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Ocean Energy: A European Perspective

PICES : October , 2010



Henry F Jeffrey

Background



North Sea, Oil and Gas Energy



**Marine Renewables:
World 1st commercial grid
connected project**



**SuperGen Marine
UKERC**

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Structure



- Overview of technologies
- Wave and tidal developments
- Deployment Scenarios
- Research challenges
- Summary



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Ocean Energy Resources



Waves: uses the kinetic energy of the water particles and the potential energy of elevated water particles

Tidal

Tidal stream: make use of kinetic energy contained in fast flowing tidal currents (generally found in constrained channels)

Tidal range: make use of the potential energy from the difference in height between high and low tides (can be found in estuarine areas)

Ocean thermal energy conversion (OTEC): uses the temperature differential between cold water from the deep ocean and warm surface water; may include submarine geothermal and seawater air conditioning

Salinity gradient: uses the pressure differential between salty seawater and fresh river water (osmotic energy)



Maturity of Technologies



Tidal barrages

Mature technology, despite limited applications.

Waves and tidal currents technologies

Significant number of technologies being developed worldwide: some of these technologies are at or near full-scale development and undergoing sea trials

OTEC technologies

Advanced stage R & D

Salinity gradient technologies

Early stage R & D

Wave Energy Technologies



Oscillating Bodies

**AW-Energy
Waveroller
(Finland)**



**Installation:
Portugal**

**UK Aquamarine's Oyster
wave energy unit**



**Fred Olsen,
"BOLT"
Norway**



**Powerbuoy (40 kW)
OPT, USA**



**Pelamis 3x750 kW
Installation:
Portugal**



Tidal Current



Northern Ireland

2007 | Open Centre Turbine (250 kW)
OpenHydro (Ireland)

2008 | Seagen (1.2 MW)
Marine Current Turbines Ltd (UK)



Installation at EMEC (UK)

Salinity Gradient Project



2009 | Osmotic power, prototype near Oslo, Norway

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Marine Current Turbines



Source: MCT **UKERC**

Pelamis Wave Power



- **Buildings their 2nd generation device (E.On)**
- **Several modules launched and nearing completion**
- **Another sale SPR**
- **Crown Estate lease**



Aquamarine power



Aquamarine Power



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Structure



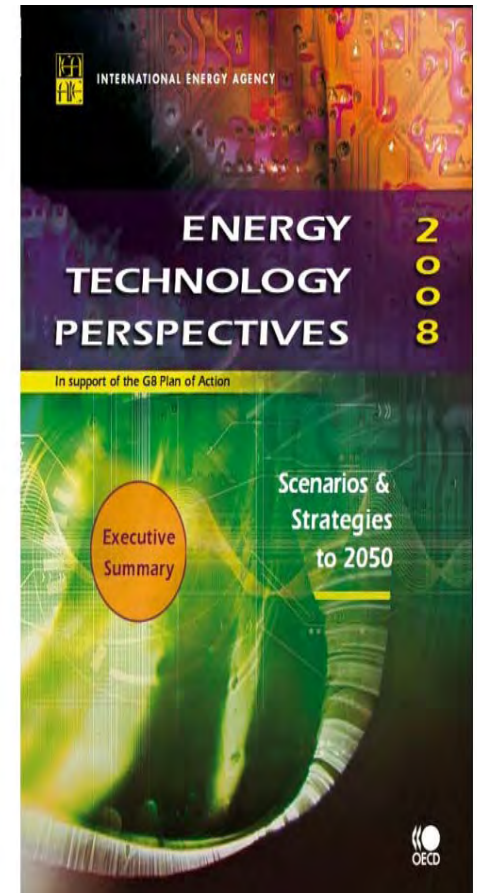
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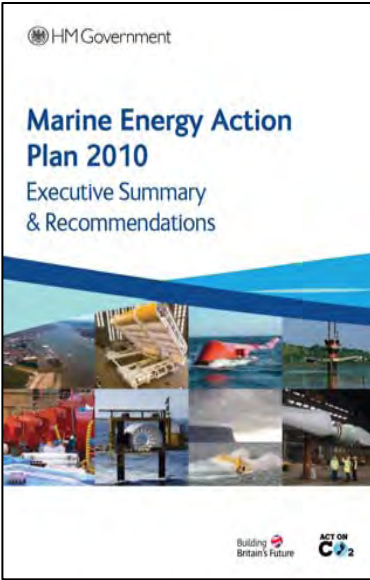
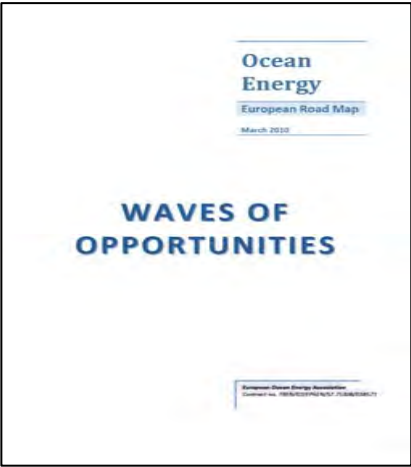
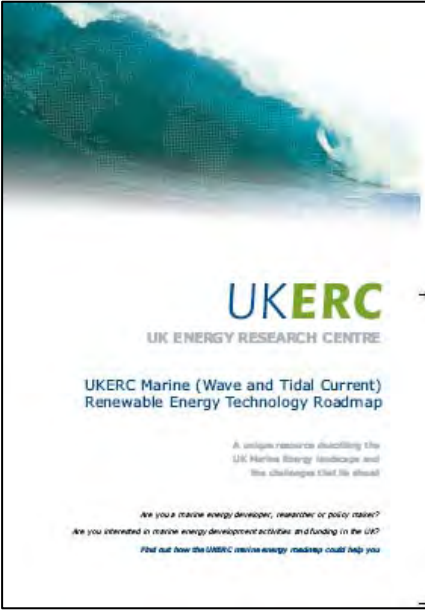
Scenarios, Strategies & Roadmaps



- Roadmaps are an effective tool to underpin the identification of policies and measures
- Focus R&D and business investments to accelerate technology development
- Coherent approach and significant engagement with the global market
- Two main types
 - Deployment
 - Development



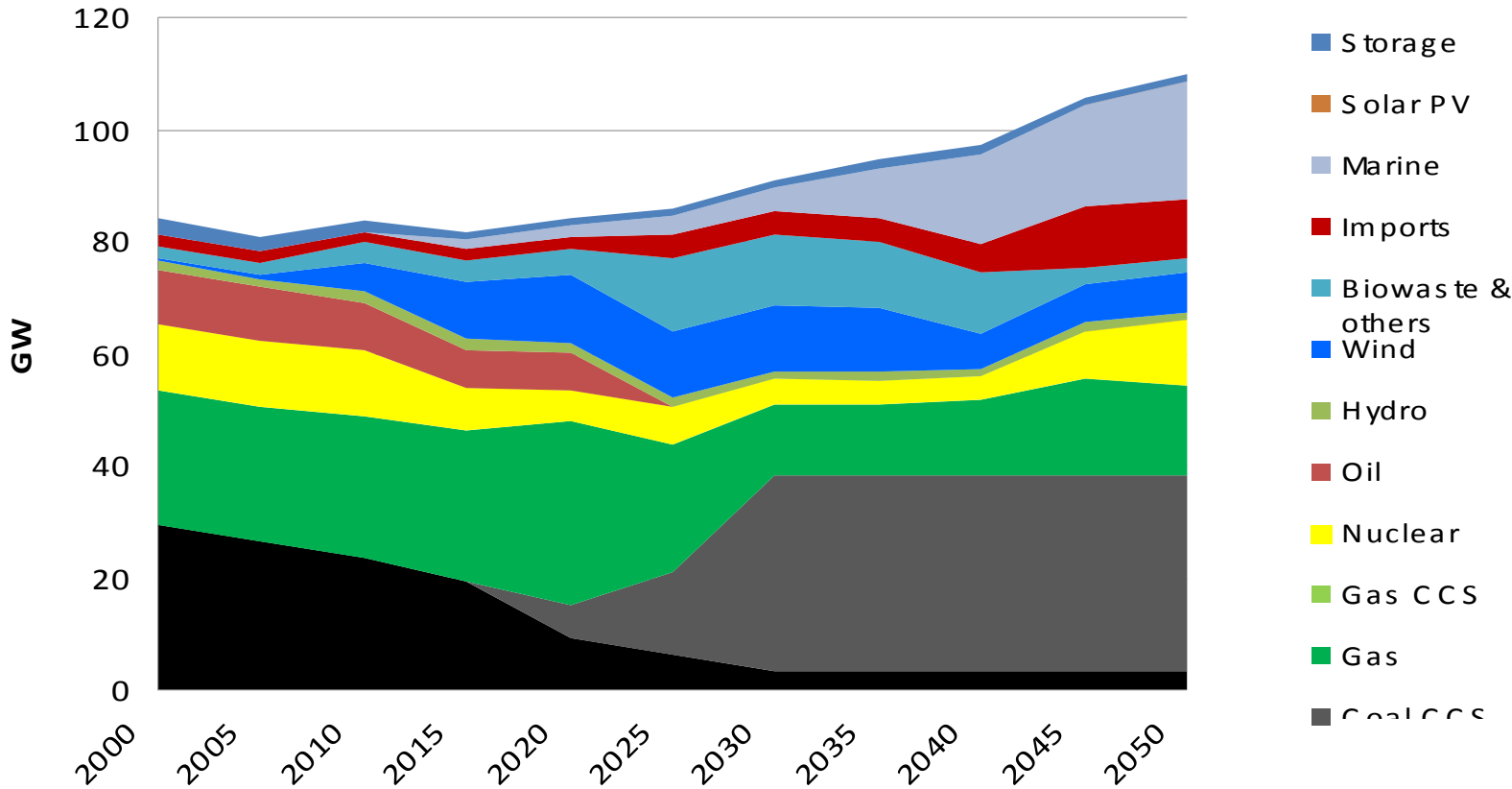
Action Plans, Vision documents and Roadmaps



UK Marine Energy: Sustained cost reduction



Installed capacity (GW)



EUOEA



Installed capacity

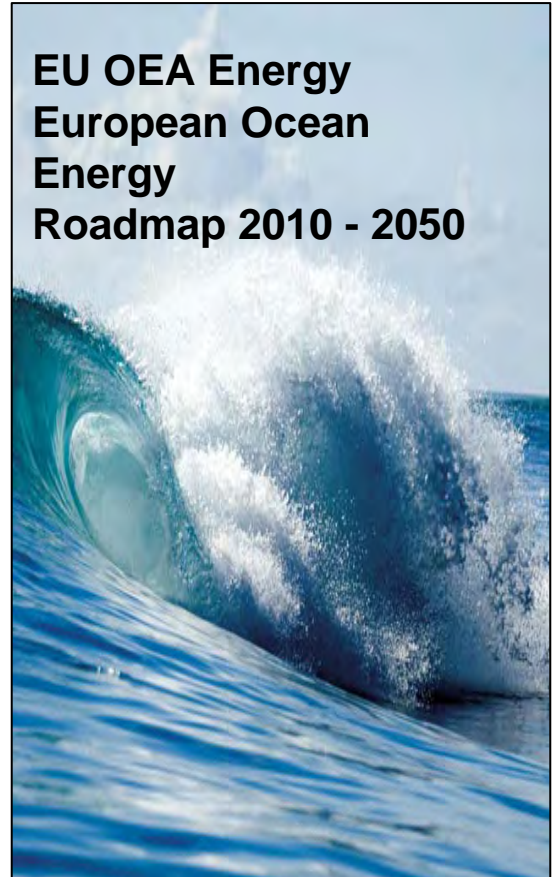
3.6 GW by 2020

188 GW by 2050

Jobs

26000 in 2020

Over 300,000 by 2050



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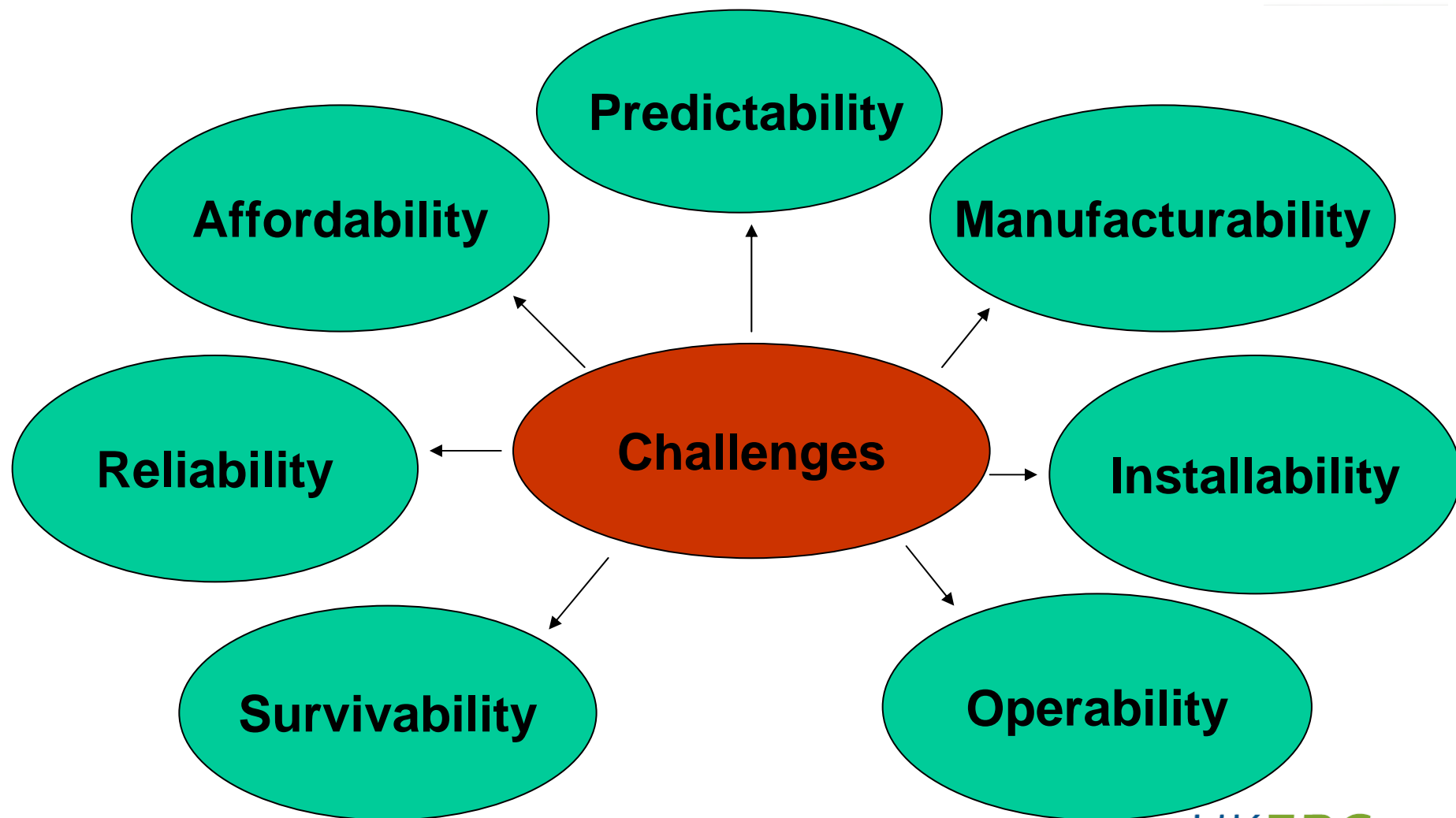
Structure

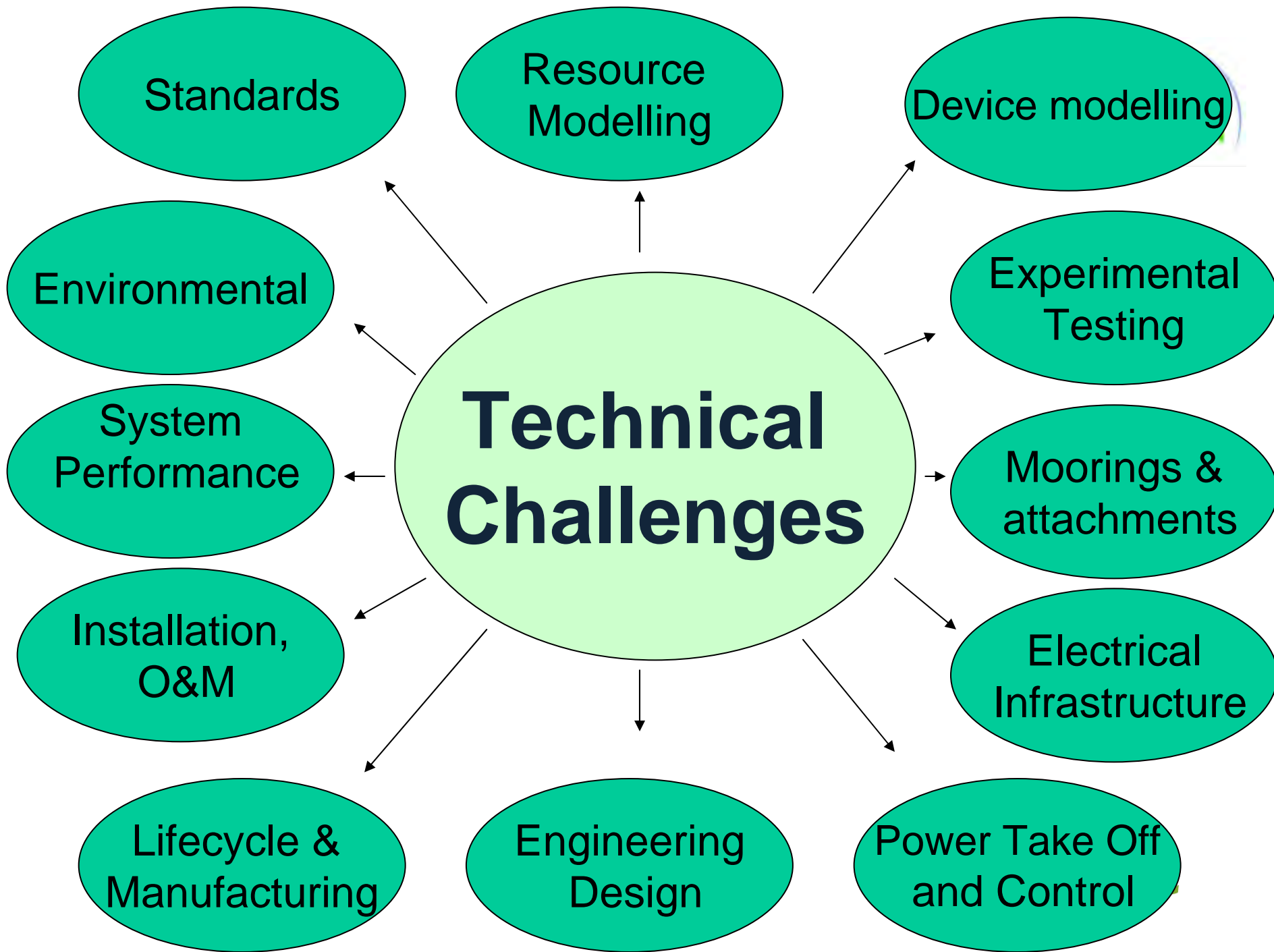


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Main Technology and Deployment Challenges

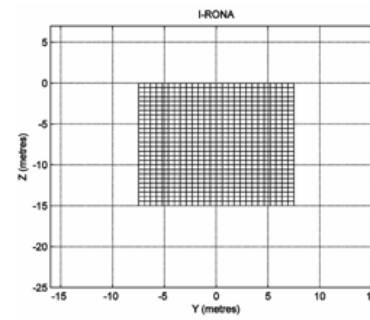
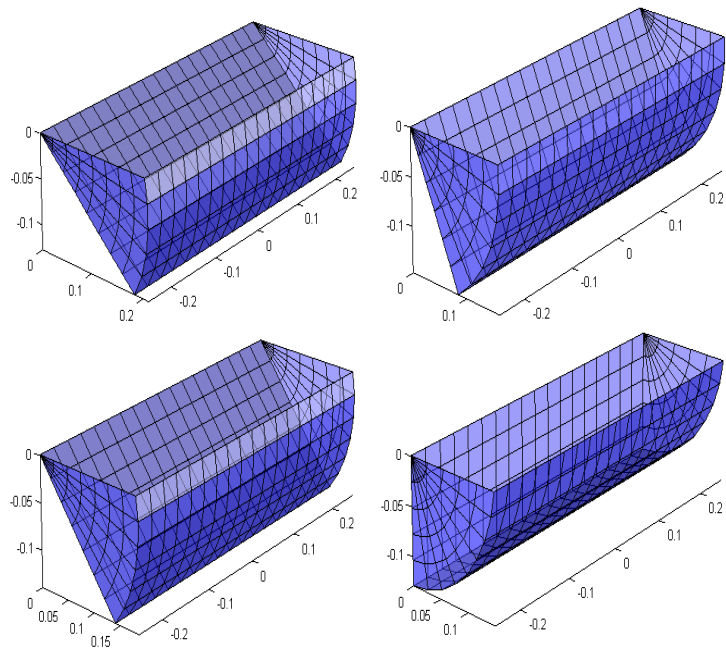




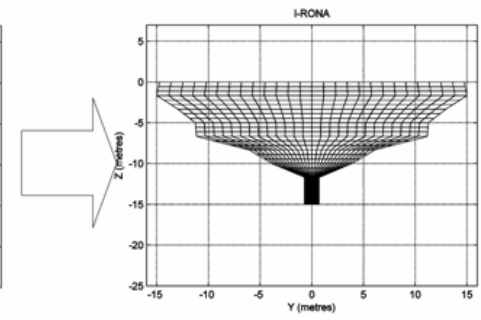
Optimisation of collector form



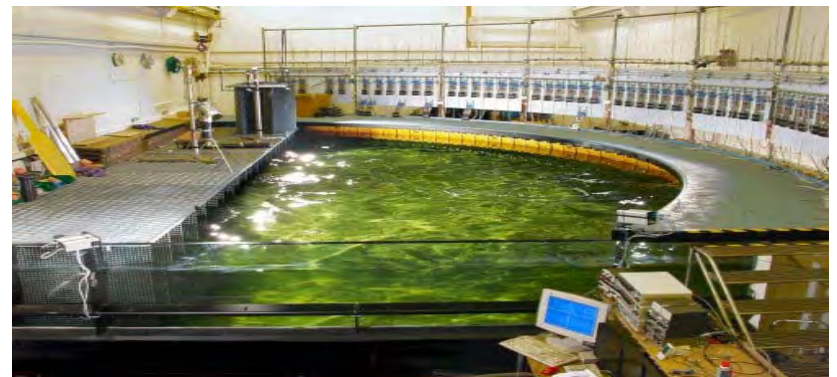
Genetic algorithms, numerical modelling and tank testing is being used to evolve better, maybe ultimately even optimal, designs of wave energy converters.



$F_C = 8.36$



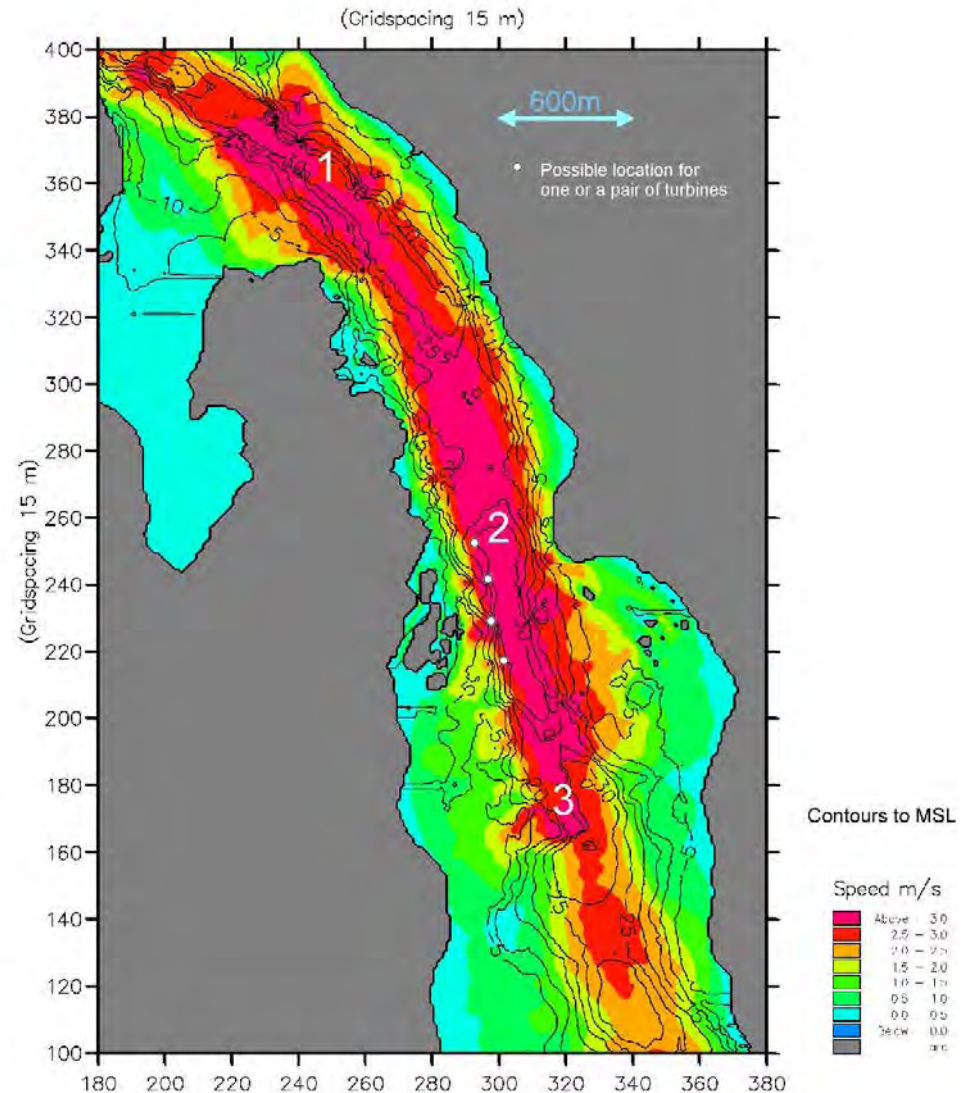
$F_C = 11.39$



Combined wave and tidal effects



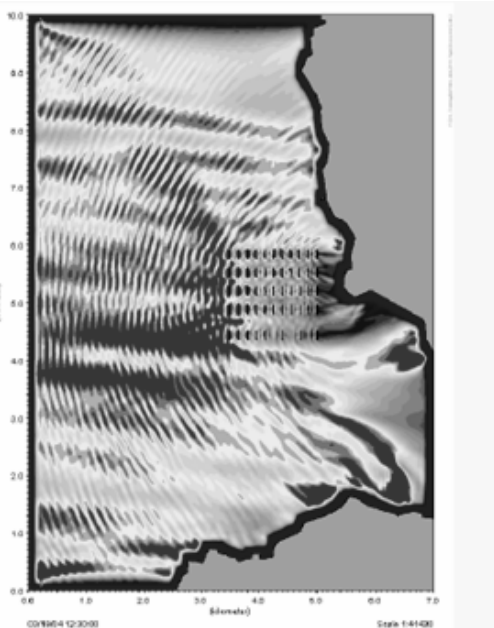
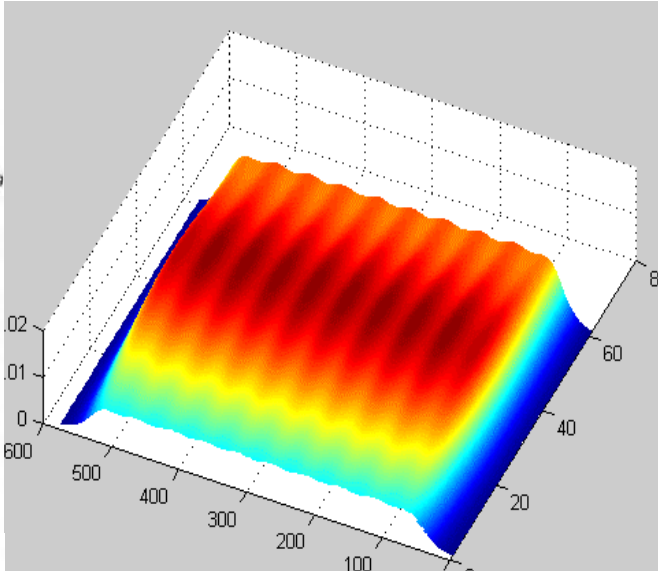
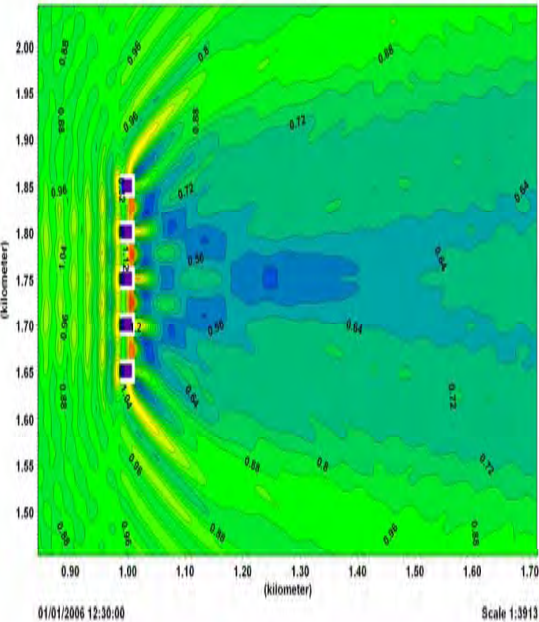
- This work is advancing design, prediction and test procedures to recognise combined presence and effects of wave and tidal currents.
- Tests are being conducted at Queens, Edinburgh and in a new dedicated 1/10th scale facility at Portaferry and at EMEC.



Arrays, wakes and near field effects



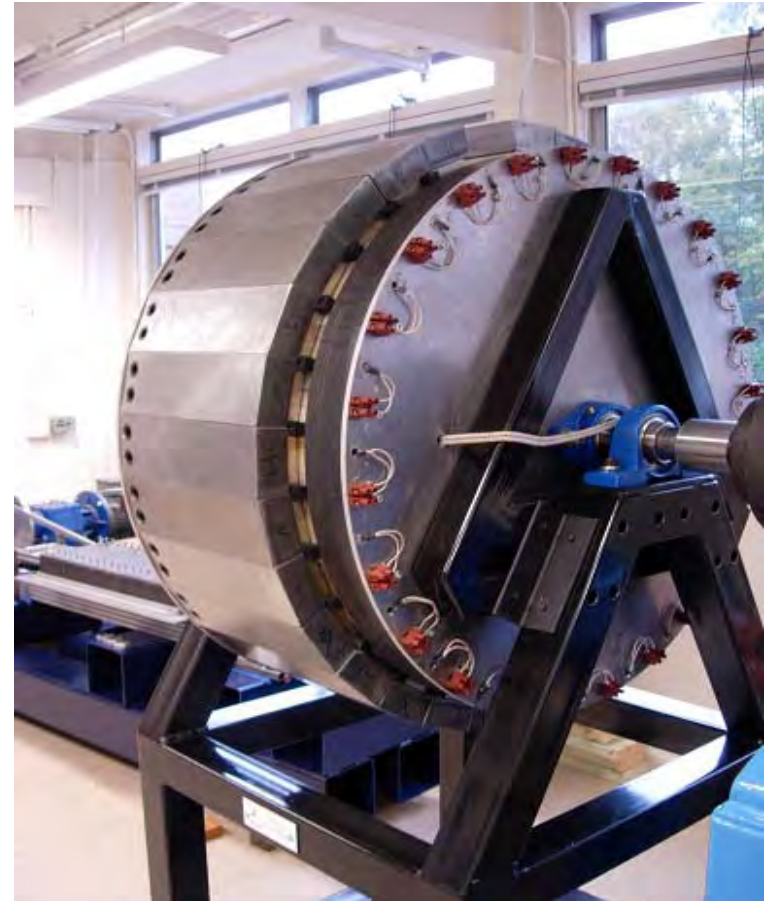
This work is determining the extent of local impact of multiple wave or tidal converters on the energy flux environment and on each other to identify the need for optimal configurations and control strategies for arrays.



Power take-off and conditioning



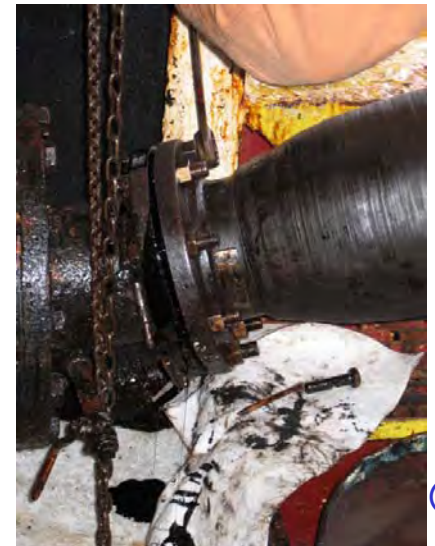
The prime-mover, drive train, generator and power converter must be designed from the outset in an integrated manner, fit for the purpose in the working environment. This work is integrating structural, magnetic, thermal and electrical designs to optimise performance:cost ratio.



Reliability



This work will establish an effective method to quantify the reliability of marine energy converters even in the scarcity of industry-specific component failure rates and environmental data. It will explore the effect of changing maintenance strategy on availability in arrays.





Ecological Consequences

This work is establishing the principal ecological consequences of the extraction of tidal and wave energy in coastal and offshore zones.

It is exploring

LONG TERM CONSEQUENCES: Population disturbance

- Population monitoring over 5 years
- GPS tracking of seal movements

SHORT TERM CONSEQUENCES: Behavioural

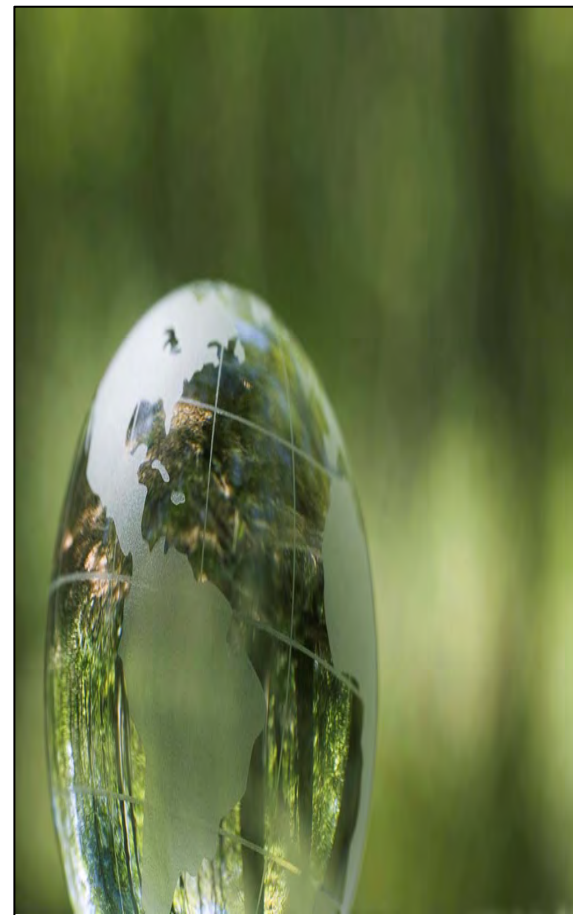
- Changes in local distribution patterns
- Active sonar

*Principal species of concern: Common (Harbour) Seal
– EU Designated Species*



Summary

- **Significant progression in the sector in deployment, policy, regulation and funding**
- **Considerable operational and research challenges to be overcome**
- **Significant opportunity for knowledge transfer**
- **International collaboration will be key.**





I'll stop Talking Now

Thanks for your attention

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