

# Development pathways to 2030

## Early arrays > 30 MW?

**Lisa MacKenzie**  
Marketing and Communications Manager



# The early days | 2003...





# The 2010s





# The 2010s

## WES PROGRAMMES



2015 2016 2017 2018 2019 2020 2021 2022

### Power Take-Off



### Novel Wave Energy Converter



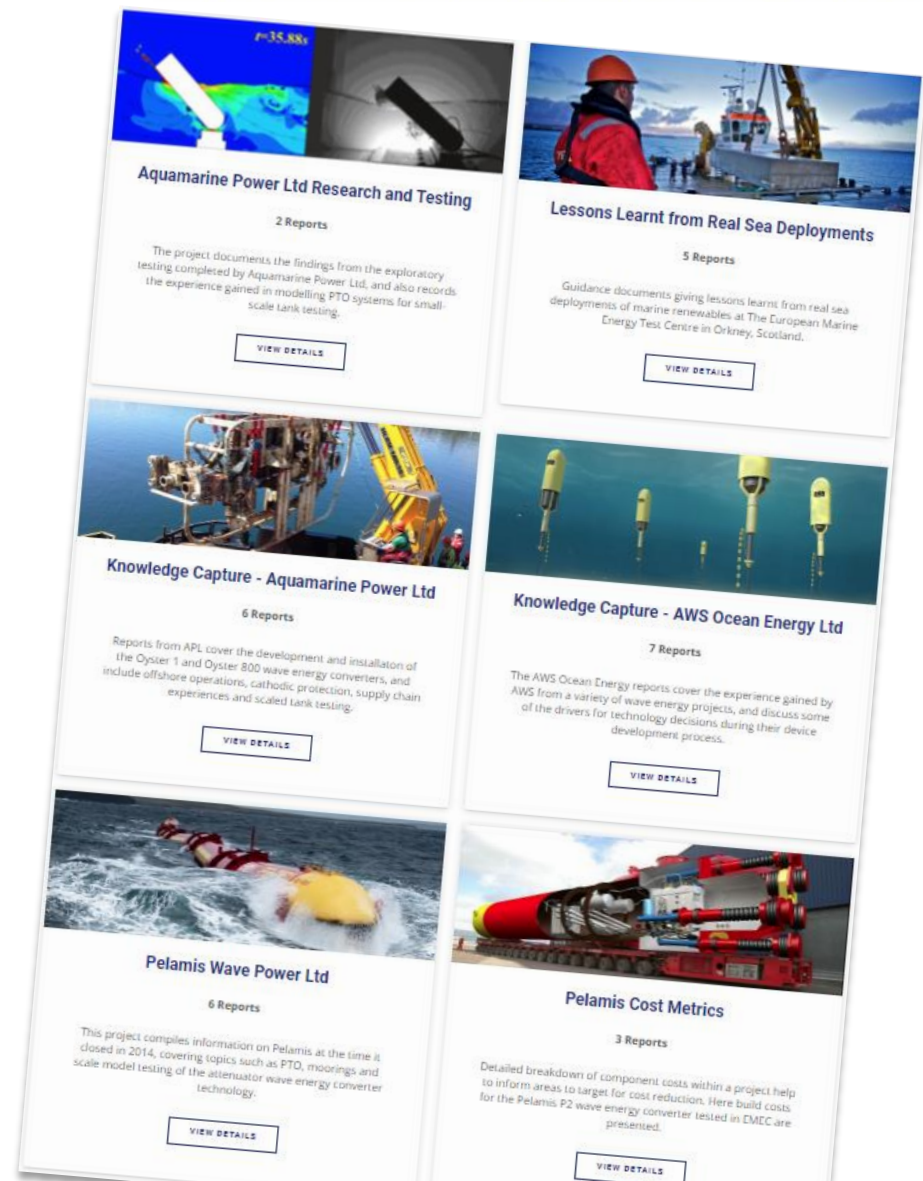
### Structural Materials



### Control Systems



### Quick Connection Systems

**Aquamarine Power Ltd Research and Testing**  
2 Reports  
The project documents the findings from the exploratory testing completed by Aquamarine Power Ltd, and also records the experience gained in modelling PTO systems for small-scale tank testing.  
[VIEW DETAILS](#)

**Lessons Learnt from Real Sea Deployments**  
5 Reports  
Guidance documents giving lessons learnt from real sea deployments of marine renewables at The European Marine Energy Test Centre in Orkney, Scotland.  
[VIEW DETAILS](#)

**Knowledge Capture - Aquamarine Power Ltd**  
6 Reports  
Reports from APL cover the development and installation of the Oyster 1 and Oyster 800 wave energy converters, and include offshore operations, cathodic protection, supply chain experiences and scaled tank testing.  
[VIEW DETAILS](#)

**Knowledge Capture - AWS Ocean Energy Ltd**  
7 Reports  
The AWS Ocean Energy reports cover the experience gained by AWS from a variety of wave energy projects, and discuss some of the drivers for technology decisions during their device development process.  
[VIEW DETAILS](#)

**Pelamis Wave Power Ltd**  
6 Reports  
This project compiles information on Pelamis at the time it closed in 2014, covering topics such as PTO, moorings and scale model testing of the attenuator wave energy converter technology.  
[VIEW DETAILS](#)

**Pelamis Cost Metrics**  
3 Reports  
Detailed breakdown of component costs within a project help to inform areas to target for cost reduction. Here build costs for the Pelamis P2 wave energy converter tested in EMEC are presented.  
[VIEW DETAILS](#)



> 2020s



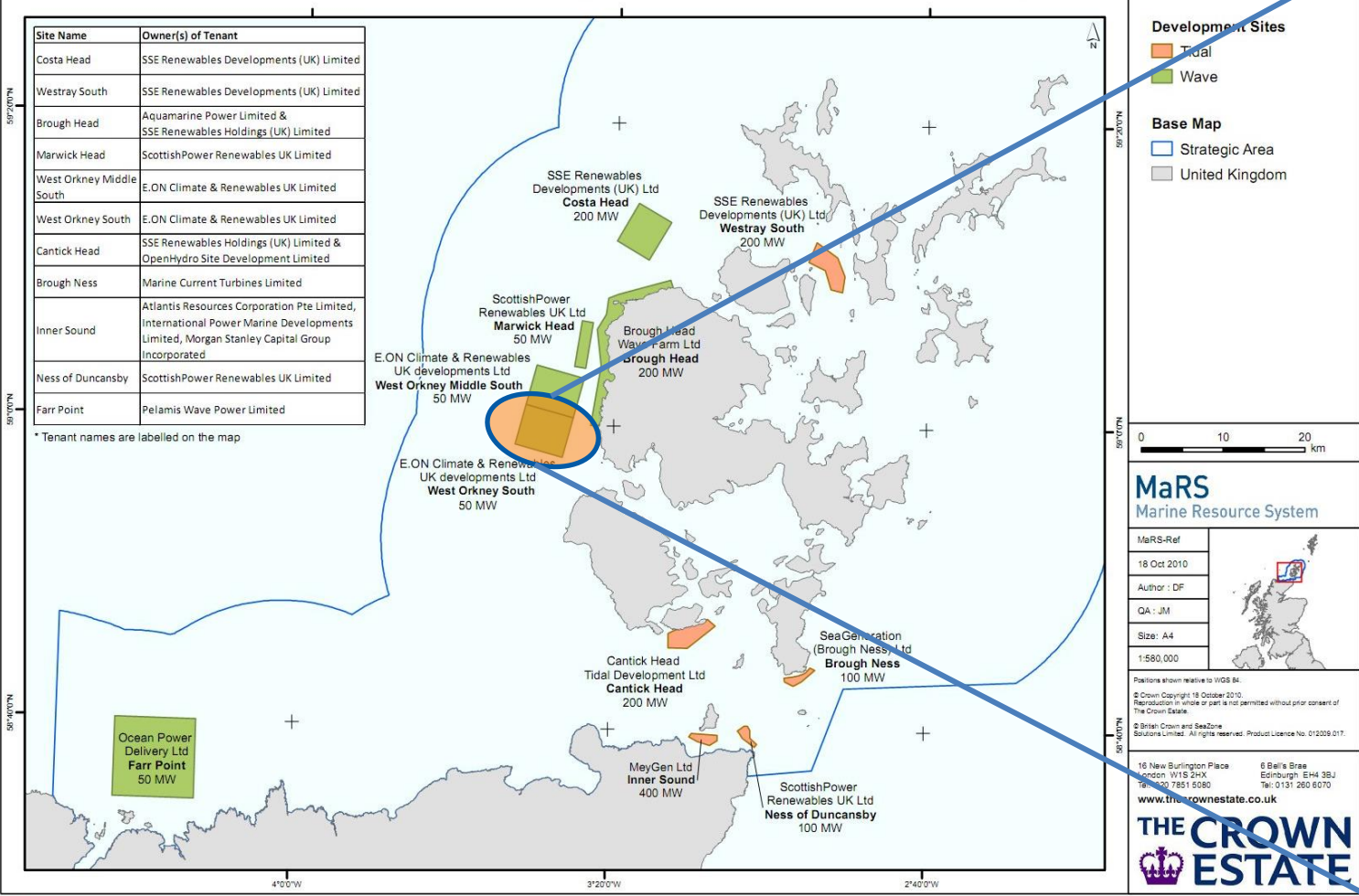
**2025 >**





2030s

**Pentland Firth and Orkney Waters Round 1 Development Sites**



**Objectives:**

**De-risk site with a project developer to establish the world's first large scale wave energy array in Scotland.**

**Ensure that Scotland maintains its global leadership in the wave energy sector**

**Development Sites**

- Tidal
- Wave

**Base Map**

- Strategic Area
- United Kingdom

0 10 20 km

**MaRS**  
Marine Resource System

MaRS-Ref: 18 Oct 2010  
Author: DF  
QA: JM  
Size: A4  
1:580,000

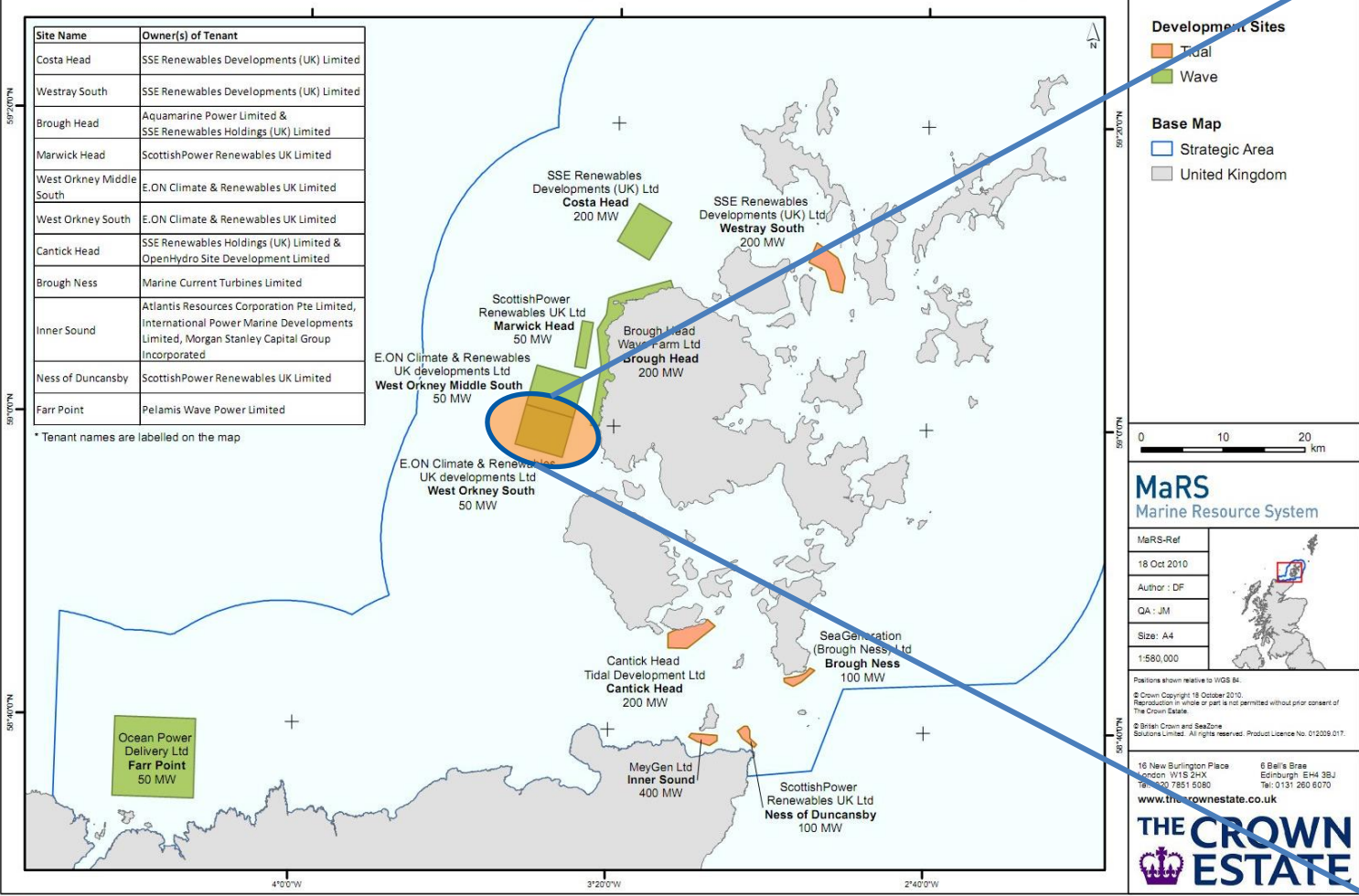
Positions shown relative to 1928 AD.  
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**THE CROWN ESTATE**

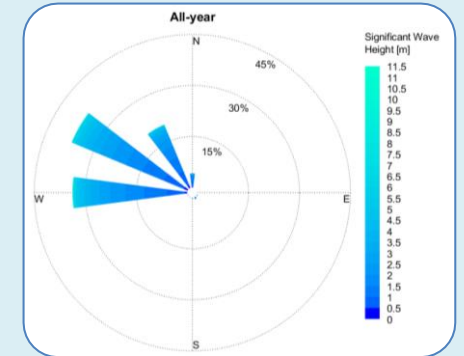
# 2030s

## Pentland Firth and Orkney Waters Round 1 Development Sites



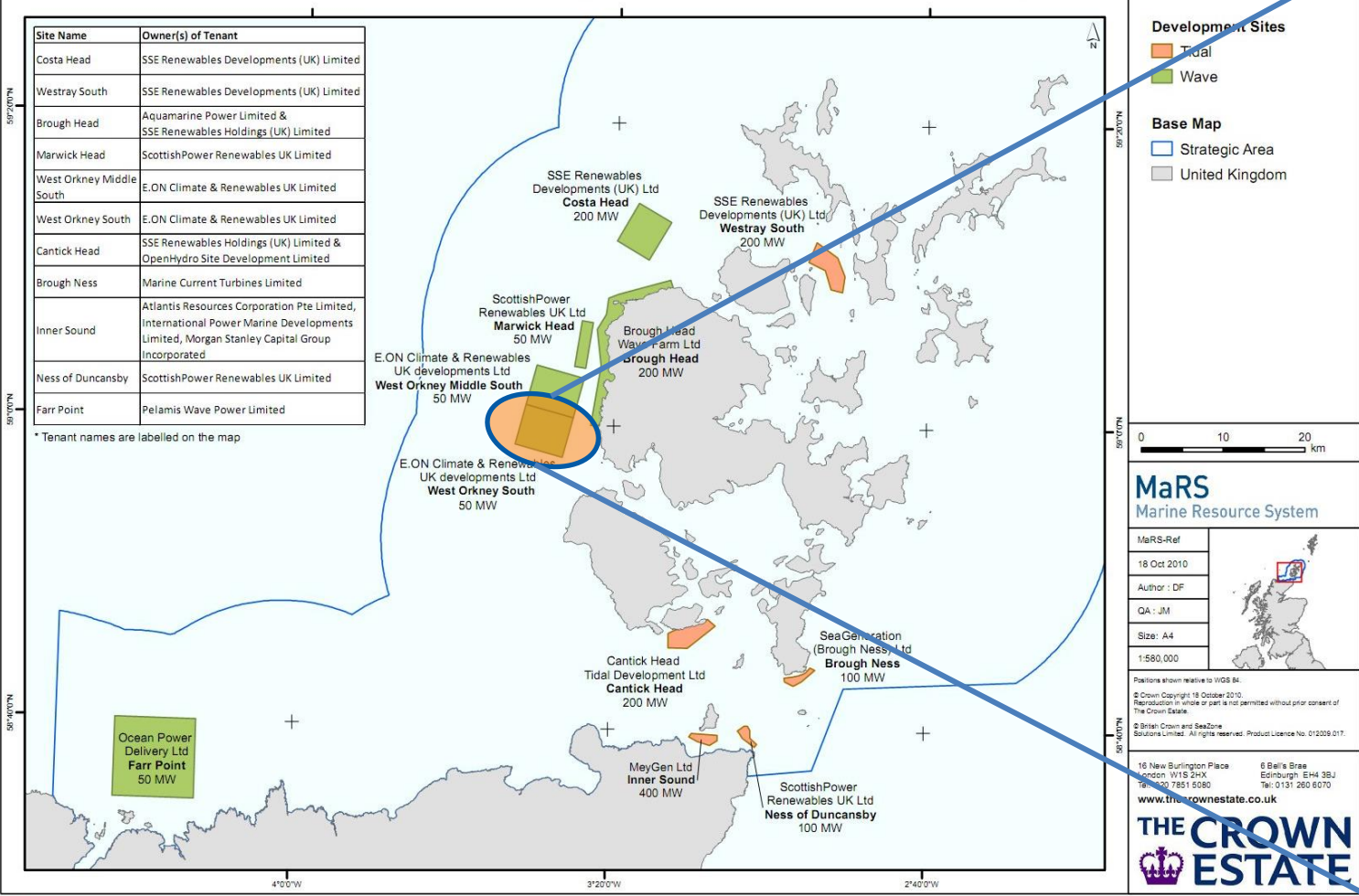
## Why West Orkney South?

- Close proximity to EMEC Billia Croo wave test site
- Strong wave resources for commercial wave project
- No overlap with protected areas
- Level of marine traffic relatively low
- Orkney 220 MW grid upgrade due in 2028



# 2030s

## Pentland Firth and Orkney Waters Round 1 Development Sites



### Next steps:

- Government support
- Secure seabed lease
- Obtain consents

### Feedback welcome:

- Do you think this is the right thing to do?
- Can you add value to this?



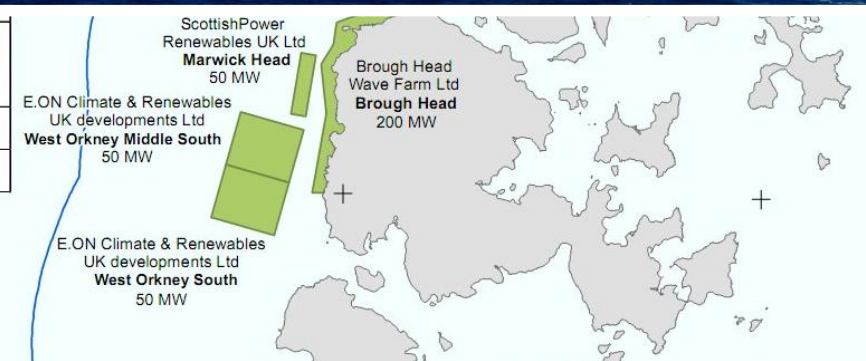
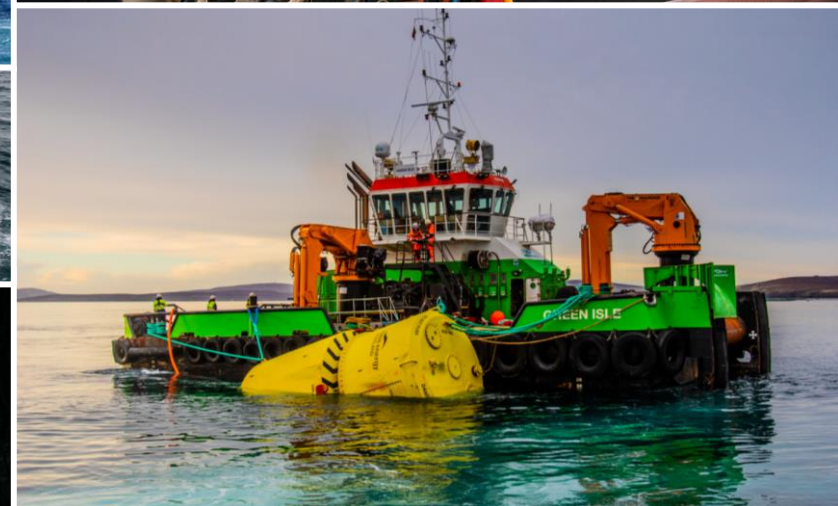
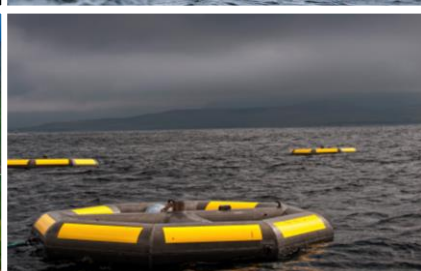
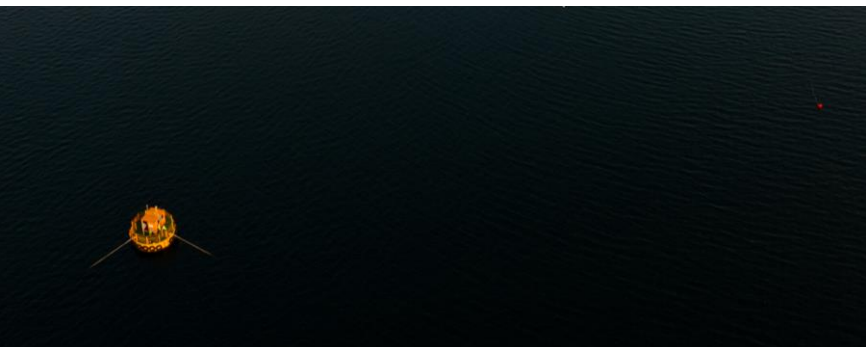
1987

I agree with my hon. Friend. I cannot see the day when we shall be generating large quantities of electricity from wind. The wind generator in Orkney, which I mentioned, is higher than Nelson's column, and the sail is about 65 m across. About 150 of those would be required to replace the power produced by a medium-sized 500 MW coal-fired station, and a good deal of space would be needed. I believe that there is potential in the technology, but I do not think that huge quantities of our electricity will come from it.

**Secretary of State for Energy, debated in House of Commons  
Monday 23 November 1987**

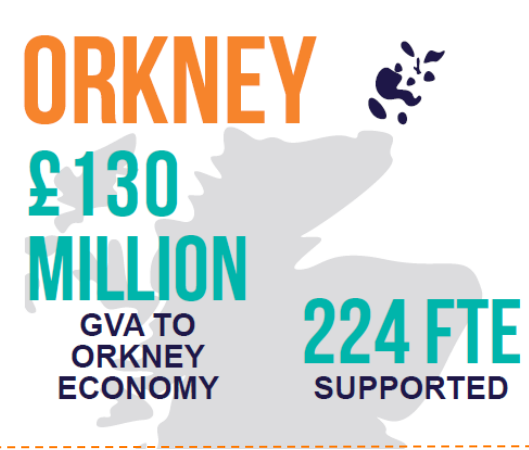


# Creating an industry





# 20 years of impact



**SHOPPING LOCAL**

**97%**  
EMEC SPEND IN UK

**67%**  
EMEC SPEND IN SCOTLAND

**50%**  
OVER £30 MILLION  
EMEC SPEND IN ORKNEY



**TOP 20**  
EMPLOYER IN ORKNEY



**R&D**

**365**  
R&D PROJECTS OVER 20 YEARS



EMEC INVOLVED IN  
**£538 M**  
R&D PROJECTS SINCE 2016

**£49.5 M**  
SECURED DIRECTLY BY EMEC



**A JUST TRANSITION** | FAIR • INCLUSIVE • LEAVE NO ONE BEHIND





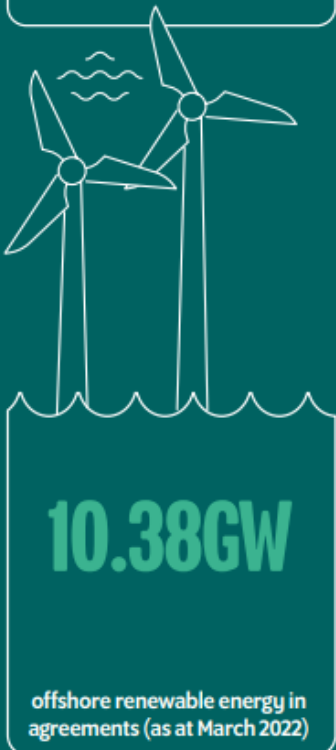
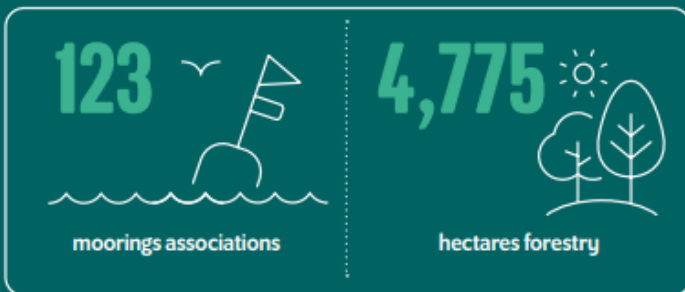
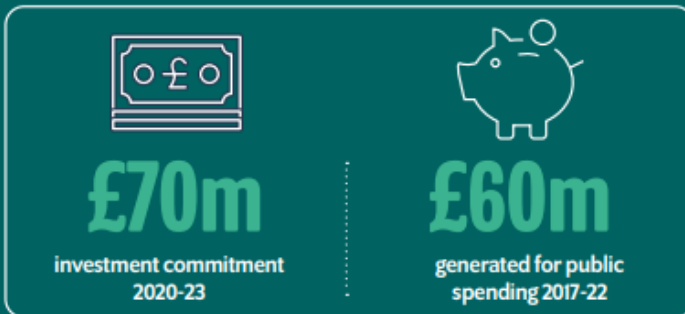
[lisa.mackenzie@emec.org.uk](mailto:lisa.mackenzie@emec.org.uk)

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# Leasing and achieving lasting value for Scotland

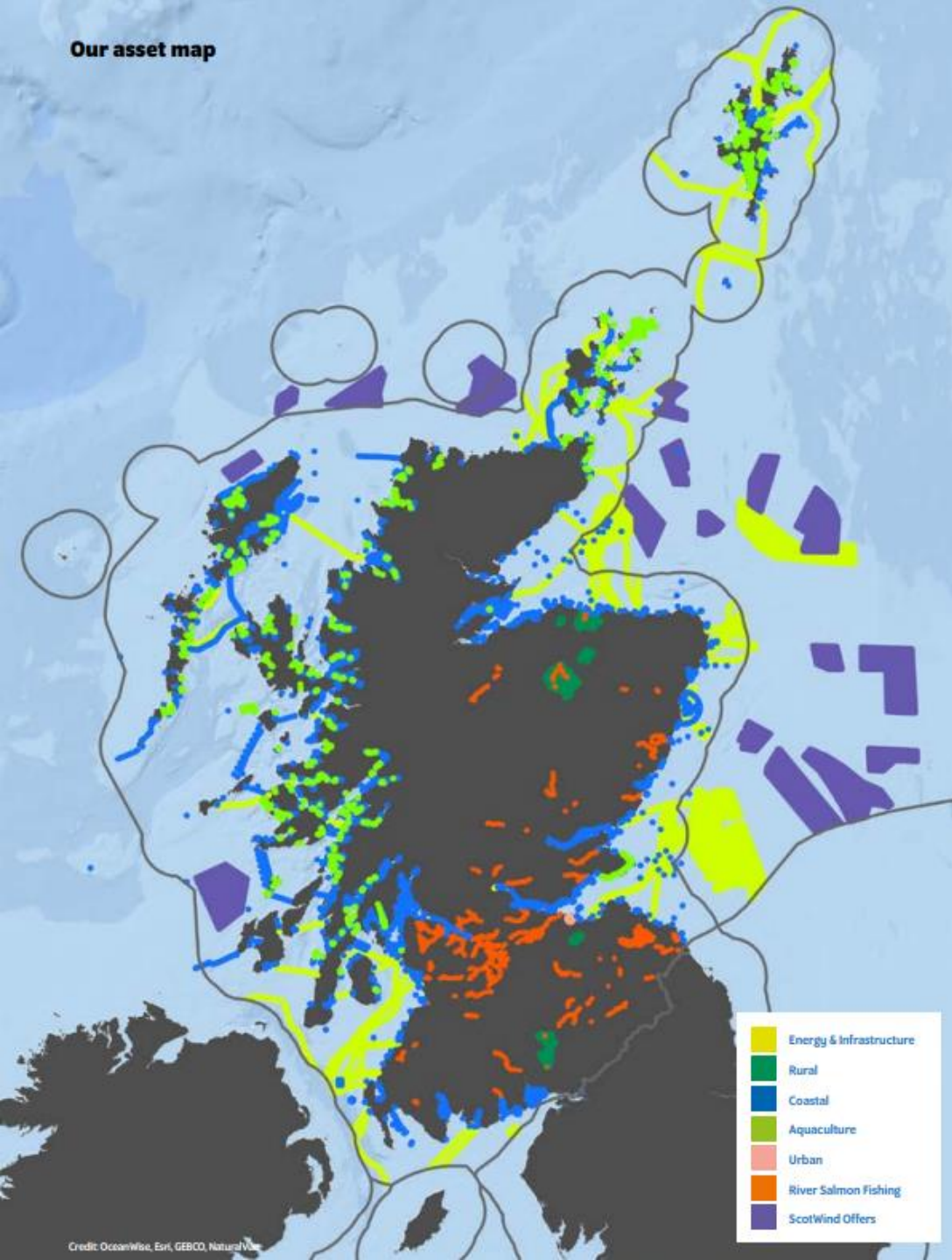
Wave Energy Scotland Annual Conference 2023



# Who are we? What do we do?

- We manage property including buildings, land, coastline and seabed on behalf of the people of Scotland.
- Our purpose is to invest in property, natural resources and people to generate lasting value for Scotland.

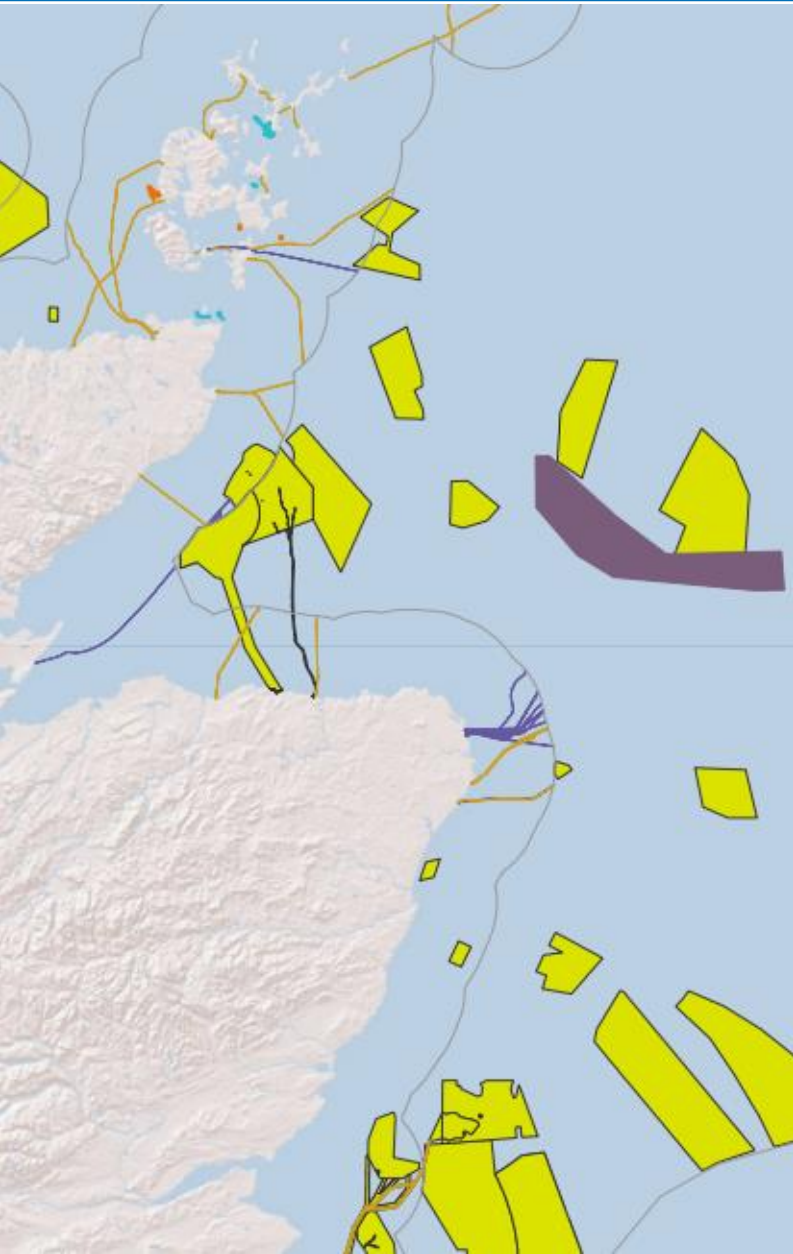




# Our Portfolio

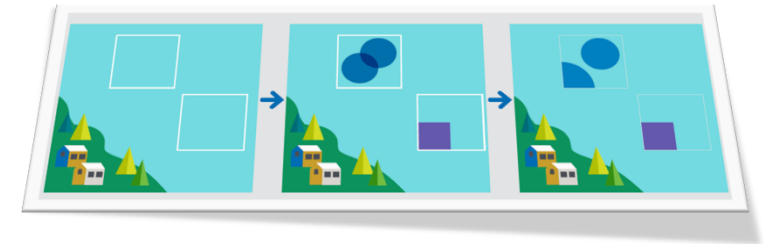


# Our key role in offshore renewables



Our responsibilities include:

- Leasing of the seabed out to 12 nautical miles (cables and pipelines, aquaculture)
- Rights to offshore renewable energy and gas and carbon storage out to 200 nautical miles

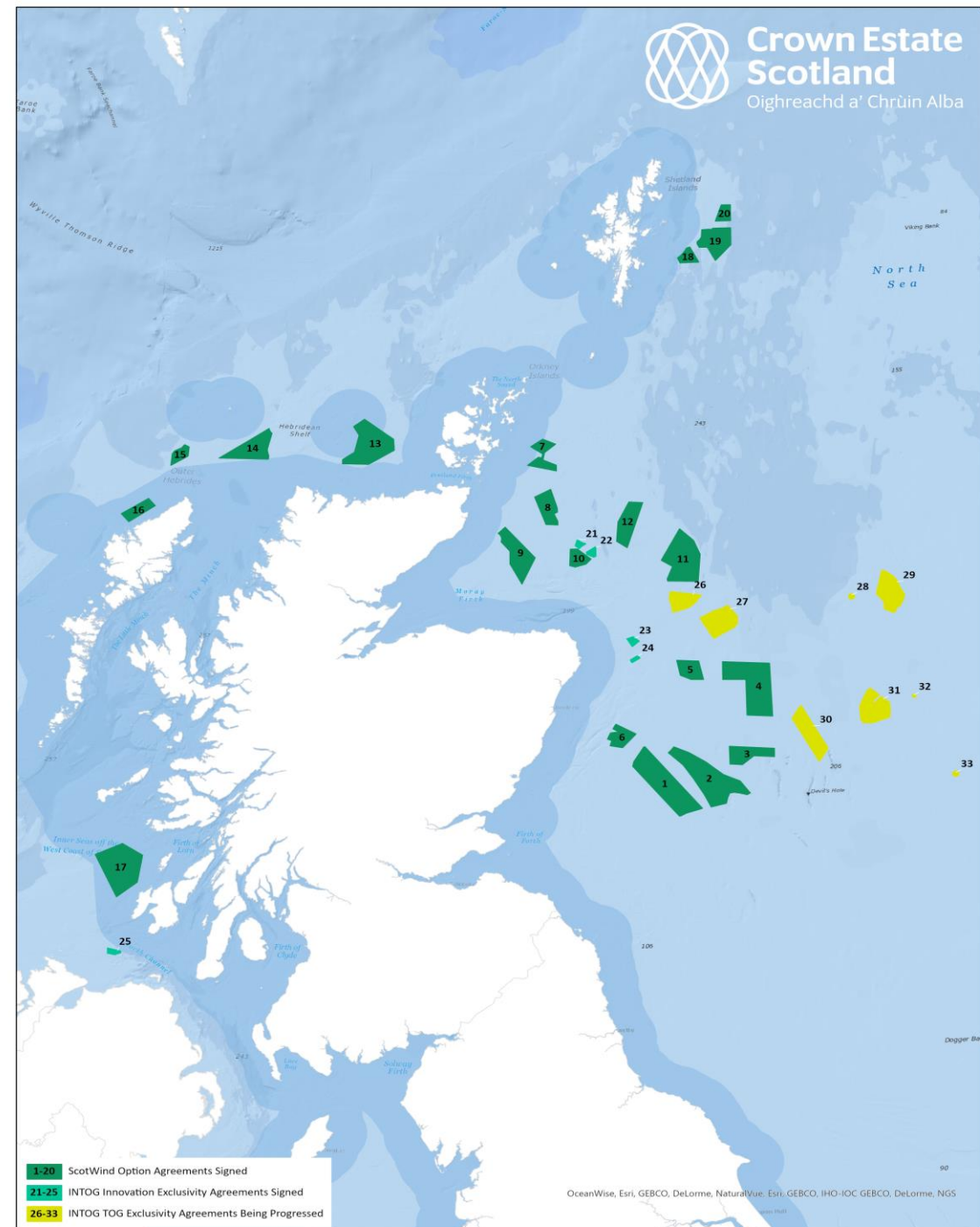


- **Marine Directorate** are responsible for strategic marine planning and grant consents for projects.
- Crown Estate Scotland award: Option Agreements provide rights to investigate the site and Leases provide exclusivity for certain activity and involve provision of rights for works. Tenants are only able to step into a Lease once necessary consents and permissions are in place.

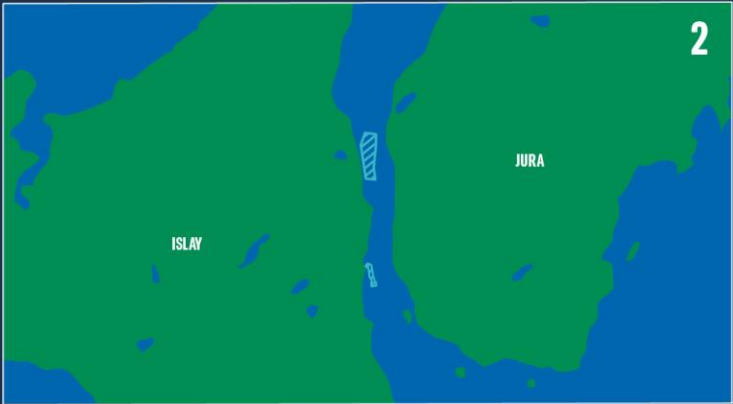


# Offshore Wind

- ScotWind leasing
  - 20 projects with 8000km<sup>2</sup> of seabed secured (from 74 bids)
  - £755m Option Fees for Scottish Public spending
  - £1.4bn average Scottish supply chain commitment per project
- Innovation and Targeted Oil and Gas (INTOG) leasing
  - Innovation projects (<100MW): To enable projects which support cost reduction and to further develop Scotland as a destination for innovation and technical development.
  - TOG projects: To maximise the role of offshore wind to reduce emissions from O&G production.
  - 13 projects awarded Exclusivity Agreements –  
IN 449MW and TOG 4.96GW
- Over 40GW of potential offshore capacity now visible in Scotland



# Wave & tidal



**Wave**  
[Hatched] Agreement / Option for Lease  
[Yellow] Lease

**Tidal**  
[Hatched] Agreement / Option for Lease  
[Blue] Lease

This map is for illustrative purposes and is not to exact scale.



# Wave and tidal

## Our work includes:



Bringing opportunities for wave and tidal energy to market by leasing and managing the seabed.



Funding research and technical studies to enable sector growth.



Investing in ground-breaking projects.



Image credit: Colin Keldie on behalf of EMEC

## Currently operating an open ad-hoc leasing process:

- Up to 3MW for test and demonstration
- 3 - 30MW where there is sufficient evidence of energy yield from selected technology

# Future wave energy colocation opportunities

- Are the colocation benefits widely recognised?
  - ✓ Energy system and economic benefits
  - ✓ Supports efficient use of the seabed
- Is there appetite from the other sectors?
  - Acceptable level of risk?
- What evidence case needs to be built to make these opportunities a reality?

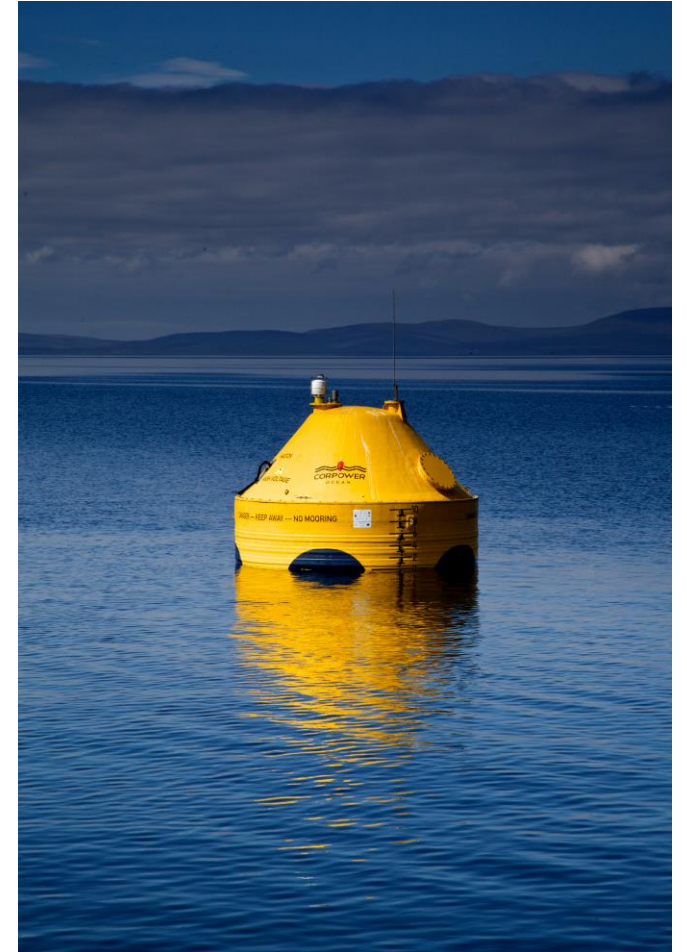


Image credit: Colin Keldie courtesy of WES



# Collaboration, cooperation and colocation

- Growth and demand

- Meeting net zero targets
- Increasing seabed demands
  - Marine protection
  - Natural capital
  - Economic activity



Image credit: Peterhead Port Authority

- Collaboration and cooperation

- Understanding other sectors and their needs
- Communication on shared space and willingness to work together
- Innovation to create colocation opportunities

**Thank you**

[www.crownestatescotland.com](http://www.crownestatescotland.com)

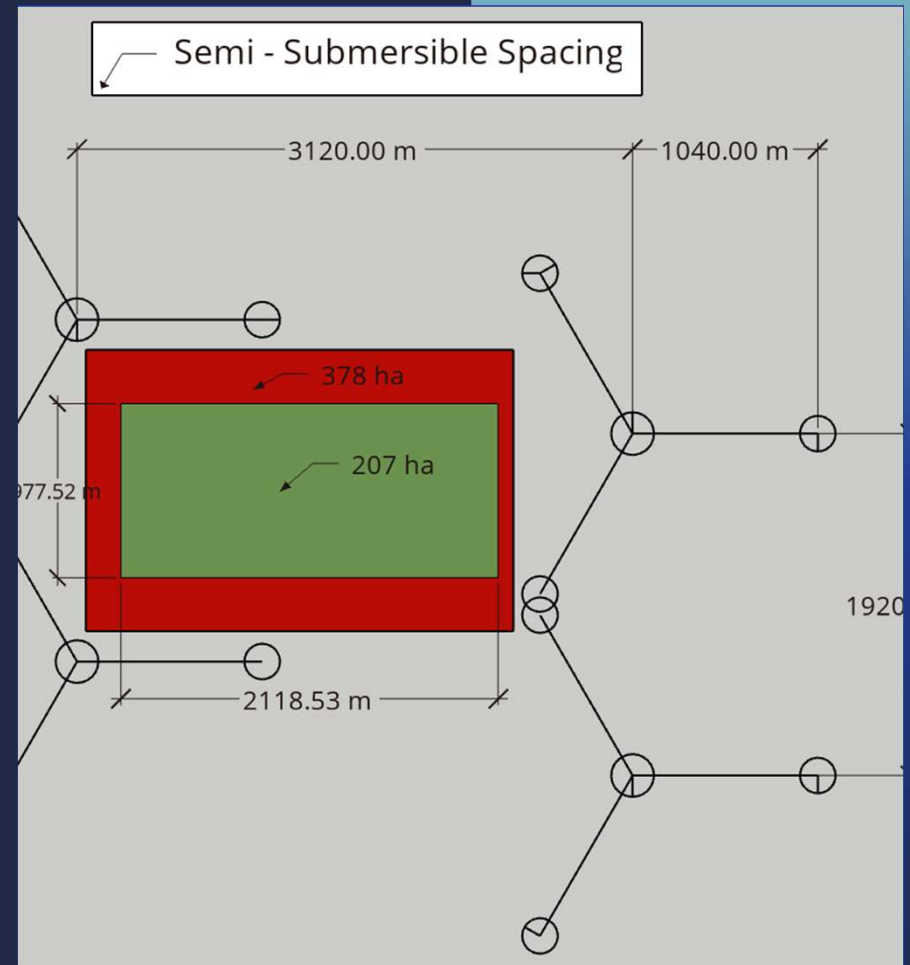


Nov 2023

# Multi-use of wind farms

Wave Energy Scotland

Christoph Harwood (Strategy Director)





# Who we are

A leading early-stage project developer in the following areas:



Offshore Wind



Sustainable Fuels, CDR



Sustainable Aquaculture



Marine Energy



Headquartered in Cork

Offices worldwide



Cork



Dublin



Belfast



Edinburgh



Spain



Newquay



Portland



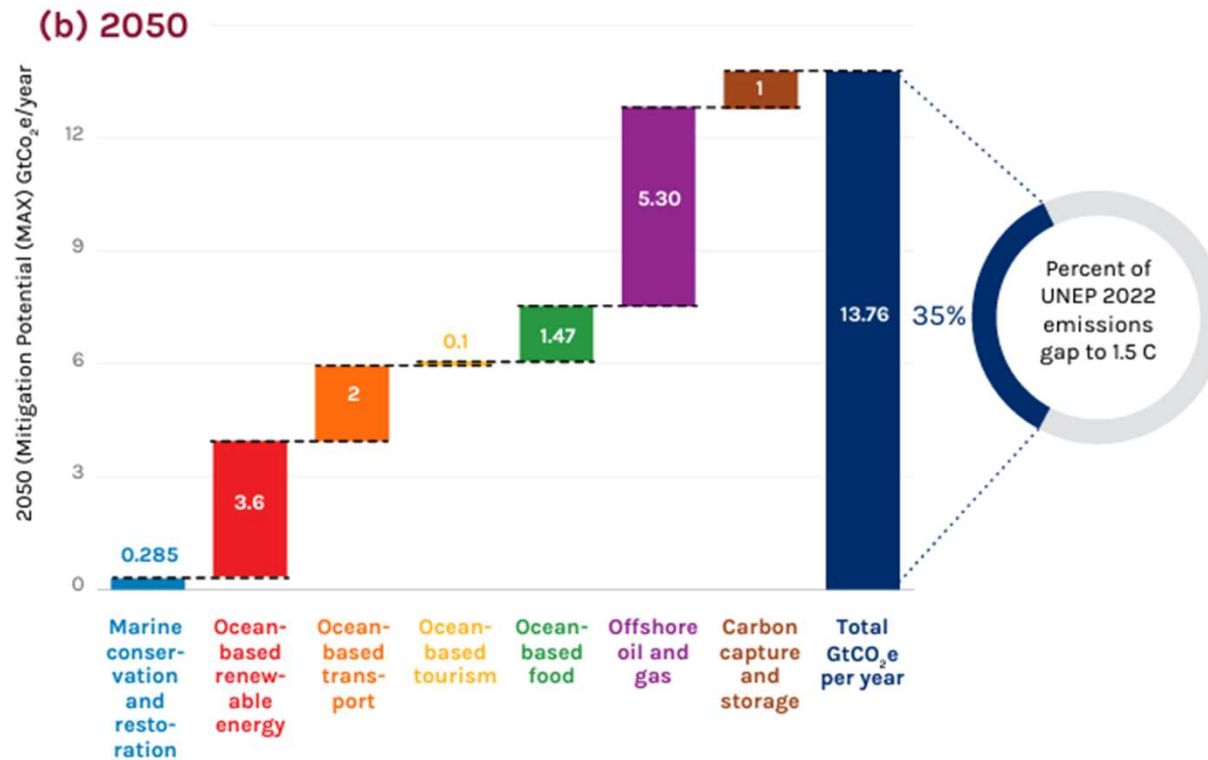
Pembroke



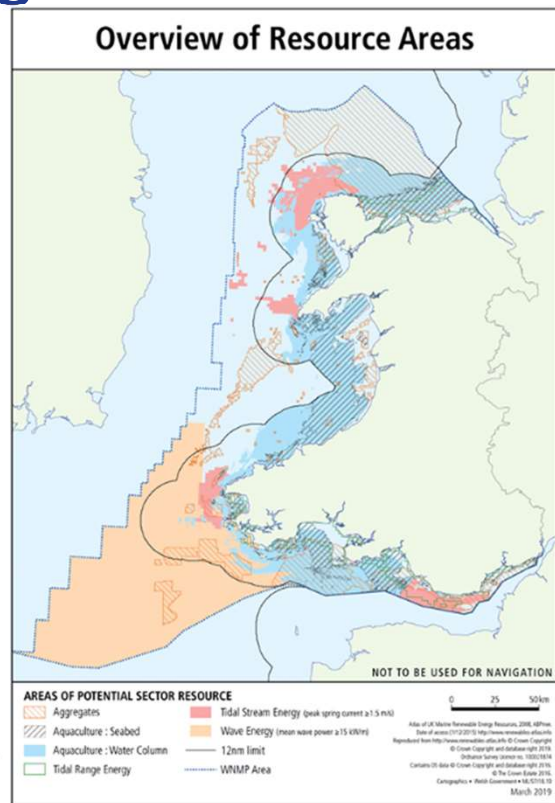
Halifax



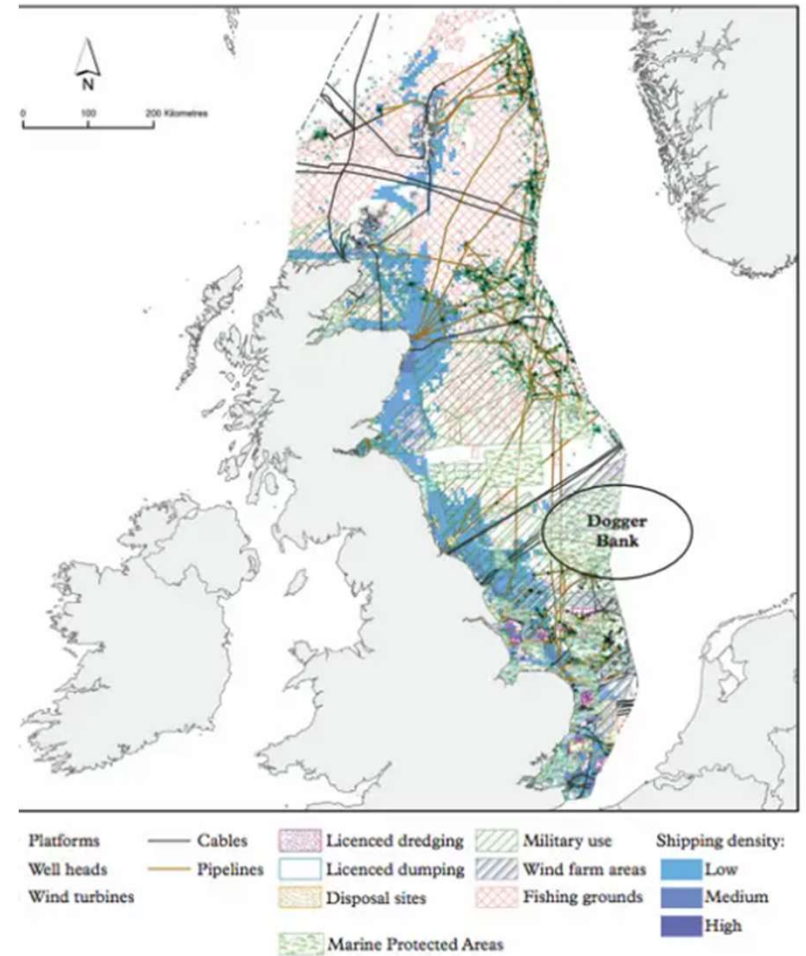
# The ocean's role in mitigating climate change



# Lack of land and sea space is challenging Net Zero targets



**Figure 1: Competition for marine space<sup>7</sup>**



Source: Cefas, February 2015. © British Crown Copyright. All rights reserved. Permission Number Defra 012012.004



## Offshore wind as route to new markets



**Power to X**

- E- fuels



**Shared space**

- Enhanced power
  - Wave
  - Solar
  - Storage
- Aquaculture
  - Seaweed
  - Finfish
- Offshore production

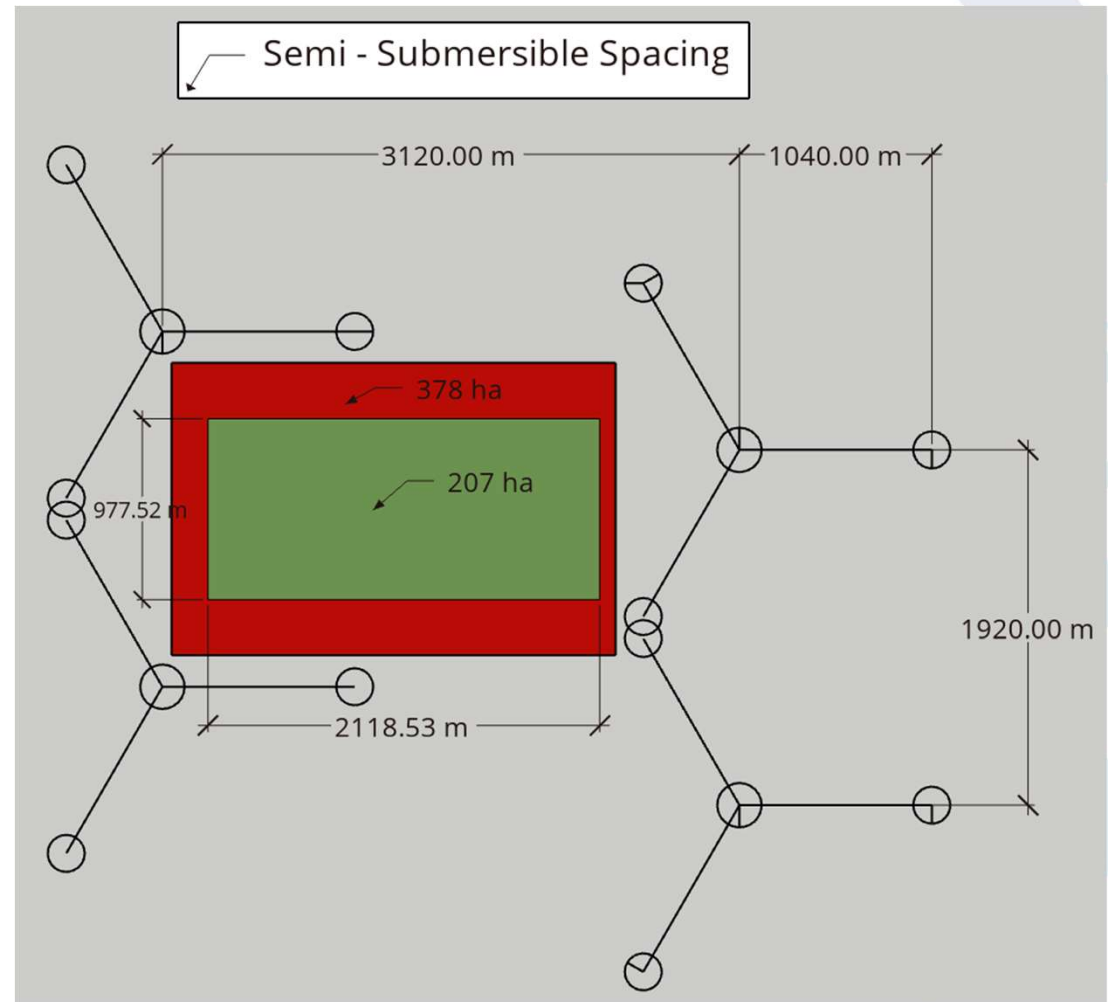
## Floating Wind space

Total area for 1GW farm site varies but usually in the 300 – 500km<sup>2</sup> range

1GW is 66 x15 MW turbines

2-300ha allowing for space around the turbines

Not all space is available





# Site Layout – Potential Footprint MUS Activities – 100MW

## Available Footprint

- Site layout 3,044 ha
- Exclusion zones around cables 830 ha
- Exclusion zones around floaters & moorings 481 ha
- Tow out zone around floater 140 ha
- Tow out zone in between strings 750 ha -

**available footprint for MUS 1,043 ha \***

~34% of the site

- Footprint is seabed space
- Moor systems can reduce this to 10%
- Can increase space through flexibility on wind farm O&M



## Offshore Floating PV Technologies



Oceans of  
Energy



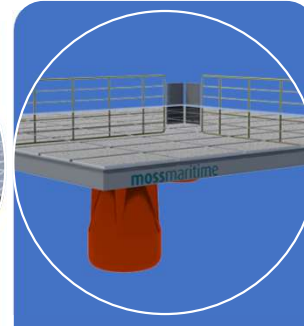
SolarDuck



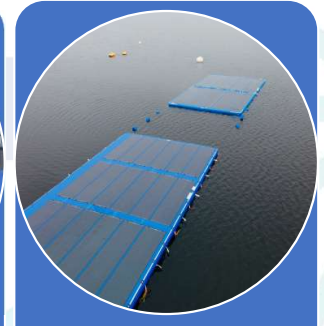
Ocean Sun



Seavolt



Moss  
Maritime



BlueWater



## Offshore salmon farming systems

- Depths of >60-100m required
- Hs of 5-15m
- Systems deployed in Norway
- Strong drive from Norwegian government



*Artic Sea Farm –  
submerging farming system*



*Ocean Farm 1*



*Havfarm*

*Impact 9*



## Seaweed

### Simply Blue have signed MOU with Arctic Seaweeds

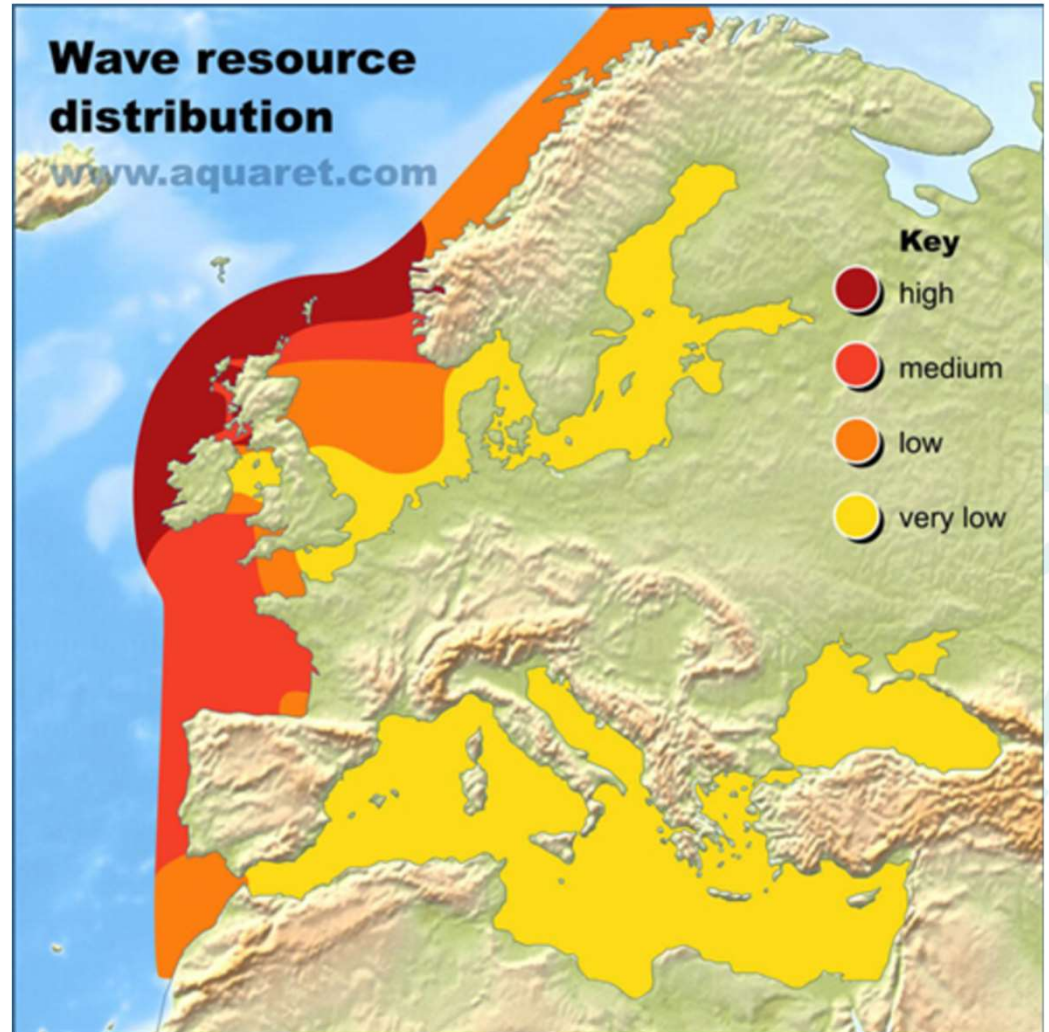
Innovative new Design for bottlenecks previously identified:

- Ability to Scale
- Offshore Solutions
- Mechanized Seeding
- Harvesting



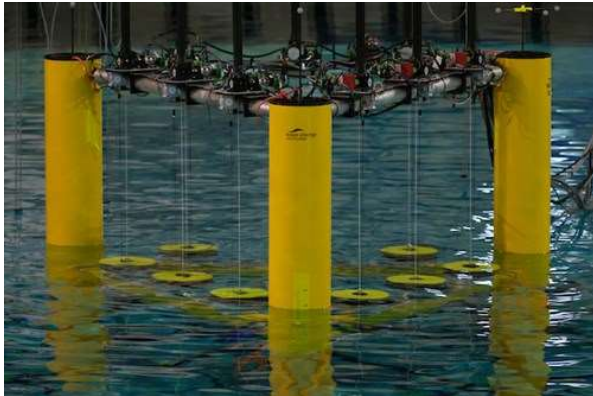


## Where should we co-locate wave and wind



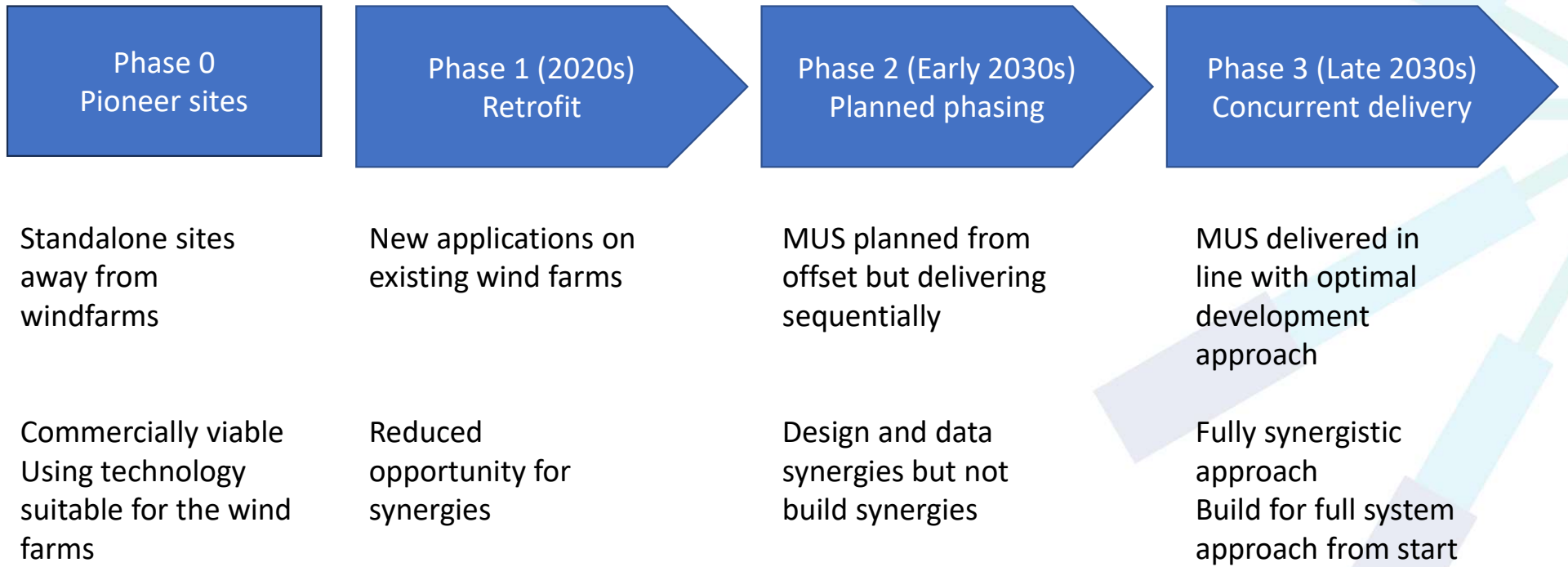
## Wave Energy

- Vertical mooring structures
- Ability to move to allow ops for WTGs/platforms
- Common O&M support teams
- Minimise Geotech/geophys surveys



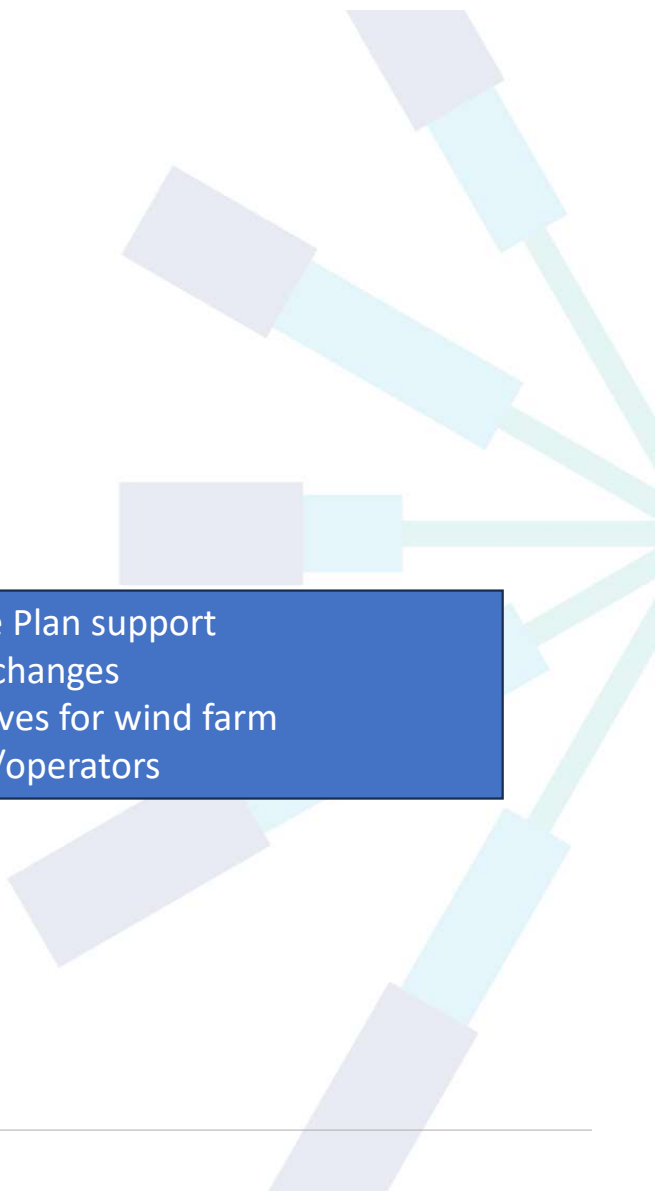


## Phasing in development of MUS wind farms



## Key issues

- Incentives for wind farm owner/operators is limited
  - Operational issues
  - Liabilities
  - Business models
  - Collaboration agreements
- Development
  - Leasing
  - Licencing/consenting
  - CfD non-price factors
- Economic benefits
  - Brings in additional parts of the local economy
  - Lack of operational experience
  - Lack of local supply chain

- 
- Marine Plan support
  - Policy changes
  - Incentives for wind farm owner/operators