Harnessing Renewable Energy from the Sea

Eurocean : October , 2010

Henry F Jeffrey
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
Structure

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

<table>
<thead>
<tr>
<th>Technology</th>
<th>Stage of Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tidal barrages</td>
<td>Mature technology, despite limited applications.</td>
</tr>
<tr>
<td>Waves and tidal currents technologies</td>
<td>Significant number of technologies being developed worldwide: some of these technologies are at or near full-scale development and undergoing sea trials</td>
</tr>
<tr>
<td>OTEC technologies</td>
<td>Advanced stage R &amp; D</td>
</tr>
<tr>
<td>Salinity gradient technologies</td>
<td>Early stage R &amp; D</td>
</tr>
</tbody>
</table>
Wave Energy Technologies

Oscillating Bodies

AW-Energy Waveroller (Finland)

Powerbuoy (40 kW) OPT, USA

UK Aquamarine's Oyster wave energy unit

Fred Olsen, “BOLT” Norway

Pelamis 3x750 kW Installation: Portugal
Tidal Current

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

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

Installation at EMEC (UK)
Salinity Gradient Project

2009 | Osmotic power, prototype near Oslo, Norway
Structure

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

Source: MCT
Pelamis Wave Power

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

Source: PWP
Aquamarine power
Aquamarine Power
Structure

- Overview of technologies
- Wave and tidal developments
- Deployment Scenarios
- Research challenges
- Summary
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
Action Plans, Vision documents and Roadmaps
ESF Vision

- Pan European Pan technology vision

- Act as a guide to policy makers and the wider stakeholders
UK Marine Energy: Sustained cost reduction

Installed capacity (GW)

- Storage
- Solar PV
- Marine
- Imports
- Biowaste & others
- Wind
- Hydro
- Oil
- Nuclear
- Gas CCS
- Gas
- Coal CCS
EU OEA Energy
European Ocean Energy
Roadmap 2010 - 2050

Installed capacity
3.6 GW by 2020
188 GW by 2050

Jobs
26000 in 2020
Over 300,000 by 2050
Structure

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

- Affordability
- Reliability
- Survivability
- Predictability
- Manufacturability
- Installability
- Operability

Challenges
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 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.
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

henry.jeffrey@ed.ac.uk