Society for Underwater Technology

OFFSHORE SITE INVESTIGATION AND GEOTECHNICS GROUP
Bath Rugby Club
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Delivery of an Offshore Wind Farm

An overview of the expectations and challenges of planning, consenting, installing and operating a large (5>MW Turbines) offshore wind farm.

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Introduction

- **GEODATA MANAGEMENT FOR OFFSHORE WINDFARMS**

- **MARINE SURVEY – EARLY PLANNING**
- Planning and Consenting
- Foundations and Turbines
- Cables

- **SITE ENGINEERING – ADVANCED PLANNING**
- Monopile Siting and Jack Up Stability
- Cable Burial Risk Assessment

- **INSTALLATION – CONSTRUCTION PHASE**
- Protecting installed Foundations
- Protecting cables during installation
- Protecting cables for lifecycle of project

Planning and Consenting

Brief Summary (Example Gwynt Y Mor)

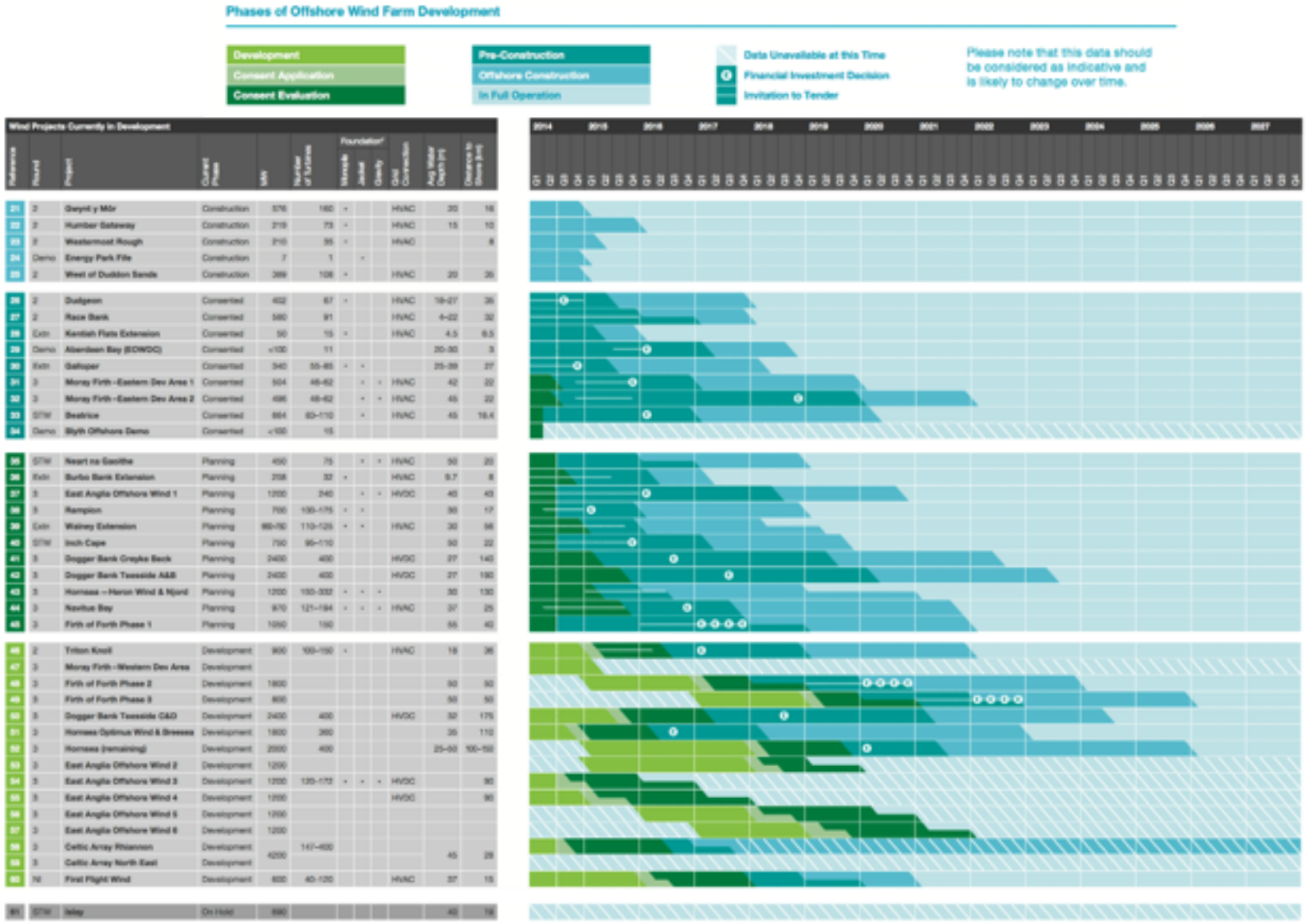
- 2002-2003 Planning and Tendering of Round 2 Wind Farms
- 2004-2005 Regional survey data acquisition / FEED Study
- November 2005, Developer submits application
- 2006-2008 Stakeholder discussions/negotiations
- Consent granted December 2008 (3 years and 1 week later)

Typical Timelines for future projects:

- Renewable UK - Offshore Wind Project Timelines May 2014
- Multiple year consenting process
- Financial Investment Decision; 1-2 years before construction
- Technology and resources - are the projects possible?

Planning and Consenting

- Source: RenewableUK



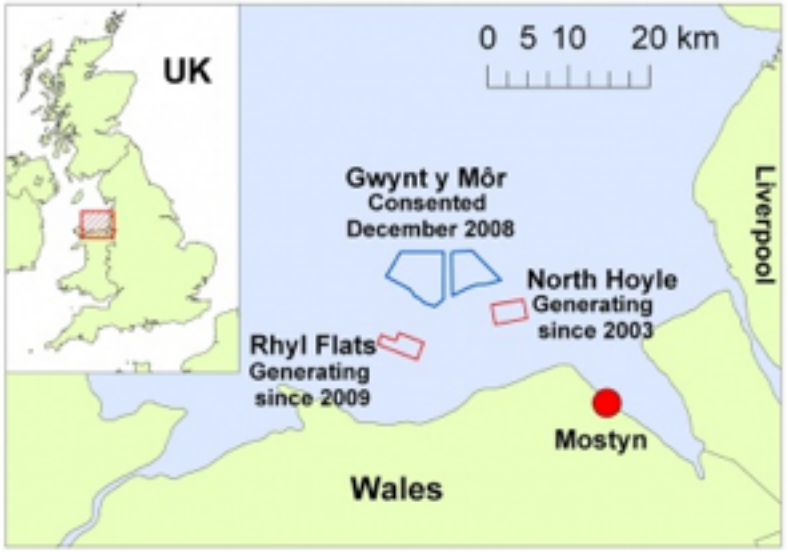
Gwynt Y Mor Windfarm

- 4 Export Cables linking 2 offshore substation platforms (OSP)
- 20-22km in length

- 162 Array Cables linking the 2 OSP with 160 monopile turbines
- Typically 1km in length

- Water depths 0m to 30m
- Varied seabed terrain
- Existing infrastructure
- (pipelines, cables, windfarms)

- Surveys 2002-2013
- Construction 2012-2014



Marine Survey Data for Offshore Wind Farms

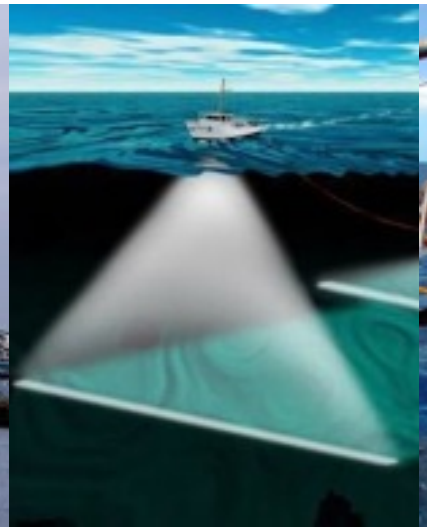
- **What types of Data?** **How is it collected?**

- **GEOPHYSICAL**
- Regional/area survey – low to medium resolution – turbine planning
- Cable Survey – medium resolution – export & inter-turbine areas
- UXO Survey – high resolution – export and array cables

- **GEOTECHNICAL**
- Boreholes at foundations, OSP and metmast locations (40m+)
- CPT at turbine foundations 5m+
- CPT for cable routes top 0-3m
- Vibrocores/sampling – for sediment classification (top 0m-3m)

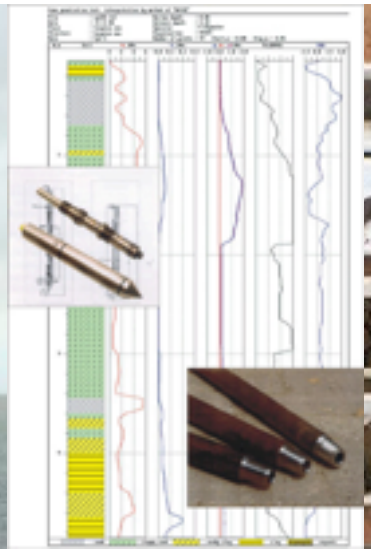
Survey Data for Offshore Wind Farms

- **GEOPHYSICAL**
- Seabed Conditions – Hazards, sediments, hardness, mobility
- Bathymetry – water depth, slopes, tides, (currents)
- Equipment – survey vessel – sidescan sonar, echo sounder, sub bottom profiler, shallow seismic, magnetometer, sampling



Survey Data for Offshore Wind Farms

- **GEOTECHNICAL**
- Soil Conditions – composition, hardness/softness, layers
- Equipment – Drill Jack Up/Vessel – Borehole Drilling, Cone Penetrometer Testing, Vibro-coring, drop coring, grab sampling
- Lab Testing – further testing of soil characteristics



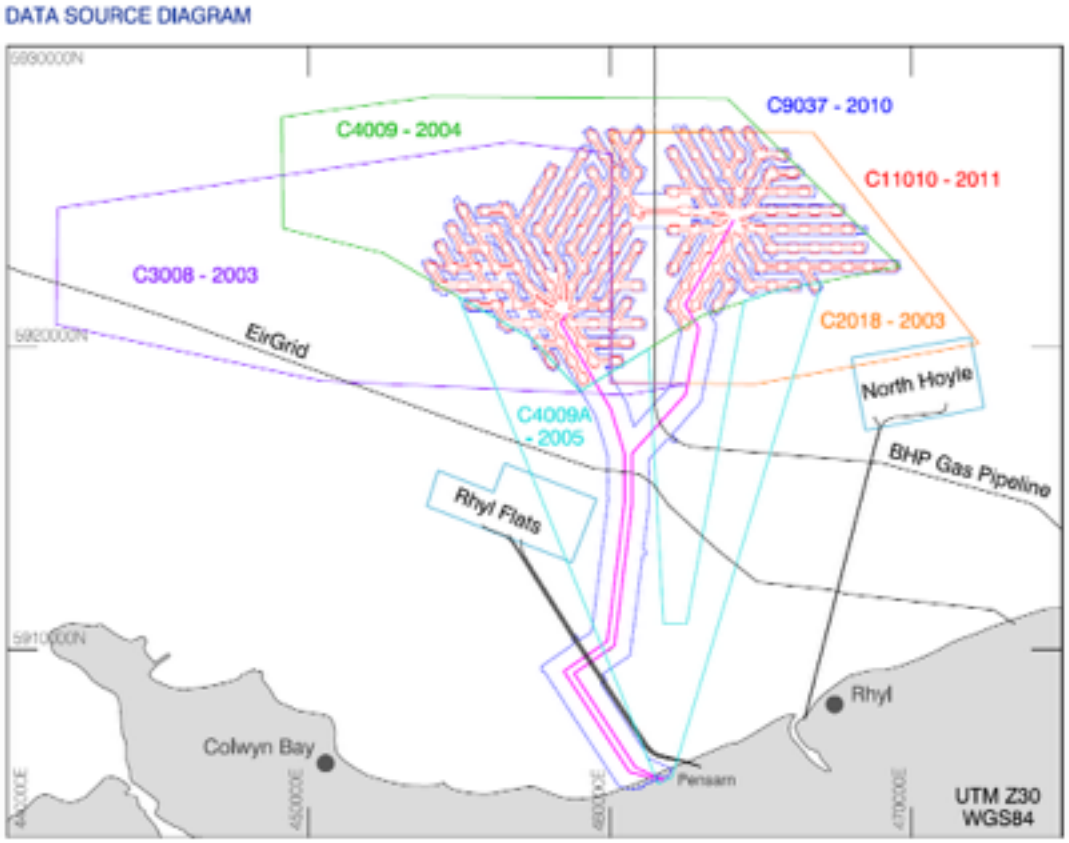
Survey Data for Offshore Wind Farms

- **OTHER SURVEY DATA SOURCES**

- **HISTORICAL DATA**
- Cable Databases / Oil & Gas Concessions
- UKHO charts
- 3rd Party Datasets (academic, government and commercial)

- **DURING CONSTRUCTION**
- Diver Swim Investigations (rock dump and aperture areas)
- Pre Survey ROV survey (cable route and lay down areas)
- Post lay inspection and bathymetry surveys (cables/rock dump)
- Detailed UXO surveys (2014 after 3 x WW2 bombs discovered)

Survey Data Acquisition on GYM

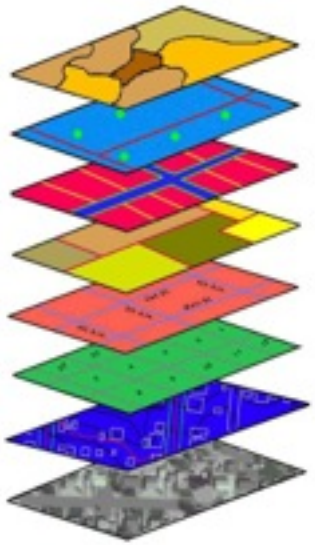


- sidescan sonar
- sub bottom profiler
- shallow seismic
- single beam bathymetry
- multibeam bathymetry
- coring
- grab sampling
- magnetometer

- towed gradiometer
- ROV gradiometer
- AUV hi res sidescan

Survey Data Management

- **DATA HANDLING** - creating a unified mapping database



Seabed bathymetry
Sediments
Seabed Hazards (boulders, wrecks, UXO)
Infrastructure (pipelines, cables, buoyage)
Boundaries (permits, shipping zones etc)
Planned construction (foundations/cables)
Temporary infrastructure (jack-ups etc)
As built construction (foundation, topsides, cables)

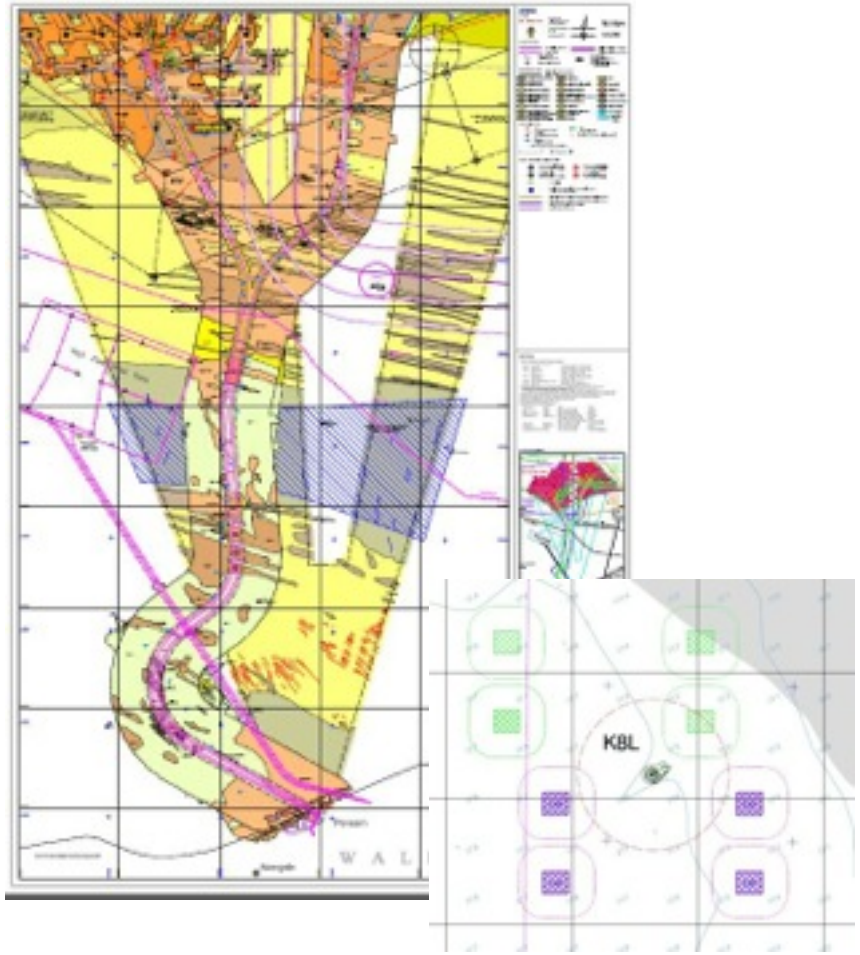
- **CAD and GIS DATABASES**
- **Evolving as works continue**

Cable Burial Assessment: Data Usage

- **CHART SERIES**
- 1:15000 OVERVIEWS
- 1:3000 ANCHOR PLANNING
- 1:500 TURBINE FOOTPRINTS

- **DATA FORMATS**:
- CAD
- GIS (SHAPE DATA)
- PDF (CAN BE VIEWED BY ALL)

- DIGITAL BUT CAN BE PLOTTED



Lessons Learned: Survey

- Good survey data is required to select appropriate cable burial methodology and equipment
- Early planning of cable routes, orientation of turbine connections
- Consideration of data coverage to accommodate anchor patterns
- Educating the end user on data suitability, resolution and data deficiencies/shortcomings
- Ensuring project flexibility to collect additional survey data when needed
- Standardise mapping and vertical reference datums

Lessons Learned: Installation

- **Good quality survey data** is vital for safe installation
- Engage with construction contractors early in project lifecycle
- Design cable routes with flexibility for different burial tools
- Carefully consider the threat level vs difficulty of installation
- Ensure lessons learned are passed on to other projects
- We are still installing, there will likely be more lessons!

Conclusions:

- GYM generated first power in September 2013
- Construction to be completed 2014 (turbines), early 2015 (cables)
- Remedial works will be required on array cables
- High scour area - seabed monitoring will be required across site
- **Expect the unexpected.** We discovered 3 WW2 bombs on site

THANK YOU, ANY QUESTIONS ?