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environmental services and products

Aquatera and MRE projects world-wide

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Aquatera: a world-leading business in sustainable island energy
400 sustainable energy projects
250 marine energy projects
10 marine array projects
30 marine energy technologies supported
50 island links
Working in 20 countries
45 staff & associates
20 strategic energy plans
100 onshore wind projects
Formed in 2000
Based in Orkney
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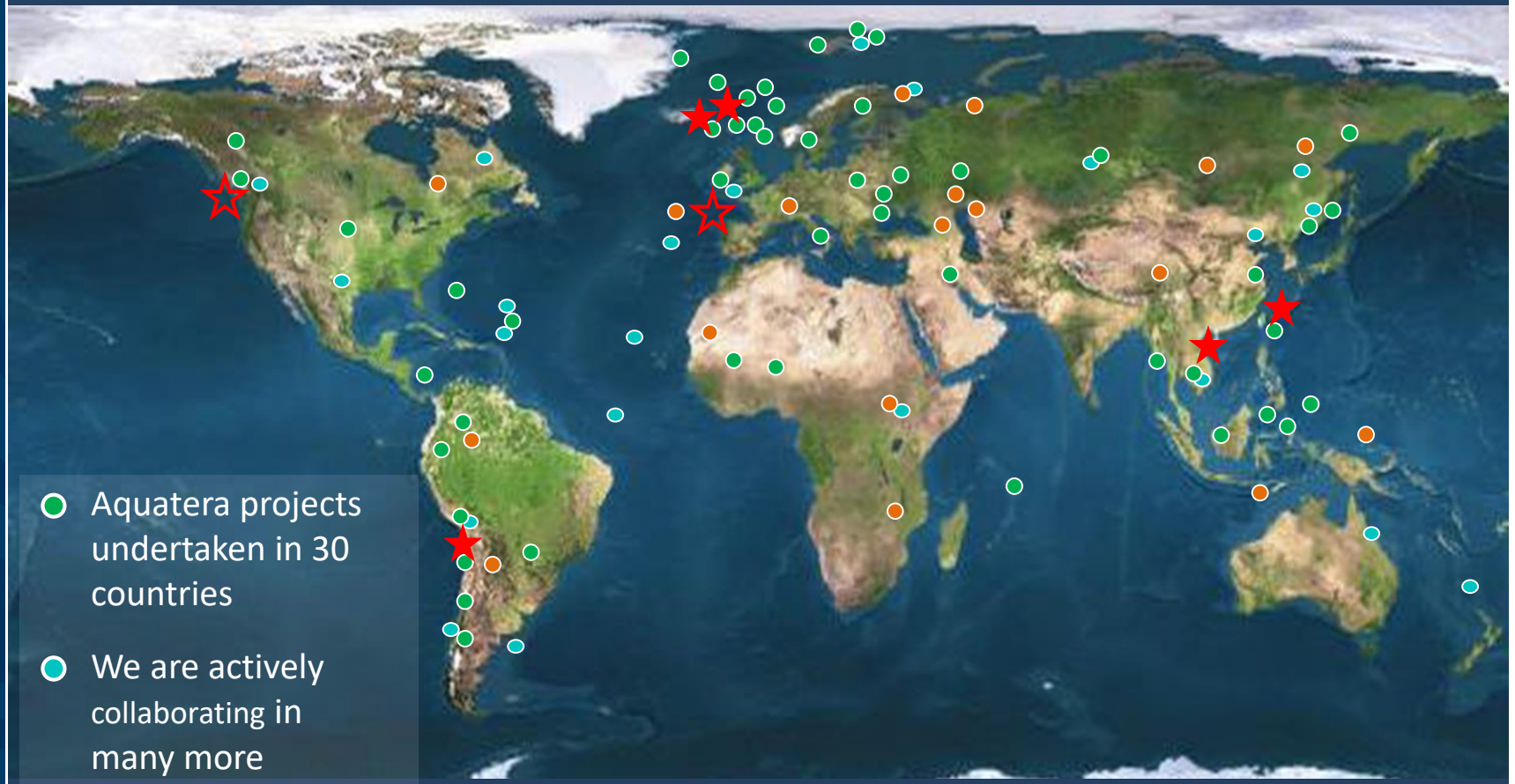
Thinking locally acting globally



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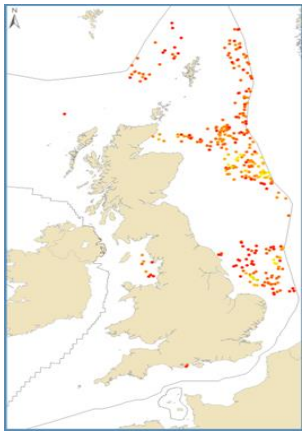
Summary of recent projects inc H2

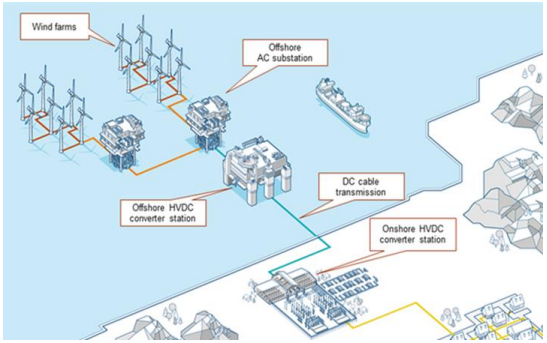
- Shapinsay low carbon vessel project

- Low carbon ferry option analysis

- Hydrogen offshore mapping



- Hydrogen opportunities in the north sea oil and gas sector



- HOP – Hydrogen Offshore Project

Shapinsay low carbon transport project

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Shapinsay low carbon transport study

Problem:

- Limited grid connection to mainland Orkney
- Community owned wind turbine being shut down regularly
- Small out of hours ferry funded by community

Possible solution:

- Ferry fuelled by either electricity or Hydrogen produced from wind turbine
  - Fuelled renewably
  - Reduced cost
  - Turbine not shutdown so much so able to claim subsidy (Feed in Tariff)

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Shapinsay low carbon transport study

- Vessel study
  - No hull design but engine type
- Infrastructure study
  - Options for both electric power or H2
- Financial analysis
  - High level cost model

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Pre-screening

	Use of curtailed electricity	Use of reasonable amount curtailed energy	
Full Electric Engine	Yes	Yes	✓
Electric Hybrid	No	No	✗
Plug-in Electric	Yes	No	✗
Full Fuel Cells Engine	Yes	Yes	✓
Hybrid Fuel Cells Engine	Yes	Yes	✓
Direct Burn Hydrogen	Yes	Yes	✓
Hydrogen Co-burning	Yes	No	✗

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2nd phase screening

Criteria	Assessment factors
Engine Safety and reliability	Accidents:
Engine Availability Timescale	Engine availability:
Engine Technical Characteristics	Engine design suitable for Shapinsay route: Curtailed energy used: Overall energy demand:. Engine weight: Engine dimensions: Switching and Load Management Options: Refuelling/Recharging:

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Hydrogen conclusion

- **The hydrogen production**
  - hydrogen refuelling system with a 21N m^3/h electrolyser which would be enough for the vessel
  - produce the daily hydrogen requirements in about 20 hours, if operating continuously and the storage system can be designed to suit the vessel
- **There are two suitable electrolysers**
  - PEMEC or AES that have a similar capital cost
  - More detailed investigation into various parameters such as water supply availability, cost and track record are needed to finalise the best option

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Preferred Option - Direct H_2 combustion vessel

- Existing petrol outboards converted to run on hydrogen
- 9.5m catamaran powered by twin 135 HP Honda petrol outboards
- run on petrol as a backup

- **Hydrogen storage system**
  - high pressure cylinders (200 bar) were recommended
  - provide the hydrogen storage for 5 days
  - The storage system is flexible and modular

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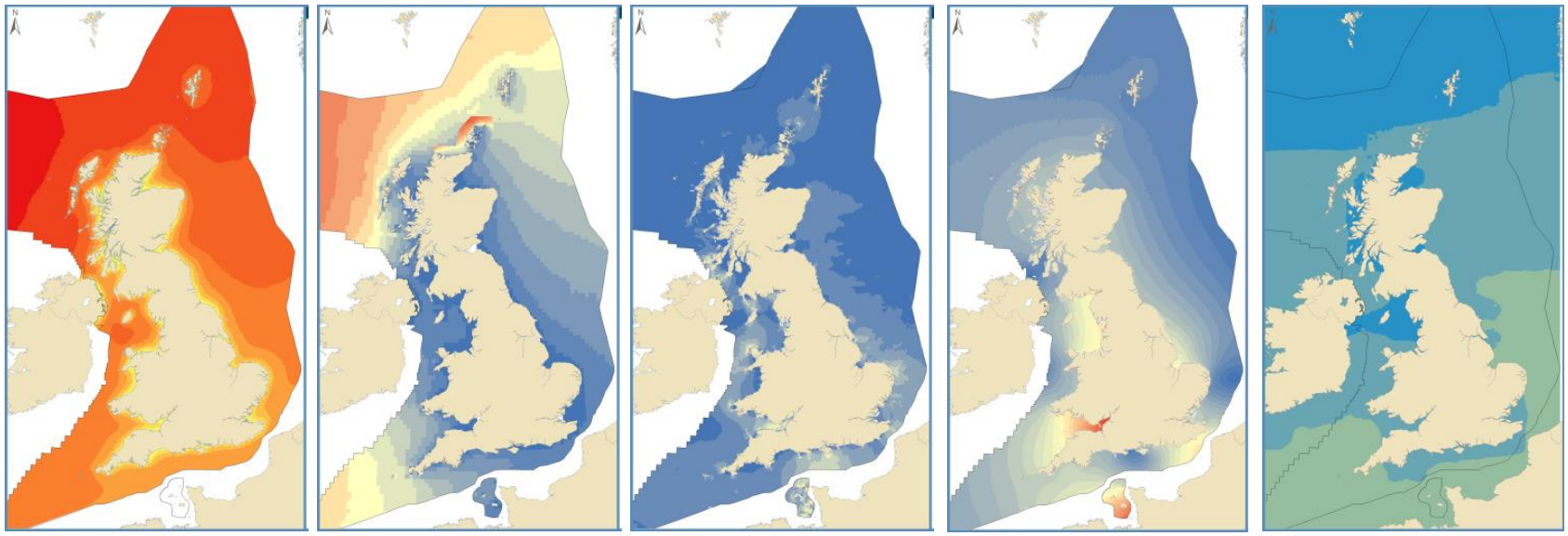
North sea hydrogen integration

Client - Oil and Gas Technology Centre

- 3 Stages (3 projects)
  - Mapping renewable assets
  - Option analysis of hydrogen production in offshore oil and gas operations
  - Develop a test centre to take hydrogen production offshore

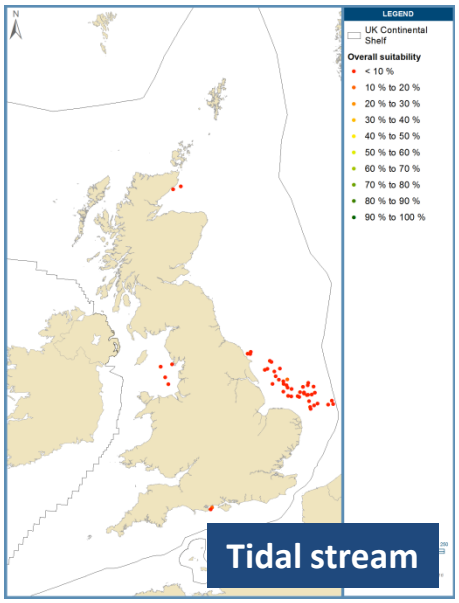
Mapping renewable energy resources

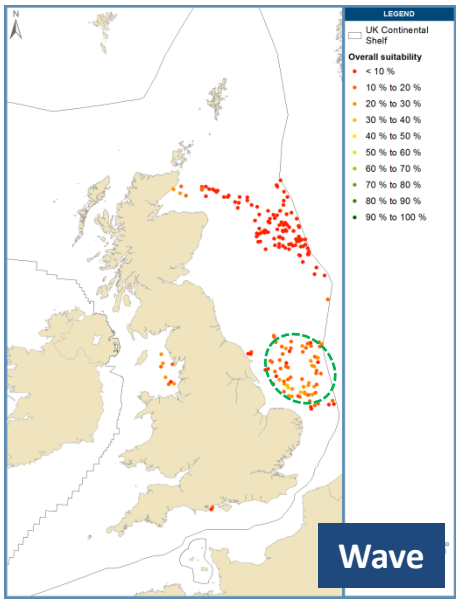
Five types of renewable energy resource were considered:

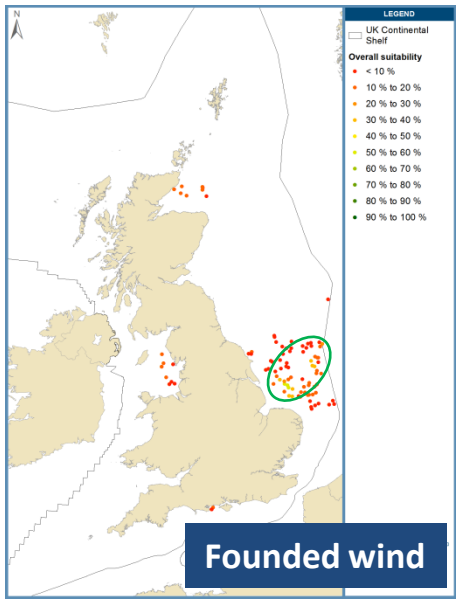


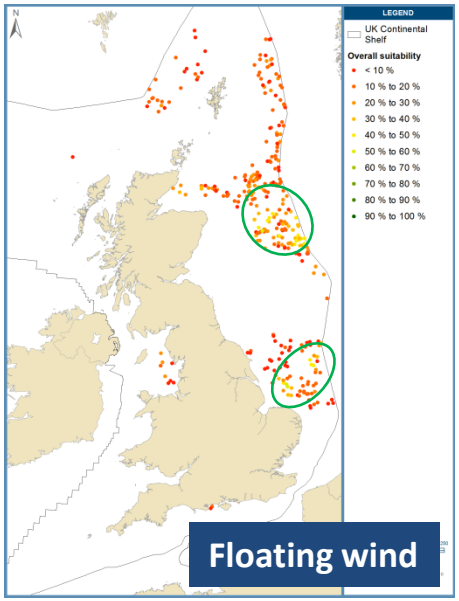
Wind | Wave | Tidal stream | Tidal range | Solar

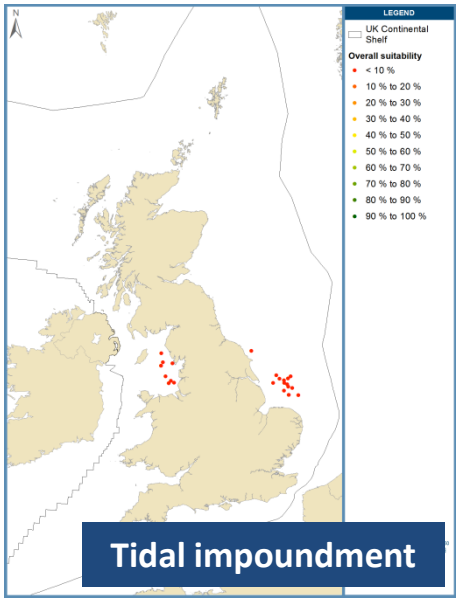
Energy source comparison

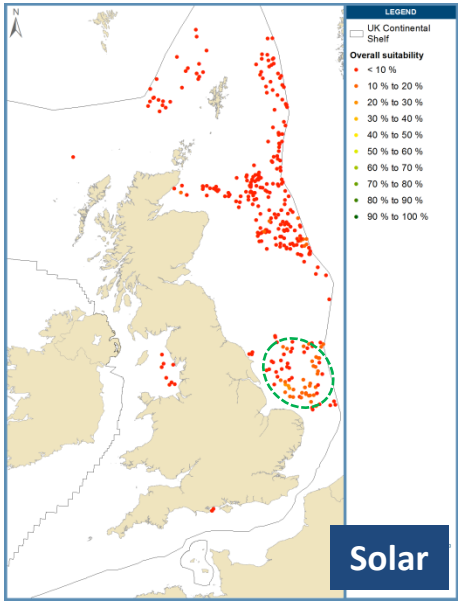












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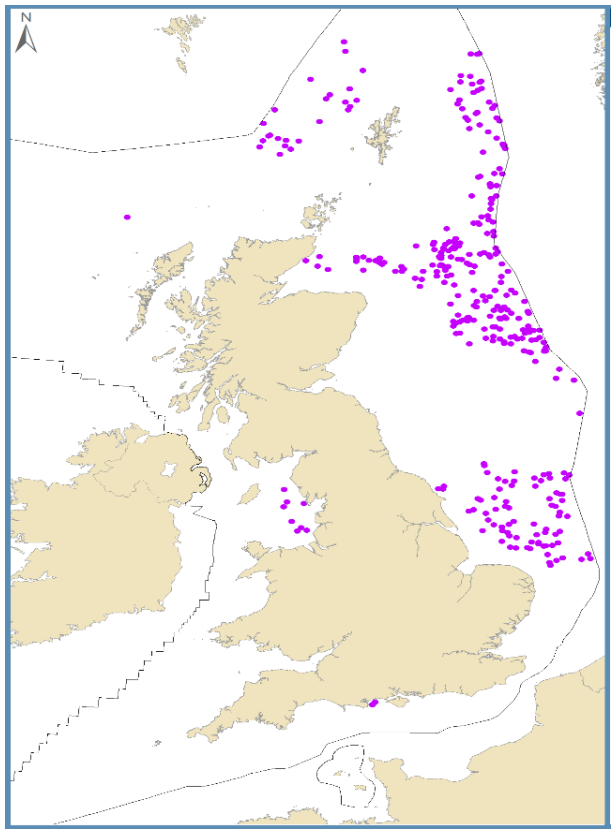
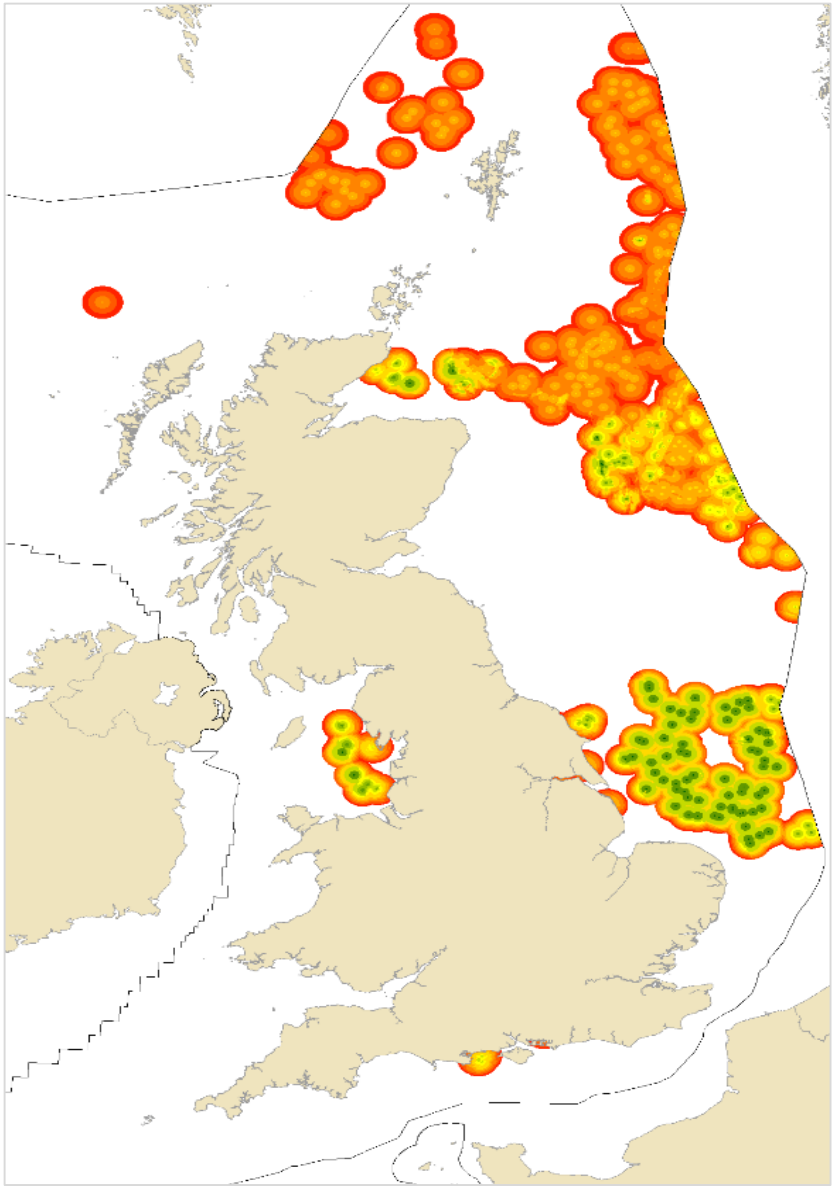
Small pools – power optimisation



- There are over 300 oil and gas small pools in the UK sector of the north sea
- Small pools serviced by tie backs are currently serviced by umbilicals
  - Bespoke design
  - Expensive approximately
  - Not designed to be reused
- How can they be avoided?
- Can H_2 provide a solution?

Example of results for fixed wind



LEGEND

UK Continental Shelf

Suitability

- Not Suitable
- < 10 %
- 10 % to 20 %
- 20 % to 30 %
- 30 % to 40 %
- 40 % to 50 %
- 50 % to 60 %
- 60 % to 70 %
- 70 % to 80 %
- 80 % to 90 %
- 90 % to 100 %
- 100 %

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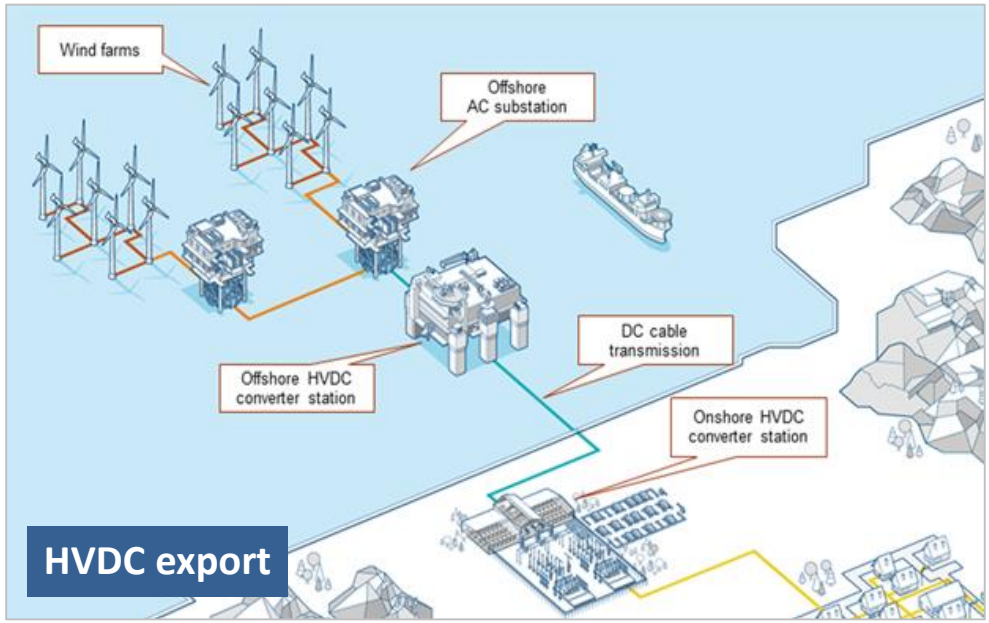
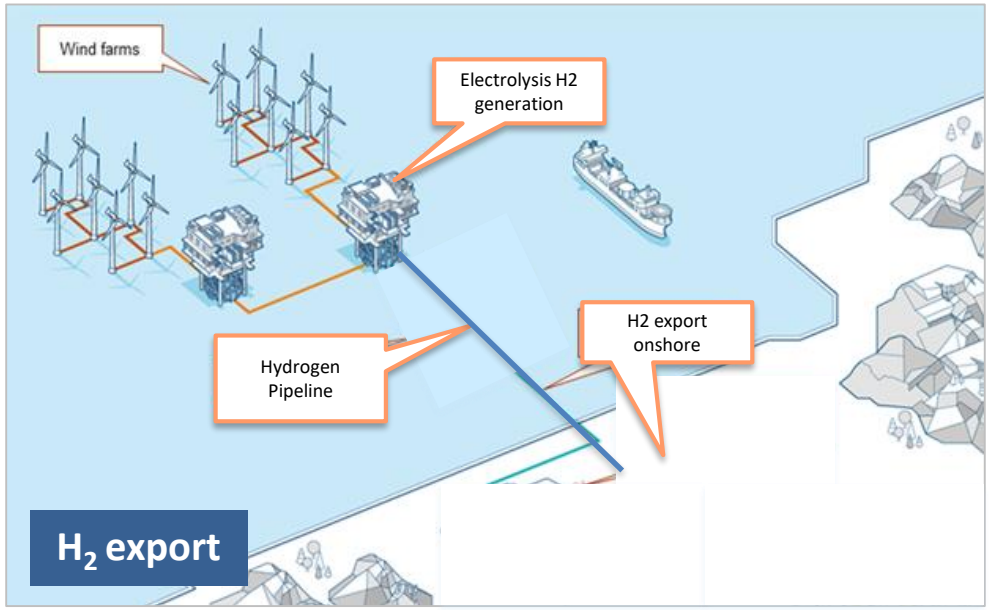
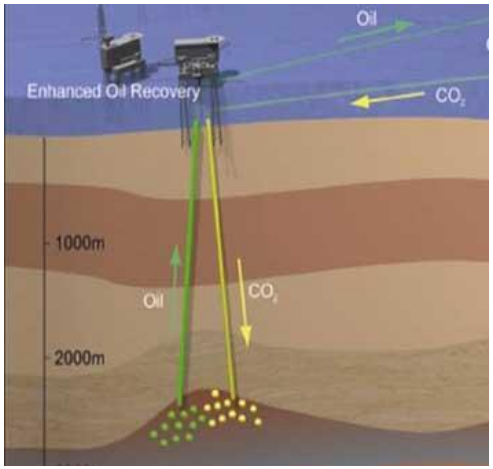
Hydrogen as alternative energy export

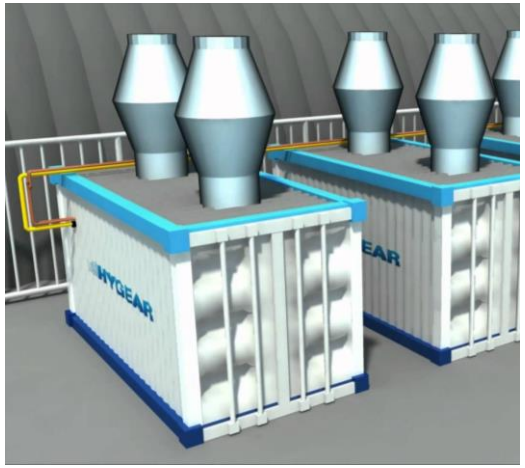


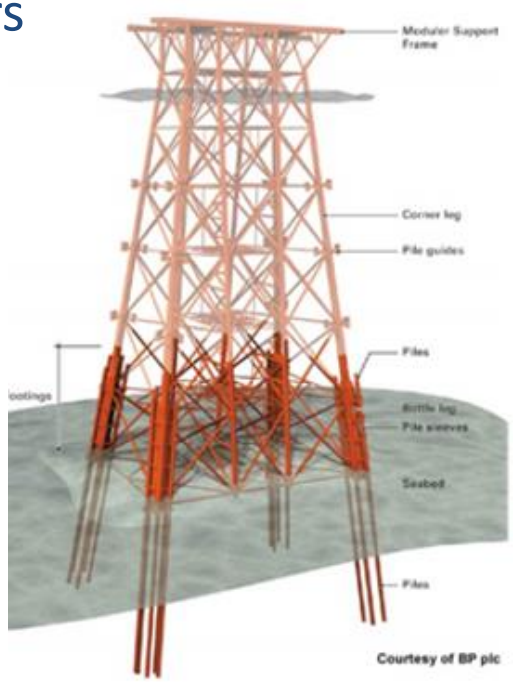


Hydrogen as an EOR enabler

- Reforming gas offshore to generate CO_2 for EOR and H_2 for export or power generation (small pools)
- SMR or ATR Technologies for conventional H2, CO_2 'by product' of H_2 production used for EOR
- Repurposing of Jacket and topsides offers decommissioning deferment potential







Thank you
and any questions ?

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