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Advancing deployment of Offshore Wind and Floating solar PV

What can be learnt from the Scottish experience?

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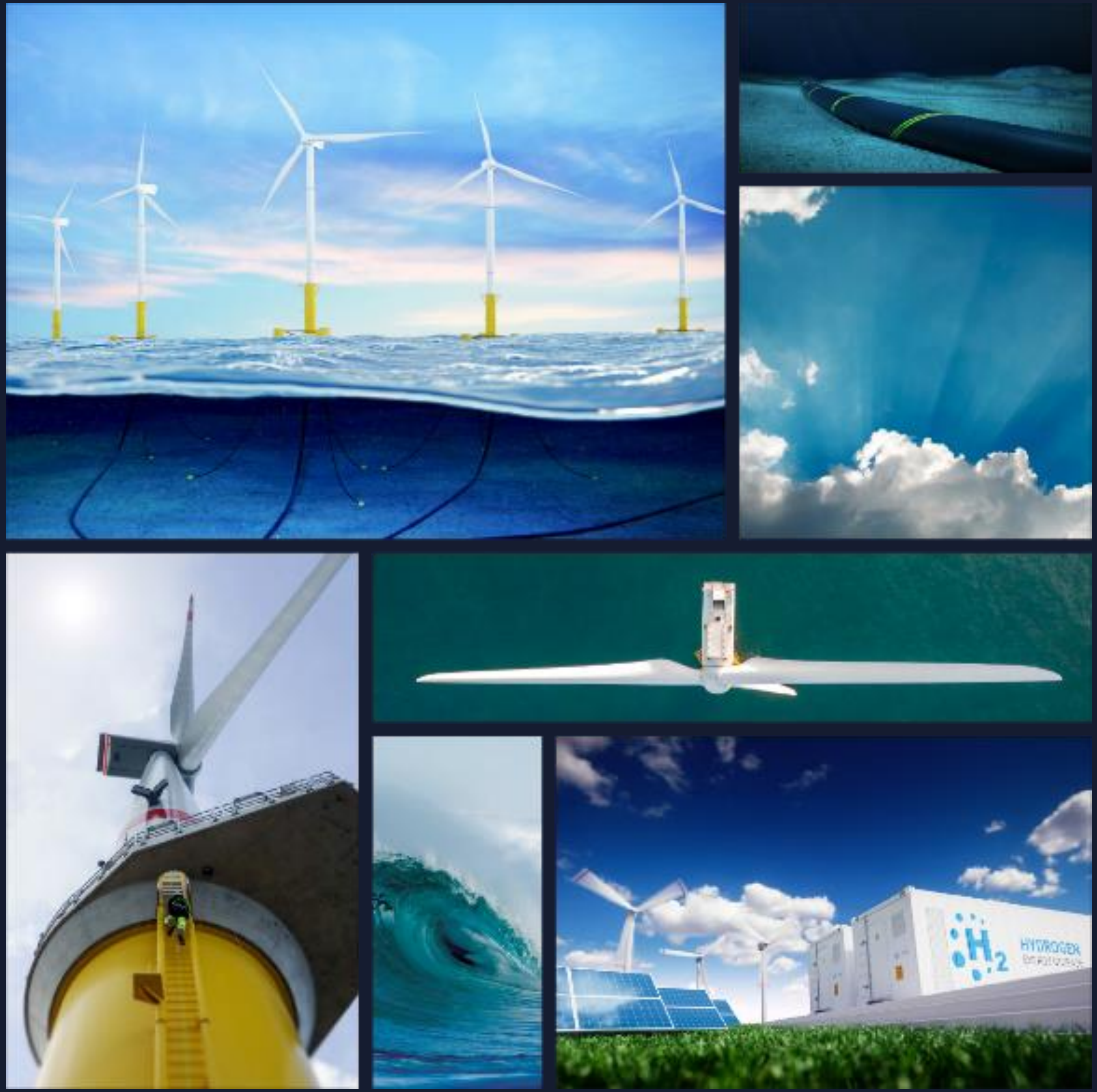


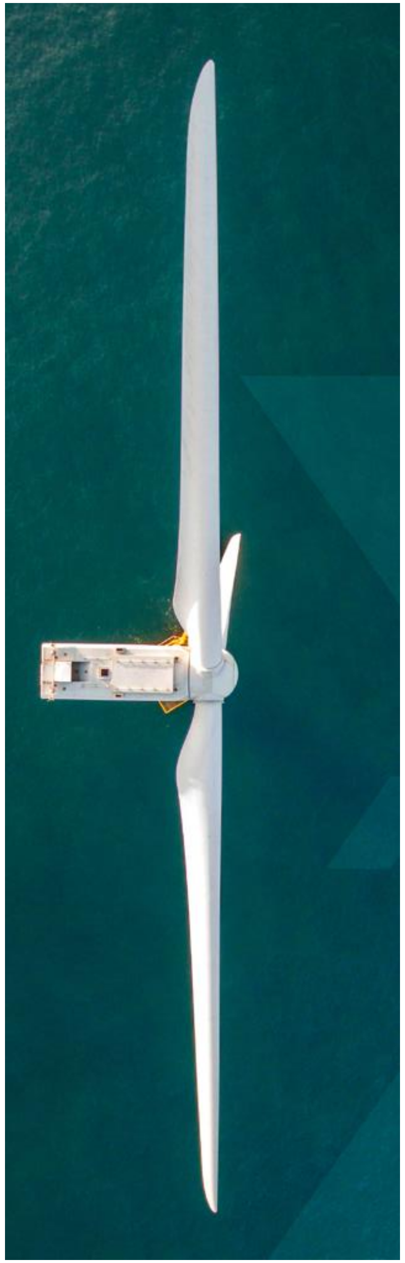
Introduction

What can be learnt from the Scottish experience?

- Case study – Offshore Wind Development in Scotland (and the wider UK)
- Key factors for achieving commercial scale offshore wind
- Key milestones that need to be met to achieve commercialisation and accessibility for SIDS

Discussion of the following topics:

- Optimal site selection
- How policy and regulation can facilitate or stall development
- The importance of data
- Technology suitability
- Ports & supply chain
- Grid connection challenges
- Route to market options and commercialisation



The Scottish Context

- Fixed Wind – the first operational commercial scale projects in Scotland, on the east coast relatively close to shore
- Pilot scale floating wind – Scotland is leading the way in commercialisation of floating wind with Kincardine and Hywind projects demonstrating the viability of the technology
- ScotWind and future fixed and floating commercial scale projects on the horizon
- In contrast, Fair Isle & Small Isles have developed small scale off-grid energy systems that supply near 100% renewables. Security of energy supply a critical driver for these communities
- INTOG opportunities for innovation and powering oil and gas

Fair Isle

- £3.5m project
- ~ half government funded
- 2x onshore wind turbines + onshore solar + battery
- 55 people in the community
- Replacement of diesel generator and end to nightly shut downs

2001 Round 1 projects – monopiles close to shore on English East coast (+ 1 Scottish project)

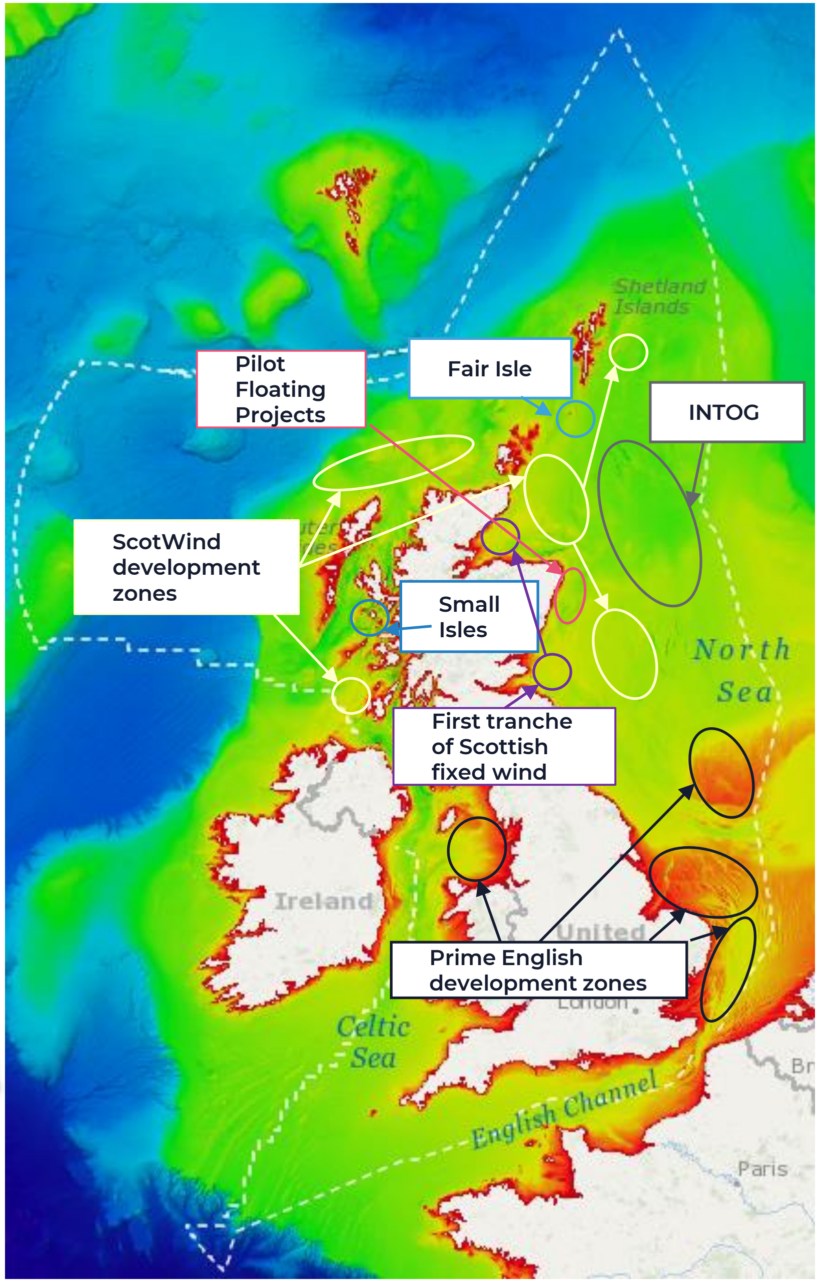
2003 Round 2 projects – monopiles, increase in project scale

2010 Round 3 projects + 1&2 extensions – Scottish and English projects, introduction of jacket foundations

2017 Extension projects – introduction of Option Agreement fee

2021 Round 4 projects – English large commercial projects further offshore, competitive option fee setting

2022 ScotWind projects – deeper water, generally further offshore. Jacket & floating solutions expected



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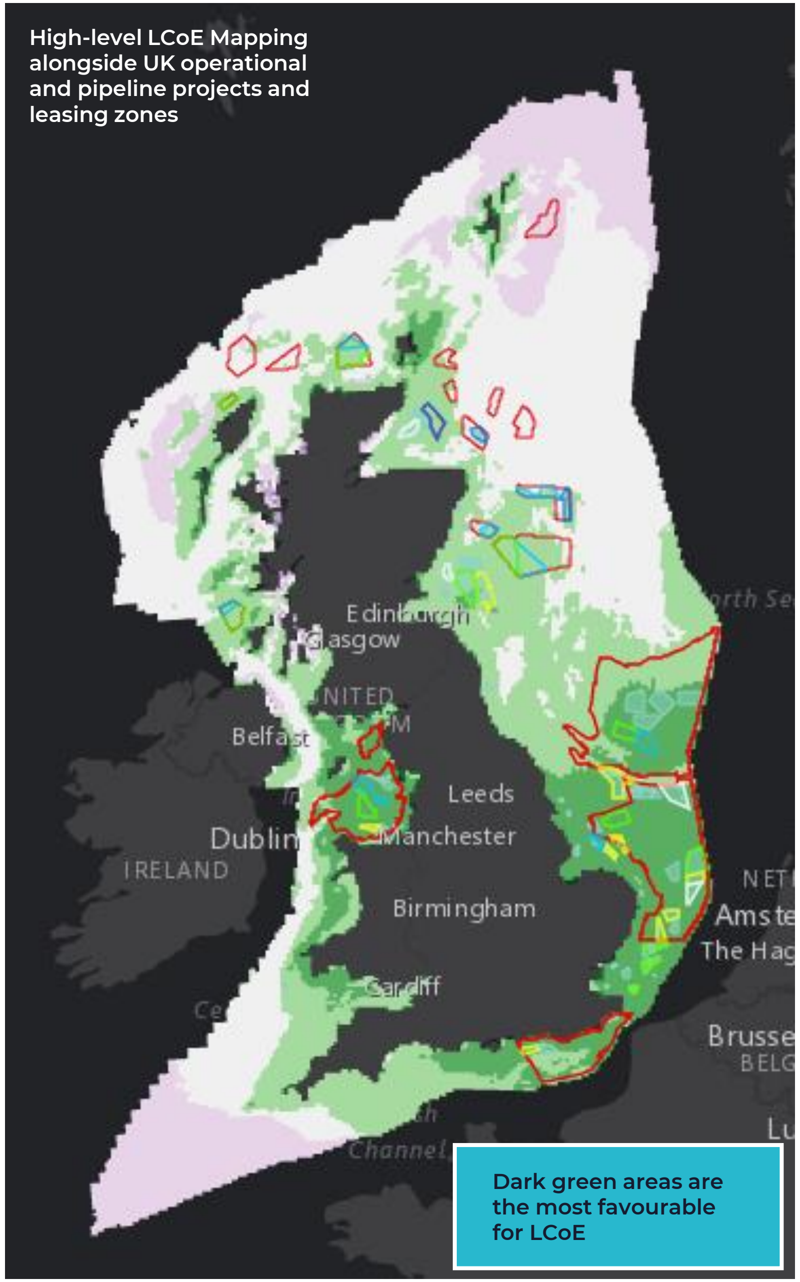
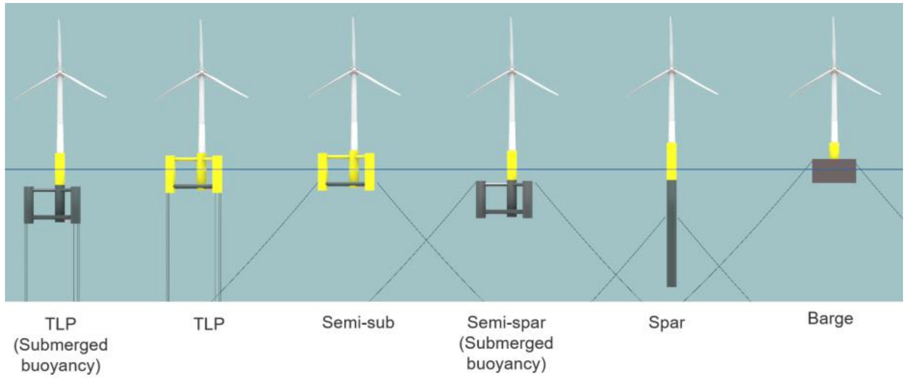
Site Selection

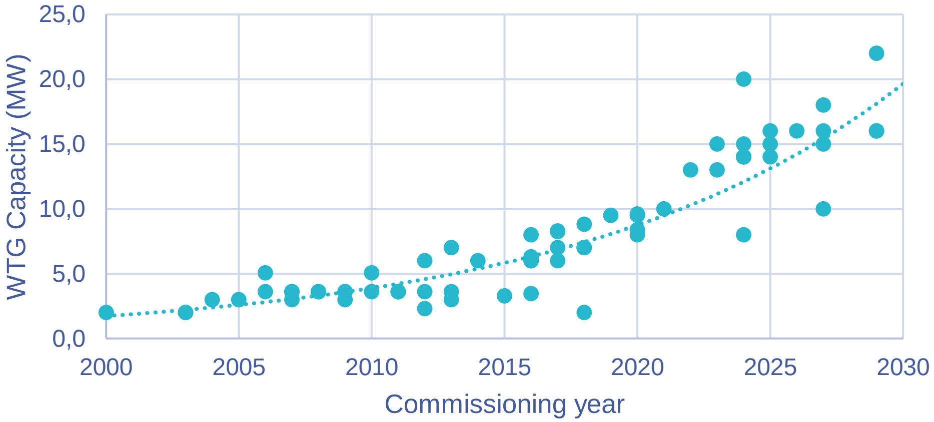
- Kick-start new markets by focusing on the easiest sites to develop first
- Shallow water depth, windy, not too wavy or with strong currents, close to shore, deep sediment deposits (not rocky), away from environmentally or socially/economically sensitive areas (e.g. protected sites and species, fisheries, shipping, existing infrastructure, recreation)
- As the industry matures and costs reduce, this opens up new, more challenging areas of seabed
- Minimising environmental impact is best practice for achieving sustainable solutions – holistic view on site selection taking into account environmental, technical and economic considerations
- Baseline data is key to enabling desktop study and site selection. Marine Scotland and other organisations have built up extensive data sets over the years in Scotland
- Marine spatial planning and seabed exclusivity – carefully managed processes help lower risk and attract developers whilst maximising project pipeline potential in a balanced way across all stakeholders
- LCoE spatial variability can also be used from an early stage to inform site selection (as shown in image to right)

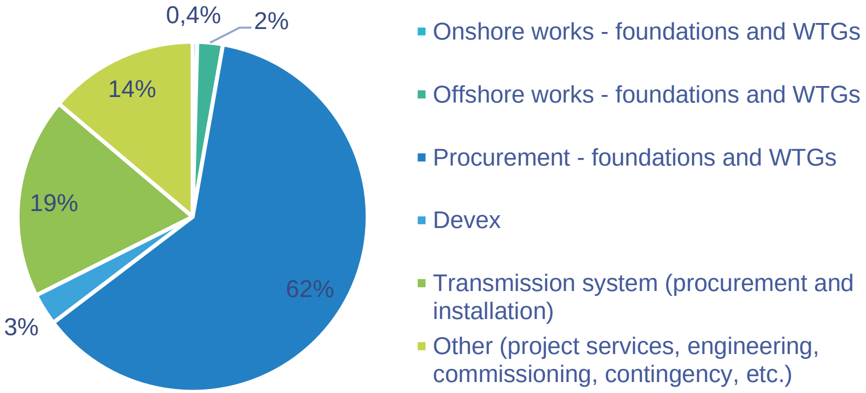


Technology

- Foundation and turbine procurement/installation costs make up the biggest proportion of the capex of a project so making the right choice is critical to a project's viability
- Monopile foundations are the cheapest and simplest to manufacture and are suitable for water depths of up to ~40m
- Jackets in up to ~80m water depth – Scottish track record is growing
- Floating foundations from around 60m+ water depth but currently no consensus on preferred design, despite Scotland being world leading, the market is still immature
- Traditionally projects have been installed in sediments although drilled and grouted piles are more recently being considered
- Are larger turbines the way forward? – slightly smaller models may still be produced by manufacturers and second hand turbines can be available – more manageable from a procurement cost but also in terms of supply chain and deployment strategy
- Choose mature technology to lower risk and cost

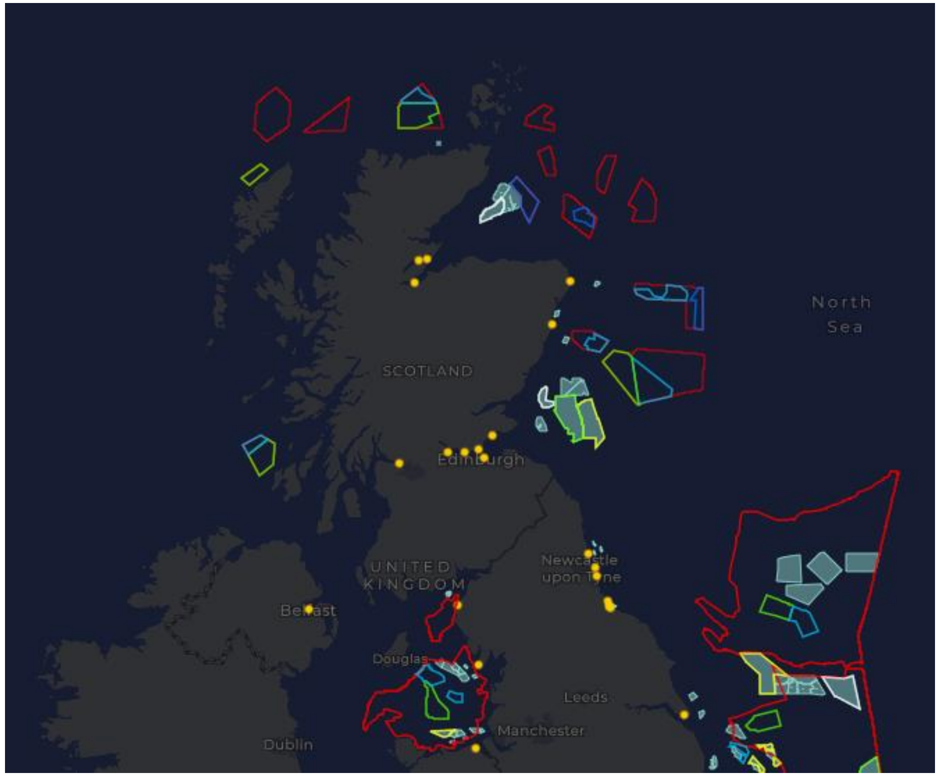






Ports and Supply Chain

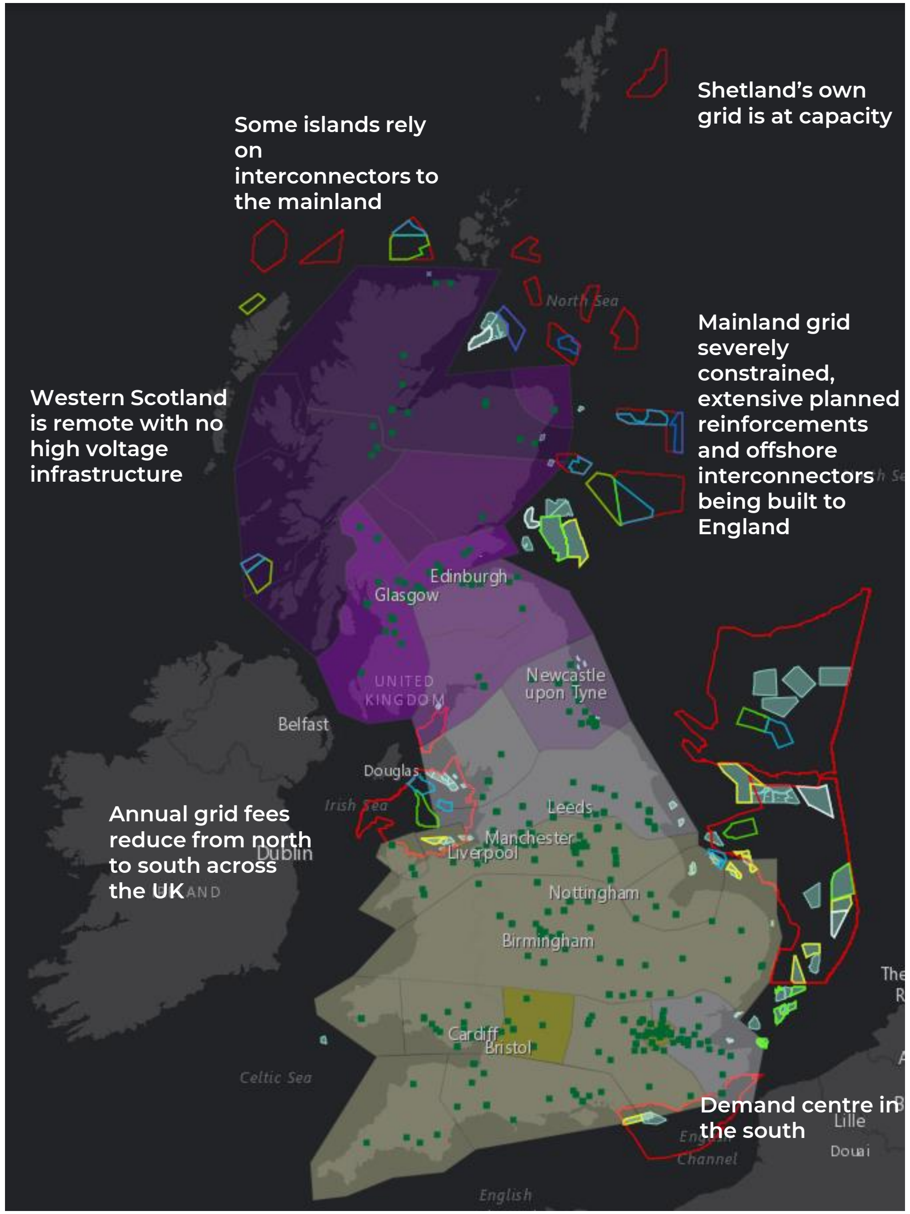
- This is a critical barrier to development, especially for floating wind where there are quite unique space and quayside requirements
- Project costs are fairly insensitive to distance to installation port (within reason) - port facilities fairly well distributed along the east coast of Scotland but the west coast is much less accessible. Only a handful of ports are suitable for floating wind and substantial upgrades are being considered at several facilities. High potential for bottlenecks when taking into account the ScotWind project pipeline
- Need strong track record in offshore construction activities – Scotland has been able to make use of Oil and Gas legacy of experience, but fixed and floating wind do have their own requirements to achieve optimal deployment strategy
- Move towards modularisation and mass manufacture for economies of scale and cost reduction
- Very large turbines are an unknown factor – potentially significant implications on fabrication, assembly and installation methodologies, equipment and durations once limits for existing facilities and vessels are reached



Key port requirements for floating wind (semi-sub)	Current (pilot scale)	Future (commercial scale)
Min draft (m)	~11	~11
Min LOA for berth (m)	~100	~300
Min beam (m)	~80	~90
Min open storage area (m^2)	~20,000	~100,000
Min lift requirement (Tonnes)	~3000	~3500

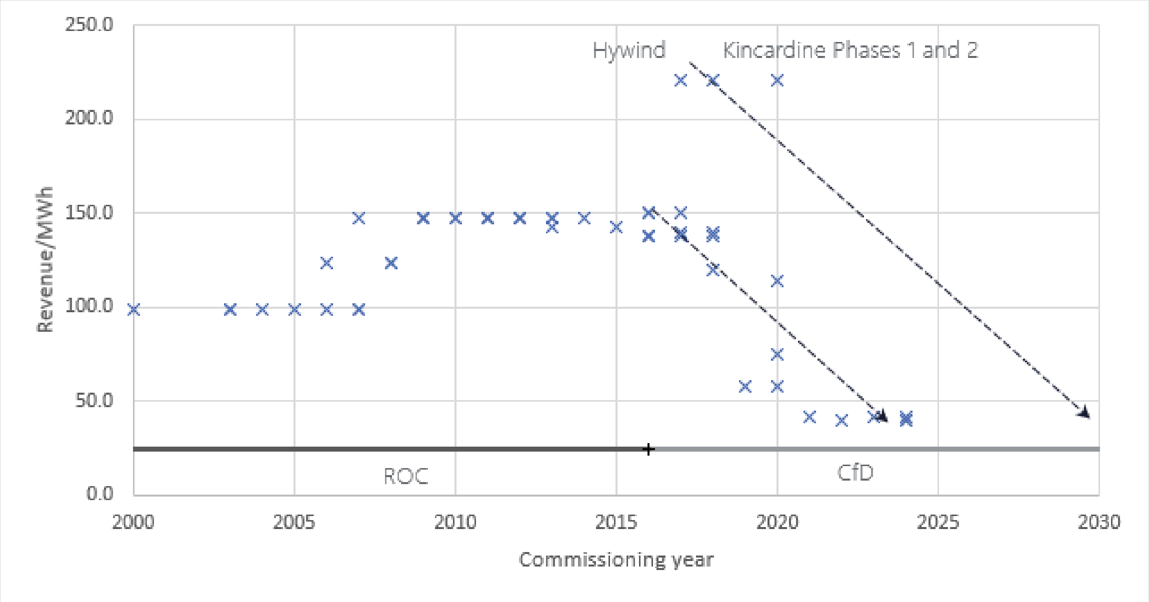
Grid connection

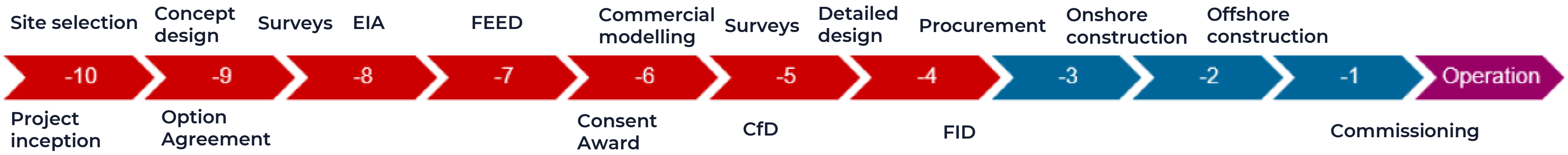
- Grid is a key constraint and barrier to development in Scotland
  - Low voltage network in many areas, especially islands and west coast
  - At capacity in many parts of the system, especially on some of the islands – Shetland, Orkney, Outer Hebrides but even the mainland network is heavily constrained
  - Far away from demand centres
  - ➢ Requires significant investment, extending the development timeline and project risk
- Centralised versus decentralised systems
  - Decentralised systems can be a way to mitigate some of the grid constraints
  - Smaller scale projects could get up and running more quickly and attract a lower level of reinforcements of the network on an individual basis and allow for a more staggered network development over time as overall capacity builds up
  - Generation is brought closer to demand but less efficient as a whole
  - Private wire systems are another option
- Ownership of developments – government/TO led or developer led?



Route to market

- Government subsidies/financing and competition driving cost reduction
- Separate subsidy pots for fixed and floating offshore wind – recognised that each has a role to play but that costs are not yet (and may never be) on a par
- Separate category for remote island wind recognising how decentralised systems can benefit communities in more remote parts of the UK
- Alternatives – PPAs and private wires, hydrogen production for energy storage - ammonia or electricity options. First pilot scale offshore wind – hydrogen projects under development
- Long development timeline with multiple milestones for commercial projects carries substantial risk and is a barrier for certain types of investors/developers





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Recommendations

1. Carefully managed marine spatial planning taking into account optimal project pipeline/industry roadmap
2. Baseline data collection and management
3. Clear regulatory process including well defined timeline
4. Holistic selection of sites with preferential conditions
5. Focus on lowest risk, cheapest technology at first
6. Coordinated approach to supply chain capacity and experience building
7. Definition of a viable route to market, from both technical (grid or other) and commercial (subsidy or other) perspectives

Key Milestone	Opportunities	Challenges
Technical feasibility	Low cost solutions are now available with monopiles in shallow waters – key is finding suitable sites	Grid infrastructure often requires extensive upgrades for medium to large scale projects Foundation solutions for deeper waters are riskier and more expensive which may or may not be offset by stronger wind conditions
Economic viability	Carefully developed projects can find a viable route to market/suitable revenue stream – especially replacement of diesel generation systems, and depending on who is responsible for developing transmission system infrastructure	Floating wind is not yet commercially viable in the most mature markets Majority of projects still depend on government subsidies for revenue stability
Political backing, policy and regulation	A clearly defined process limits development risk and attracts developers by offering seabed exclusivity at early stage, a pragmatic approach to marine planning and consenting, and revenue stability via subsidies	Extensive data sets required for marine spatial planning Slow timescales for implementation of new policies/regulations through the political process
Capital investment	The right policies and route to market can attract developers that are able to cover the offshore wind farm build costs from the outset With a confirmed pipeline of projects, strategic port and supply chain investments can be triggered – regional manufacturing and installation hubs	Grid investments are likely to require public funding High levels of capital investment for commercial scale projects results in reliance on interest from large, international organisations Smaller scale, community led developments could be more achievable from a capital investment perspective

Questions?

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