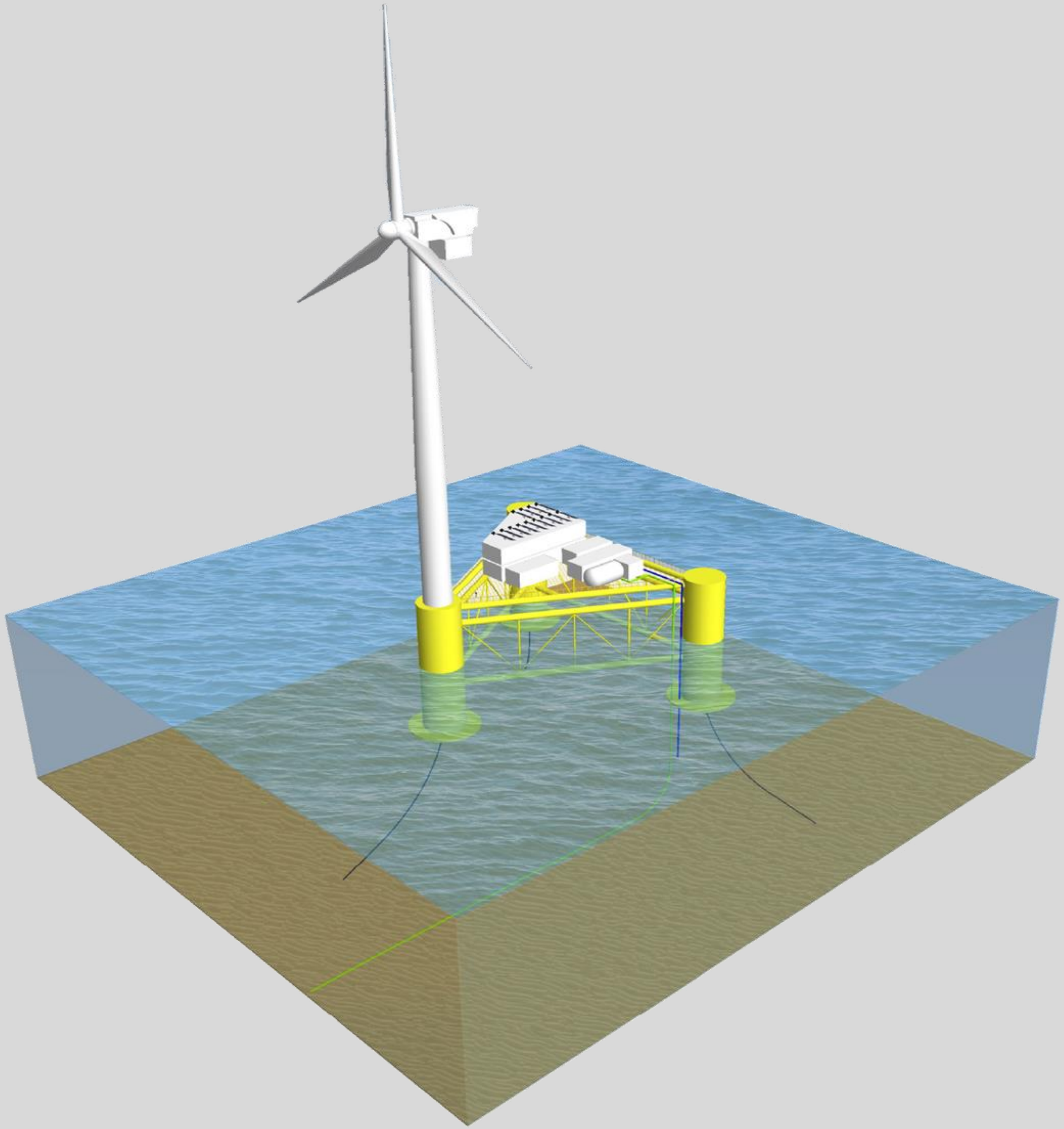

Investing in Shared Hydrogen Transmission Infrastructure Can Unlock Deep Offshore Wind Energy

Presented at: All Energy Conference
Presented by: David Wickham

Date: 11th May 2022

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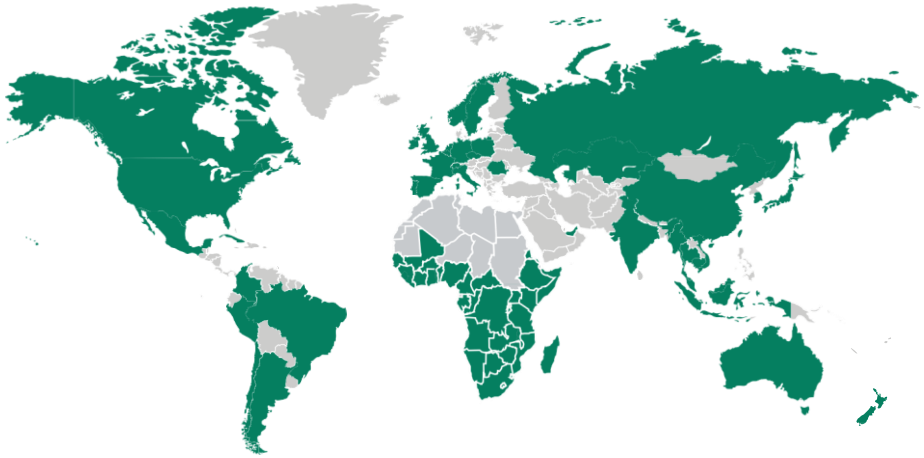

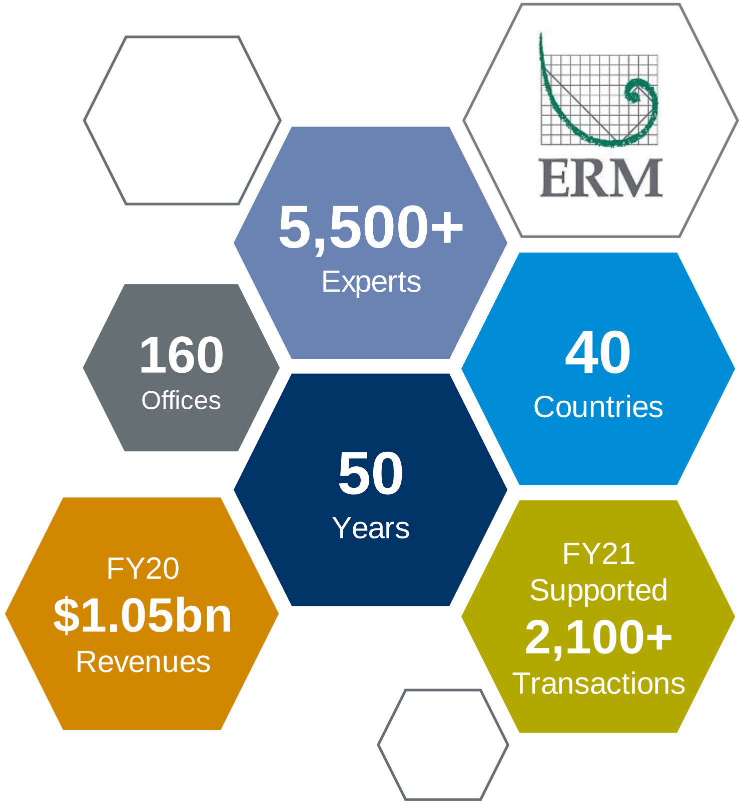

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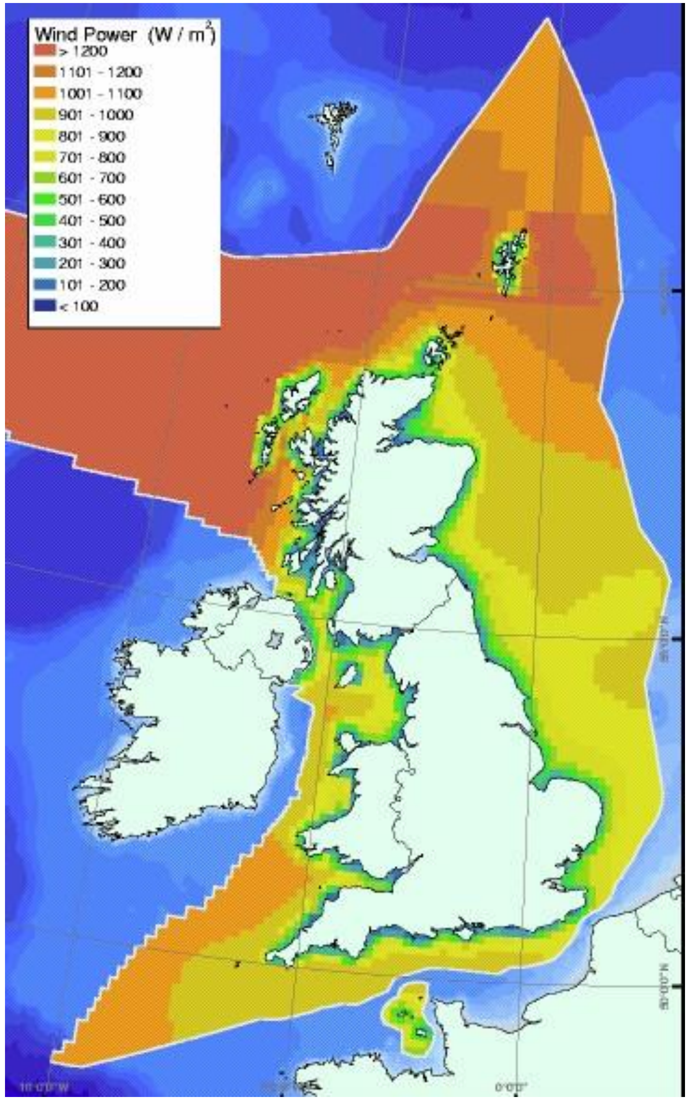
The UK Has Significant Wind Reserves in Deep Water Regions

- The United Kingdom is a unique situation with a plethora of offshore wind resources. Majority in deep waters:
  - **790GW** in waters depths **50 – 100m[1]**;
  - **1,030GW** in water depths **100m+[1]**.
- Fundamentally agreed that deep offshore floating wind will play a vital part in decarbonisation.
- The implementation of shared infrastructure is vital to unlocking floating offshore wind, and hydrogen enables that.



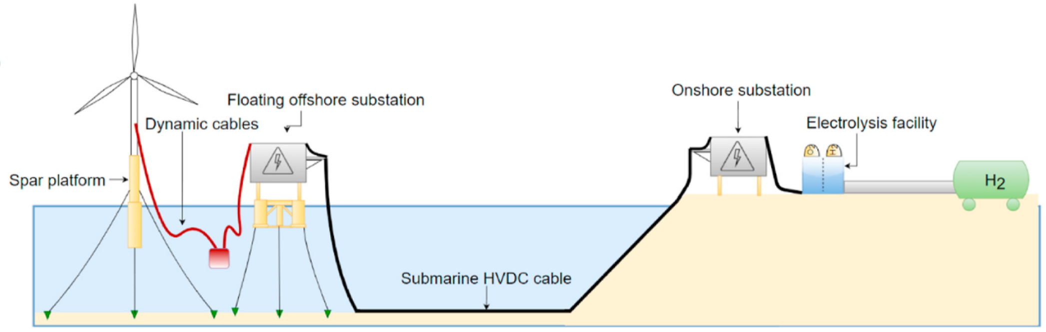
Source for Figure: The Azimuth Project

Source: 1 - [Two Terawatts average power output: the UK offshore wind resource | Claverton Group (claverton-energy.com)]

Decentralised Offshore Electrolysis Has Key Advantages Over Other Topologies

- 3 main topologies for producing hydrogen from offshore wind:
  1) Centralised onshore electrolysis;
  2) Centralised offshore electrolysis;
  3) Decentralised offshore electrolysis.
- Focus on decentralised offshore electrolysis, due to the following advantages:
  - Cost effective for all distances from shore.
  - Sharing infrastructure is easier.
  - No separate additional support structure is required.
  - Configuration is more modular.

1



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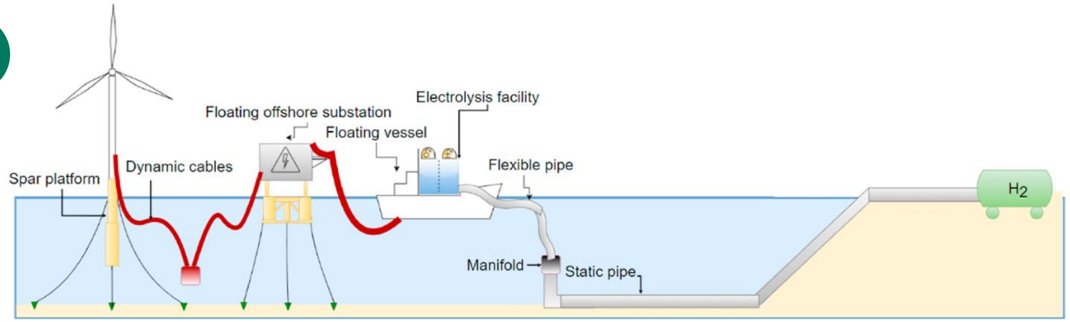

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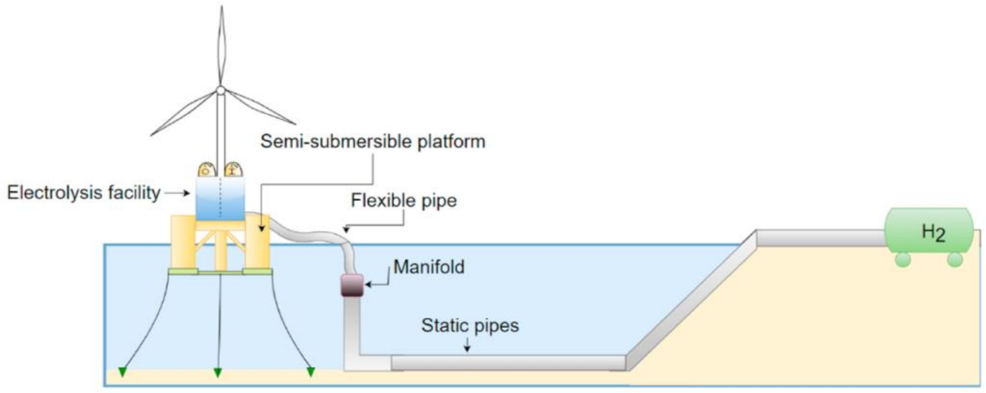
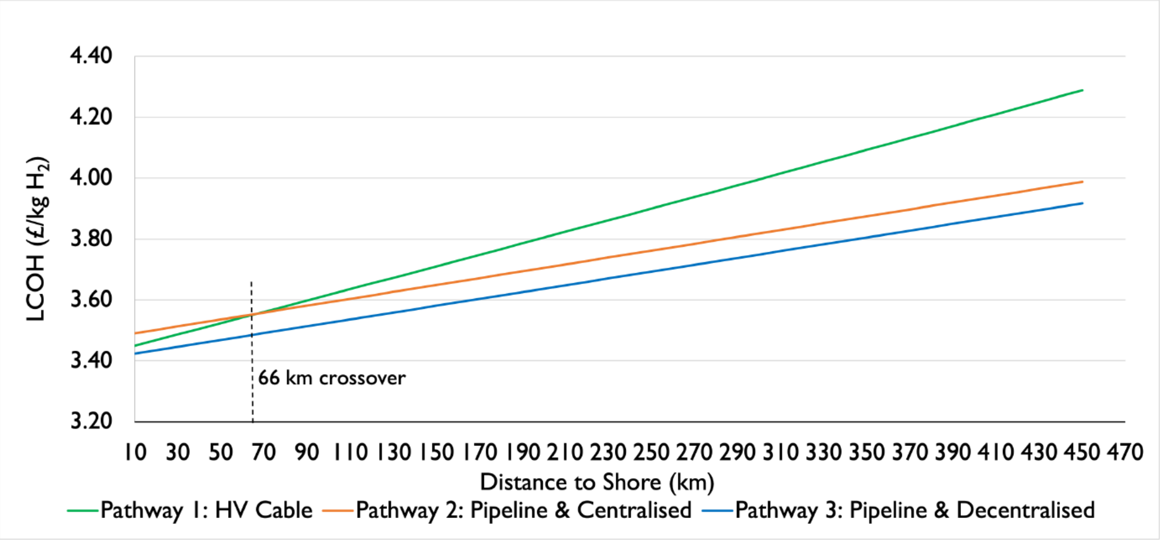


Source for Figures: Omar S.Ibrahim et al. Dedicated large-scale floating offshore wind to hydrogen: Assessing design variables in proposed typologies

Decentralised Offshore Electrolysis is The Most Economical Configuration for Hydrogen Production

- ERM's own analysis concluded that decentralised offshore electrolysis is the most economical configuration.
- Other resources agree with this conclusion, in particular, an unpublished piece of work by Max Peel et al. found that for all distances from shore it was the most economically advantageous.
- For this reason, ERM has pursued this design configuration with ERM Dolphyn (floating offshore wind to hydrogen concept).



Source: M. Peel et al. A Match Made at Sea: Hydrogen and Floating Wind (Unpublished)

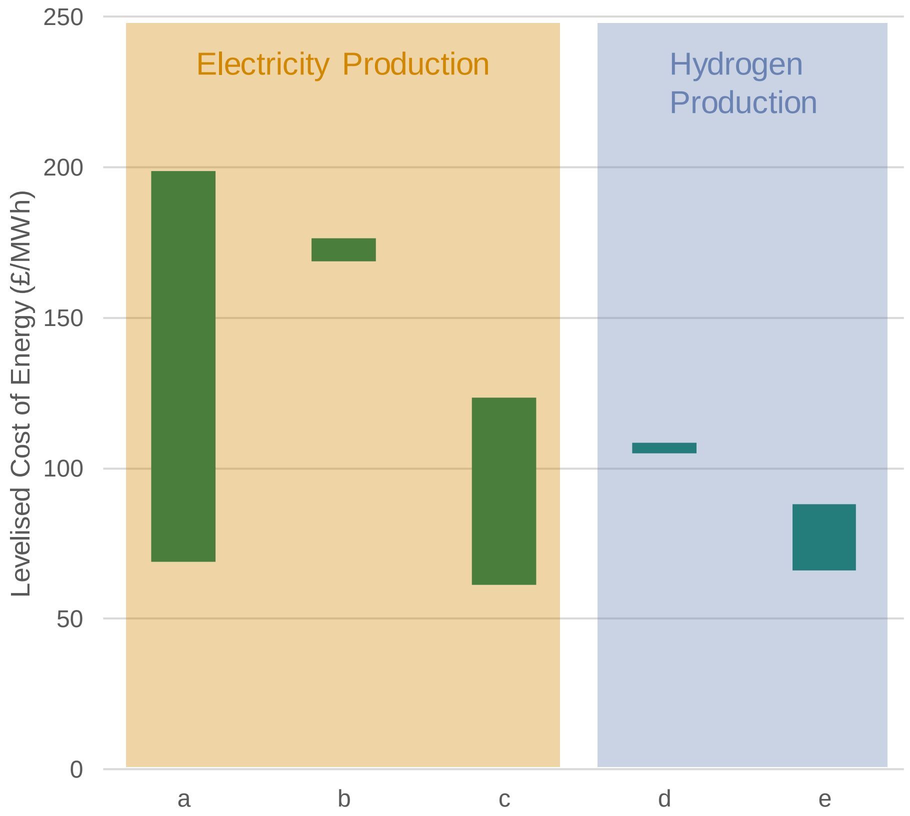
Hydrogen Production LCOE is Within the Same Region as Electricity Production from Floating Offshore Wind

- Hydrogen and electricity production from floating wind is comparable in the levelised cost, due to:
  - HVDC CAPEX and installation cost.[1]
  - Lower carrying capacity of HVDC wires vs H2 pipelines.[1]
  - Electricity losses over HVDC wires over long distances.[1]
- Further benefits to hydrogen other than costs include:
  - Provides an alternative to regions with high electricity grid constraints e.g. South Wales.
  - Reduces cable congestion.
  - Allows for sharing of offshore infrastructure.

Alignment with external references:

*"The cost of the pipelines to shore is found to be lower compared to electricity cables and this is closely dependent on the distance of OSW farm and platform to shore. The cost to supply and install the hydrogen pipeline is estimated at roughly **£1m/ km**. This compares favourably with the cost to supply and install 220kV export cable of roughly **£1m/ km and a 1.2GW windfarm requiring three to four cables, giving an export cable supply cost of >£3m/km**. If retrofitting of existing O&G pipelines is also considered, then the cost can drop even lower."*

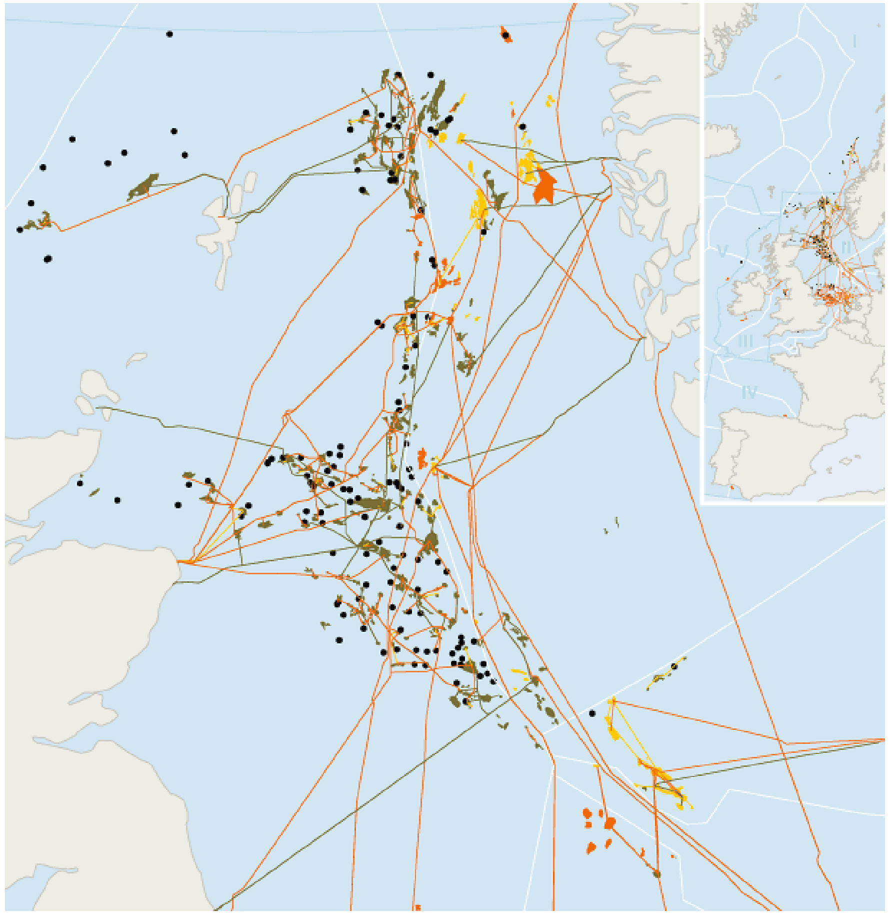
Source: ORE Catapult, 2020, Offshore Wind and Hydrogen, Solving the Integration Challenge



Sources:
a) Levelised cost of energy for offshore floating wind turbines in a life cycle perspective | Elsevier Enhanced Reader
b) Incorporating stochastic operation and maintenance models into the techno-economic analysis of floating offshore wind farms | Elsevier Enhanced Reader
c) applsci-10-08899.pdf
d) M. Peel et al. A Match Made at Sea: Hydrogen and Floating Wind (Unpublished)
e) Solving-the-Integration-Challenge-ORE-Catapultr.pdf

Source: 1 - DeSantis, Daniel et al. "Cost of long-distance energy transmission by different carriers."

Potential for Further Expansion through shared Transmission Infrastructure



Source for Figure: [QSR 2010 - Offshore Oil and Gas Industry - What are the problems? (ospar.org)]

- Hydrogen pipeline transmission allows oversizing to create a trunk line, shared between developers.
- Greater economies of scale can be achieved with a higher capacity hydrogen pipeline vs electrical cables.
- This characteristic makes it ideal for unlocking floating offshore wind.[1]
- Furthermore, utilising shared offshore hydrogen pipelines are analogous to the O&G industry:
  - Build on the expertise of a developed industry.
  - Already shown shared offshore infrastructure is possible (c. 5 pipelines connect Scotland to 100s of O&G rigs as seen in Figure to the left).
  - Part of a "just transition".

Source: 1 - Cost of long-distance energy transmission by different carriers (nih.gov)

Key Summaries

The United Kingdom has a plethora of wind resources located deep offshore.

In order to harness this, it is vital to develop optimal transmission infrastructure.

Hydrogen pipelines are well suited for this application:

- Significant economies of scale with increased capacity.
- Allows oversizing and a modular roll-out of wind farms.

Significant and important opportunities for collaboration on sharing offshore transmission infrastructure.

Allows building upon vast learnings from the O&G sector and just transition

Thank you

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