CELTIC SEA - INSTALLATION OF FLOATING OFFSHORE WIND TURBINES

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ABSTRACT

Floating offshore wind turbines are part of the future for marine renewable energy. Both demonstrator and pre commercial floating wind turbines are being considered for installation in the Celtic Sea. As the floating offshore wind turbine industry continues to develop, the capabilities of new crane vessels can play a crucial role in their installation. This presentation assesses current installation vessel requirements and capabilities in particular for installing the moorings and sub sea cables .

The water depths, average wind speed and potential areas of the Celtic Sea are discussed. The naval architecture aspects of floating wind turbine installation for tow out include intact stability, bollard pull and motions. In addition as the floating offshore wind turbine is being installed there are motion considerations of connecting mooring lines and electrical cables.

The floating offshore wind industry is in early stages of development and installation vessel requirements are still being considered. The presentation discusses the potential of different floating offshore wind substructures types for installation in the Celtic Sea.

Connecting – Cable Layer = dynamic cable
AHTS = connect moorings

INDEX

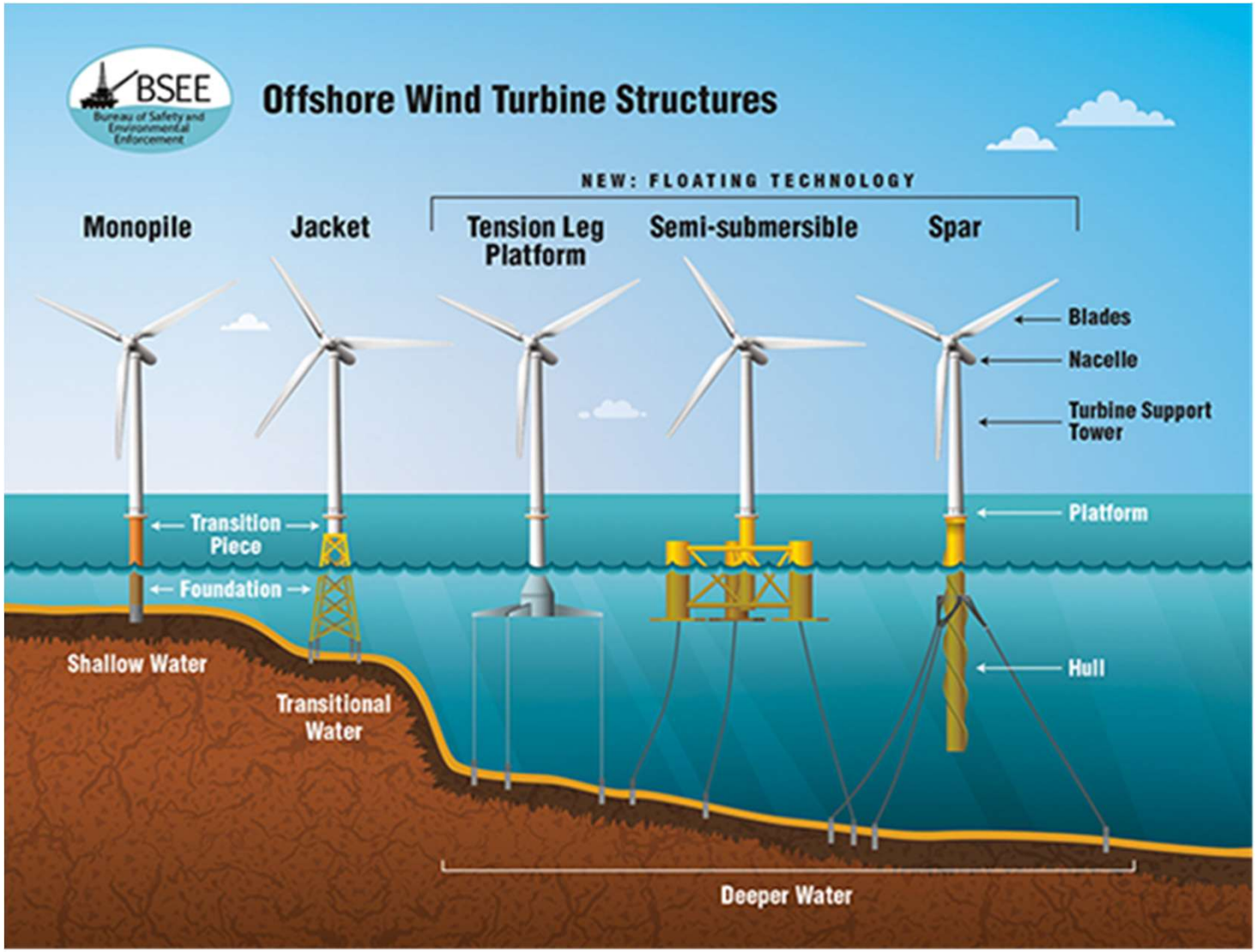
1. INTRODUCTION

The Celtic Sea is a possible area for floating wind deployment. This presentation will look at floating wind types, local ports, installation vessels required for floating offshore wind turbine installation.

2. FLOATING WIND TYPES

Floating wind possible water depths > 60m
Starts to be economical (compared to fixed) > 80m

FIXED TO FLOATING (ref [1]



Notes

SEMI SUBMERSIBLE

a. The Wison has 12 mooring lines, 3 per column

b. The Windfloat has 4 moorings and 3 columns

- 2 on the column supporting the turbine
- 1 each on the other 2 columns

SPAR

a. 70 to 80m draft. Probably not possible to return to port for heavy maintenance

TLP

a. Low intact stability during tow out, need temporary buoyancy or offshore crane
b. Complex mooringds. Probably not possible to return to port for heavy maintenance

SPAR TYPE (ref [2])

There are 5*5MW steel floating spar offshore wind turbines in Scottish waters

Draft =70m

Norway is building 11*8.8MW concrete Spars

Current status of FOWT

Name	Type	Sub Structure Built	Sub Structure Material	Turbine Outfitting	Final location	Status
Wind float	Semi sub	Spain	Steel	Portugal	Portugal	Operating (3 * 8.4MW)
Wind float	Semi-sub	Spain	Steel	Netherlands	UK (East coast of Scotland)	Operating (5 * 9.6 MW)
Hywind	Spar	Spain	Steel	Norway	UK (East coast of Scotland)	Operating (5 * 6MW)
Hywind	Spar	Norway	Concrete	Norway	Norway	Under construction (11 * 8MW)
Barge	Damping pool	France	Concrete	France	France	Demo (1 * 2MW)
Barge	Damping pool	Japan	Steel	Japan	Japan	Demo (1 * 3MW)
Wison	Semi-sub	China	China	China	China	5MW

SEMI SUBMERSIBLE (ref [3])

Semi submersible offshore wind turbines

There are 3*5.5MW off Portugal

There are 5*9.6MW in Scottish waters

Draft = 10-12m

WISON SEMI SUBMERSIBLE (ref [4])

SUBSTRUCTURE:
> 91m long
> 91m wide
> 32m height

For a 5MW Wind Turbine and extreme typhoon conditions.

Wison tow out

Vessels:

- Large towing tug with bridle
- 3 medium sized tugs for steering

WISON CONNECTION OF MOORINGS

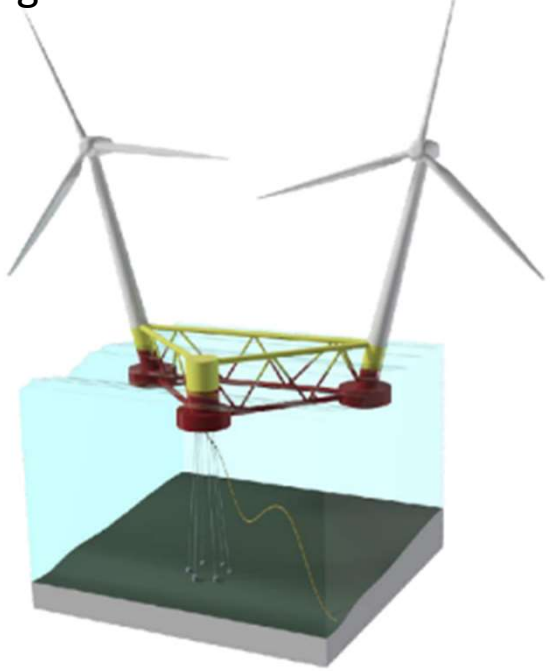
MOORING CONNECTION, LARGE CRANE VESSEL

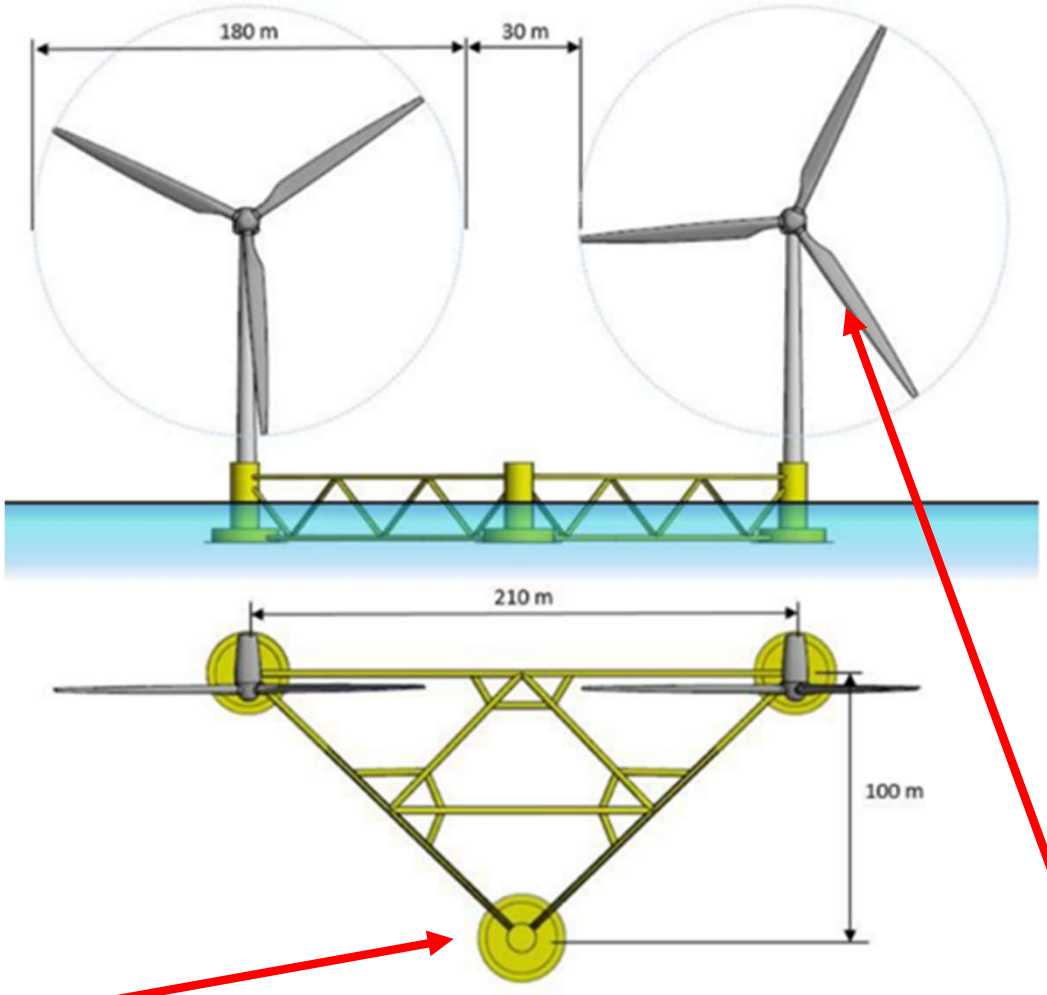
SMALL CRANE VESSEL

WISIN CONNECTING DYNAMIC CABLE

HEXICON (for WAVEHUB) Ref [5]

Length = 390m
Width = 120m
Draft = 10m
Height above water = 210m





SWIVEL-TURRET

180m rotor diameter = 2*9MW

CELTIC SEA

AREA

The following countries are in the Celtic Sea:

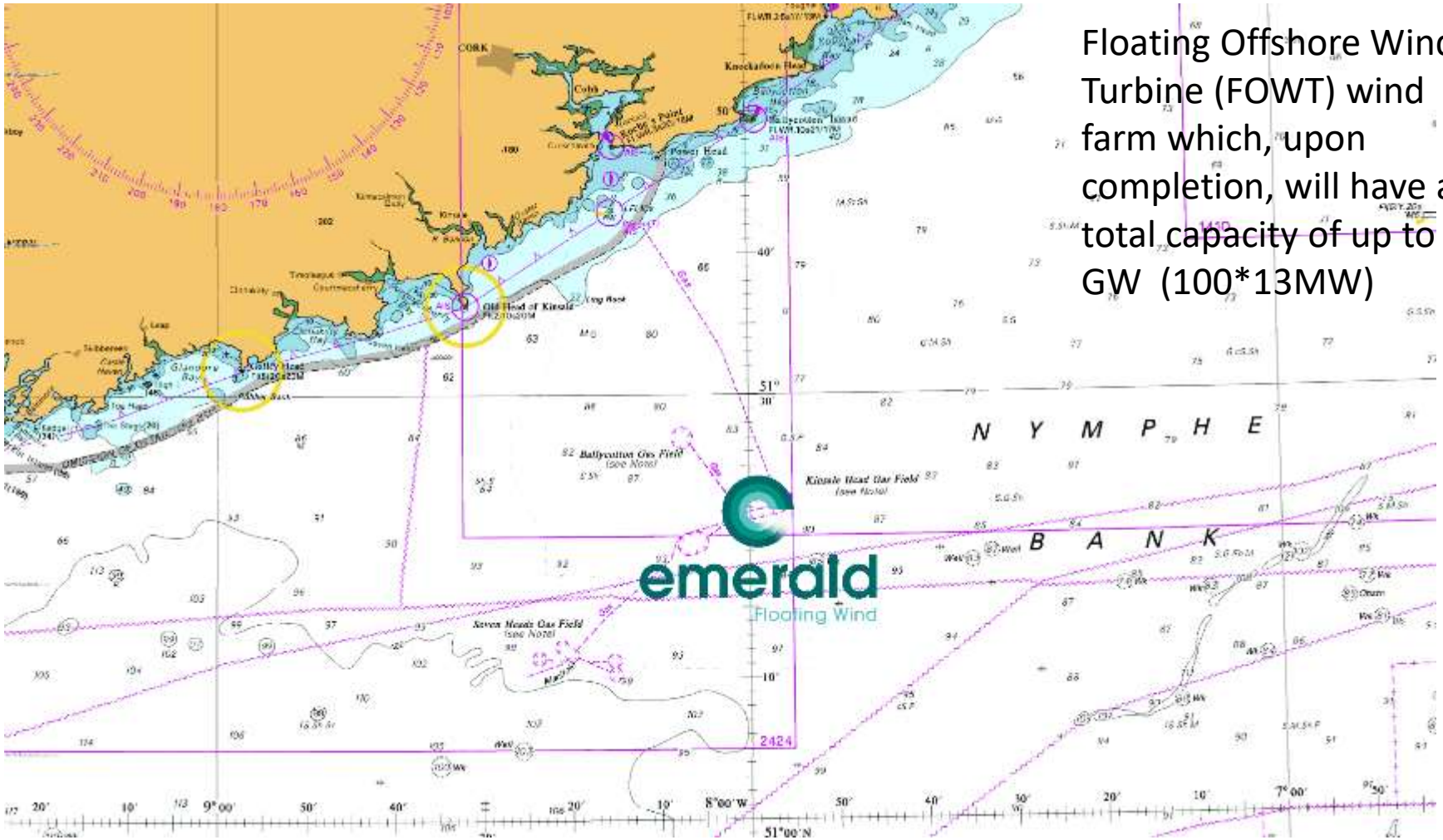
- Irish Republic
- United Kingdom
- France

The Celtic Sea is south west of the line between Rosslare and Fishguard.

CROWN ESTATE

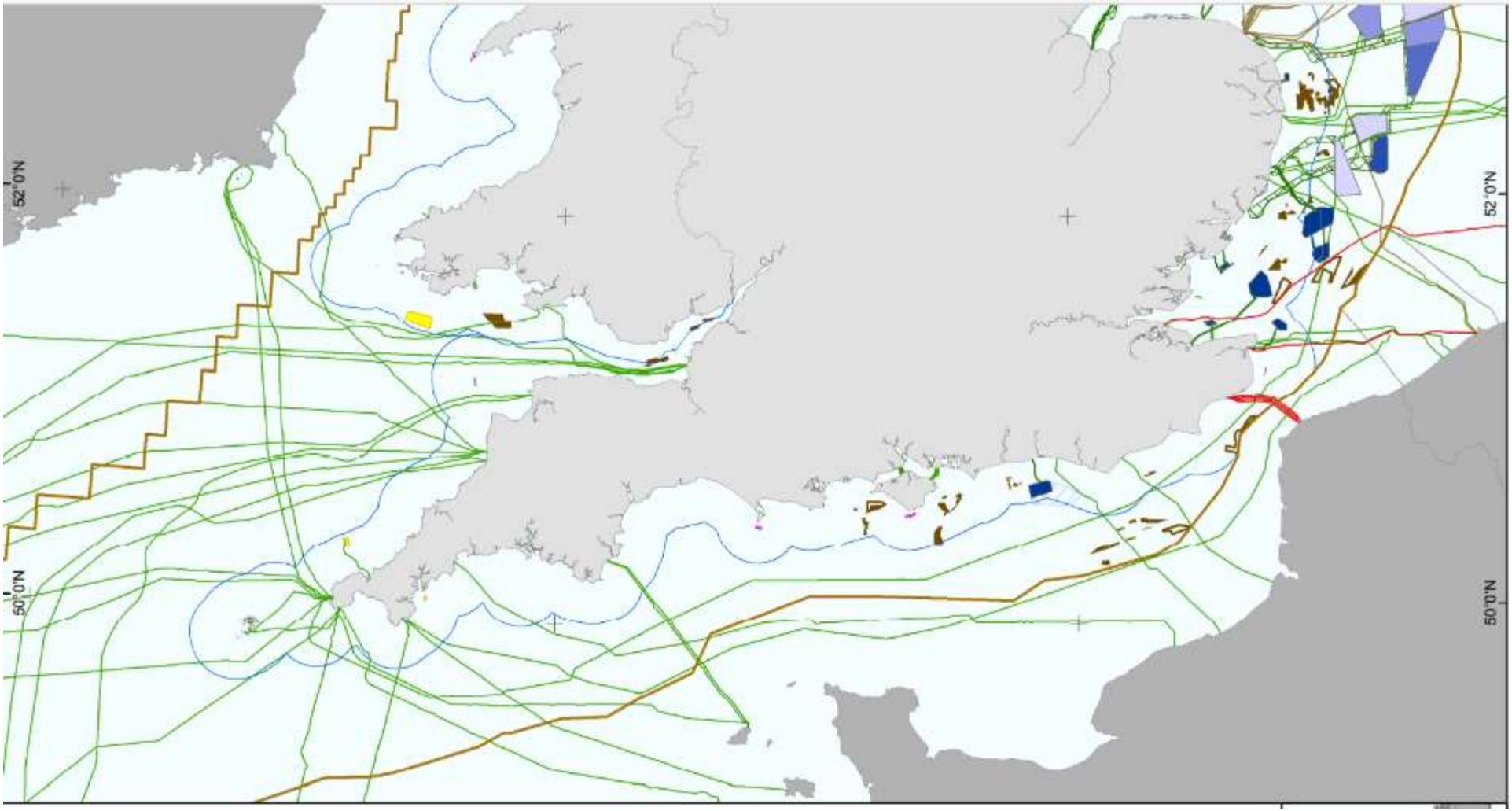
The Llŷr project involves two offshore sites with a capacity of 100MW each south of Pembroke, while the 100MW Whitecross scheme is to be located off the coast of Devon and Cornwall.

Emerald Off Cobh



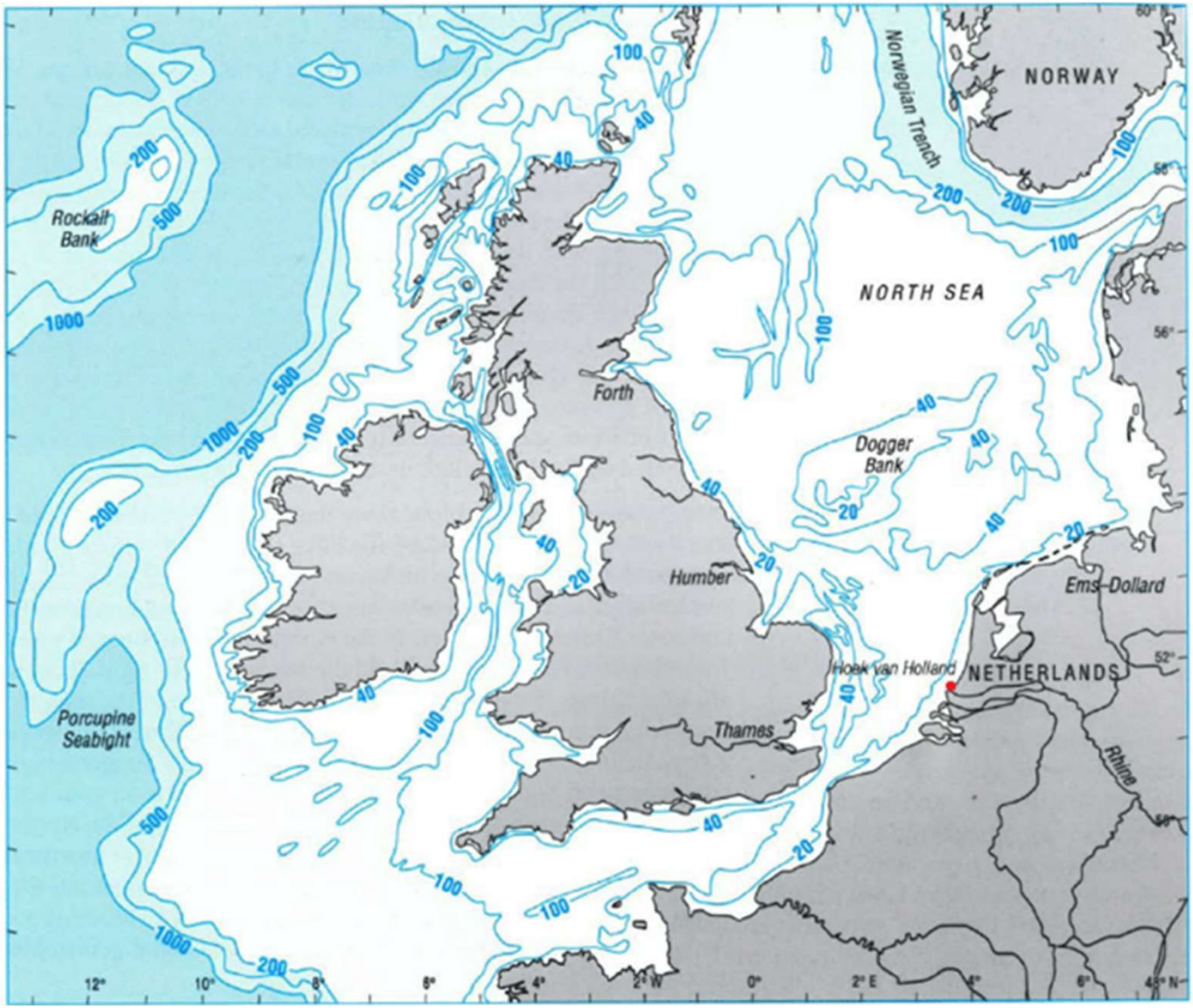
Floating Offshore Wind Turbine (FOWT) wind farm which, upon completion, will have a total capacity of up to 1.3 GW (100*13MW)

UNDERWATER CABLES



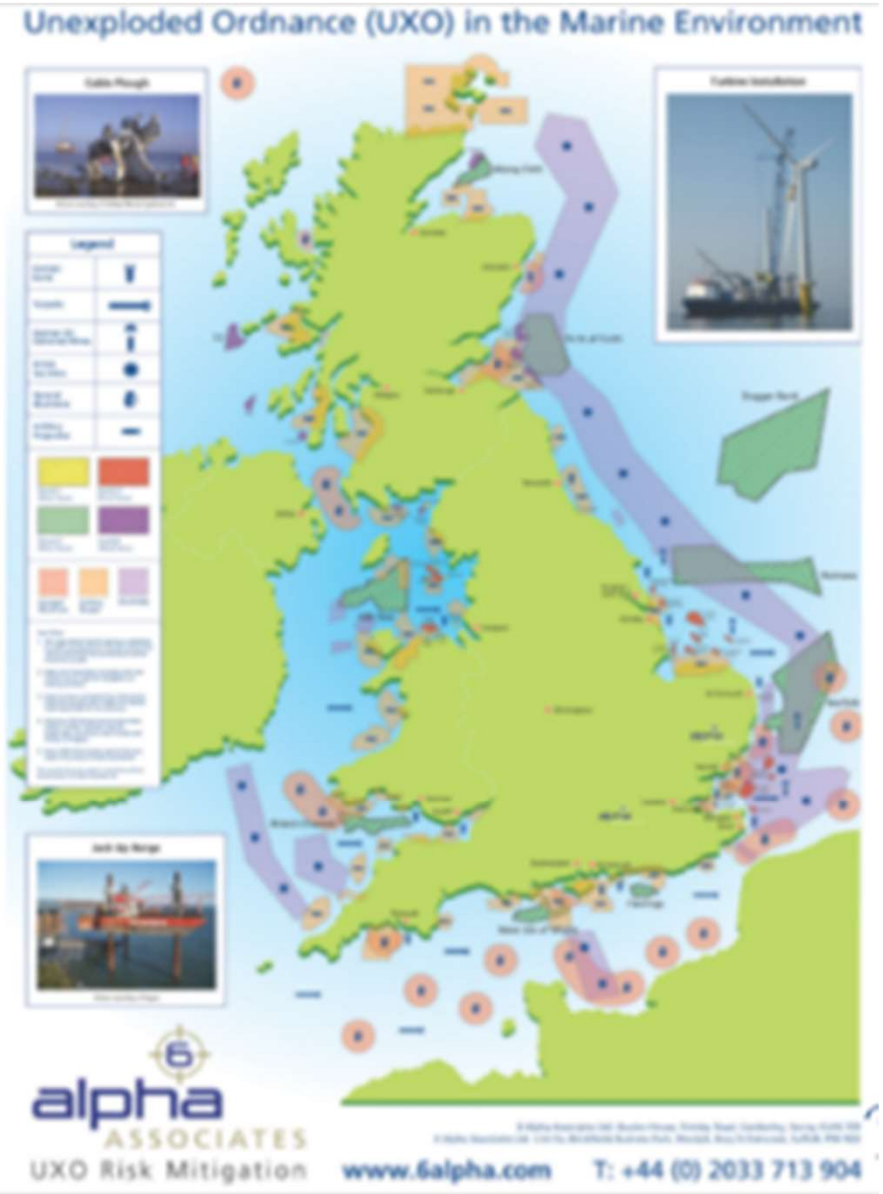
WATER DEPTHS

In metres



Unexploded Ordnance

- A lot of UXOs around the UK
- Not all the same type
- Strategies for dealing with UXOs may vary from:
  - Leave alone
  - Remove
- Selection of strategy will depend on UXO type, location, and cost

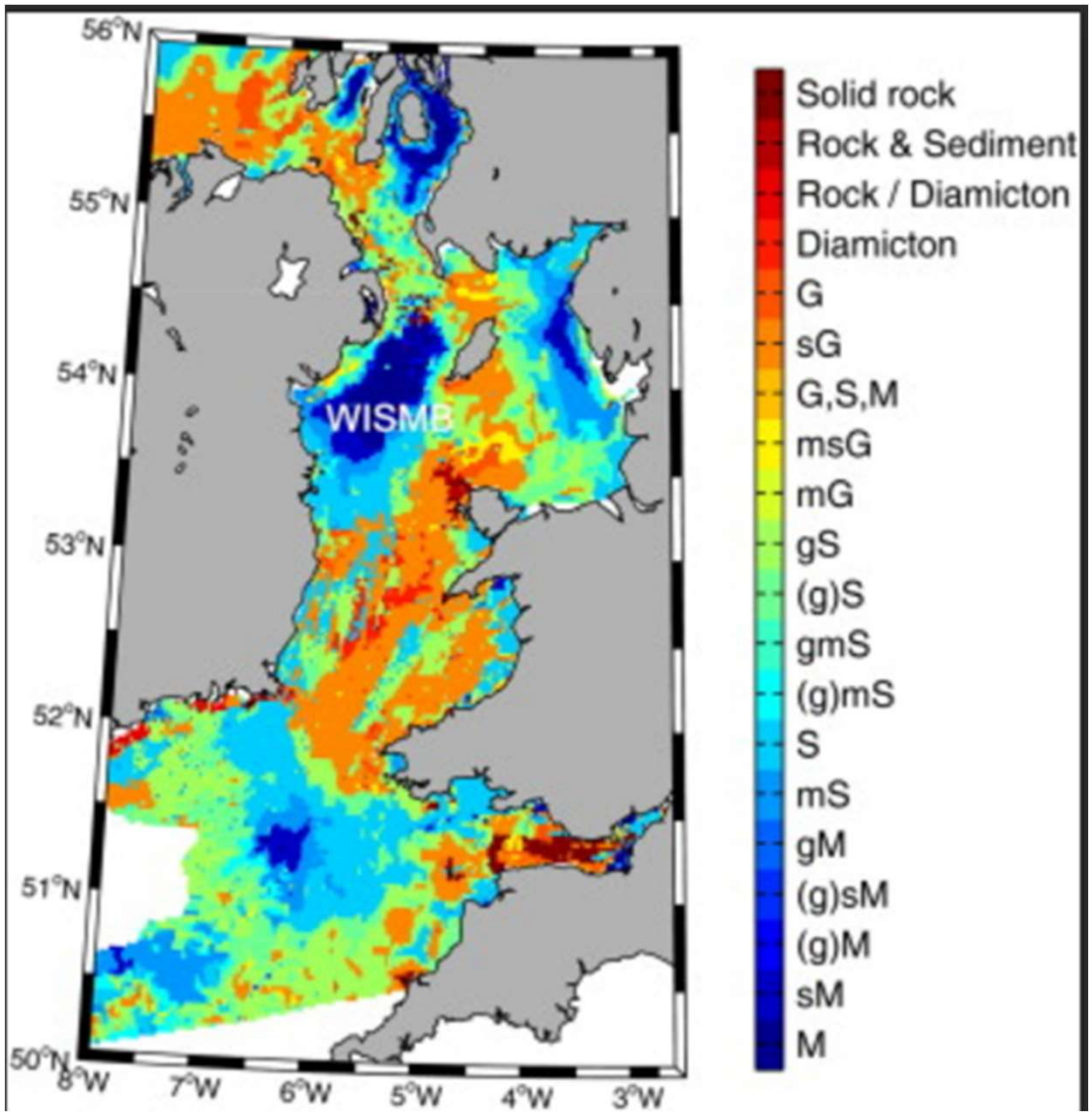


SEABED

Hard:
- Drilling pile

Medium
- Driven pile
- Suction pile

Soft:
- Drag anchor



LOCATIONS

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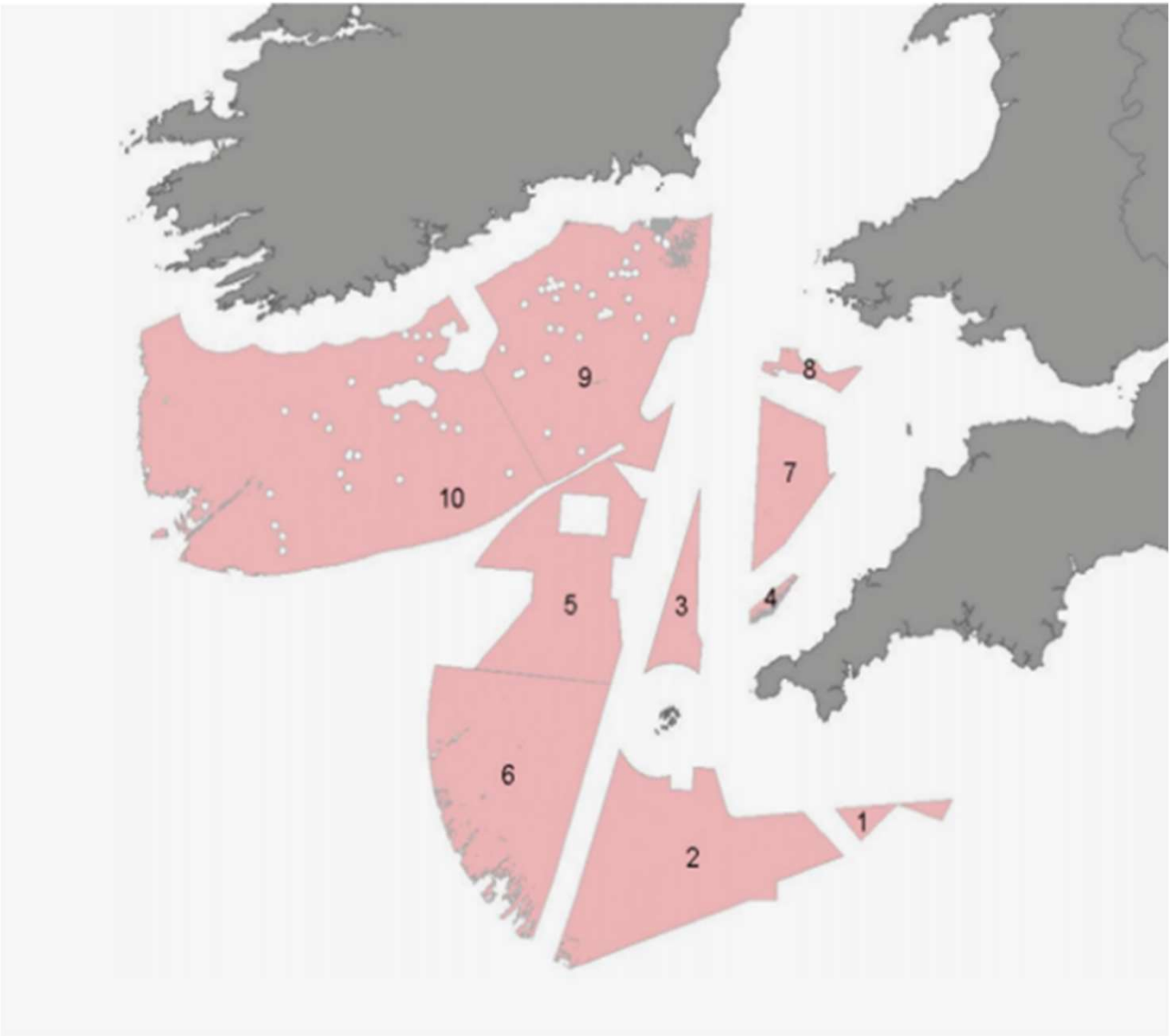
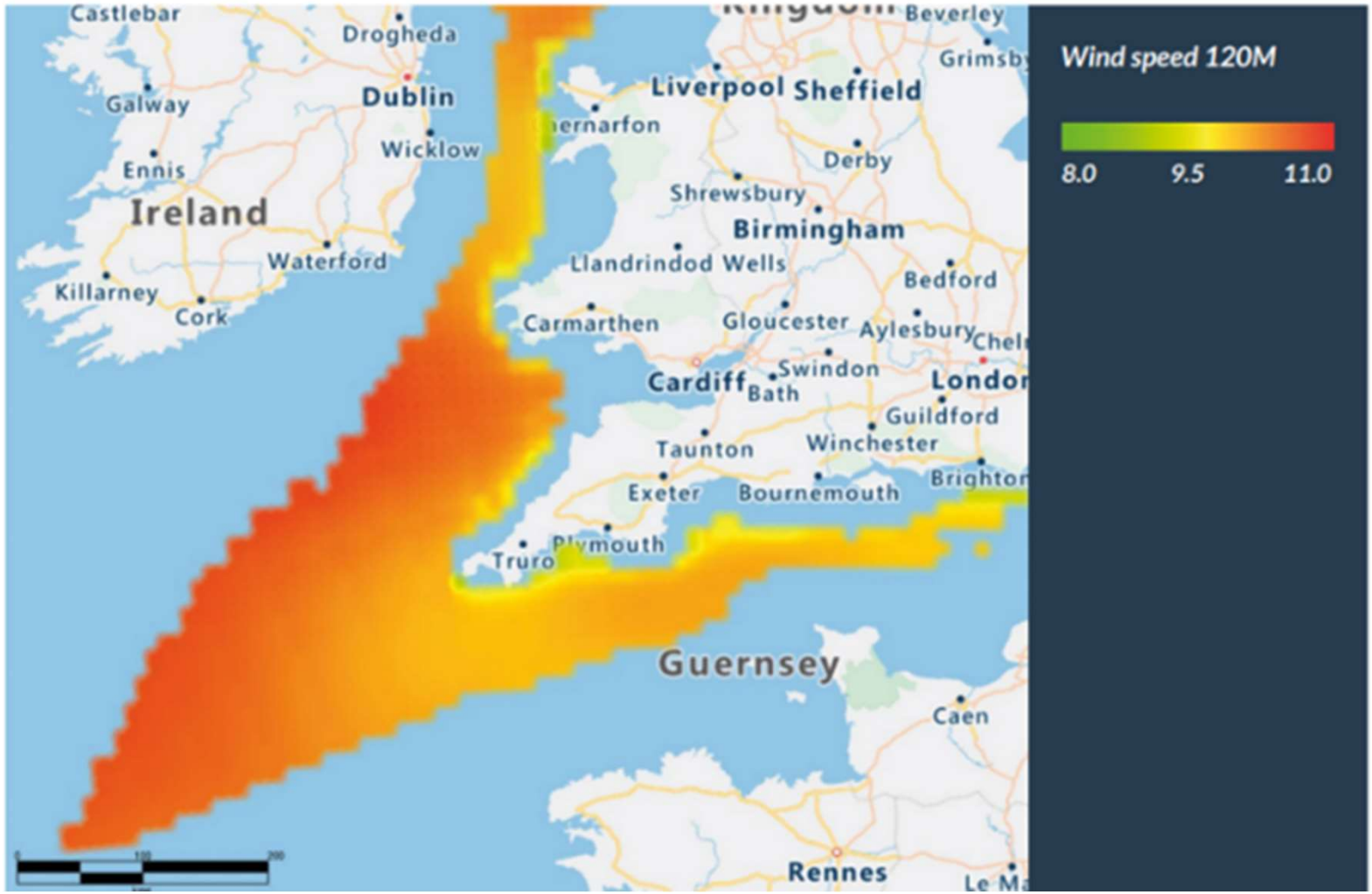


WIND SPEED


Castlebar
Drogheda
Beverley
Grimsby
Wind speed 120M
Liverpool
Sheffield
Dublin
Galway
Wicklow
Derby
Ennis
Shrewsbury
Ireland
Birmingham
Waterford
Llandrindod Wells
Bedford
Killarney
Cork
Carmarthen
Gloucester
Aylesbury
Swindon
Cardiff
Bath
Guildford
Taunton
Winchester
Exeter
Bournemouth
Plymouth
Truro
Guernsey
Caen
Rennes
8.0
9.5
11.0

The impact of turbines on radar RAF PORTREATH

Offshore windfarms, when in the line of sight of radar, have a detrimental effect on Ministry of Defence's (MOD) primary surveillance radar capability used to deliver a 'recognised air picture' for Air Defence.

Radar returns from within-radar line of sight wind turbines comprise reflections from both the static and moving elements; providing different challenges for the radar operator. While reflections from the stationary elements of wind turbines can be removed by utilising stationary clutter filters, the rotating turbine blades impart a Doppler shift on the reflection that cannot be easily removed.

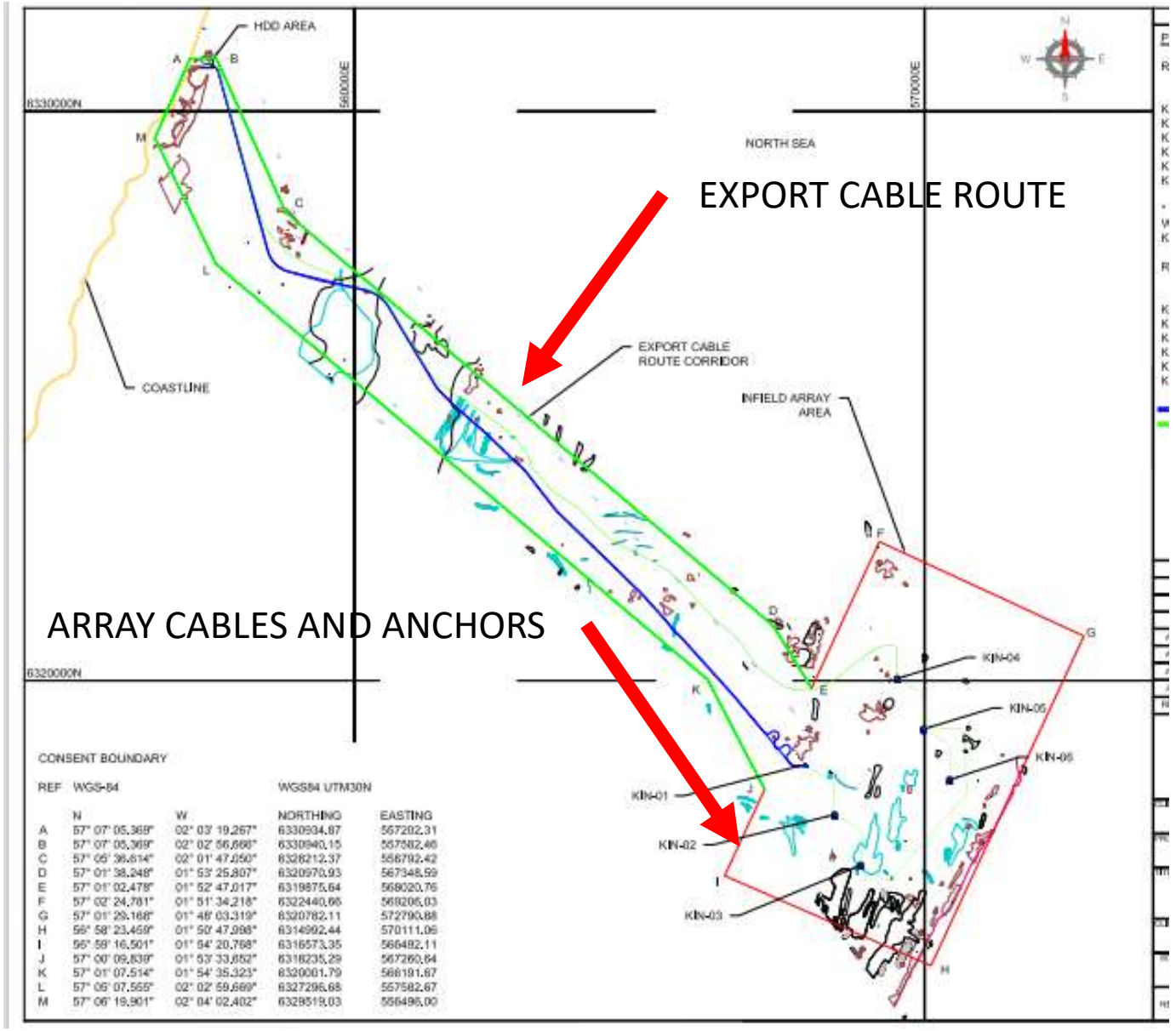
WILD LIFE

World Wind Fund for Nature has gathered research results and knowledge about offshore wind power projects and their influence on the marine environment. Offshore wind farms, with both floating and seabed-mounted turbines, hold vast potential as a sustainable energy source and as a contributor to the shift from fossil to renewable.

However there are concerns

- During installation of noise from pile driving and disturbance of the seabed.
- Electrical power cables emit radiation and may alter behaviour of fish
- Collisions with birds

SAFETY ZONE NO
- TRAWLING
- ANCHORING



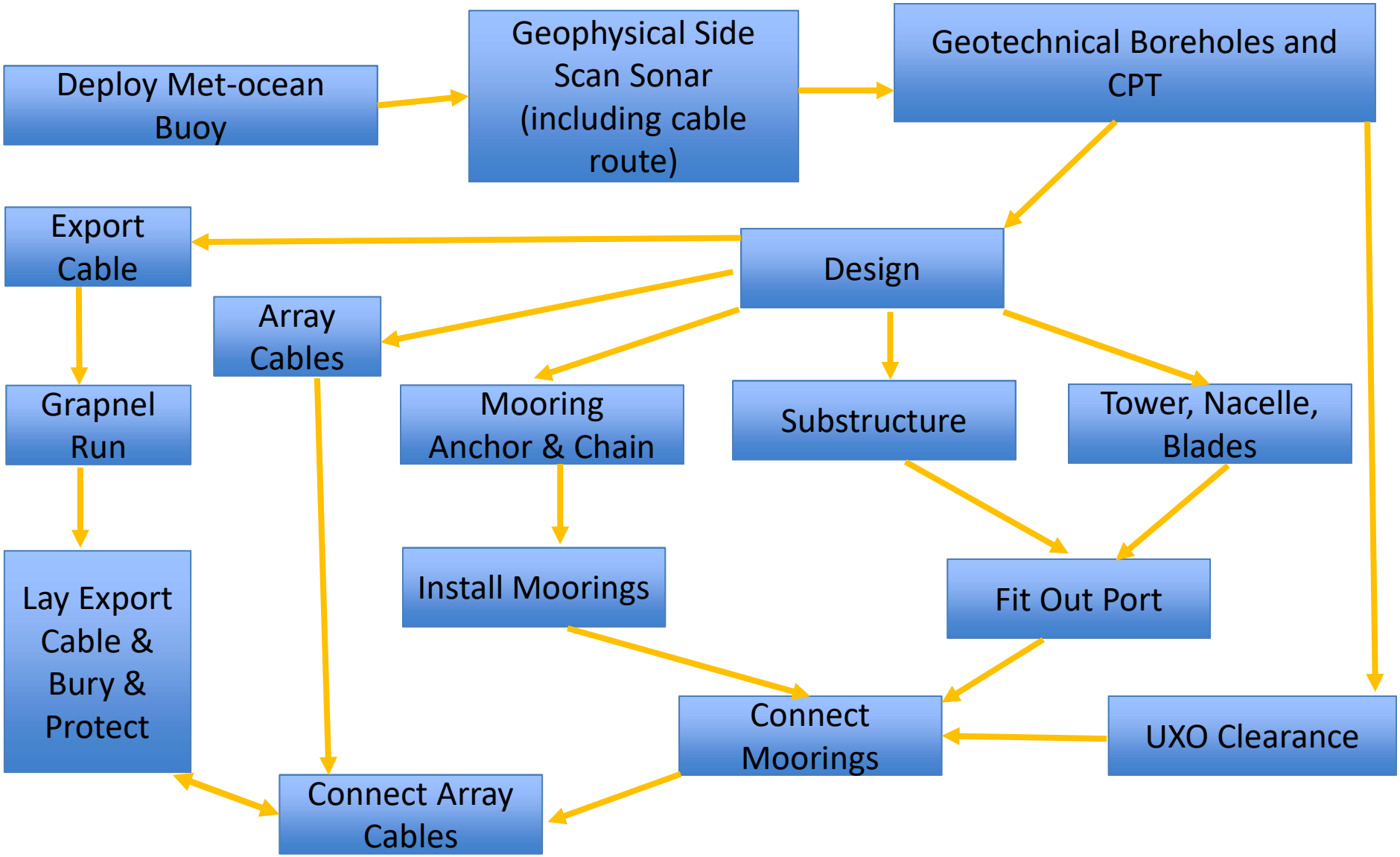
WATERDEPTHS AND FLOATING TYPES

Dark Blue
= Monopiles

Light blue
= Jackets

Green =
Floating

INSTALLATION SEQUENCE


Deploy Met-ocean Buoy
Geophysical Side Scan Sonar (including cable route)
Geotechnical Boreholes and CPT
Export Cable
Design
Array Cables
Grapnel Run
Mooring Anchor & Chain
Substructure
Tower, Nacelle, Blades
Lay Export Cable & Bury & Protect
Install Moorings
Fit Out Port
Connect Moorings
UXO Clearance
Connect Array Cables

SURVEYS

METOCEAN

Metocean measurement services cover parameters such as tides, currents, waves, water levels, wind, air pressure, air/water temperature, salinity

GEOTECHNICAL

GEOQUIP SAENTIS + GMR600

Heave compensated drilling vessel

Deliver to the Client, reliable data comprising high quality undisturbed samples, PCPT, seismic PCPT and PS logging data.

Initial soil analysis offshore.

The DP2 vessel, specially designed for offshore support and ROV services in harsh weather conditions and has been commissioned to conduct offshore geotechnical operations. The vessel comes with spacious accommodations and workspaces and the fully heave compensated GMR600 drilling rig has been installed over the 4m x 4m mid-ship moon pool. It has 720m^2 deck space she provides a stable platform for offshore geotechnical operations.

GEOPHYSICAL

Multi-tasking DP1 vessels are :

•Fitted with a permanently mobilised suite of high resolution geophysical and hydrographic survey equipment, including a multibeam, a new generation parametric sub-bottom profiler and solid digital seismic streamers

•Fitted with environmental, geotechnical and ROVSV equipment deployed using both stern and side hydraulic A-frame handling equipment

•Fully networked to provide plug-and-play interconnectivity and make use of dual DGPS high precision surface positioning and HiPAP acoustic underwater positioning

DIVE SUPPORT VESSEL (saturation diving)

The DSV 'Mermaid Endurer' is a Norwegian purpose built DP2 dive support and light construction vessel, specially designed for operations in severe weather conditions such as the North Sea. The vessel has high manoeuvrabilityand station keeping capabilities and is equipped with a built in 18-man single bell saturation diving system complete with a self-propelled hyperbaric lifeboat. The vessel has a 100-tonne active heavecompensated knuckle boom crane and accommodation for 86 personnel. The DSV 'Mermaid Endurer' is DNV classed and flies the Panama flag.

ROUTE CLEARANCE

- Pre-Lay Grapnel Runs (PLGR) to remove surface debris (including fishing nets, redundant wiring and ropes) from the cable route, creating a clear path for the submerged plant and burial vehicle during trenching.
- Removal of OOS (out-of-service) cables found within the installation corridor to create a clear and safe passage for new cable installation.
- Removal and relocation of boulders, using an Orange Peel Grab or multi-purpose ROVs to clear obstructions from both low and high-density areas

Observation ROV

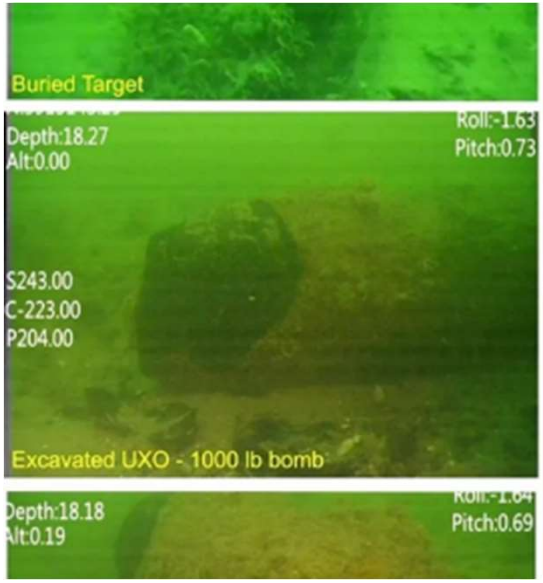
Work class ROV

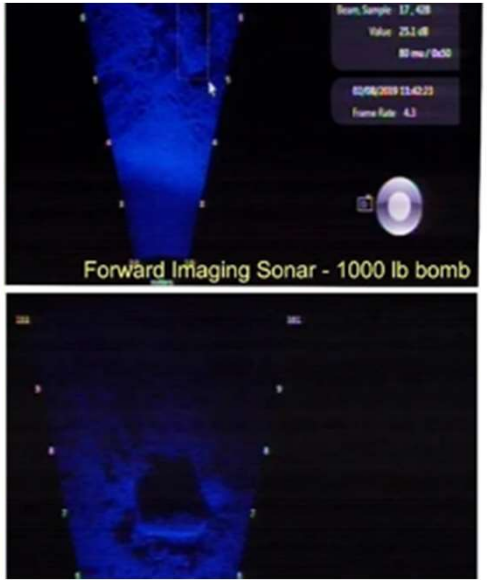
UXO CLEARANCE

UXO solution, from initial survey through to subsequent positive explosive ordnance disposal (EOD) on designated targets, using the latest technologies and techniques to deliver results safely, efficiently, and cost-effectively:

- Detection, identification, removal and disposal
- Innovation in disposal including bubble curtain noise mitigation

The same investigation will assess potential archaeological features





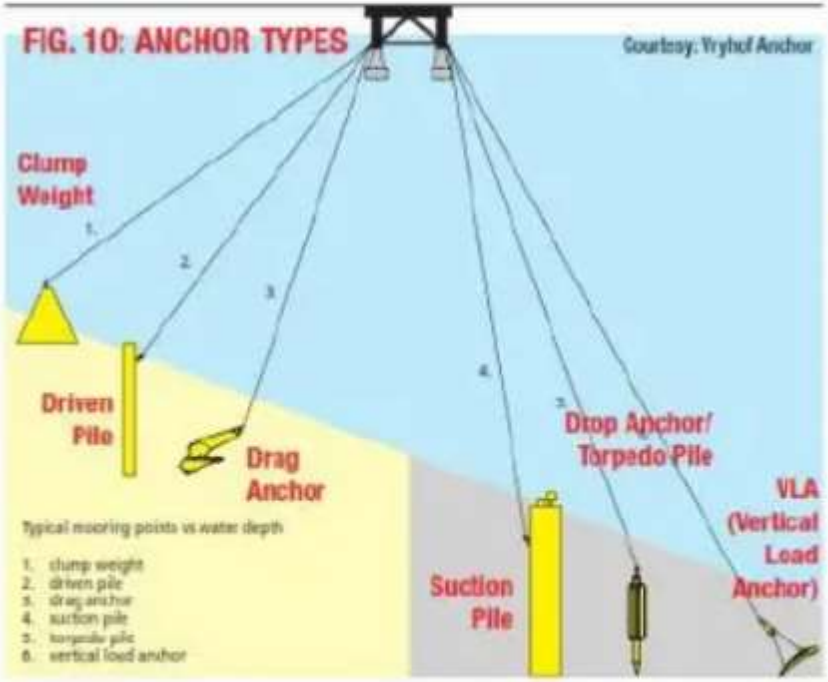
VESSELS

ANCHOR HANDLER TUG SUPPLY (AHTS) + ROV
Drag anchor installation and structure tow out

LOA:	93.8 m
Breadth	23.0 m
Draft	8.0 m
Accom:	68 persons / ROV garage
Bollard pull:	277 t

Offshore Anchor Types

1. Gravity (Clump)
2. Drag Embedment
3. Suction Caissons/ Piles
4. Driven Piles
5. Others (Drop, Torpedo, VLA, SEPLA)



Source: Course Notes: Mooring Components Ngee Ann Polytechnic Singapore

FAST TRANSPORT HEAVY LIFT CRANE VESSELS

AEGIR

BOKALIFT-1

CONSTELLATION

STELLA SYNERGY

ALFA

ORION

Fast Transport Heavy Lift Crane Vessels

- About 100,000 pounds/day
- Dynamic positioning
- Cranes from 2,500 to 4,000 t capacity

Used for installing the following

- Driven piles
- Drilled piles
- Suction piles
- Gravity piles

Conventional Anchoring Solutions

Gravity Anchors

Needs Hard Seabeds for Sliding, Settlement



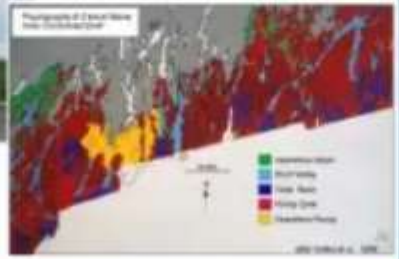

Suction Caissons

Needs ~ > 1* D NC Clays and/ or Sands

Drag Embedment Anchors

Needs Adequate Soil Layering/ Depth

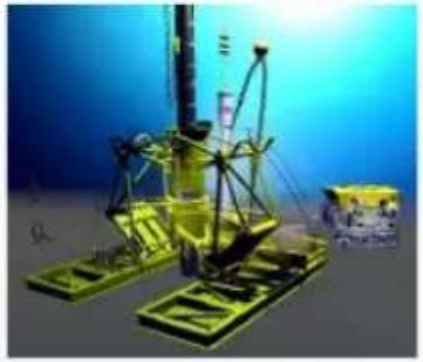




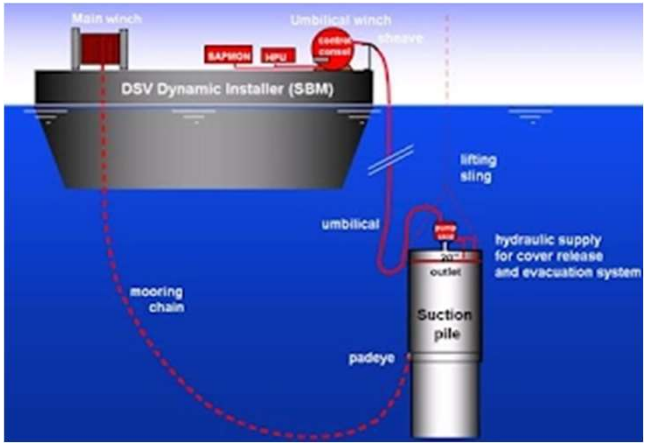
Recommended: Intermoor Mooring Chart 2013

Anchor Piles

Steel Driven/ Drilled & Grouted



SUCTION PILES



PILE DRIVING FRAME

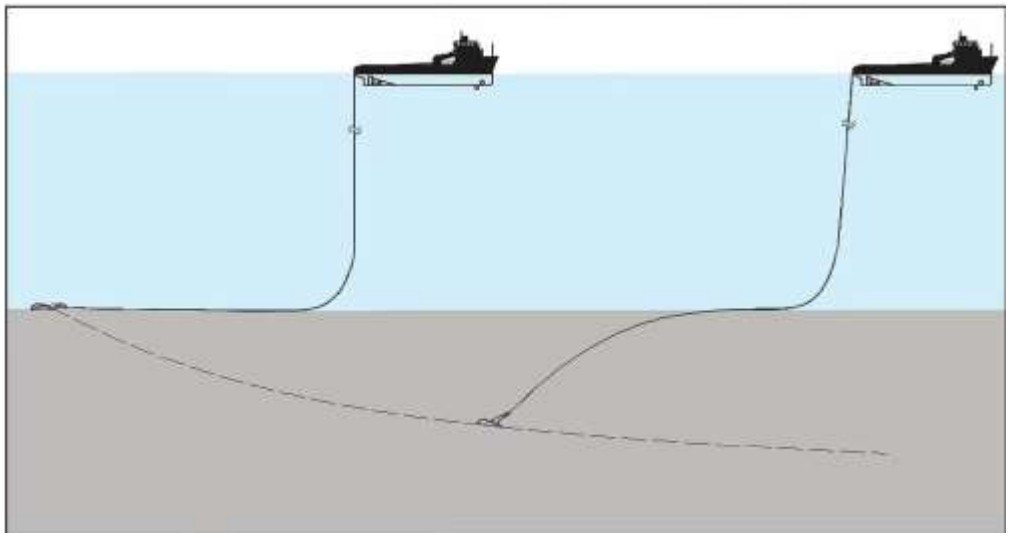
WORK ROV HANGER UNDERWATER HAMMER UNDERWATER PILE FRAME

UNDERWATER PILE DRILLING

GRAVITY ANCHORS

For use inshore for wet storage anchors.

DRAG ANCHOR



TOWOUT (large tugs, 3 medium size tug)

HARBOUR TUGS

On Thursday October 12th, in Saint Nazaire's harbour, BOLUDA NANTES SAINT NAZAIRE's tugs VB Croisic and VB Ouragan assured shifting operations of France's first floating wind turbine. With its dimensions of 36 meters by 36 meters, its depth of 7.5 meters and its weight of 5,000 tonnes, shifting the complex structure of the FLOATGEN wind turbine constituted a technical and maritime challenge which made it necessary for us to adapt our usual towage manoeuvres. BOLUDA FRANCE's highly qualified teams met this challenge with flawless ease.

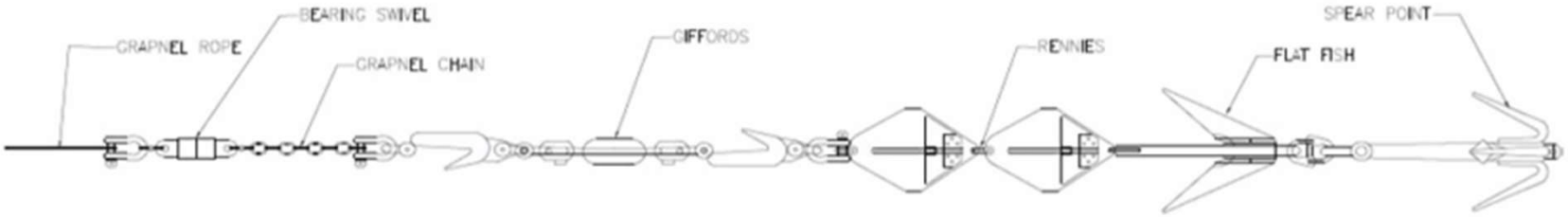
HARBOUR TUGS WITH SUBMERSIBLE BARGE

CABLE LAYING VESSELS (220kv export cables)

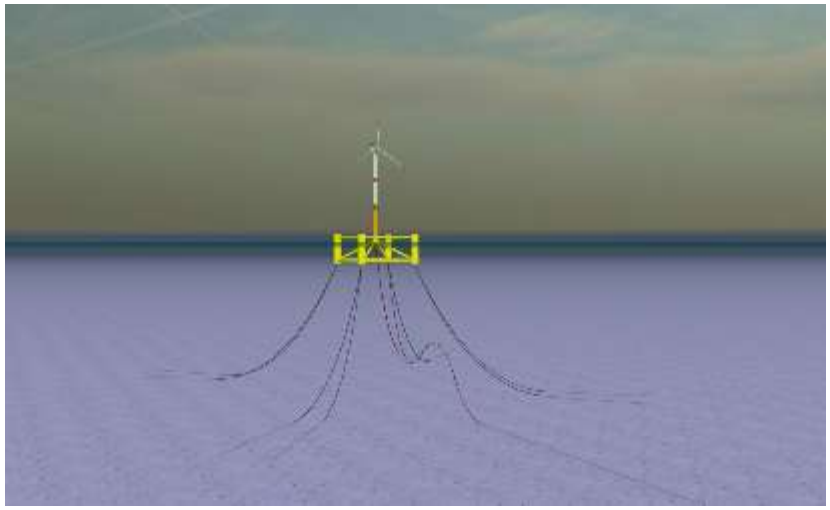
GRAPNEL

Route Clearance – Grapnel Train

The Pre Lay Grapnel Run – or PLGR occurs a few days before the Cable installation. The ship dredges a grapnel to clear any obstacle that could obstruct the plough, such as fishing nets, ropes, lines, and any other debris present along the Cable route.



DYNAMIC ARRAY CABLE (33kv)

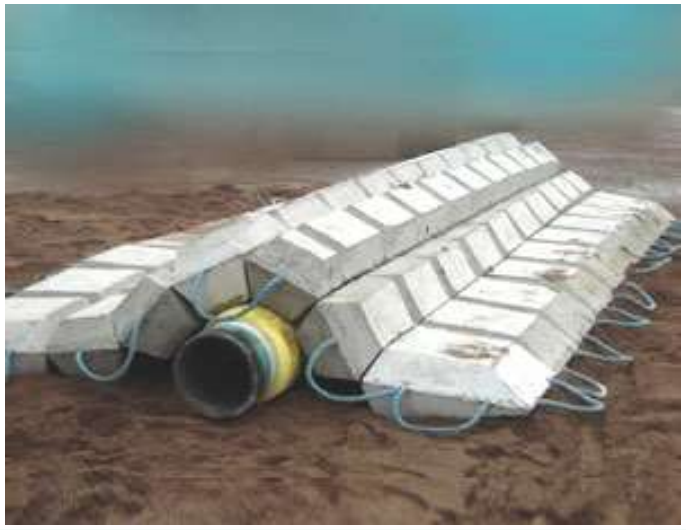


Utilising specialist cable installation vessel such as the Normand Clipper, the latest addition to their fleet, Global Offshore will install one export and five inter array cables at the site, totalling 30.3km at Kincardine

PORTUGAL - Connection of dynamic array cable

CABLE TRENCHING

CONCRETE MATS FOR SUBSEA CABLE PROTECTION



SERVICE OPERATION VESSEL (SOV)

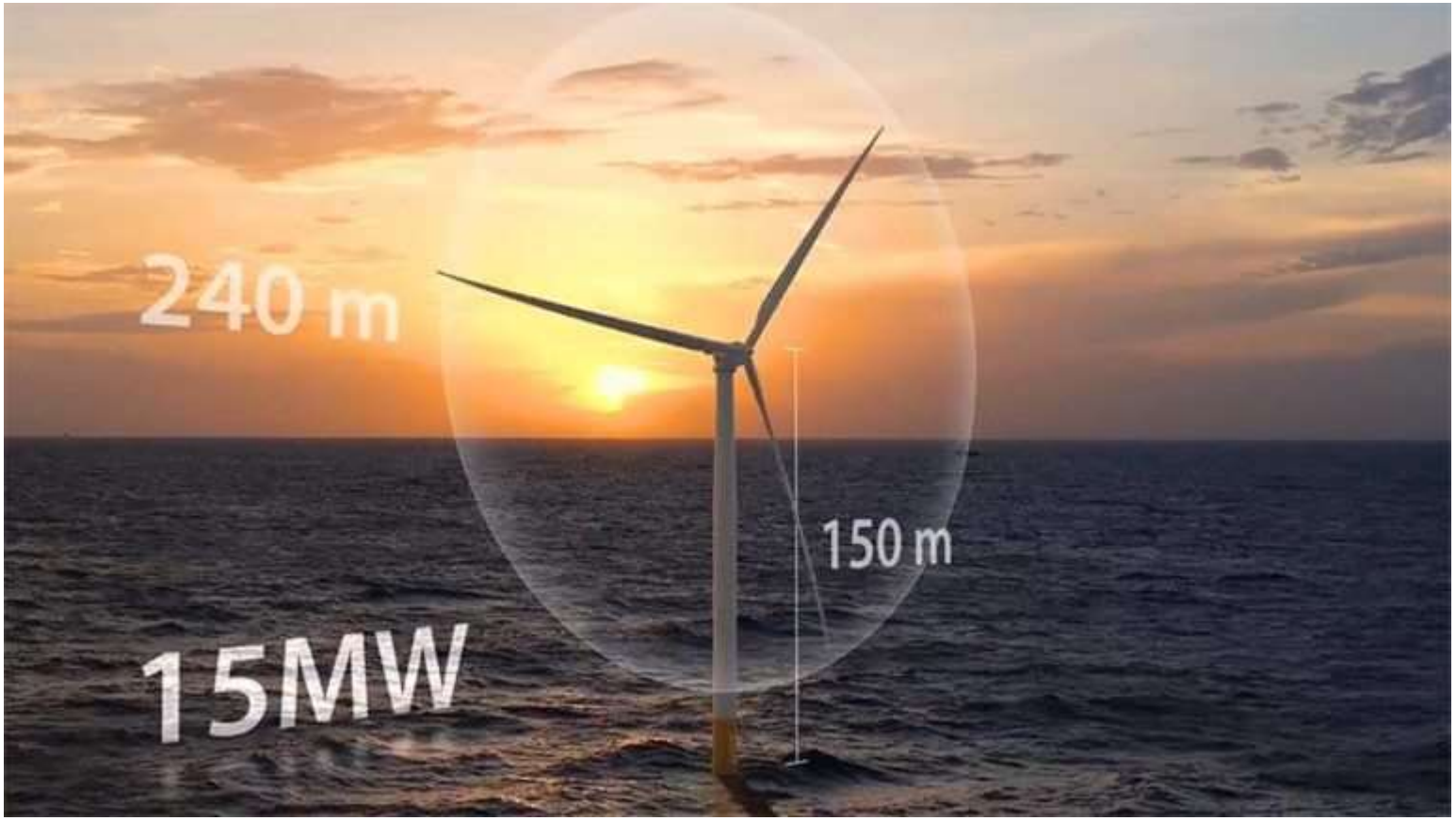
TELESCOPIC GANGWAY
HEAVE COMPENSATED

CREW BOAT

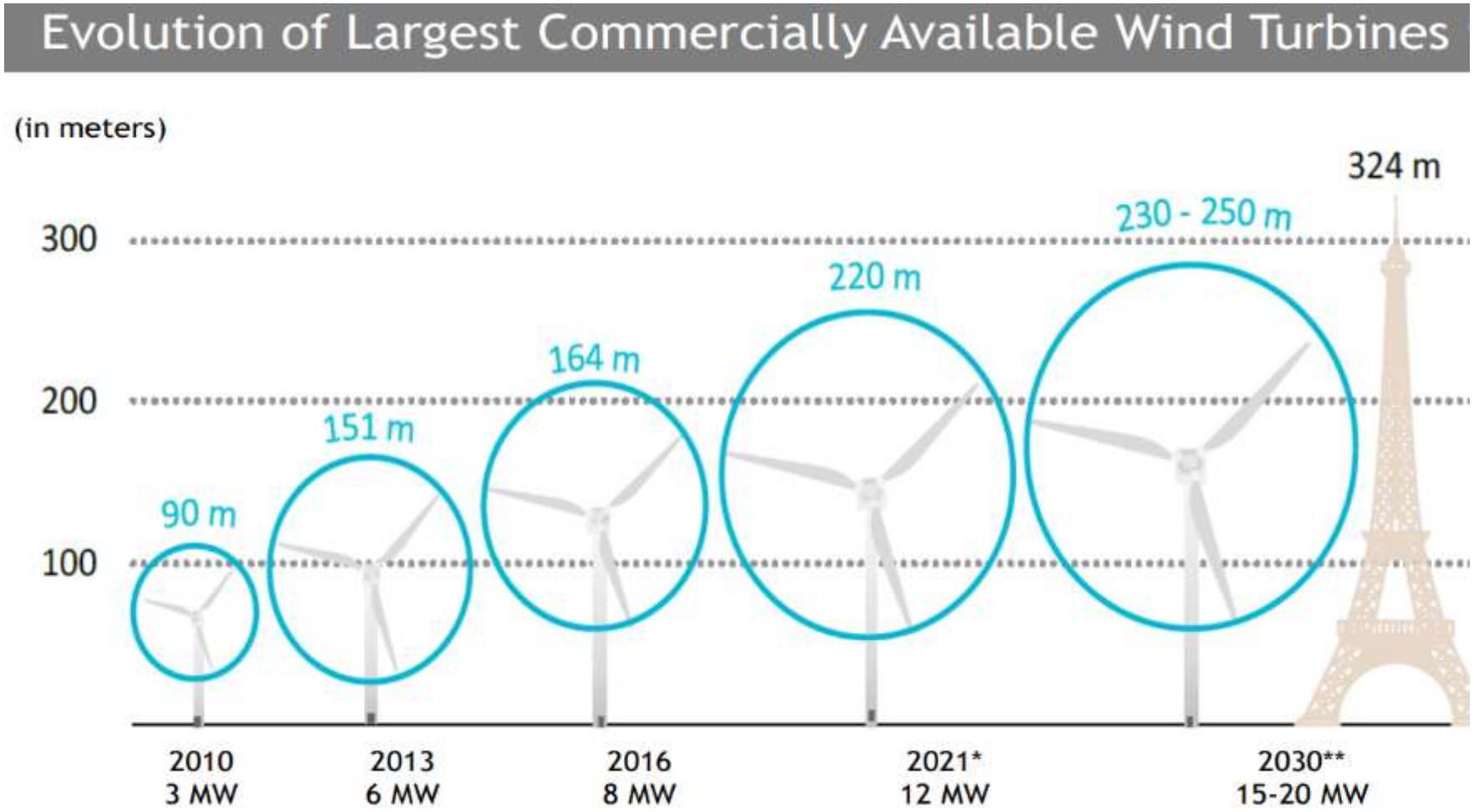
TURBINE SIZE

- Current size =10MW, 230-metre tip heights and 200-metre rotor diameters, hub 130m above water line
- On order = 15MW, 270-metre tip heights and 240-metre rotor diameters, hub 150m above water line
- Future =20MW, 340-metre tip heights and 310-metre rotor diameters, hub 185m above water line

15MW WIND TURBINE TIP = 270m



WIND TURBINES VS EIFFEL TOWER



CONCLUSION

Functions required:

- Survey vessels for metocean, GeoTech, GeoPhysical
- Heavy Transport Vessel, substructure dry transport from the shipyard to the fit out port
- Harbour tugs
- Cargo ships for anchors and chains, delivery to mooring port
- AHTS-Drag Anchor. DP2 Crane vessel pile options
- Cable loadout direct onto cable lay vessels
- Cargo ships for blade, tower and nacelle transport to the fit out port
- AHTS for tow out from fit out port and mooring connection

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THANK YOU FOR YOUR TIME

ANY QUESTIONS ?

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