallow waters which are also the domain of quite static fisheries (n.b., lobster fishing) or sensitive seasonal species (n.b., scallops, prawns). But it is likely to remain an issue with later Phases regardless of their format i.e., 'developer' or 'plan' led. EQUALLY, ORE PROJECT DEVELOPERS ARE CONCERNED AT THE FRICTION THAT CAN ARISE WITH FISHERS OVER SURVEYS. MOREOVER, ORE INTERESTS WANT DATA TO BE COLLECTED AND ANALYSED TO APPROPRIATE INTERNATIONAL STANDARDS AND IN AS EFFICIENT A WAY AS POSSIBLE.

3. Data Gathering and Analysis Stages

Data gathering and analysis follows several different steps *which are not necessarily sequential*. A review of the technologies employed at various stages

is contained in the Appendix 1 and an infographic illustrating the sequence and timing of developer-standard survey works is set out at Appendix 2.

Geophysical - basic
Geophysical surveying 'maps' the seabed and sub-seabed and is undertaken by the Marine Institute/Geological Survey of Ireland (GSI) axis under the INFOMAR umbrella to International Hydrographic Organisation 1A standard. There are a wide range of sub-seismic options for this work, depending on project need, site characteristics, etc.

The State surveyed off the Shannon estuary recently and a further survey is planned for the Celtic Sea in Spring 2024. THE FULL REQUIREMENTS OF EARLY-STAGE GEOPHYSICAL DATA WILL NOT BE PROVIDED BY INFOMAR. PROJECT DEVELOPERS OR THE STATE WILL LIKELY STILL NEED TO UNDERTAKE MULTIPLE GEOPHYSICAL SURVEY CAMPAIGNS TO INFORM ON DETAILED ENGINEERING DESIGN.

The work to date, and planned, under this heading is important to high level planning by ORE during *general* site identification and selection. All the State can provide is Geophysical - basic to IHO 1a standard and sporadic, often incompatible, supplementary data that were collected for various research projects. This doesn't meet developer needs (as illustrated by inconsistencies with modern ITTs and projects) and if developers bid based on such information, their conservative estimates will result in higher prices.

Geophysical - advanced
Advanced geophysical surveying is necessary to finalise the selection of individual sites and at present is undertaken by developers (or by data companies - either as contractors to ORE or with the intention of selling their data and analysis to ORE). Data density and resolution are higher in *Geophysical – advanced* i.e., the number of survey 'lines' undertaken in each area is higher and additional sensors are used.

Two points are worthy of note here: first, the sub-bottom survey needs of Bottom Fixed Wind (BFW) and Floating Offshore Wind (FLOW) projects are often different in terms of the depth of penetration needed. BFW developers are seeking information on 'bedrock type' to fix turbines into. This means that a BFW project may need confirmation that the bedrock is at least 30/50/100M deep depending on the type of foundation they are using. FLOW promoters are particularly concerned about the anchoring potential of the seabed and the

composition of the (soil, mud, clay etc) and the depth of it to bedrock. Moreover, second, sub bottom surveys can vary in their results depending on the specific 'sub-bottom profilers' etc used.

Metocean – basic

Metocean is the measurement of the water column from the seabed to the sea-surface (including the air-sea interface). It involves waves, currents, water depth, turbidity (sediment dynamics), water quality, salinity, and water temperature. This provides ORE developers with critical information on site characterisation which feeds into turbine design criteria.

In Ireland, the Marine Institute (MI) has 5-6 weather buoys which collect some of this data. These data sets need to be temporal with a minimum of 12 continuous months. Met Eireann funds the MI buoy network as this data is used in their model validation and it has recently also started equipping the Commissioners of Irish Lights (CIL) with wave sensors. Metocean data is ultimately used to calibrate/validate high resolution hydrodynamic models, which makes the data acquisition *standards* set, and attained, of great importance.

THERE IS LITTLE TO NO INDUSTRY ROLE IN THIS PUBLIC DATA COLLECTION EXERCISE. THERE IS ALSO LITTLE TO NO METADATA ON THE DATA QUALITY, CALIBRATION, VALIDATION. THE MARINE INSTITUTE HAS LONG TERM DATA SETS BUT IT IS SPATIALLY SPARSE IN PLACES AND QUALITY IS INCONSISTENT IN MANY DATASETS.

In Ireland, insofar as offshore Metocean – basic is undertaken, is the preserve of the Marine Institute, Irish Lights and Met Eireann. For ORE purposes, there may need to be other Metocean surveys utilising ADCP and waveriders etc, work which could be undertaken by specialist contractors too.

Metocean - advanced

Typically, an ORE project may employ two metocean buoys on a site for as long as two 12-month periods and the work is undertaken by, or on behalf of, project developers, typically utilising buoys etc hired from specialist contractors.

A 12-month survey period represents the *minimum* data collection period necessary as the aim is to get annual/season variation and extremes so 24-month surveys are more typical of industry practice. Metocean - advanced is relatively cheap compared to geophysical or geotechnical activity, but an

uninterrupted time series is critical, and, for that the reason, more than one measurement system is deployed. Most developers also de-risk by having equipment measuring on the seabed and ideally the same equipment measuring from a mooring data buoy, again this is to compare data sets and provide confidence.

The main change recently in metocean practice is the move from equipment provision to data provision by contractors, so risk is being passed onto these specialist contractors. Again, DATA STANDARDS AND DATA QUALITY REQUIREMENTS VARY BETWEEN THE PUBLICLY AVAILABLE DATA AND THAT REQUIRED BY ORE DEVELOPERS.

Bird, bats, and mammal Surveys

Surveys of birds, bats, and mammals are undertaken by project developers once a general site location has been identified and are not normally intrusive on fishing activities. Increasingly, these take the form of aerial digital surveys and developers normally employ contractor specialists.

Bird and bat measurement options include aerial surveys (drones, planes), or radars fitted on buoys or headlands (which provide temporal coverage) - bird and bat radars are being increasingly requested by Government stakeholders in Europe. Marine mammal surveys can be undertaken by aircraft and by drones or by using hydrophones on buoys deployed at sea, the latter again providing more accurate temporal data sets. The key issue revolves about understanding seasonal migration and the movement of bird, bats, and marine mammals. The main reason for the bird and mammal surveys is to provide ecological baseline data and feed into Environmental Impact Assessments.

Geotechnical surveys

In practical terms, a geophysical survey is undertaken to assure project developers that a specific site can bear the 'loads' of e.g., the foundations for BFW turbines which, e.g., may penetrate the seabed, and to inform on appropriate foundations/mooring design. It involves taking cores from depths which are normally beyond the current capabilities of Marine Institute vessels, although advanced digital techniques may also be employed. Geophysical surveys are the natural preserve of the project developer as they are vital to the final layout, engineering design etc of ORE arrays, and would generally be employed at more advanced project design stages.

Table 1 Summary of current surveying practices

FORM OF SURVEY	CURRENTLY UNDERTAKEN BY (OR BY CONTRACTORS ON BEHALF OF)
Geophysical-basic	Marine Institute/GSI
Geophysical-advanced	Project developers
Metocean-basic	Marine Institute/Irish Lights/Met Eireann
Metocean-advanced	Project developers
Birds, bats, and mammal surveys	Project developers
Geotech surveys	Project developers

3. Addressing concerns – step 1

The concerns we seek to address are:

- The requirement to improve data gathering and analysis and, also, to achieve international data standards appropriate to ORE decision-taking.
- The frequent, often repetitive, nature of ORE surveying with its perceived disruption to fishing.

The policy framework within which data collection and analysis must work is somewhat fluid at present. While Phase 1 projects are proceeding on a 'developer led' basis, Phase 2 will be plan led. Phase 2.1 will be in the recently announced draft Southern DMAP and Phase 2.2 will possibly locate in two DMAPs, yet to be determined, in the Irish Sea.

In the interests of the efficient use of resources, both private and State, and in the interests of harmony with fishers, THE ASSOCIATION BELIEVES THAT DATA GATHERING – REGARDLESS OF SPONSOR, STATE OR PRIVATE – BE CONFINED, WHERE PRACTICAL, TO FINALISING DMAP SELECTION AND, SECOND, TO IDENTIFYING AND PREPARING A CHOSEN SITE(S) FOR DEVELOPMENT.

What should this look like in practice? MRIA recommends two steps. The first and most urgent one would involve AN EXPERT GROUP – WITH APPROPRIATE TECHNICALLY QUALIFIED INDIVIDUALS FROM BOTH STATE AGENCIES AND FROM INDUSTRY - WHICH

SHOULD BE ESTABLISHED BY THE DEPARTMENT OF ENVIRONMENT, CLIMATE AND COMMUNICATIONS (DECC) to:

- REVIEW AND REPORT ON THE DATA CURRENTLY AVAILABLE (INCLUDING THAT ALREADY COLLECTED BY INDUSTRY FOR SPECIFIC PROJECT AREAS) IN RESPECT OF THE LIKELY/POSSIBLE DMAPS UNDER PHASES 2 AND BEYOND
- RECOMMEND A COURSE OF ACTION TO
    - 'SWEAT' (I.E., ENGAGE IN DEEP ANALYSIS OF) THE CURRENT INFORMATION TO ENABLE EARLY ACTION ON DMAP/SITE(S) DETERMINATION
    - 'FILL' ANY GAPS IN THE DATA ALREADY COLLECTED BY INDUSTRY OR, WHERE THIS IS NOT POSSIBLE, WITH NEW DATA COLLECTED IN APPROPRIATELY DESIGNED CAMPAIGNS FOLLOWING CONSULTATION WITH INDUSTRY
    - WHERE NECESSARY, CONTRACT SPECIALIST FIRMS TO UNDERTAKE THE WORK. IRISH FIRMS SHOULD BE GIVEN PREFERENCE FOR THIS WORK WHEN POSSIBLE.
- RECOMMEND THE APPROPRIATE IHO ETC STANDARDS IN RESPECT OF ALL DATA GATHERING AND ANALYSES

The approach recommended should reduce the extent of *Geophysical- basic* and *Metocean – basic* surveying required and improve standards which in turn may somewhat reduce the need for *Geophysical – advanced* and *Metocean - advanced* work by project developers. The confidence of project developers in the quality of the data gathered is key to addressing the concerns cited earlier in this paper. The approach is summarised in table 2 below.

Table 2 Potential impact of step 1

FORM OF SURVEY	CURRENTLY UNDERTAKEN BY	POSITION UNDER STEP 1
Geophysical-basic	Marine Institute/GSI	Identify standard to which INFOMAR has been reprocessed to. If gaps in DMAP areas, then review new INFOMAR data acquisition and industry data sets. Utilise private contractors to process new data or fill data gathering gaps as necessary.
Geophysical-advanced	Project developers	Should reduce requirement
Metocean-basic	Marine Institute/Irish Lights/Met Eireann	Should reduce requirement. Utilise private contractors as necessary. At the moment, data collection platforms are not the same & would be good to do an exercise of intercomparison.

		Also, these are only collecting waves data & not current!
Metocean-advanced	Project developers	No change
Bird, bats, and mammal surveys	Project developers	Review practice elsewhere and, as appropriate, adopt 'best practice'
Geotechnical surveys	Project developers	No change

4. Addressing concerns – step 2

The Future Framework will be fully 'plan led' with e.g., EirGrid being responsible for the direct provision of offshore infrastructure (cabling, substations). There is still time available to undertake a more radical approach to surveying and data analysis than suggested for step 1 above.

The MRIA recommends that the Marine Institute be tasked with co-ordinating this approach and acting as the repository for all data gathered. Survey standards should be set in consultation with industry and under the guidance of the expert group referred to below. This may require extra resources at the Institute and may be partially covered by deliberations underway at present at the Seafood ORE Working Group. In addition, where industry provides data (existing or new) to inform DMAPs, an appropriate means of compensation should be considered.

To ensure that the work is undertaken to a standard acceptable to industry, the Association repeats the recommendation above that a standing technical advisory group be established, with representatives from both the agencies and from industry, to monitor the survey and analysis work and to ensure appropriate standards are met.

Given the cost involved to the State in undertaking the work outlined, the industry would be minded to engage with DECC on a pricing model to access the data. Two key requirements would have to be met from industry's perspective: a reasonable and negotiated price mechanism and achievement of agreed, high standards in both the collection and the analysis of data coupled with ongoing consultation and engagement with industry.

Table 3 Impact of step 2

FORM OF SURVEY	CURRENTLY UNDERTAKEN BY	POSITION UNDER STEP 2
Geophysical-basic	Marine Institute/GSI	Confined to selecting and finalising DMAPs in the Future Framework; utilise private contractors as necessary
Geophysical-advanced	Project developers	Confined to facilitating site selection within DMAPs; utilise private contractors as necessary
Metocean-basic	Marine Institute/Irish Lights/Met Eireann	Confined to facilitating site selection within DMAPs; utilise private developers as necessary
Metocean-advanced	Project developers	No change
Birds, bats, and mammal surveys	Project developers	Examine scope for centralised approach
Geotech surveys	Project developers	No change

THREE FURTHER ISSUES FOR DISCUSSION BETWEEN INDUSTRY AND DECC ARE, FIRST, HOW THE LEGAL RESPONSIBILITY FOR THE INTEGRITY OF DATA SUPPLIED BY THE STATE ABOUT SPECIFIC DEVELOPMENT SITES WILL BE DEALT WITH. SECOND, WHAT SHOULD BE THE SCOPE FOR ALTERATIONS TO ORESS BID PRICES IN LIGHT OF ISSUES IDENTIFIED POST ORESS BY DEVELOPERS IN RESPECT OF STATE-IDENTIFIED SITES. THIRD, IRELAND HAS AT LEAST THREE LEADING DATA SURVEY AND ANALYSIS COMPANIES – GREEN REBEL MARINE, TECHWORKS MARINE AND XOCEAN. PUBLIC PROCUREMENT OF CONTRACTOR DATA SURVEY AND ANALYSIS MUST ENABLE IRISH COMPANIES TO COMPETE - A RECENT, MAJOR, STATE TENDER DE FACTO RULED THEM OUT.

THE MRIA URGES DECC TO WORK WITH DETE TO ESTABLISH CLEAR ALIGNMENT ON HOW PUBLICLY ISSUED TENDERS FOR WORK IN THE ORE SECTOR WILL ENCOURAGE PARTICIPATION FROM INDIGENOUS IRISH COMPANIES - THIS SHOULD BE ENCOURAGED AS A PRIMARY AIM TO DELIVER SUSTAINABLE ECONOMIC BENEFIT TO IRISH-BASED COMPANIES

5. Summary

Industry's starting point is that while INFOMAR is an excellent resource, there are gaps in the national datasets, and in some cases issues with their quality

and applicability, which need to be addressed to inform future spatial planning for ORE. Moreover, project developers will always require specific data to inform on their engineering needs at specific sites and these data, and their acquisition, falls outside of the remit of the State. It is noteworthy too that Geophysical and Geotechnical data collection elsewhere for ORE has not been found to have a significant impact on the environment or on species, but we would support a focus on research in this area. Nor is there any evidence that the collection of metocean data or data to monitor birds, bats, fish, shellfish, or marine mammals have adverse impacts on these species. It is also important to state that WE NEED BASELINE DATA SETS WHICH SHOULD BE SUBJECT TO ONGOING APPROPRIATE MONITORING TO ASSESS THE EFFECTS/IMPACTS, IF ANY, OF ACTIVITIES IN THE DMAPS (INCLUDING EFFECTS/IMPACTS WHICH WOULD NOT NECESSARILY ARISE FROM ORE).

The Association's views involve two practical and achievable steps.

First, *engagement with industry to achieve standards on which ORE investment decisions can be made*. *It is recommended that private contractors be employed where there is a shortfall in State resources and capabilities*. Alongside this, we recommend that industry and State bodies work together to 'sweat' existing information located in various State and private organisations. A significant amount of relevant data has been collected by industry over the last number of years and that, rather than re-inventing the wheel by commissioning unnecessary surveys and delaying development, this data should be considered to inform on DMAP selection in Phase 2 and the Future Framework.

Second, particularly once DMAPs have been selected, any *data that is required should be gathered and analysed to standards agreed with industry and independently validated*. This should be undertaken on a 'once off' basis utilising both State and private expertise with the costs incurred in collecting and analysing developer ready data being recovered via sale of the data to ORE.

The cumulative impact of the steps recommended in this Paper should be to reduce the impact of surveying on fishers, improve the quality and accessibility of data relevant to ORE, improve support to policymakers and, finally, facilitate deployment of consented wind farms at a faster pace than is likely under current arrangements.

1 Appendix 1 Description of Equipment

1.1 Geophysical Surveys

Geophysical surveys are non-invasive, non-destructive surveying methods that help to inform the physical properties of a subsurface. These surveys are used to help identify minerals, energy, groundwater resources, geological structures, geohazards, and more. For offshore renewable projects, geophysical surveys are generally used to determine seabed type (rocky, sandy), sub seabed conditions (e.g., depth to bed rock), presence of certain ecosystems, e.g., reefs, presence of archaeological artefacts (e.g., wrecks) and hazards (e.g., unexploded mines).

A brief description of the type of equipment used for marine geophysical surveys include.

1.1.1 Multibeam Echosounder (MBES)

A multibeam echosounder (MBES) is a type of sonar that is used to map the seabed. It emits acoustic waves in a fan shape beneath its transceiver. The time it takes for the sound waves to reflect off the seabed and return to the receiver is used to calculate the water depth. Unlike other sonars and echo sounders, MBES uses beamforming to extract directional information from the returning soundwaves, producing a swath of depth soundings from a single ping.

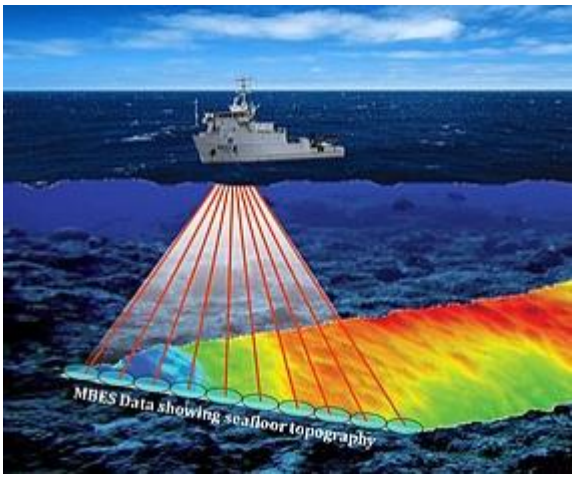

Figure1: Example of mapping by Multibeam Echosounder (MBES) and example of common unit used (Kongsberg EM2040)

MBES systems are generally hull mounted - the Kongsberg EM2040 may be taken as an example of an MBES system. Typical operating frequencies are between 200-700kHz.

1.1.2 Side Scan Sonar (SSS)

Side-scan sonar is used to efficiently create an image of large areas of the sea floor. Side-scan sonar imagery is also commonly used to detect debris items and other obstructions on the seafloor that may be hazardous to shipping or to seafloor installations by the oil and gas industry.

The side scan sonar device typically is towed from a survey vessel as a submerged pod. The typical operating frequency range is between 300 to 900 kHz. Figure 2 illustrates an example of an image taken using side scan sonar and of a common device used (an EdgeTech 4200).

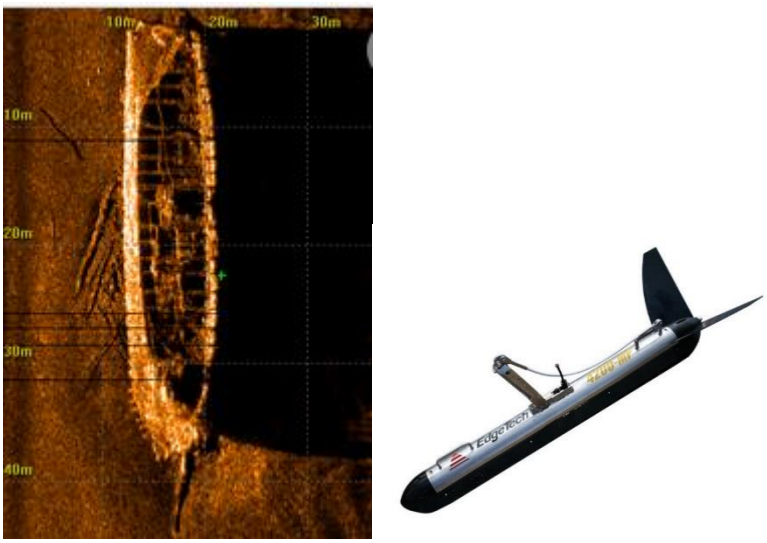

Figure 2: Side scan sonar of a shipwreck (Aid) and example of a towable Side Scan Sonar (SSS) device (Seatronics)

1.1.3 Sub-Bottom Profiler (SBP) and Ultra-High Resolution Seismic (UHRS)

Shallow SBP and UHRS surveying produces a 2-D or 3-D information on the subsurface up to potential depths of over 50m below the seabed, depending on the geological conditions encountered and the choice of system used. Types of SBP available include:

- **Pinger** — The highest-frequency system (operating between 2 and 20 kHz). Produces a high-resolution image capable of resolving small features. However, it cannot penetrate very deep into the seabed (10s of metres, depending on sediment type and water depth).
- **Chirp** — Another high-frequency system used for high resolution, shallow penetration surveys (usually 20-50m depending on sediment type and water depth). Chirps produce a long (low frequency) pulse, made up of multiple higher frequency waveforms. This increases the overall energy that can be output by the source, improving penetration.
- **Parametric** – A system that produces a set of primary sound beams that interact to produce a lower frequency secondary sound beam. These systems produce more productive, narrower beams that reduce noise and ringing, thereby maximising penetration, and data resolution. Penetration can reach up to 70 m below the seabed (depending on local geology).

Types of UHRS systems include:

- **Boomer** — A lower-frequency system (dominant frequencies between 500 Hz and 5 kHz) capable of penetrating much further beneath the seafloor (up to 100m, depending on local geology).
- **Sparker** — works by producing an electrical spark, which vaporises the sea water around the tip of the sparker array. This vaporised water rapidly expands producing a pressure wave. Large very high-powered (~12,000kJ) sparkers can produce lower frequency (down to 50Hz) and penetrate down to 1,000m (depending on local geology).

Boomers and Sparkers are often used in later stages of investigation to assess potential geological hazards and build ground models needed for engineering design. These surveys are more efficient

when designed using other geophysical data, often collected during planning or reconnaissance phases of investigation.

The Seatronics Edgetech 3300 may be taken as an indicative example of a hull-mounted pinger system and will have an expected operating frequency range of approximately 2-16 kHz with sound pressure levels of 200dB re1µPa at 1 metre range. Parametric SBPs have become a standard in the OWE industry; an example is the Innomar Medium-100, which produces a secondary frequency of approximately 2-22 kHz with acoustic source levels of 247 dB//µPa re 1m. The Applied Acoustics device may be taken as an indicative example of a boomer source and will have an expected operating frequency of approximately 2.5 kHz with sound pressure levels in the range of 208-211dB re1µPa at 1 metre range. **Error! Reference source not found.** and **Error! Reference source not found.** illustrate examples of SBP and parametric devices. Figure 6 provides an example of a SBP image using a parametric system.

Figure 4: Example SBP Boomer source (Applied Acoustics)

Figure 5: Example parametric SBP Piner source (Innomar)

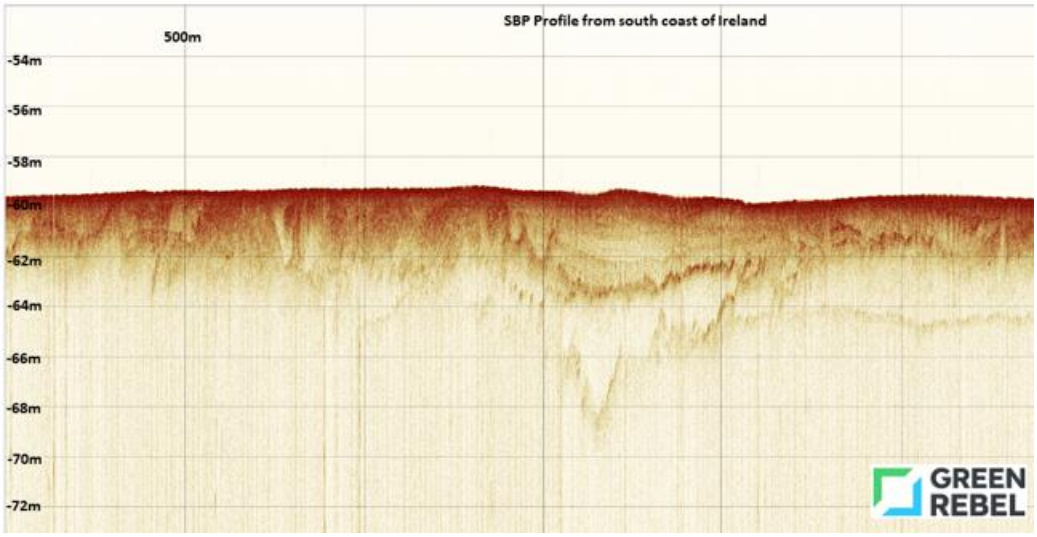

Figure 6: Example of an SBP Image (Green Rebel)

1.1.4 Magnetometer

A magnetometer is a passive instrument that measures changes in the Earth's magnetic field. In ocean exploration, it is used to survey cultural heritage sites such as ship and aircraft wrecks, to characterize geological features on the seafloor and to identify hazards (e.g., unexploded mines known as UXOs). It is often used in tandem with side scan sonar, which produces a map of the surface. The magnetometer data is used to complement this information by picking up on artefacts that are buried below the seafloor.

The magnetometer is often towed from a survey vessel, often 'piggybacked' from a side-scan sonar 'fish'. Figure 7 illustrates an example of a towed, caesium vapour magnetometer device. (a Geomatrix G882, which is industry standard).

Figure 7: Example of a Magnetometer device (Geomatrix)

1.2 Geotechnical Surveys

The purpose of a geotechnical survey is to evaluate the physical properties of the seabed sediments and/or bedrock formations. These methodologies ensure a comprehensive understanding of the subsurface is achieved to a suitable depth and to rule out the existence of weaker formations which may influence the safety or performance of a wind turbine and its support structure. The geotechnical surveys are used to verify the geophysical data and require interaction with the seabed surface and sub surface to extract samples. The type of surveying generally done consists of Boreholes, Cone Penetration Testing, Vibocore or Gravity Samplers, all of which are described below. The extent, depth, and frequency of most of these survey types will likely be project specific as they are dependent on the makeup of the seabed, geological conditions and preferred foundation type of the project developer.

1.2.1 Boreholes

A borehole is deep vertical hole with small diameter drilled into the ground to obtain soil samples for investigation required to inform the construction of suitable foundation for the planned structure. The depth, width, location, and number of boreholes will be dependent on the data received from the geophysical survey; the likely geological make-up of the survey site and the type of foundations planned. Therefore, surveys tend to be project specific. Samples from the boreholes are retrieved and analysed to ascertain seabed and subsurface make up. Figure 8 shows a borehole rig and schematic of how the system works.

Figure 8: Borehole rig and schematic of system working.

1.2.2 Cone Penetration/Penetrometer Tests (CPTs)

The cone penetration or cone penetrometer test (CPT) is a method used to determine the geotechnical engineering properties of soils and delineating soil stratigraphy. CPT evaluates subsurface conditions and geotechnical soil properties. CPTs are a quasi-static penetration test, meaning that the cone is pushed at a slow rate rather than driven with a hammer or rotary drilling. Unlike boreholes no samples are taken by the CPT. Again, the number of CPT locations are dependent on the data received from the geophysical survey and the likely geological make-up of the survey site. The depth of the CPT is dependent on the resistance found.

Figure 9: Example of a block push seabed CPT system (Fugro Seacalf)

1.2.3 Vibracore/Vibrocore/ Gravity Sampler

Vibracoring is a common technique used to obtain samples from water-saturated sediment. These corers work by attaching a motor that induces high frequency vibrations in the core liner that in turn liquefies the sediment directly around the core cutter, enabling it to pass

through the sediment with little resistance. The depth, width, location, and number of boreholes will be dependent on the data received from the geophysical survey; the likely geological make-up of the survey site and the type of foundations planned. Therefore, the task will likely be project specific. Figure 10 shows an example of a vibracore system.

Figure 10: Example of a crane-deployed vibracore system

1.3 Metocean surveys

The objective of the metocean surveys is to evaluate the wind, wave, and tidal conditions in the application area. Often existing models and national data sets can be used to inform on the initial site assessment, but once a site is chosen, the preference is to gather data onsite for a continuous period (i.e., 1-2 year's seasons of data). This data is then used to inform on several aspects of the project, i.e., the engineering assessments, yield assessments and to validate numerical models. A number of different sensors are used to gather this data from both seabed and surface locations Due to these surveys being done over annual cycles, data is generally required in real-time so that should an issue happen, it can be corrected as soon as possible rather than waiting for 3 months, which may result in an additional year of data being required.

The deployment of a metocean surveys in Ireland requires Foreshore Licenses for the footprint on the seabed of the Seabed ADCP. Depending on the site bathymetry and known conditions, several units may be deployed to ensure fully redundancy and mitigate any risk of data loss.

1.4 Equipment

A brief description of the metocean survey equipment types is included below.

1.4.1.1 ***Seabed Frames***

The seabed frames would generally contain an upwards looking ADCP. This is used to determine the principal tidal and current regime of the proposed survey area, as well as provide information on waves. A typical seabed frame is deployed on the seabed using the crane or "A" frame of a survey vessel. The ADCP sits within a small seabed frame with approximately typically 1-1.5m long by 0.75-1m wide at the base and 0.6m height off the seabed. The total weight of the frame and ADCP will vary depending on the amount of ballast required to ensure the frame does not move over the deployment period, this can range from 300-600kg. The ADCP and seabed frame will be attached to a ground line, with a clump weight (approx. 150kg) and to an acoustic release system carrying a rope retrieval system. This will ensure that all equipment is recovered from the seabed after the monitoring period. Figure 11 illustrates an example ADCP device.

This data is generally not transmitted in real-time, and is used in conjunction with surface metocean buoys, and as such sometimes it will be up to 3 months before the surveyor knows if they have the right data.

Figure 11: Example ADCP device

*1.4.1.2 **Metocean Buoy***

Metocean buoy(s) will also need to be deployed to measure wave height and direction over an annual cycle, using a spectral wave sensor. Most wave buoys are also fitted with ADCP current profilers (providing a downwards looking system) to feed into the engineering design of the project. It will be moored to the seabed by a suitably sized mooring line and anchor structure.

These buoys range in size depending on the deployment environment and the number of redundancies required. Offshore wind developers are today measuring other parameters on such buoys, which provides value-add to the data, such parameters include sea surface wind speed and direction, temperature, humidity, precipitation in conjunction with the ocean waves and current data. Additional turbidity data provides information of use for sediment dynamics at the deployment location, in some cases underwater noise and marine mammal information can also be collected from such buoys.

Figure 12: Example of metocean buoys (TechWorks Marine)

The traditional wave-only wave rider buoy such as a Datawell Directional Wave Rider are also used. Figure 13 illustrates an example of a Wave Rider Buoy.

Figure 13: Example Wave Rider Buoy

*1.4.1.3 **Floating Lidar***

A Lidar is a vertical wind profiling sensor, which measures from 10m altitude to 300m. These sensors are used to measure the wind resource at offshore wind sites and provide developers with accurate hub height 'bankable' wind resource data. The lidar uses doppler shift to measure wind resource much in the same way an ADCP at sea measures doppler shift to measure tidal flows. There are two companies which manufacture these sensors used by the offshore wind industry globally - ZX and Leosphere. Their products both work the same way.

Historically 'met' masts were deployed on sites e.g., SSE off Arklow has a Lidar unit which has been on a met mast for the last 20 years collecting data. Today most developers deploy floating lidar buoys on their sites, with data being transmitted in real-time to re-risk any potential downtime. As with metocean buoys, it is recommended to deploy more than one system to de-risk the potential data losses. This data is required by developers to confirm the viability of their selected site.

Floating lidar buoys are also used to collect ancillary data such as waves and currents, bearing in mind the size of the platform may influence the collected data. Bird and bat radars can also be fitted on them to provide key information for project development.

The Carbon Trust has a clear roadmap to the commercial acceptance of floating lidar technology which is being followed by the manufacturers and used by the developers to de-risk data being collected. Most floating lidars are stage 2 (pre-commercial) or stage 3 (commercial) certified.

The image below is of a Green Rebel Floating Lidar unit. Green Rebel, headquartered in Cork, has conducted successful commercial deployments of its own floating lidar buoys and is one of only eight Stage 2 certified manufacturers globally.

Figure 14: Example of a Floating Lidar unit (Green Rebel)

1.4.2 Data Requirements

These surveys need to be carried out over a minimum 12-month period, ideally 24 months to ensure the first year is not an 'outlier' year. Gaps in the data will result in an incomplete data set. It is critical that all the raw data be kept for re-processing at later dates. Significant data gaps generally result in a repeat of a full annual cycle survey.

Collecting all ancillary metocean data together, at the same location and over the same deployment duration, ensures that relationships can be established between wind-waves and ocean-waves, for example, or the presence of marine mammals based on certain season or oceanic conditions. It adds value to the dataset for the long-term site development.

The Floating Lidar data is generally developer led in full, but in some EU states the State is deploying some of these to gather baseline data for site developers. Basic metocean data which can include waves, currents, meteorology, turbidity is sometimes collected by the State as part of its ongoing data collection, such as the long term "M" Buoys in Ireland.

1.4.3 Deployment Location

The final location of the seabed frames and wave buoy's will be decided based on the hydrography of the site to ensure all meteorological and oceanographic variations are captured for accurate model representation of the site, and with further detailed engagement with key stakeholders, in particular fishers, in the area.

Appendix 2 Infographic illustrating sequence and timing of survey tasks.

1. A sample timeline, taken from the Society for Underwater Technology's "*Guidance Notes for the Planning and Execution of Geophysical and Geotechnical Ground Investigations for Offshore Renewable Energy Developments*".

(link: https://www.sut.org/wp-content/uploads/2014/07/OSIG-Guidance-Notes-2014_web.pdf)

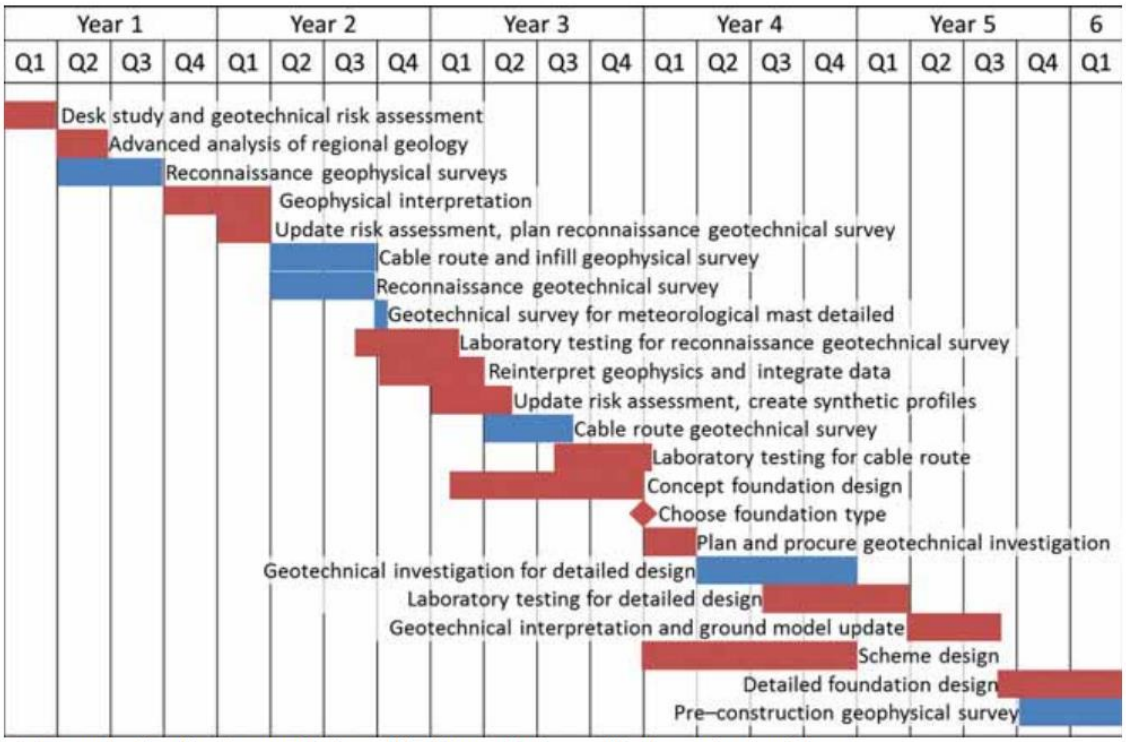

Figure 3: Example Timeline for an Offshore Wind Farm Project – Site Investigation Phase