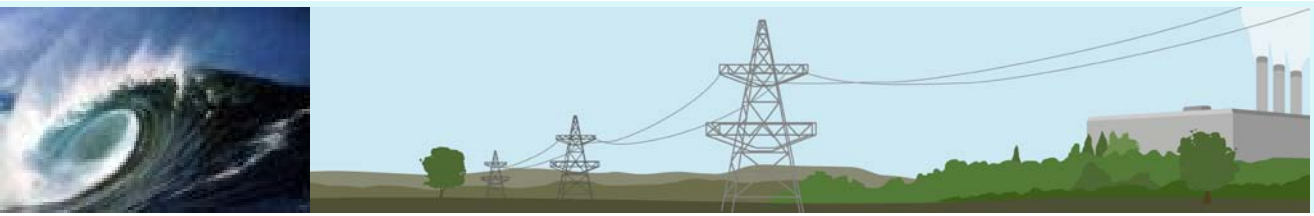


# Harnessing Renewable Energy from the Sea

**Eurocean : October , 2010**

SUPERGEN

Henry F Jeffrey

UK Energy Research Centre
University of Edinburgh

UKERC
UK Energy Research Centre

# Background

**North Sea, Oil and Gas Energy**

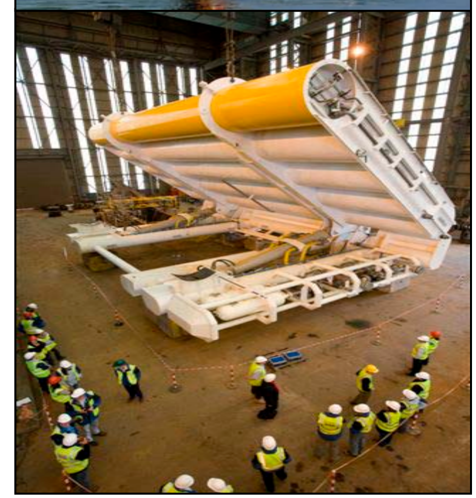
**Marine Renewables: World 1st commercial grid connected project**

**SuperGen Marine**

**UKERC**

# Structure

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

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# Offshore Wind

Targets

- 40 GW by 2020
- 150 GW by 2030

- **Over 100 GW already in planning**

# 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)

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# 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**

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# Tidal Current


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

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

# Salinity Gradient Project


**2009 | Osmotic power, prototype near Oslo, Norway**

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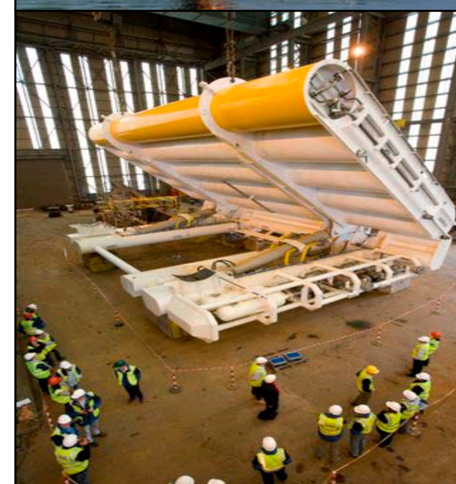

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# Marine Current Turbines

Source: MCT

# Pelamis Wave Power

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

Source: PWP

# Aquamarine power

# Aquamarine Power

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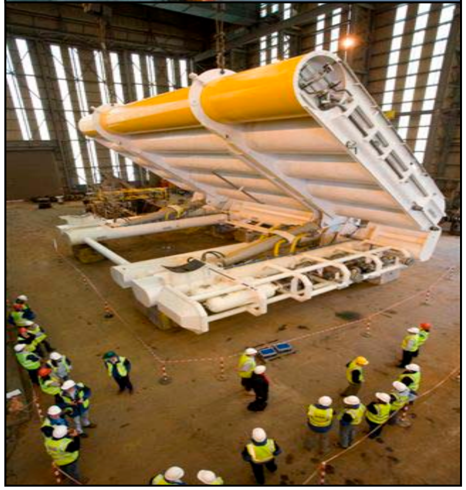
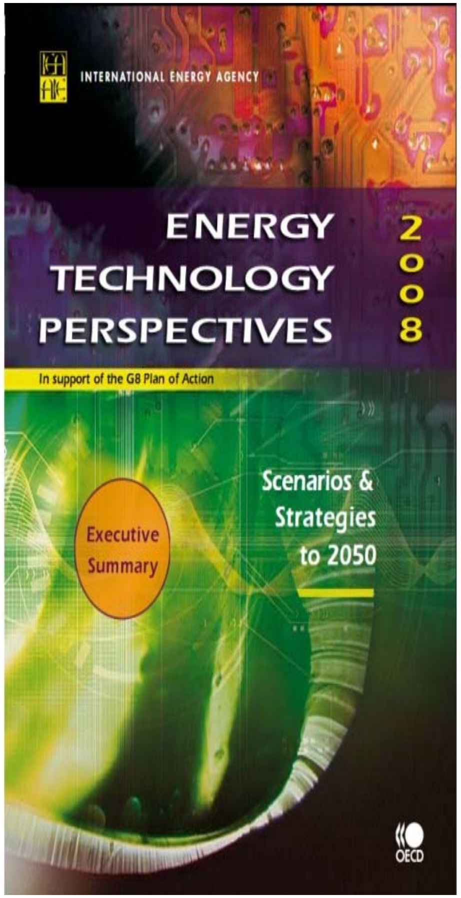


# WHY Roadmaps

- 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

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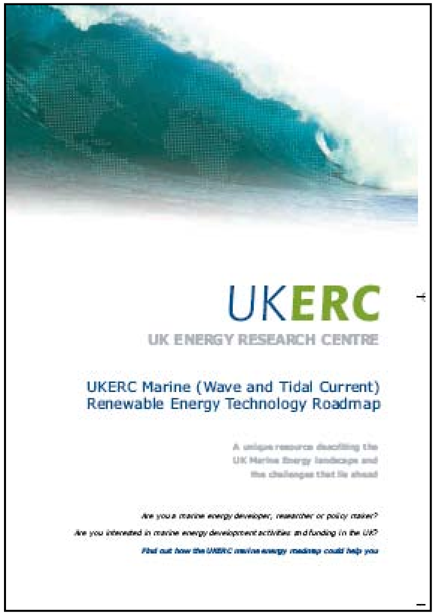
# Action Plans, Vision documents and Roadmaps

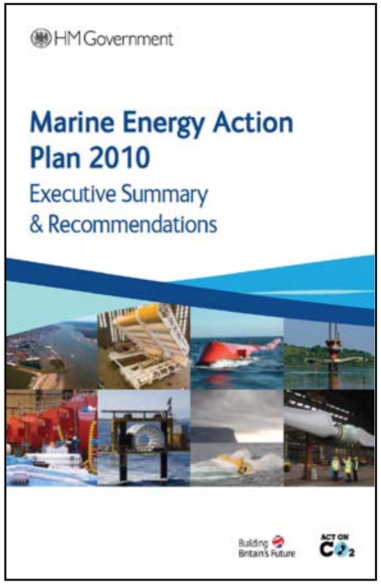

energy technologies institute




The Scottish Government

Ocean Energy
European Road Map
March 2010

WAVES OF OPPORTUNITIES




NREL
National Renewable Energy Laboratory
Innovation for Our Future

EUROPEAN SCIENCE FOUNDATION
SETTING SCIENCE AGENDAS FOR EUROPE

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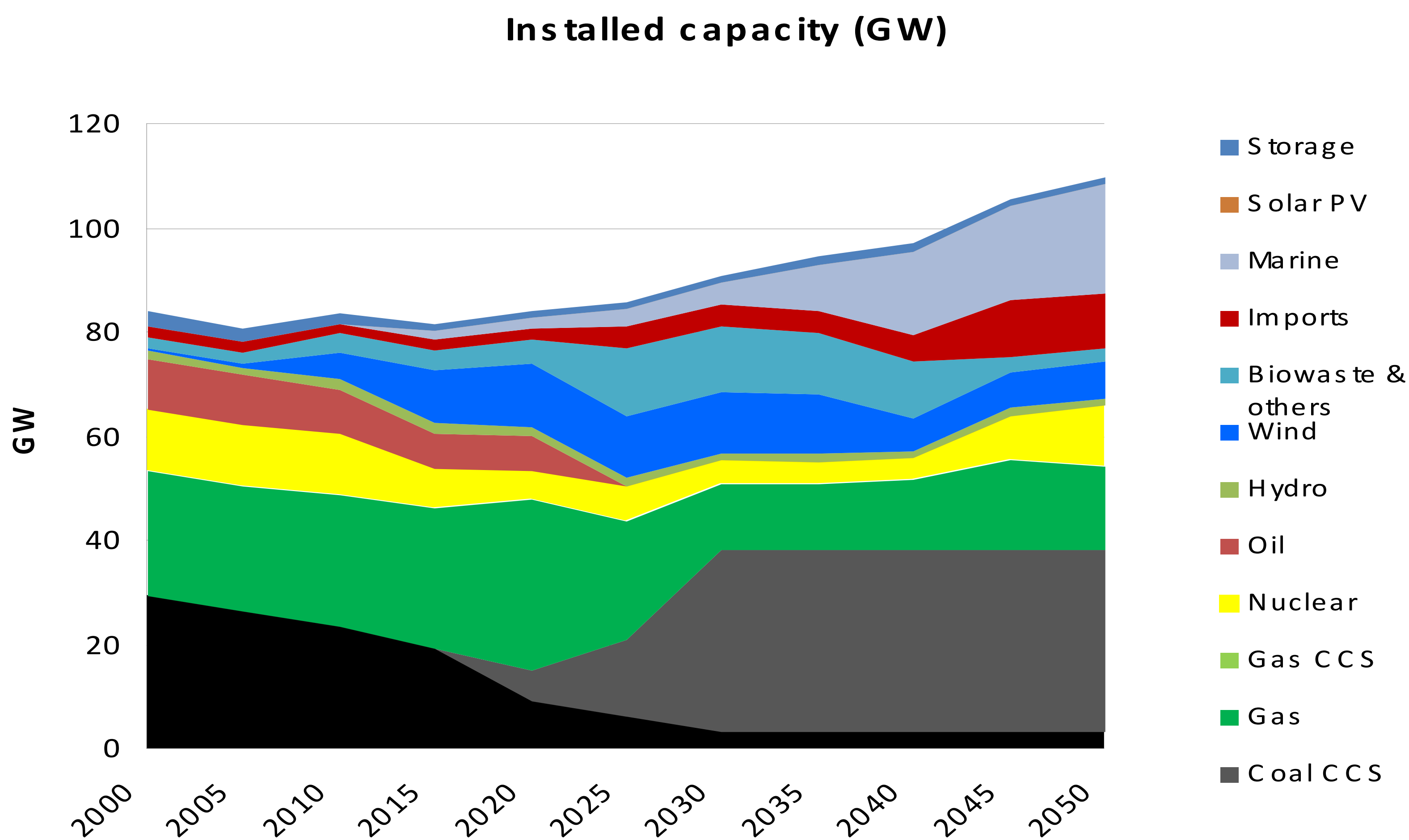
# ESF Vision

- Pan European Pan technology vision
- Act as a guide to policy makers and the wider stakeholders

# UK Marine Energy: Sustained cost reduction



# EUOEA

## Installed capacity

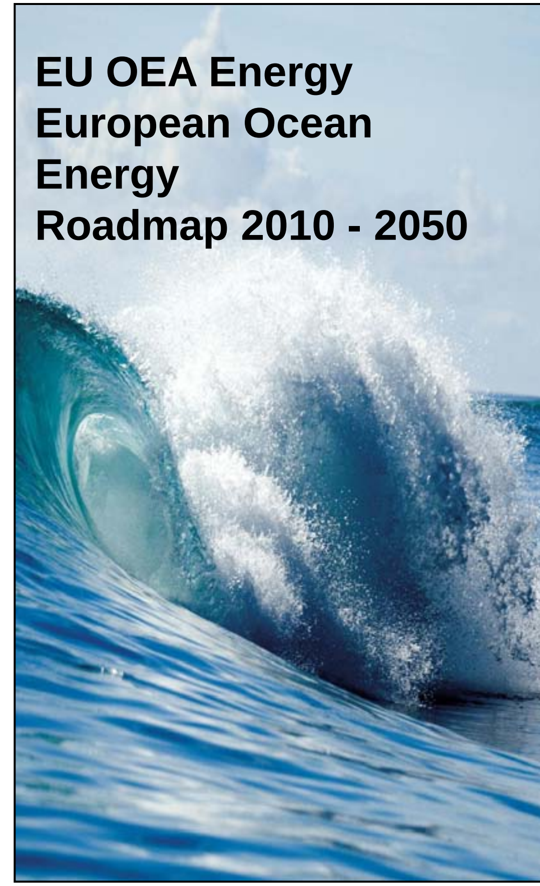
**3.6 GW by 2020**

**188 GW by 2050**

## Jobs

**26000 in 2020**

**Over 300,000 by 2050**



# Structure

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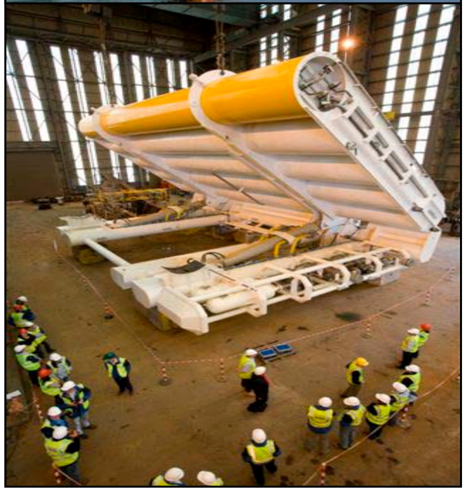
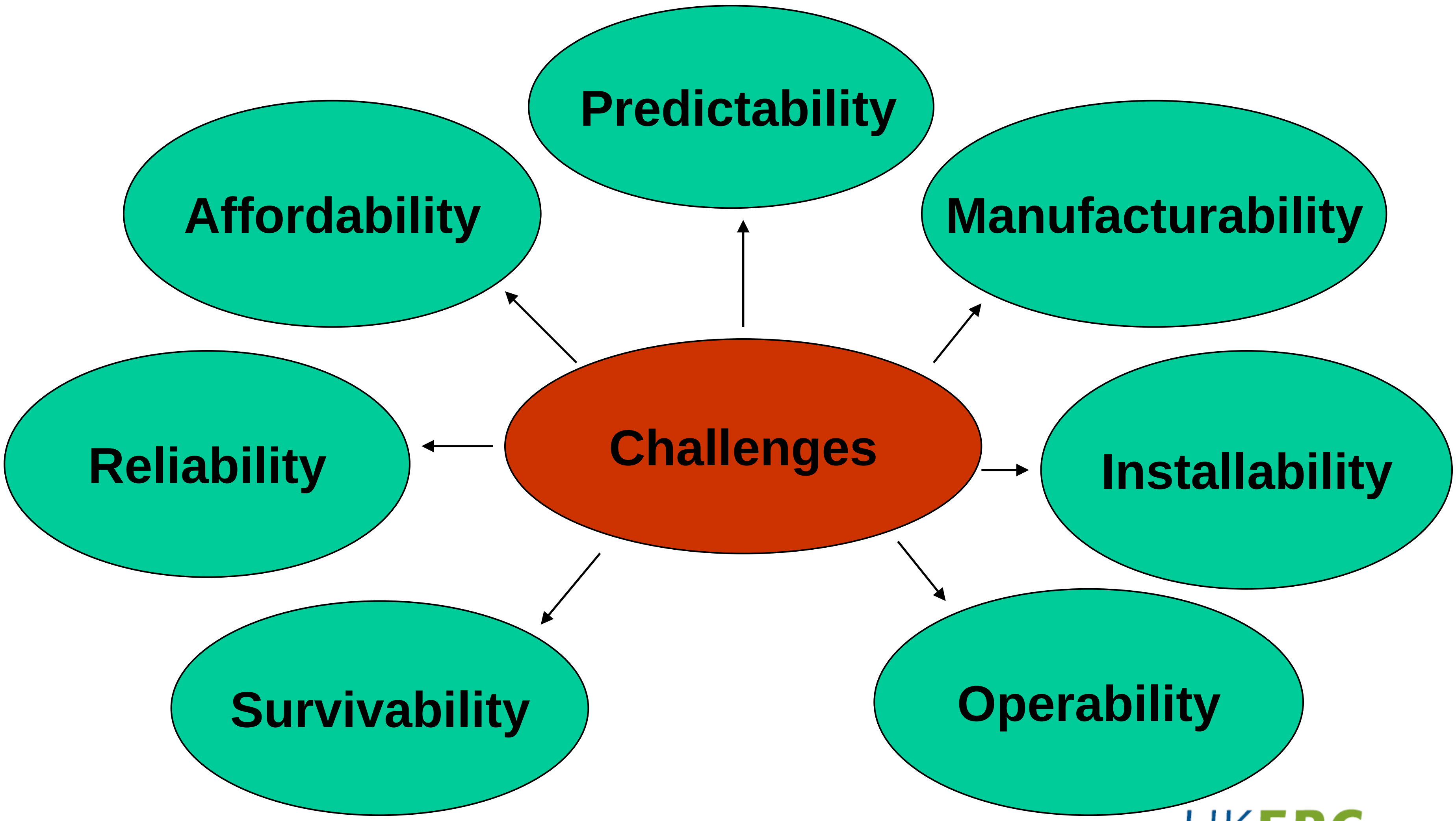
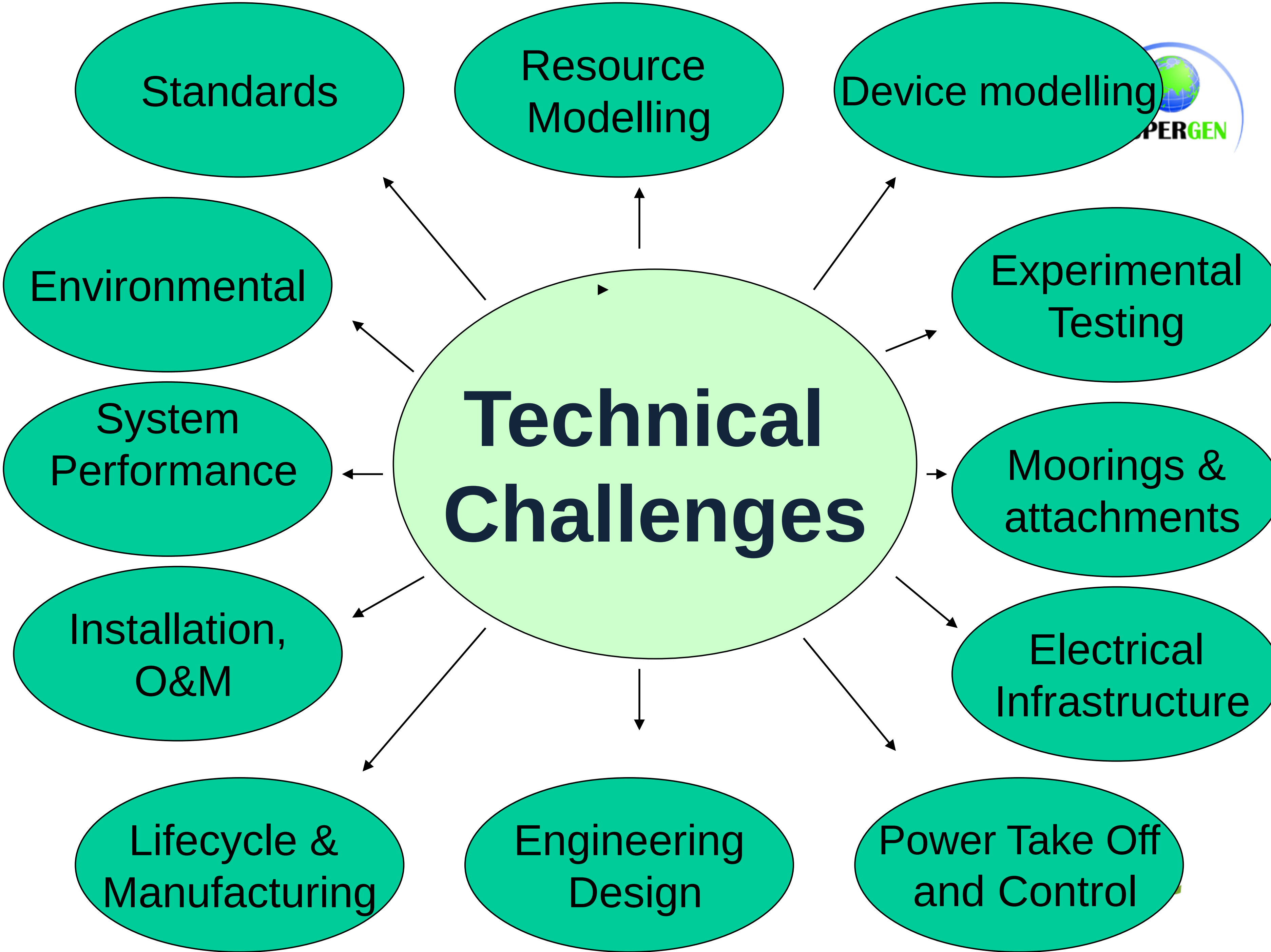


# Main Technology and Deployment Challenges

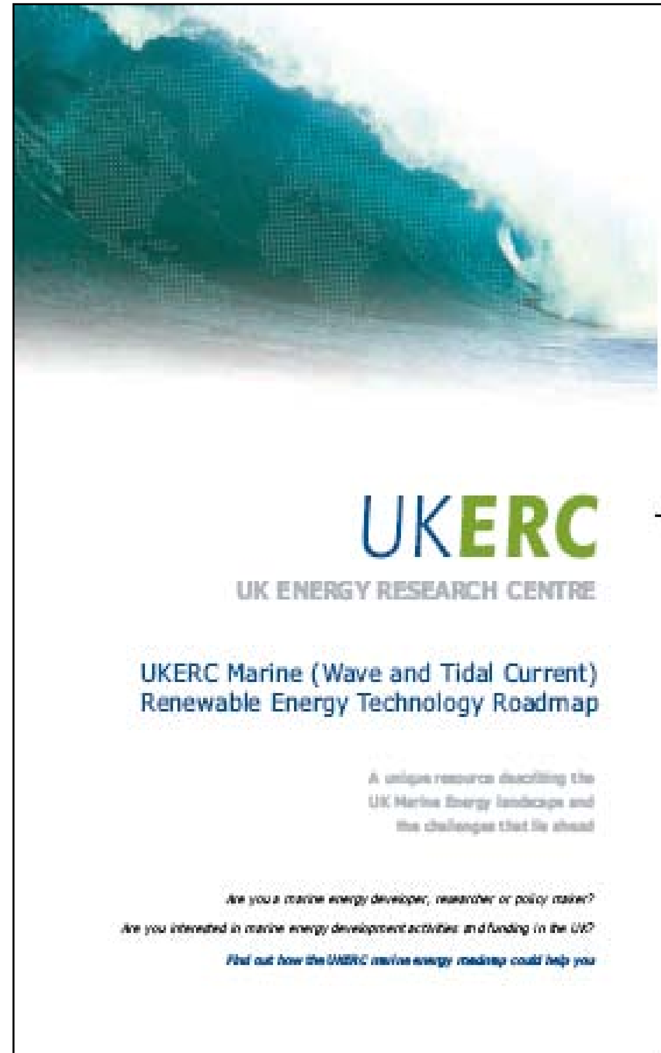



Technical Challenges
Standards
Resource Modelling
Device modelling
Environmental
Experimental Testing
System Performance
Moorings & attachments
Installation, O&M
Electrical Infrastructure
Lifecycle & Manufacturing
Engineering Design
Power Take Off and Control

# UKERC Road Map

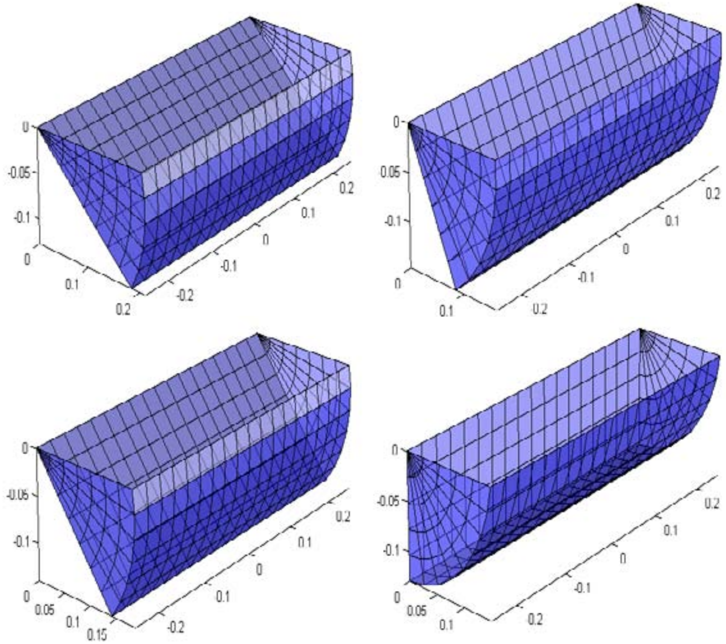
identified research challenges to establish the industry as:

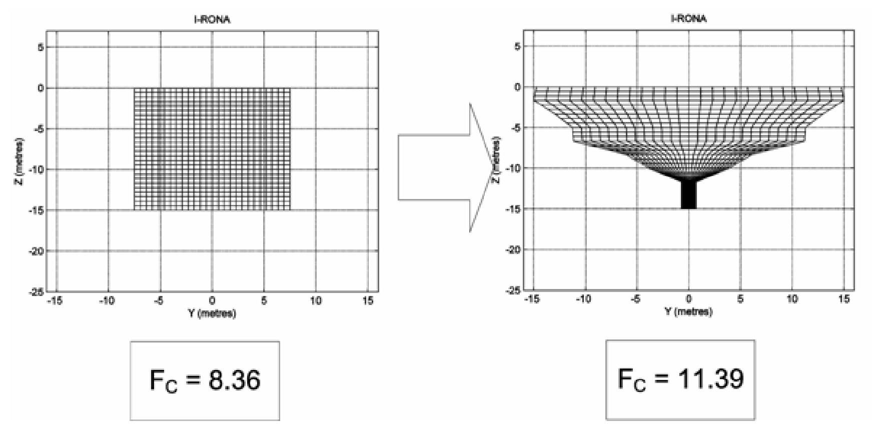
- Availability of test facilities across the range of scales
- Moorings and foundations for progressively deeper water
- Resource spatial and temporal modelling
- Resource: device modelling
- Integrated PTO designs and control
- Installation and O&M techniques
- Industry standards & life cycle analysis
- Design for survivability and yield
- Electricity network infrastructure and technology
- Economic appraisal & policy interaction

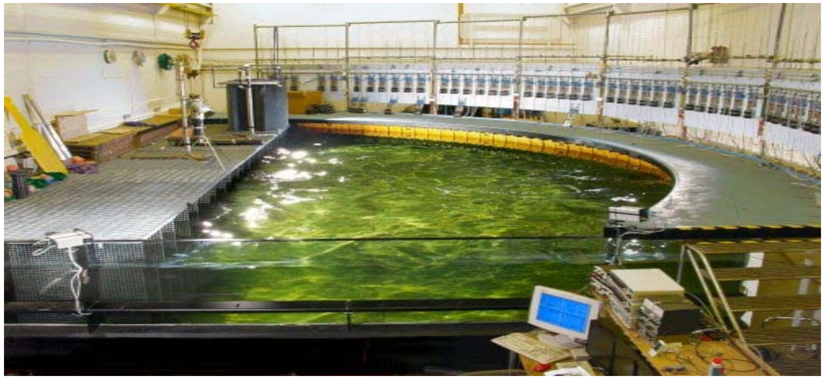


# Optimisation of collector form

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



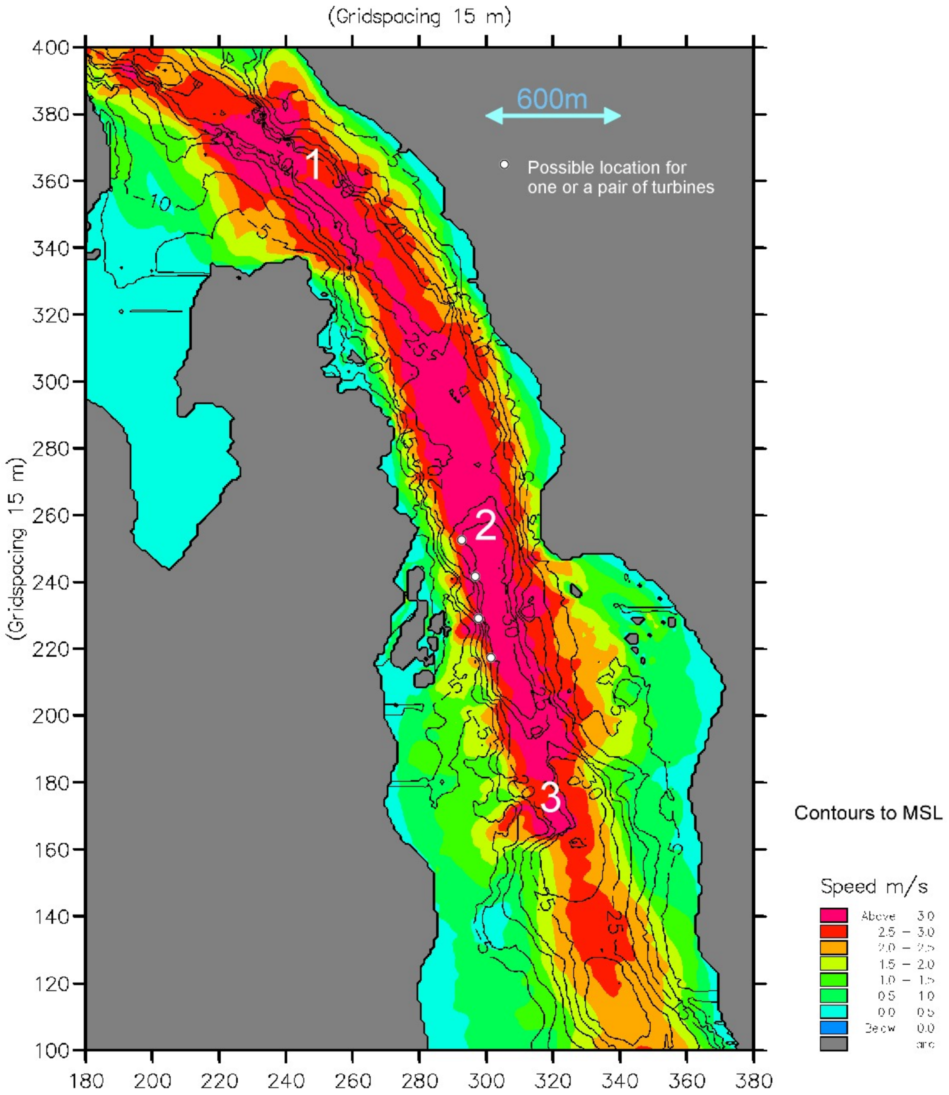


# Combined wave and tidal effects

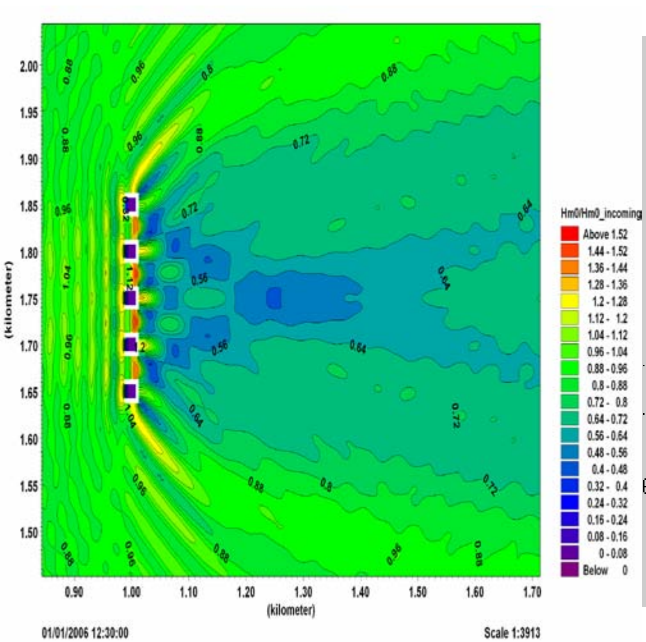
- This work is advancing design, prediction and test procedures to recognise combined presenc[e] and effects of wave and tidal currents.

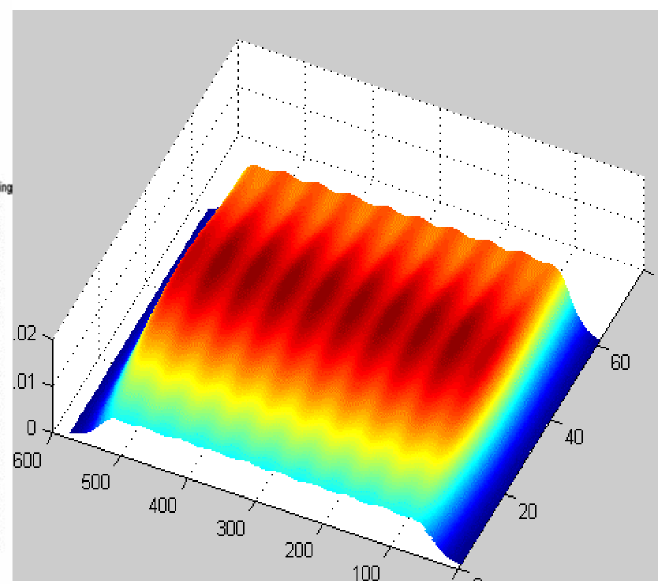
- Tests are being conducted at Queens, Edinburgh and in a new dedicated 1/10th scale facility at Portaferry and at EMEC.

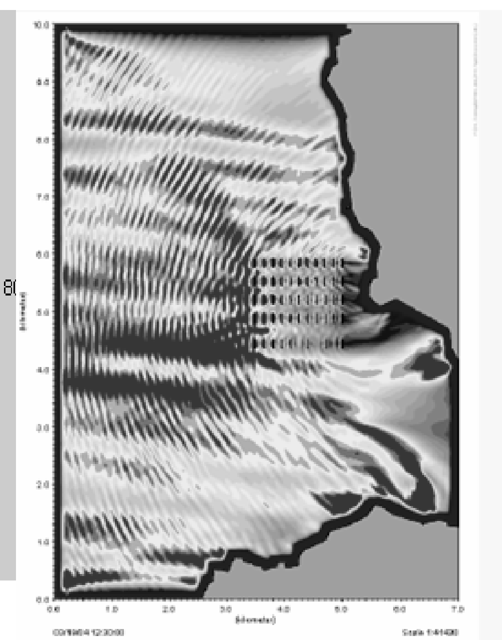


# Arrays, wakes and near field effects

**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

- Commonality will be key.

- ESF Vision offering a European, pan technology approach.

Ill stop Talking Now

Thanks for your attention

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