OCEANEERING®

Route Preparation / Protection of Windfarm Subsea Cables

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Presentation Overview

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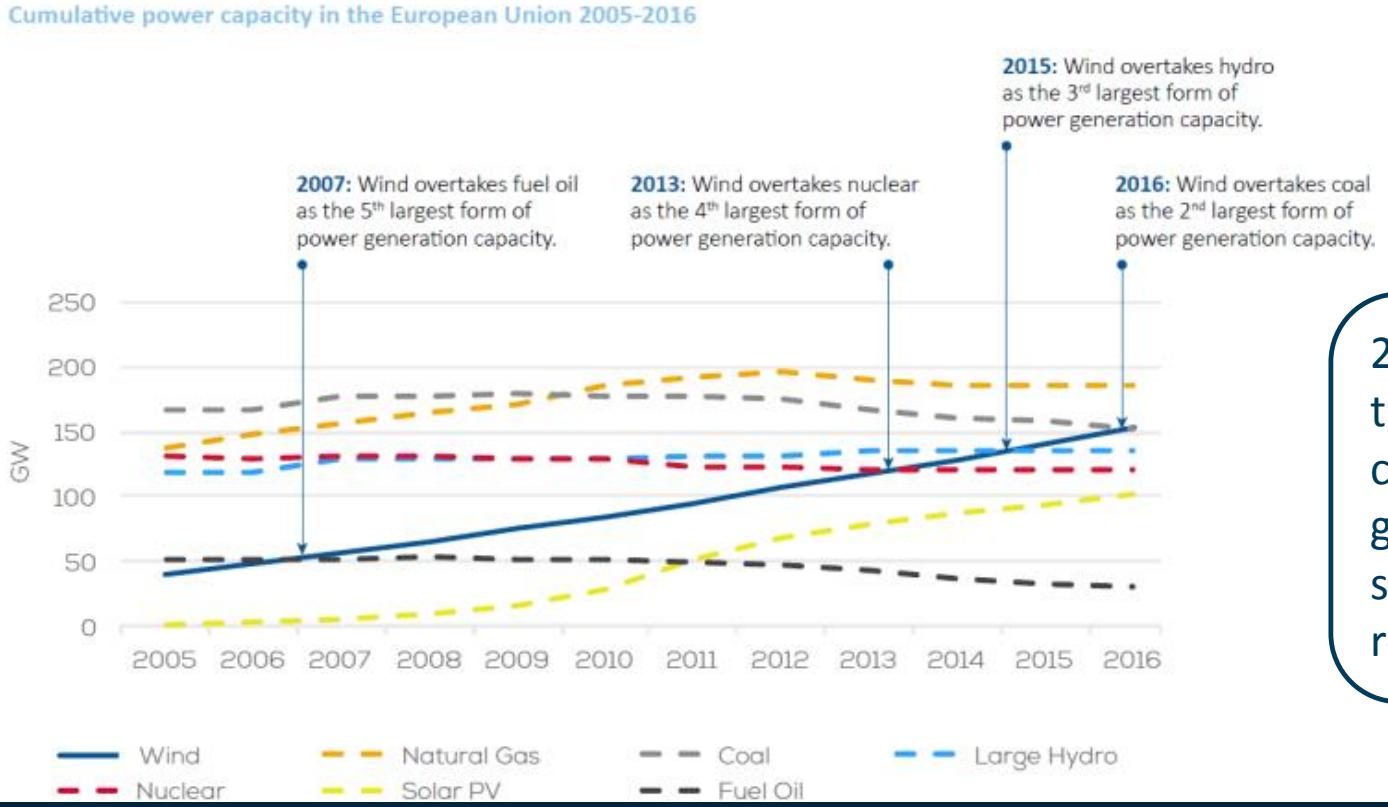
Introduction to Offshore Wind

- Power generation utilising offshore wind turbines is coming to AUSTRALIA!
- In fact plans are already well advanced for the “Star Of The South” windfarm, to be developed off the coast of Gippsland in Victoria
- Offshore wind power has been one of the fastest growing power generation sources in the world over the last 2 decades

Wind Energy is 2nd Largest Power Generator In Europe

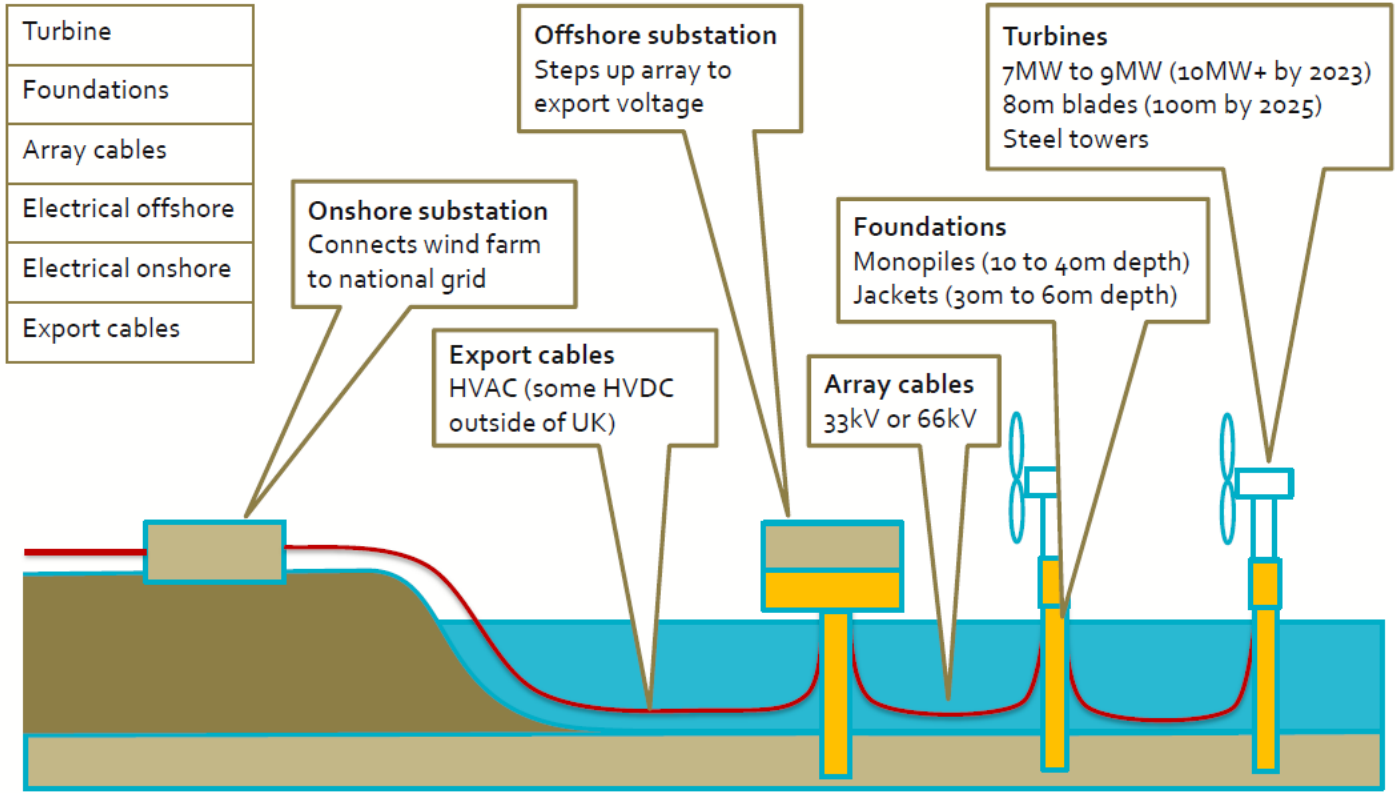


21st April 2017 was the first day without coal as a fuel for generation in the UK since the industrial revolution

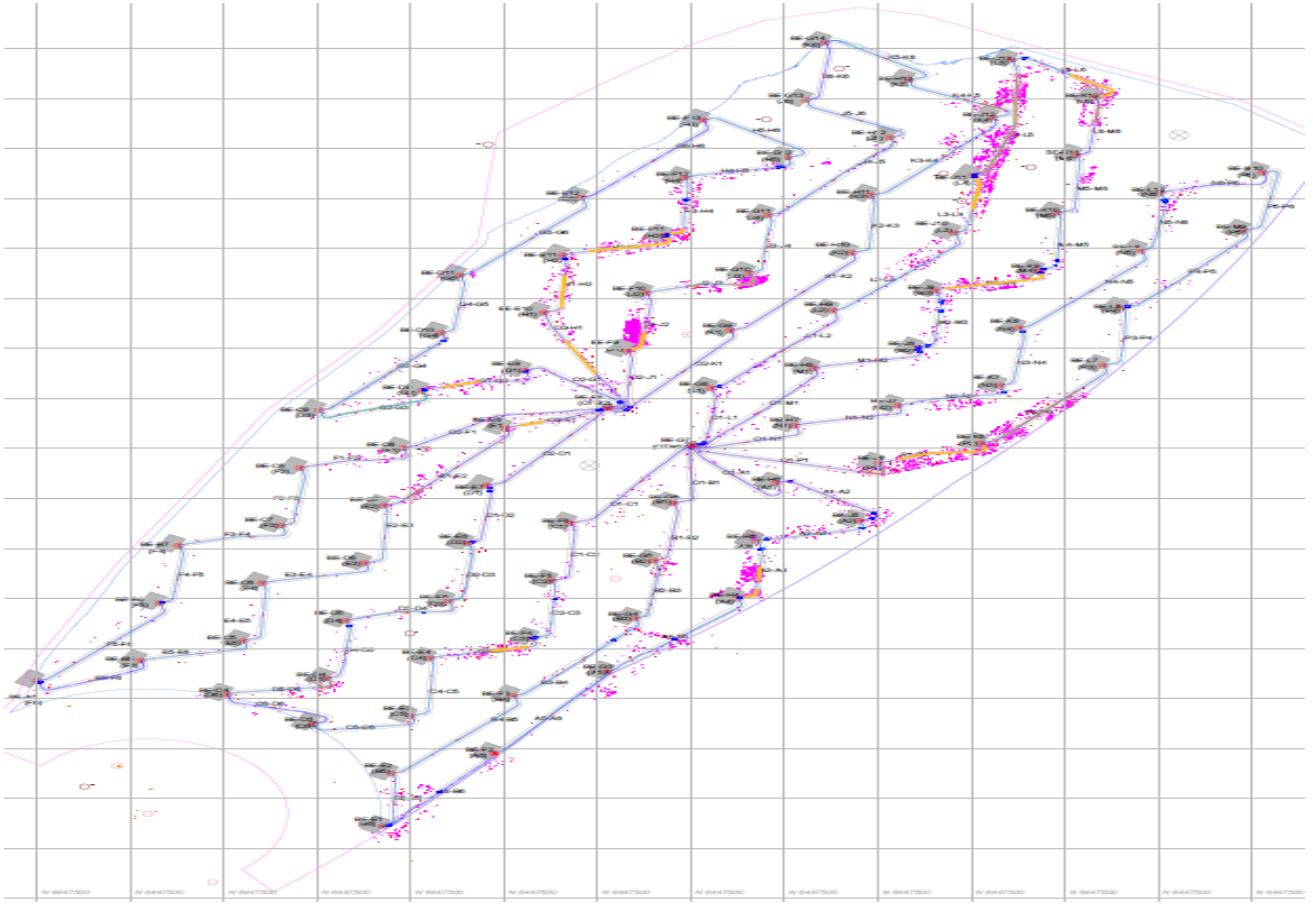
Why Go Offshore?

- The space available to build windfarms offshore is enormous and not subject to the same planning or infrastructure constraints as a potential onshore site
- Winds offshore are both stronger and more consistent than onshore, so higher amounts of energy can be harvested from each wind turbine
- Australia as an island continent has a large amount of potential offshore acreage for development of offshore wind
- Average wind speeds offshore can be predicted on an annual basis with a high degree of reliability

Offshore Wind Farms – The Basics



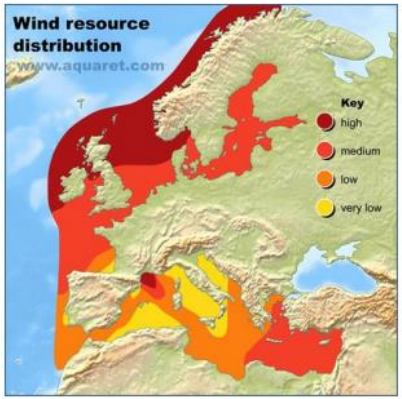
Typical Offshore Wind Farm Layout



Offshore Wind Farms – Project Timeline

5 to 8 years | 1 to 2 years | 20 to 25 or…(?) years

Project Development → Construction → Operation

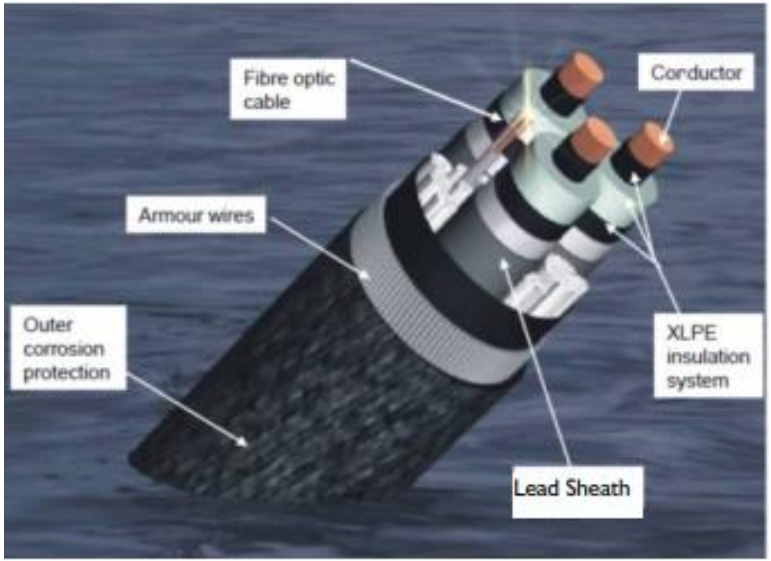


Inter – Array Cables

Inter array subsea cables, connect WTG to WTG and connect the WTG strings to offshore substations.

Typical IAC cross section:

- 3N^{o} Copper conductor cores, insulated
- Fibre optic cable integrated into cable bundle
- Armour layers for mechanical protection
- Outer corrosion protection
- Overall OD approx. 250mm (6”)
- Operation Voltage 33kV or 66kV
- Length of cables range from 600 m to 1600 m



Design Considerations of IACs

IACs may be subject to certain conditions that relate to the location of the development site that need to be considered during their design.

1) **Environmental Conditions** – Large hydrodynamic forces can be generated by the actions of currents, tides and wave action as a result of the close proximity of the windfarm to the shoreline and the relatively shallow water depth

2) **Geotechnical Conditions** – The shallow seabed composition may contain boulder fields, sand waves and mega ripples

3) **External Influences** – The effect on the IACs of other sea users in the form of dropped objects, anchors and interaction with fishing gear

If not adequately addressed at the design stage, these conditions can lead to “On bottom” stability issues and damage to the cables during their installation and operation.

Installation of IACs

IACs are generally loaded out in long continuous lengths from the manufactures factory onto carousels located on the installation vessel. The individual IACs are then cut to length during installation.

Should the location of a windfarm site in Australia encounter some or all of the previously noted conditions:

- Environmental
- Geotechnical
- External

Then there could be a requirement for route preparation and / or pre–cut trenching. These activities can be performed ahead of the IAC cable installation phase thereby not impacting the cable installation schedule.

Introducing the Oceaneering Scar Seabed System

The Scar Seabed System has been developed to deliver a single solution for route preparation / pre-cut trenching for subsea cables and umbilicals.

- The Scar plough in route preparation mode can provide a cost effective means for achieving a clear corridor typically 15 mts wide along the cable routes. Route clearance speeds range from 400 to 800 mts/hour

- By pre-cutting trenches along the IAC routes (typically 0.8 mts deep), the cables are installed directly into the trench, thereby shielding them from the effects of prevailing hydrodynamic forces. IAC cables in trenches also have a high degree of protection from snagging loads due to anchors and fishing activities