IHO Presentation – Offshore Renewables

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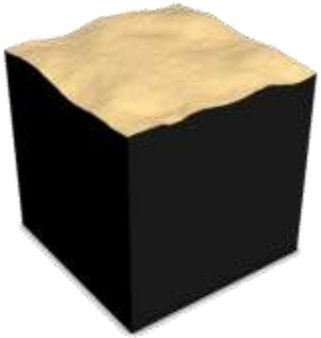
Fugro's Resources in Renewables

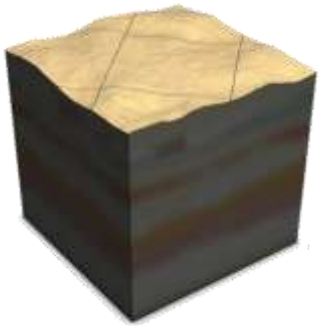
Fugro:

Consults	Measures	Samples	Interprets	Integrates
Geophysical Data	Geotechnical Data	Environmental Data	Meteorological Data	Oceanographic Data

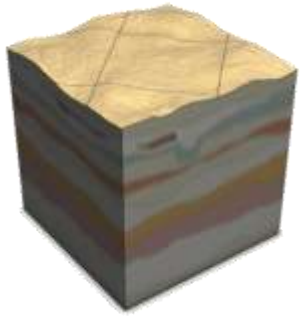
Site Design and Assessment



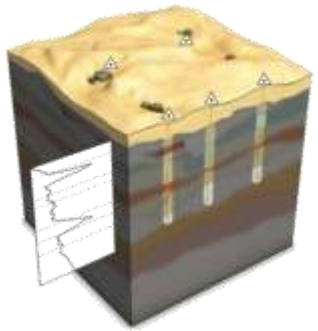
Starting Point



Desk top study

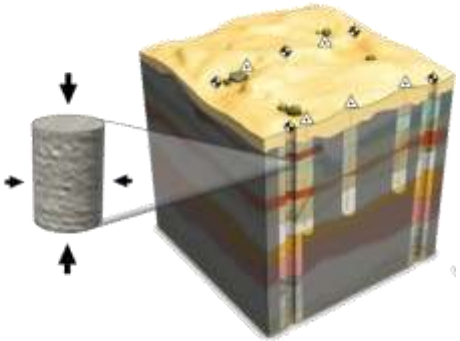


Geophysical Surveys



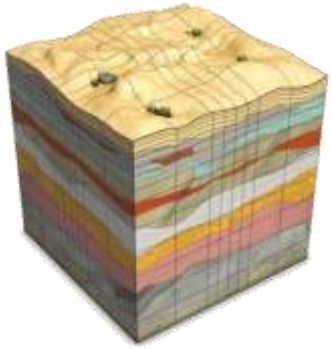
Insitu Testing (CPT)

Boreholes sampling & testing

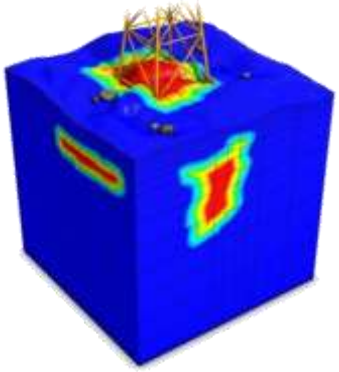


Lab Testing and Analysis

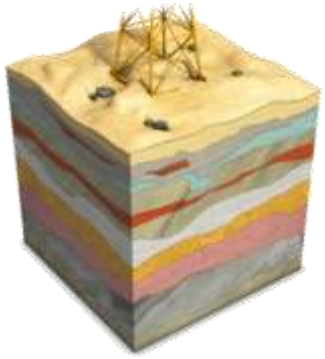
Interpretation and Integration



Engineering Ground Model



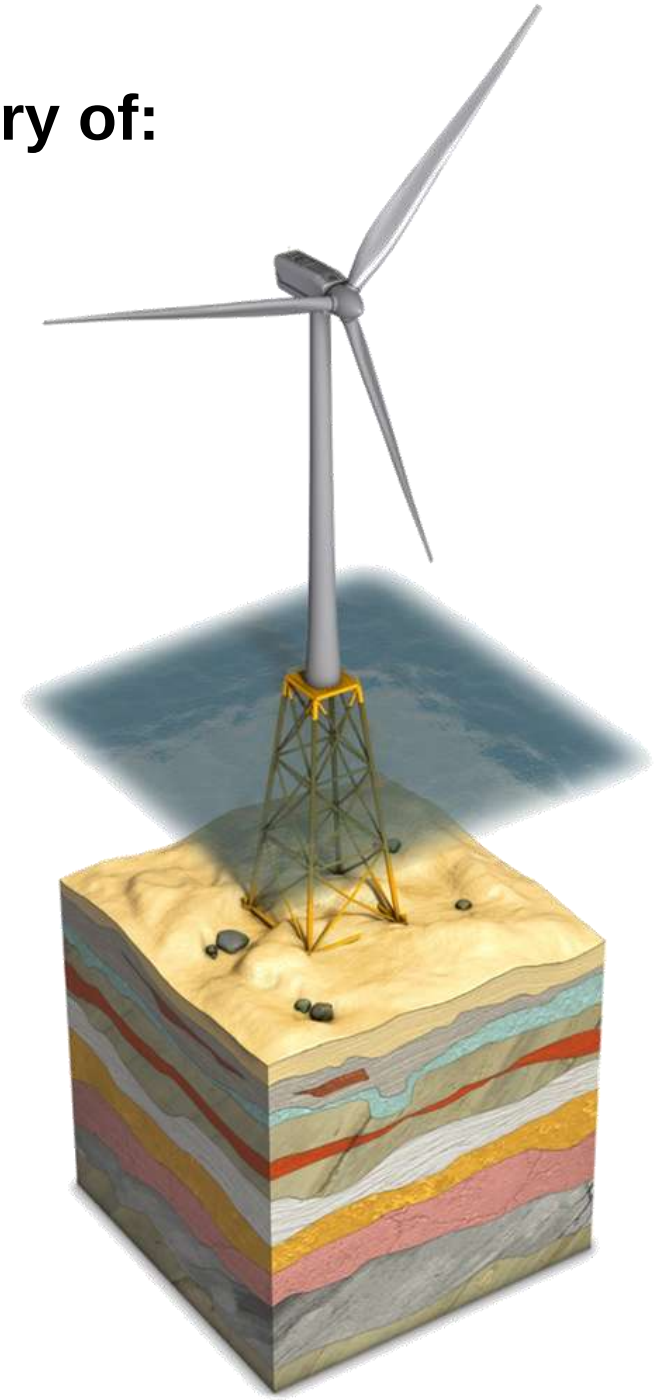
Engineering Analysis and Design



Optimised design

Supporting in the delivery of:

Optimised design and location, installed on time and operating reliably



Typical Offshore Wind Project Life Cycle

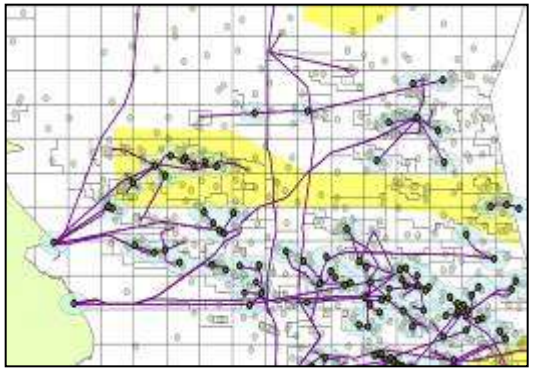
Feasibility and licence application → Consent and FEED studies → Detailed design and procurement → Construction and commissioning → Operation and maintenance → Decommissioning

1. Feasibility and licence application *(1 year)*
2. Consent and FEED studies *(2 years)*
3. Detailed design and procurement *(2 years)*
4. Construction and commissioning *(2 years per project zone)*
5. Operation and maintenance *(25 years)*
6. Decommissioning

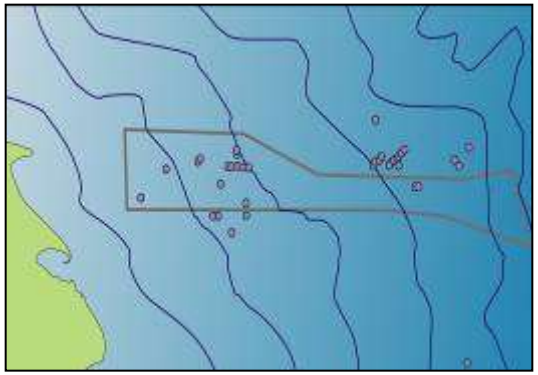
Desktop & Feasibility Studies

Feasibility and licence application | Consent and FEED studies | Detailed design and procurement | Construction and commissioning | Operation and maintenance | Decommissioning

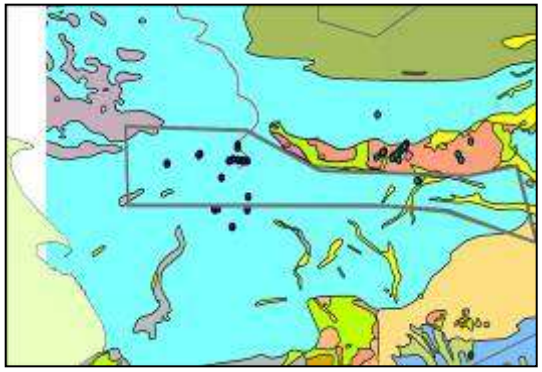
Before a site can be considered for development, existing information about the target location need to be gathered and analysed.



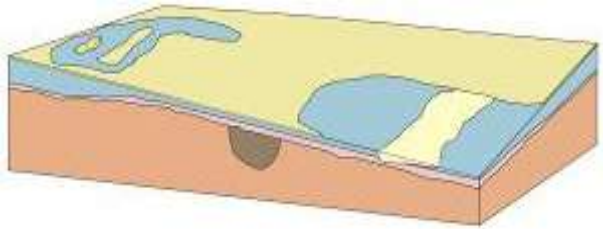
Public Domain



Client



Fugro Experience



Site-Specific Soil Model

Initial **risk mitigation** and **management strategies** are developed jointly with the client and continually updated throughout the development of the 'ground model'.

Site screening of all available data to select suitable sites.

Environmental Survey

Feasibility and licence application | **Consent and FEED studies** | Detailed design and procurement | Construction and commissioning | Operation and maintenance | Decommissioning

Fugro is able to provide the marine environmental consultancy services required in the development of offshore marine renewable facilities.

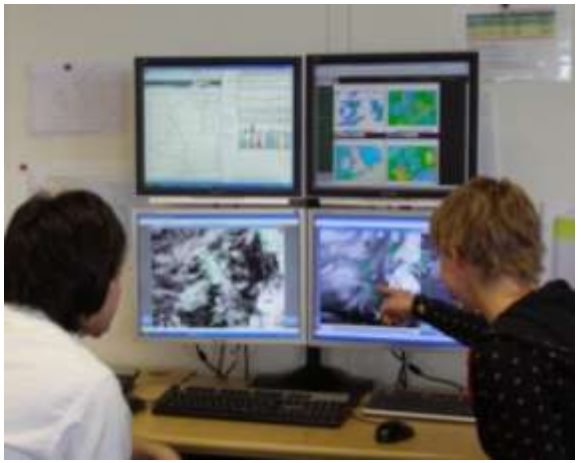
Environmental services include:

- *Marine environmental impact assessment*
- *Management and permitting*
- *Environmental appraisal*
- *Survey and monitoring services*
- *Biological analysis*

Metocean

Feasibility and licence application | **Consent and FEED studies** | **Detailed design and procurement** | Construction and commissioning | Operation and maintenance | Decommissioning

The collection and integration of metocean data enables cost effective foundation design and aids the selection of appropriate installation vessels



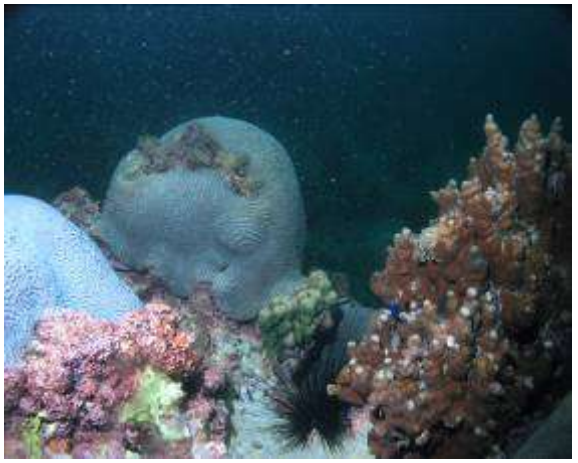
Data sources include:

- *Measured (ad-hoc, project basis)*
- *Real-time monitoring (buoy networks & platform based)*
- *Remote sensed data (winds, waves, currents)*
- *Modelled data (range of current, wave & atmospheric models)*

Site Investigation: Geophysical Survey

Feasibility and licence application | **Consent and FEED studies** | Detailed design and procurement | Construction and commissioning | Operation and maintenance | Decommissioning

Armed with desktop study and risk assessment data, Fugro is able to plan and undertake an optimum geophysical survey campaign.



These surveys may include:

- *Multibeam echo sounder surveys*
- *Sidescan sonar surveys*
- *Reflection & refraction seismic surveys*
- *UXO surveys / LIDAR*
- *Environmental sampling & testing*
- *Ultra high resolution multi-channel digital seismic*

New Geophysical Vessel for Renewables

Site Investigation: Geotechnical Survey

Feasibility and licence application | **Consent and FEED studies** | **Detailed design and procurement** | Construction and commissioning | Operation and maintenance | Decommissioning

Fugro deliver a thorough analysis of the target site using the most up-to-date technology via our geotechnical vessels and jack-up rigs.

Geotechnical services may include:

- *Boreholes and Seabed CPTs*
- *Wireline WISON CPT*
- *Wireline geophysics*
- *100mm diameter wireline coring*
- *Push (WIP) Sampling*
- *Offshore laboratory testing*

Geotechnical Vessel Listing

Europe / Africa / ME

- **Fugro Commander**
- Bavenit
- Bucentaur
- Fugro Adventurer
- **Markab**

SEA / Australia

- Mariner*
- Greatship Maya
- Fugro Voyager (2012)

Americas

- Seaprobe*
- Fugro Explorer
- Fugro Scout (2013)

Long Term Charter

- **Gargano**











** to be replaced with new builds*

Specialist Equipment: Block Drive CPT

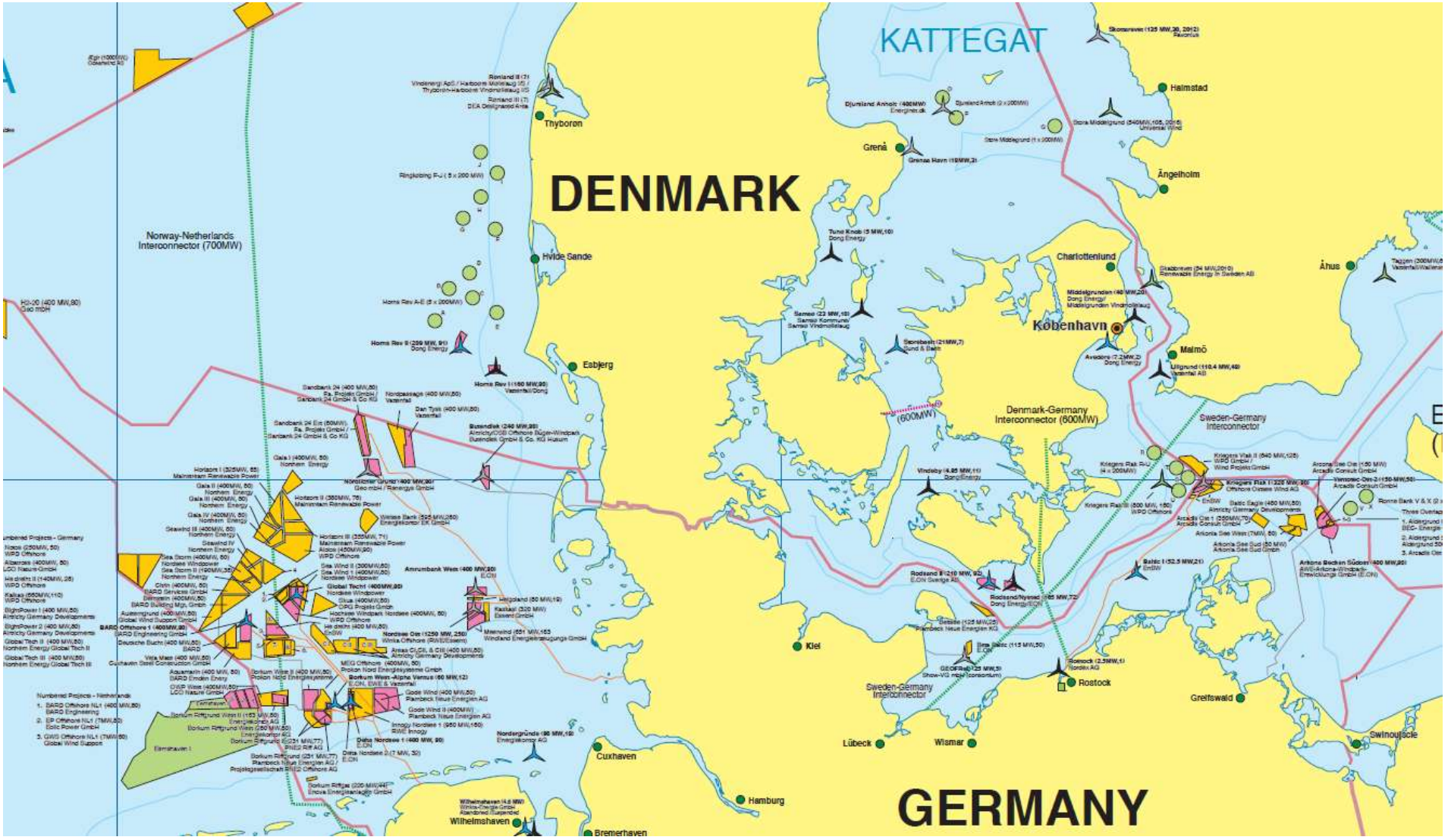
EQUIPMENT SPECIFICATION	
Thrust capacity	200 kN
Weight in air	250 kN
Height	4.9 m
Base size	3m x 3m
Power supply	20-40 kVA

Specialist Equipment: Piggy Back Drilling

Specialist Equipment: Charon Boom Coring

Fugro Commander

Fugro Wind Farm Experience - *Germany*



Fugro Wind Farm Experience - *UK*

Laboratory Testing

Feasibility and licence application | **Consent and FEED studies** | **Detailed design and procurement** | Construction and commissioning | Operation and maintenance | Decommissioning

To determine accurate predictions of foundation behaviour detailed soil/rock analysis is required.

Our laboratories provide:

- *Routine soil testing*
- *Effective stress testing*
- *Soil dynamics testing*
- *Rock testing*

Laboratories – *Global Capacity*

Total Stress Testing:	**Global Capacity**
UU triaxial systems	67
Small shearbox	46
Large shearbox	6
Ringshear	7
Oedometers (incremental)	330
Oedometers (CRS)	50

Effective Stress Testing:	
Effective stress systems (ie CU/CD)	285
Number of these capable of anisotropic consolidations	95
Number of cells with Bender Element option	13
Number of cells with small strain option	9
Number of cells with K0 consolidation option	46

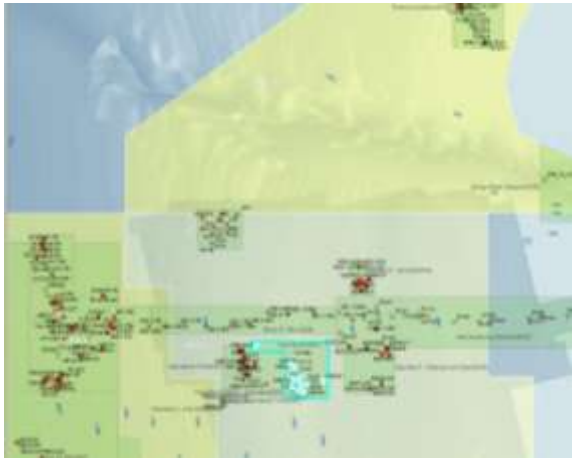
Dynamic/Cyclic Testing:	
Cyclic triaxial	12
Direct Simple Shear (static or cyclic)	29
Resonant column	13

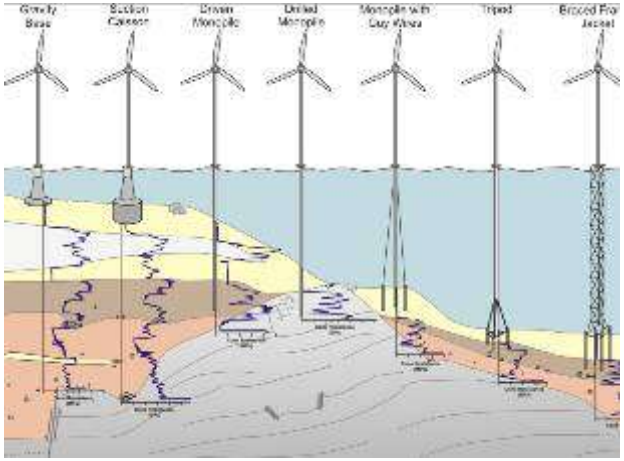
Staff:	
Total number of lab staff	591
Number of these on geotechncial testing	226

Foundation Design & Engineering

Feasibility and licence application | **Consent and FEED studies** | **Detailed design and procurement** | Construction and commissioning | Operation and maintenance | Decommissioning

Structural foundations are critical to the integrity of offshore renewable facilities, especially when located in harsh or challenging environments.





- *Mudmat calculations*
- *Drivability studies*
- *Leg penetration analysis*

Data Management

Feasibility and licence application | Consent and FEED studies | Detailed design and procurement | **Construction and commissioning** | **Operation and maintenance** | Decommissioning

Windfarm developments generate significant volumes of data which needs to be managed, processed and archived

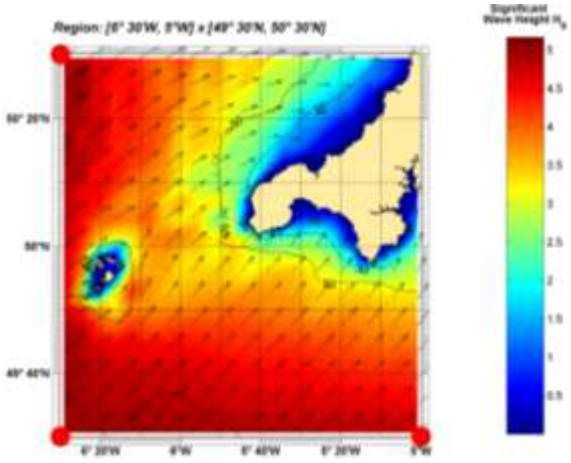
Our data management services include:

- *Collection and integration of all survey data*
- *Structural condition monitoring*
- *Sample storage*
- *'As built' data for the wind farm and cables*

Metocean construction support services

Feasibility and licence application | Consent and FEED studies | Detailed design and procurement | **Construction and commissioning** | Operation and maintenance | Decommissioning

Information about the environmental conditions in which marine structures will operate underpins the planning, installation and operational phases.



Our metocean specialists are able to provide:

- *Site specific weather forecasting*
- *Vessel downtime analysis*
- *Real-time environmental monitoring*
- *Helipad monitoring*

Foundation Installation Services

Feasibility and licence application | Consent and FEED studies | Detailed design and procurement | **Construction and commissioning** | **Operation and maintenance** | Decommissioning

Marine large diameter piling requires specialist plant and experienced operators

- *In house design and fabrication*
- *Large diameter drilling to 8+ meters*
- *Pile top relief drilling*
- *'Hammer less' piling*

Structural Monitoring

Feasibility and licence application | Consent and FEED studies | Detailed design and procurement | Construction and commissioning | **Operation and maintenance** | Decommissioning

Monitoring of structures and foundations will provide increased confidence in designs and may lead to future reductions in cost.

Our structural monitoring specialists are able to provide:

- *Pile hammer performance and pile capacity assessment*
- *Structural behaviour*
- *Foundation design assessment*

Pile testing and monitoring

Marine Construction Support and O&M

Feasibility and licence application | Consent and FEED studies | Detailed design and procurement | **Construction and commissioning** | **Operation and maintenance** | Decommissioning

Offshore installation of cables and the operation and maintenance of offshore cables and turbines require cost effective solutions

Our marine construction and O&M support services include:

- *Seabed trenching*
- *ROV subsea inspection*
- *Positioning and levelling of jacket structures*
- *Vessel installation stability assessments*
- *O & M vessels*

Cables

Feasibility and licence application | Consent and FEED studies | Detailed design and procurement | **Construction and commissioning** | **Operation and maintenance** | Decommissioning

Cable design and installation requires high quality integrated data and appropriate installation and inspection machinery

Our cable services include:

- *Geophysical and geotechnical surveys*
- *Data integration*
- *UXO surveys*
- *Laboratory testing*
- *Burial assessment*
- *Depth of burial surveys*

More information available at:
www.fugrorenewables**.com**

Thank You