Floating Wind Turbines: Environmental Considerations

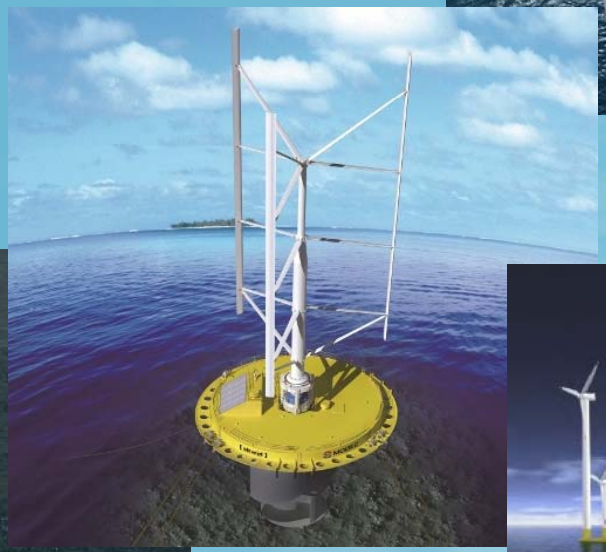
Daniel Wood*, Victoria Bendall, Silvana Birchenough, Julie Bremner, Freya Goodsir, Ines Martin Grande, Jon Rees, Ainsley Riley, Sarah Watts

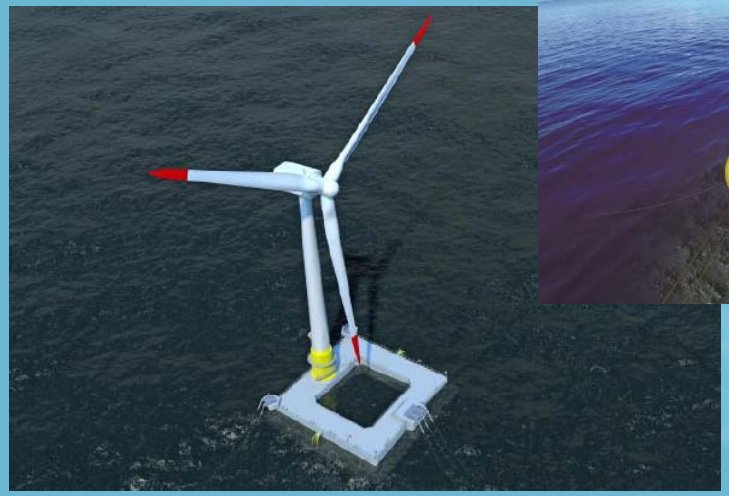
Daniel.wood@cefas.co.uk

Cefas

Floating Wind

- Lots of different designs
- Few prototypes





Site Selection Factors

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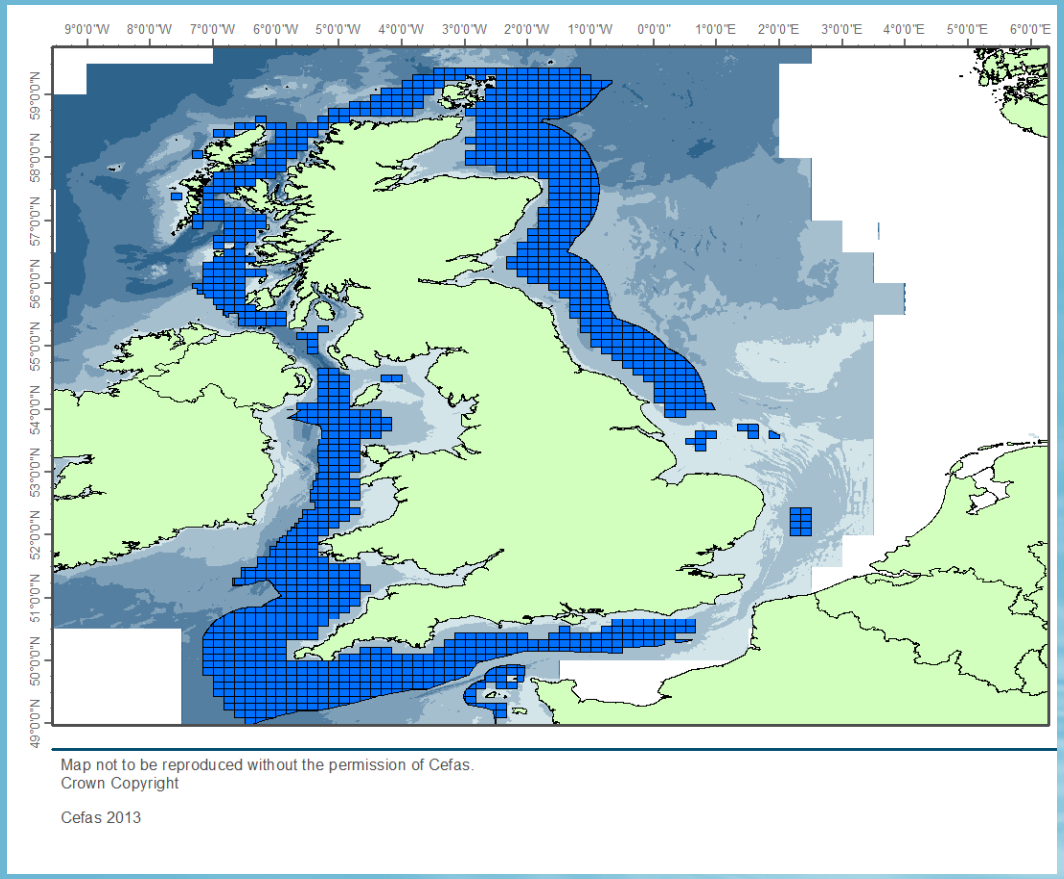
Where?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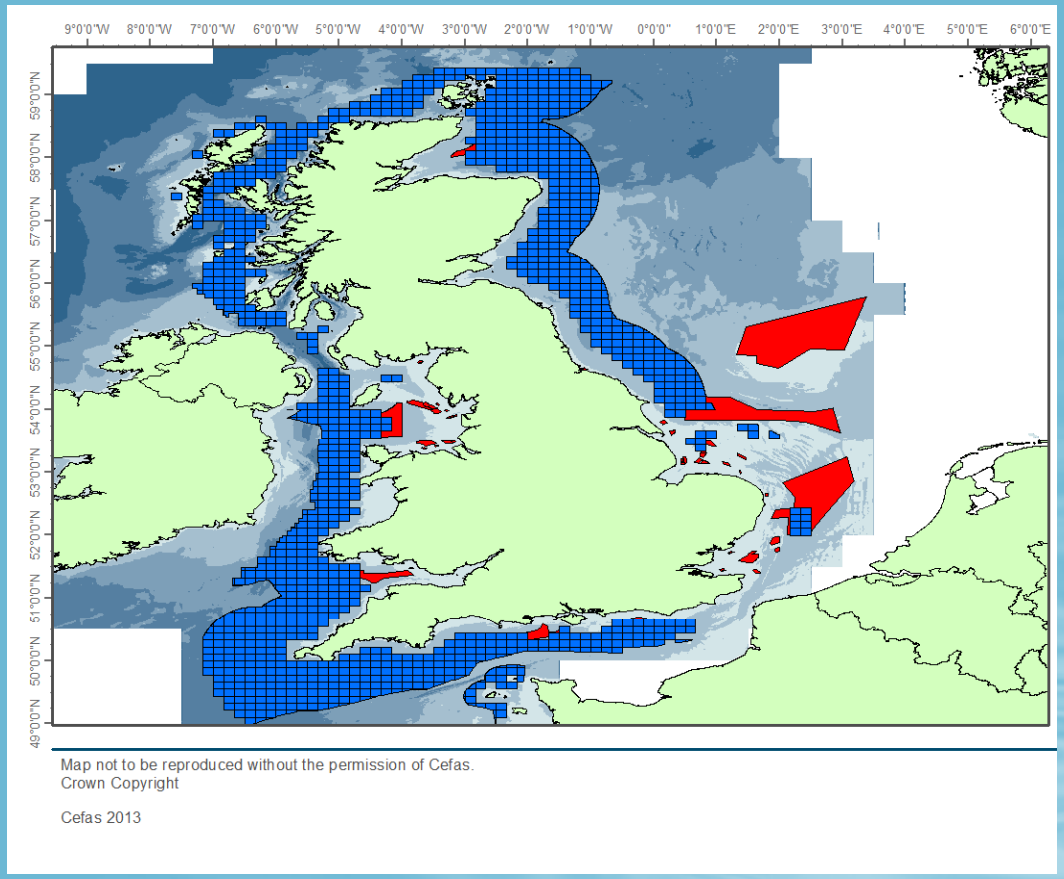
Where?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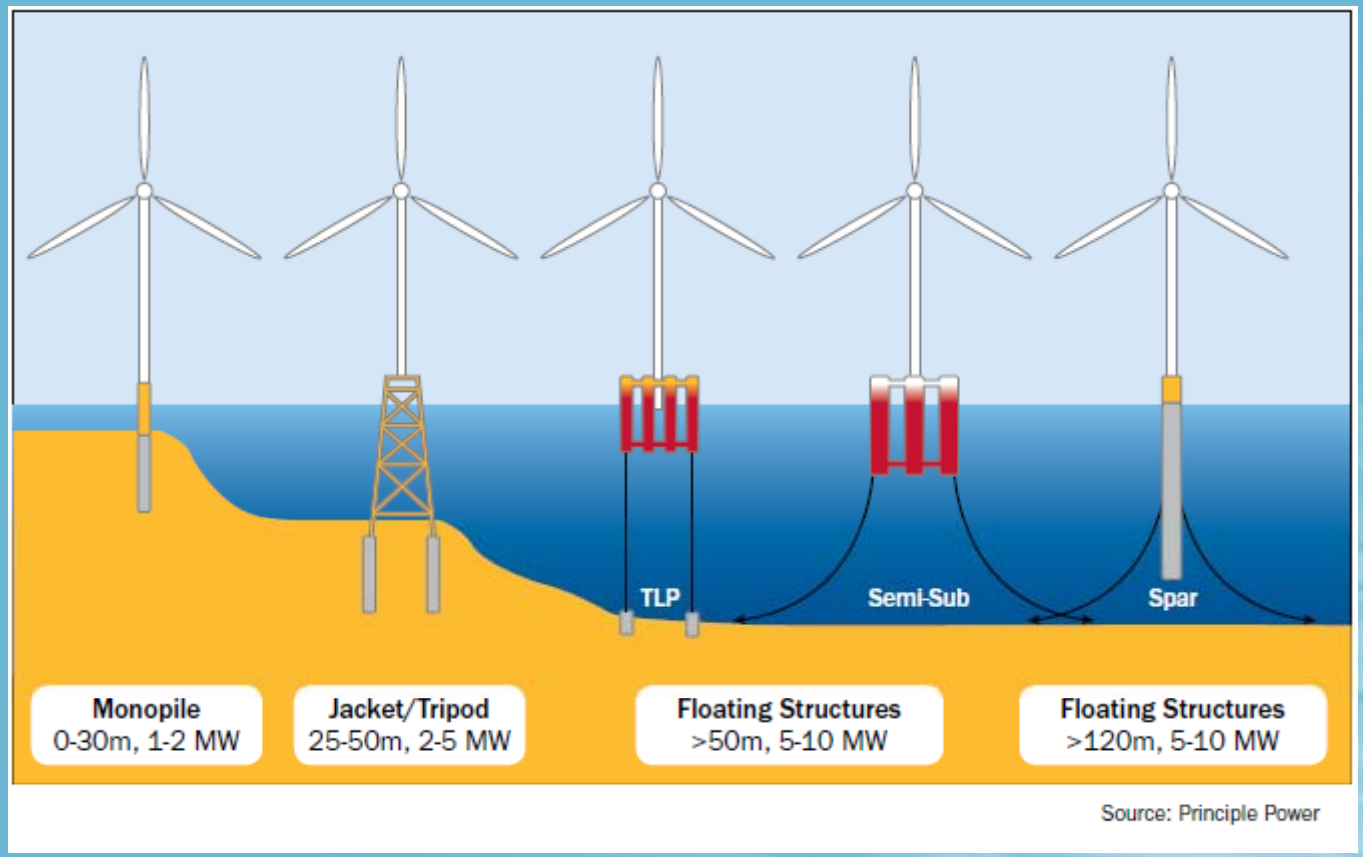
Types



Source: Principle Power

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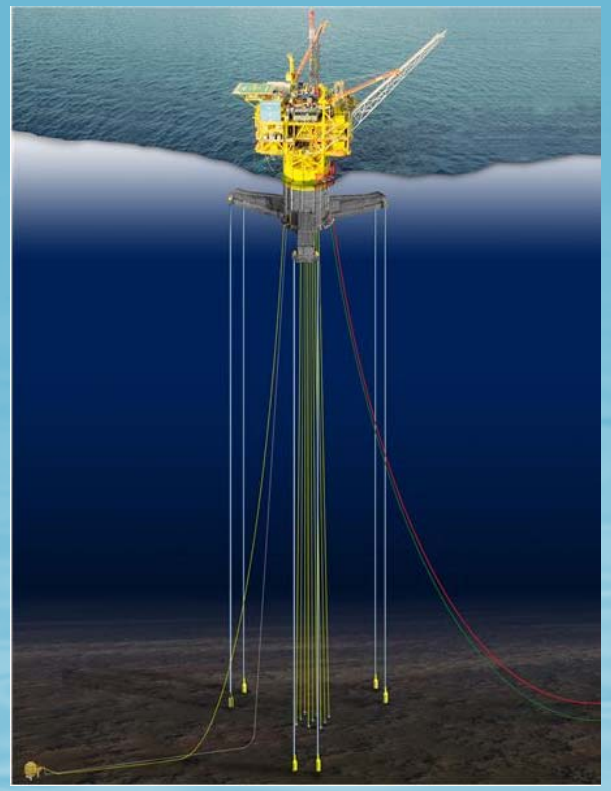
Tension Leg Platforms

- Used in O&G Industry
- Deep waters
- Add 1 wind turbine
- In shallow water



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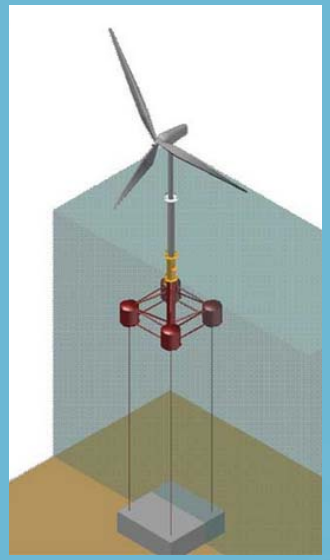
Anchors

1.



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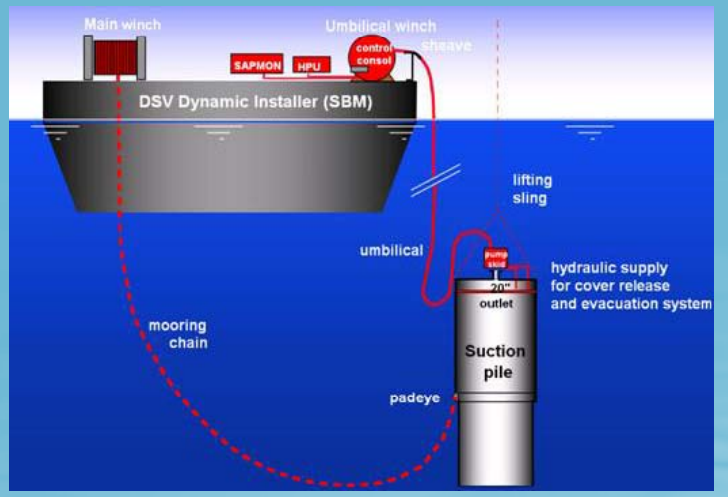

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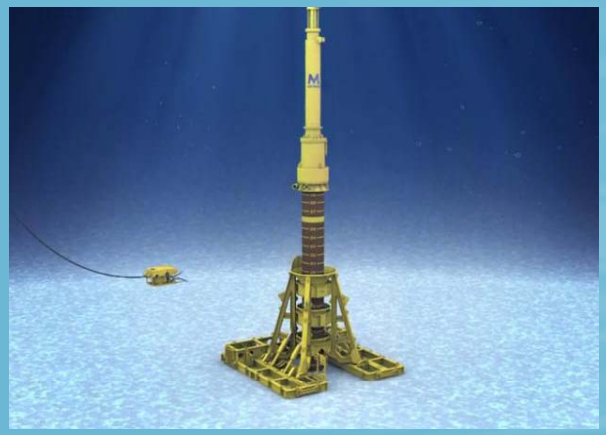


4.

Cefas

Power cable

- Held to seabed
- EMF
- Sharks / turtles?

Cefas

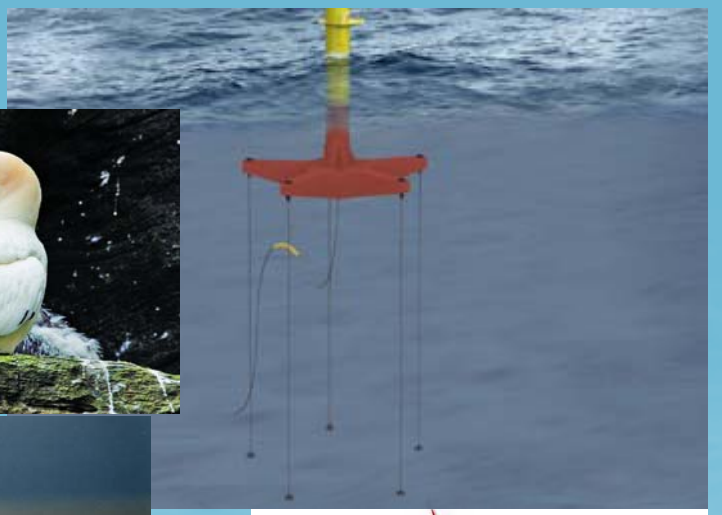
Structure

- Hydrodynamics
- Biofouling
- Removal of biofouling?
- Fish attraction

Cefas

“Key” Receptors

- Entanglement?
- Food?
- Roosting?
- Collision risk?



Operational noise

- Operational noise
- Resonance?

Cefas

Summary

1. Construction: Similar to fixed wind
2. Operation: Unknowns
3. Decommissioning: depends on anchors

Cefas

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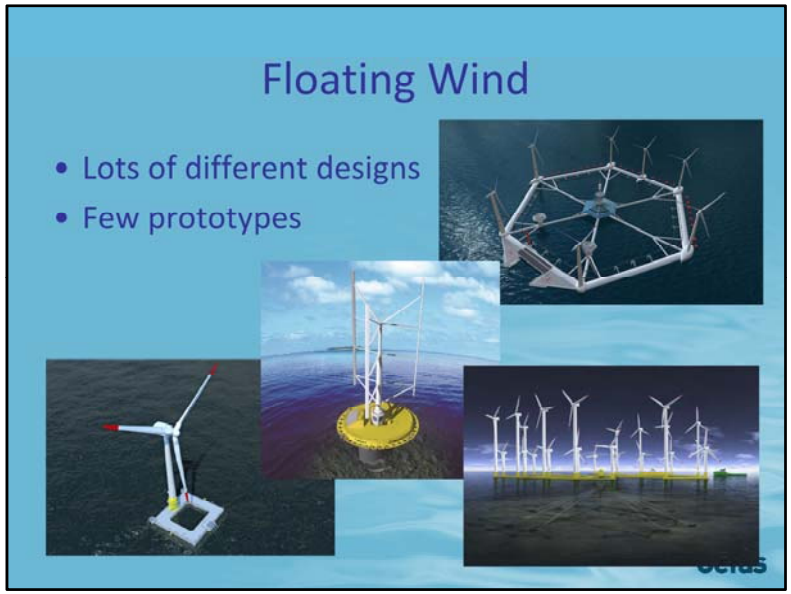
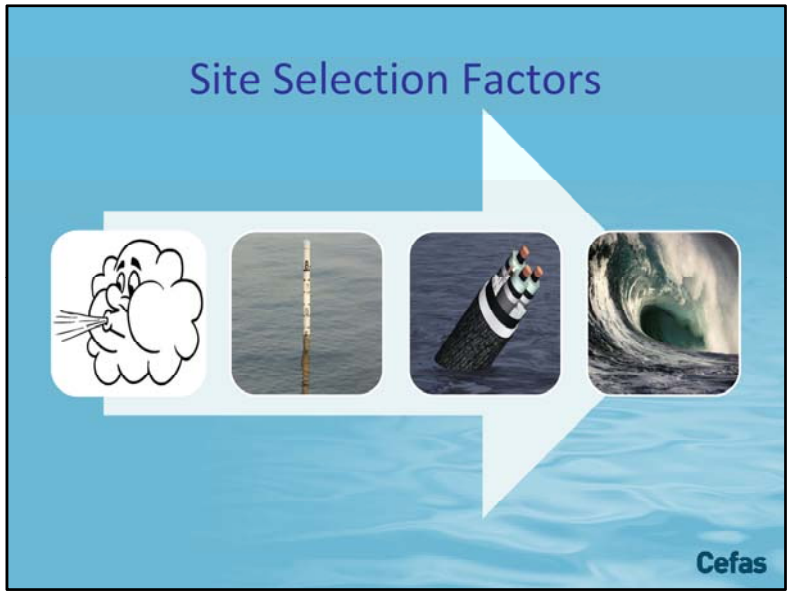
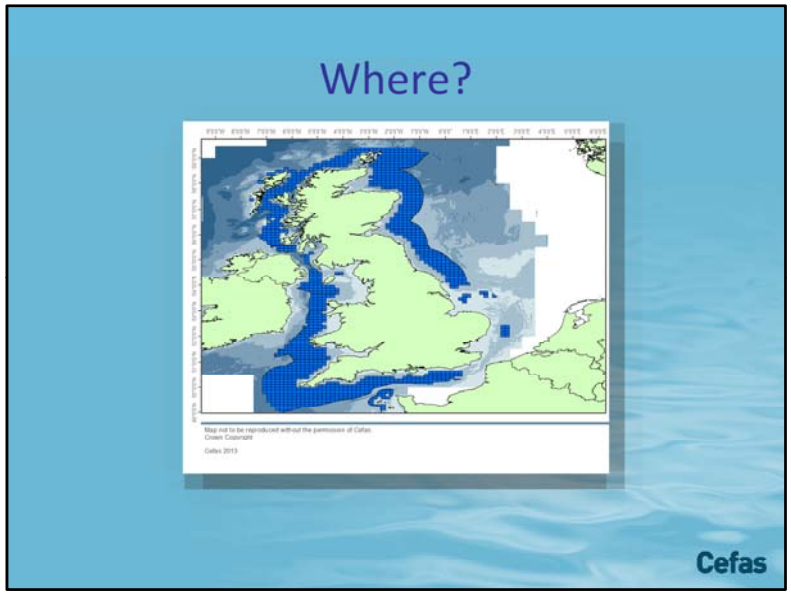


Modec.com
Ideol.com
Hexicon
Designs been around for many years. All sorts of different styles. However, most are still either in CAD designs or models in test pools. Few prototypes/demonstrators being tested. I.e. Sway – Norway, Blue H – Italy, various options being tested off Japan

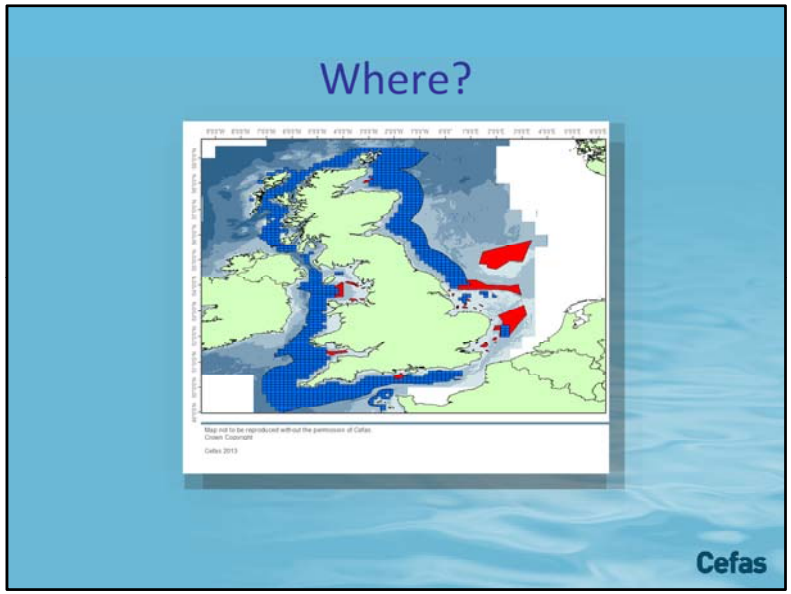


Need wind – enough to make the rotor spin, but not too much. Too much is becoming less of an issue as turbines and rotors get bigger
Need sufficient water depth. 50m appears to the minimum. Deeper often makes things easier….however, the UKCS isn't particularly deep
Cables – need to be able to connect to the grid. Cabling costs a large part of CAPEX. Unlikely to see floating wind very far offshore. At least not until offshore grid connections are sorted out.
Waves – don't want too many extreme waves. Makes things more challenging and therefore more expensive.

Power cable: http://subseaworldnews.com/2012/04/10/belgium-nexans-subsea-cables-for-northwind-offshore-wind-farm/
Wind: http://skfr.org/high-wind-alert-2
http://fineartamerica.com/featured/crashing-storm-wave-vince-cavataio.html

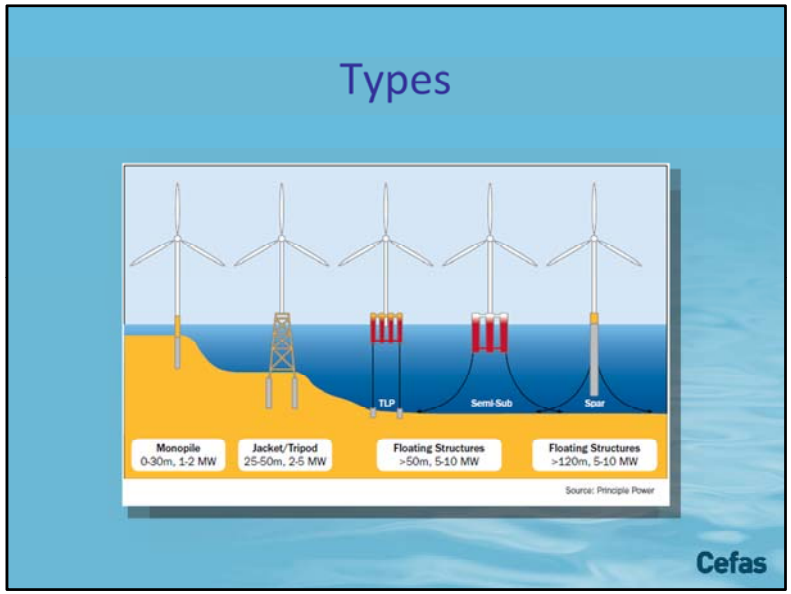


Map of UK potential sites
Contrast with R1,2 and 3 sites
50m+ water depths, within 100km of coast, 9ms wind speeds



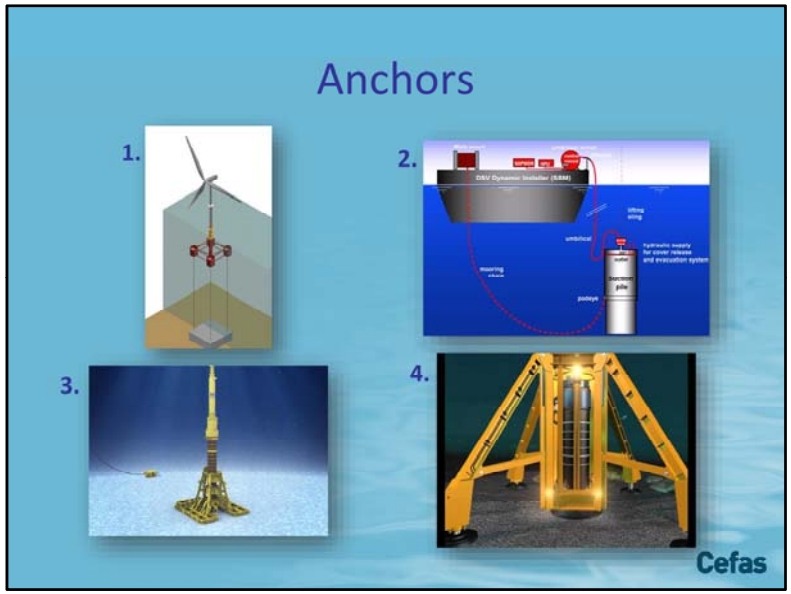
Map of UK potential sites
Contrast with R1,2 and 3 sites

New areas to what we are looking at today. Data gaps?



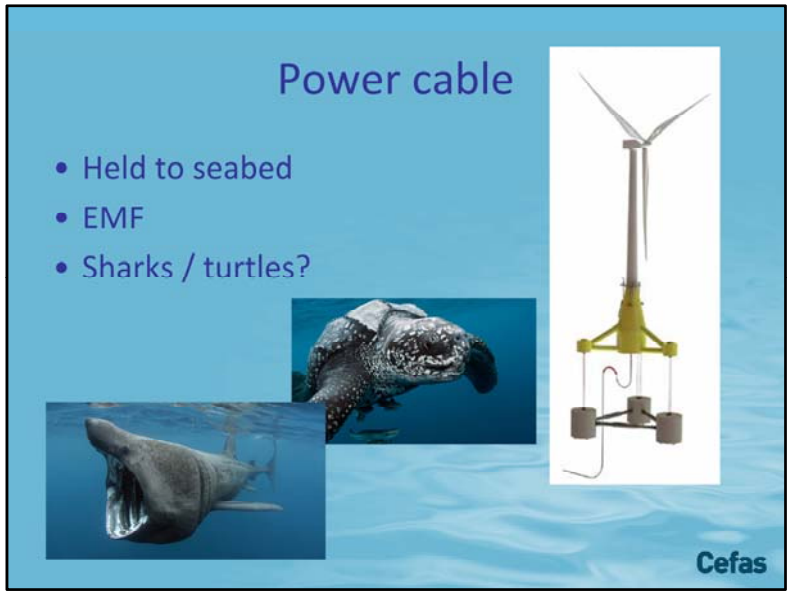
120+ spar buoys look like a good option. UK doesn't have much water this deep so unlikely to see (m)any of these
75-120 semi-subs. Few areas suitable. However, in shallow UK waters means the area taken up by mooring lines could be quite large
50m+ TLP's cost effective. Technically possible to go shallower however, run into competition from jackets

http://www.brighthubengineering.com/marine-engines-machinery/30775-different-types-of-offshore-production-platforms-for-oil-extraction/#imgn_4



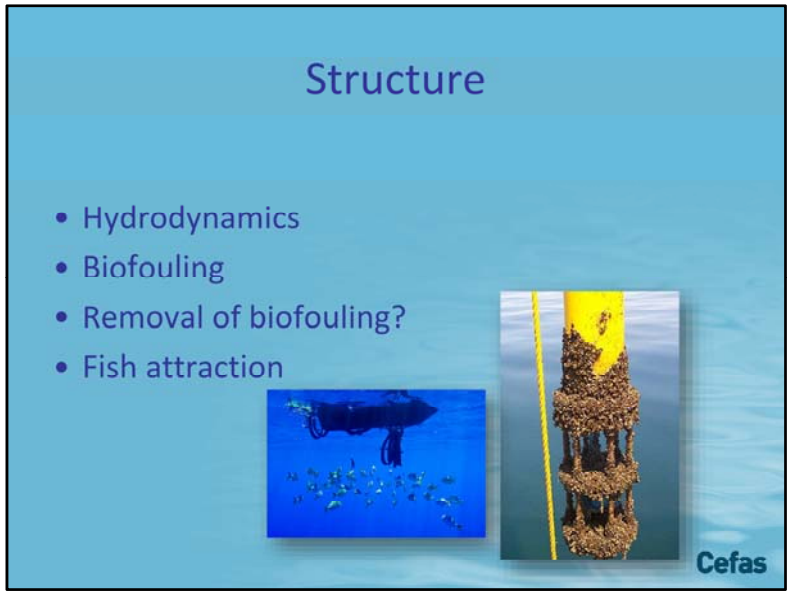
GBS – http://www.xanthusenergy.com/products/ocean-breeze.php
Suction anchor: http://www.v-gurp.nl/offshore/anchor-types.html
http://www.offshoreenergytoday.com/brazil-stabframe-successfully-deployed-at-waimea/
Bladeoffshore.com

GBS – inert, concrete doesn't leach much. Lots of colonisation (good and bad). Scour likely to need to be monitored, at least initially. Cannot be decommissioned easily. Cannot be trawled through
Mud / suction anchors? – need very specific soil conditions. Doesn't appear to be particularly invasive in comparison to other anchoring methods.
Piled (underwater). Similar noise levels to monopiling. Expect similar effects seen from installing jacket structures.
Drilled and grouted. Not very noisy. Need to dispose of cuttings (but not contaminated unlike O&G). Can be drilled below seabed level – leave in place post decommissioning?



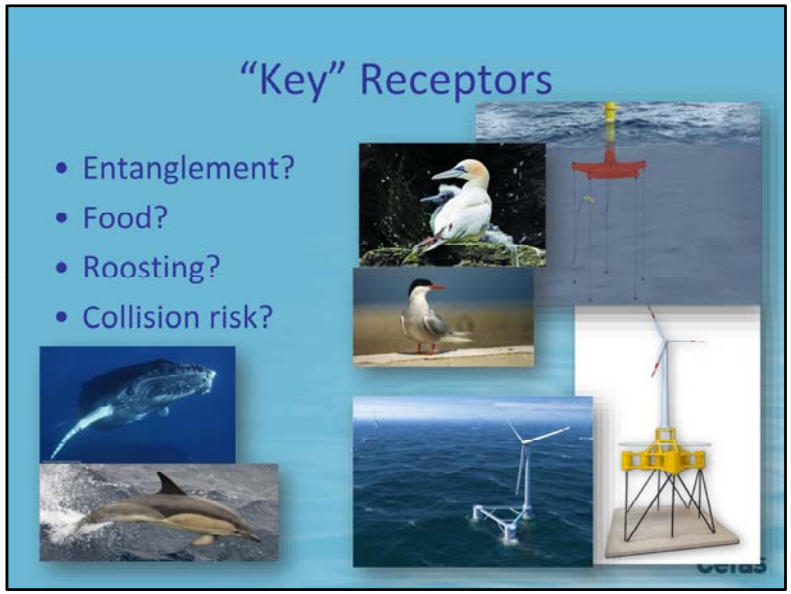
http://www.theguardian.com/environment/2011/aug/13/leatherback-turtles-jellyfish-welsh-coast
Basking shark © The Shark Trust / Charles Hood
http://www.subcon.com.au/wp-content/uploads/2013/05/scour-protection.jpg

Power cable exposed to water column. Held to seabed to avoid erosion of power cable – therefore little scour.
We know very little about EMF. Migratory routes up UK west coast for basking sharks. Sharks most sensitive to EMF. Turtles thought to deviate from course in presence of EMF. But then return later. We don't know if if EMF is an issue.



http://upload.wikimedia.org/wikipedia/commons/thumb/3/3d/Zebra_mussel_GLERL_4.jpg/220px-Zebra_mussel_GLERL_4.jpg
FAD: GREENPEACE / ALEX HOFFORD

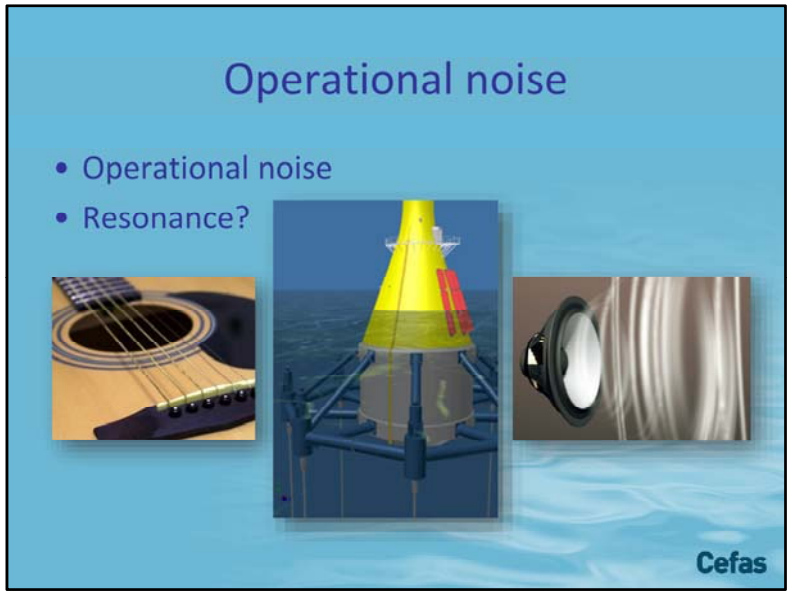
Wide variety of structures. Most are quite large. Potentially effects on hydrodynamics might need to be monitored. Particularly near sensitive areas.
Do you remove the biofouling? Some developers planning to use antifoulants, others want to remove bio fouling. Others plan to design to the structure to accommodate the extra weight of the biofouling.
Anything that floats will attract fish. Along with the added attraction of biofouling communities we can expect to see lots of fish attraction.



Entanglement tension leg structures have taught mooring lines. – simple structures (point to top right) unlikely. More complex structure (point to bottom right) maybe….but a lot of things have to go wrong first. Ultimately we don't have enough/any data to support entanglement.
Collision? Possibly? Probably species specific

Attraction due to food presence

Dolphin (wiki)



Operational noise complete unknowns. No similar recordings to compare to.
Could noise from gear box travel down structure and resonate out into the water column? Could mooring lines start strumming like a guitar string? Worth noting that resonance could lead to fatigue stresses. Therefore, engineers will be looking to minimise this.

Summary

1. Construction: Similar to fixed wind
2. Operation: Unknowns
3. Decommissioning: depends on anchors

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