



SuperGen Marine 2

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Engineering and Physical Sciences
Research Council



Aims and objectives



EPSRC-funded 4 year collaborative project at end of year 1
Generic research with long-term objectives to:

1. To increase knowledge and understanding of device-sea interactions of energy converters from model-scale in the laboratory to full size in the open sea.
2. Reduce risk and uncertainty for stakeholders in the development and deployment of technology;
3. Enable progression of marine technology and energy into true positions in future energy portfolios.

Additional aims

to build capacity in and for the sector
to internationalise effort and connections



Activities within Supergen

- Operates through 11 parallel work streams
- Each Work Stream is multidisciplinary and directed to specific deliverables
 - Deliverables commenced in month 3!
- Most work streams are multi-institutional
- Programme was developed with consultation between the research, development and regulatory sectors

External Engagement



- **ACADEMIC**

- **Affiliate Programme**

- University of Durham
 - Southampton University
 - The Robert Gordon University
 - University of Manchester
 - University of Exeter
 - UHI Millennium Institute

- **International Partners**

- HMRC, TU-Delft, ECN; Dalhousie University, Oregon State University, Florida Atlantic University, UMass; Universities of Osaka City and Hokkaido; Harbin Engineering University, Guangzhou Institute for Energy Conversion (CAS) and Dalian University of Technology

- **INDUSTRY**

- **Research Advisory Forum**

- Includes representatives from:

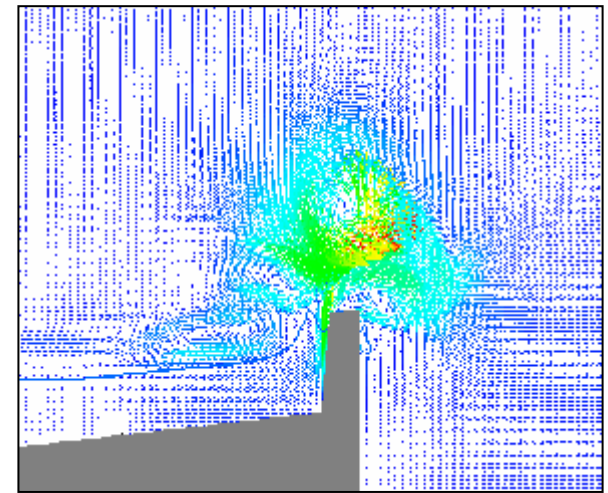
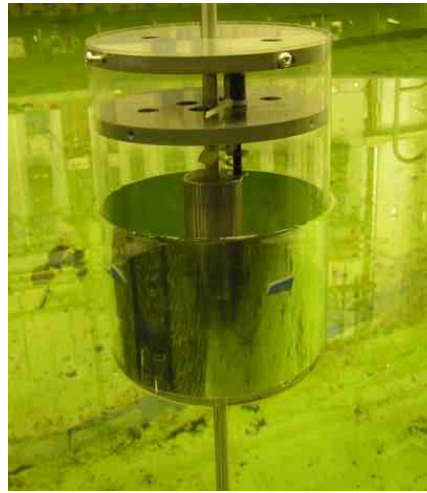
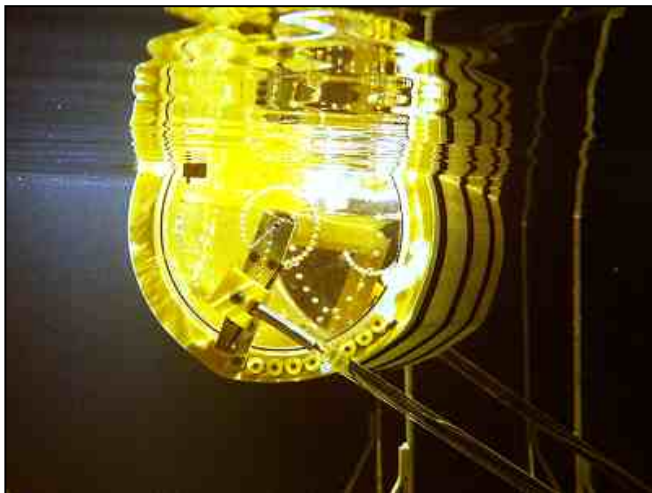
- Marine Current Turbines, Open Hydro, Pelamis Wave Power, Ocean Power Technology, Scottish & Southern Energy, Scottish Power, EdF, E-On, NPower, ETI, Carbon Trust, EMEC, NaREC, Crown Estates, Scottish Natural Heritage



WS1: Numerical and physical convergence

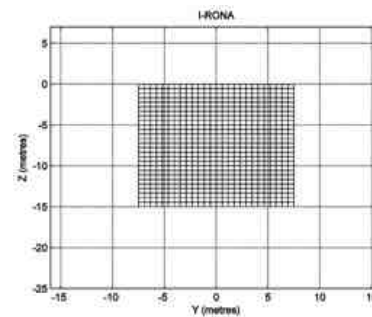
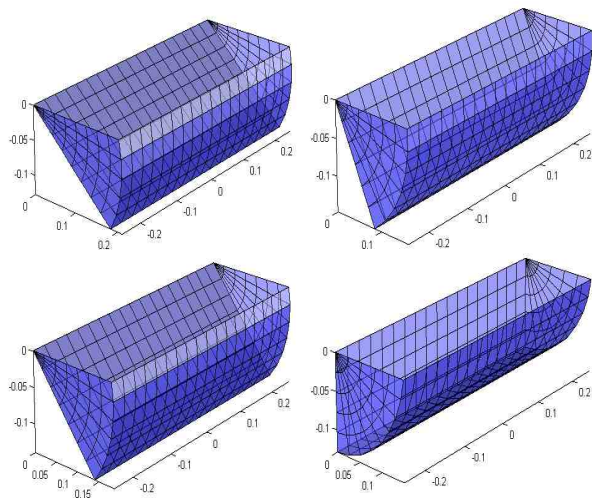
- A systematic study of the applicability of alternative analytic strategies for wave and tidal current systems
- This includes:
 - Identification and benchmarking of tank test procedures and techniques between different tanks
 - Identification and benchmarking of alternative numerical analysis techniques
 - Cross comparison and systematic evolution of best practise in both

WS1: Numerical and physical convergence

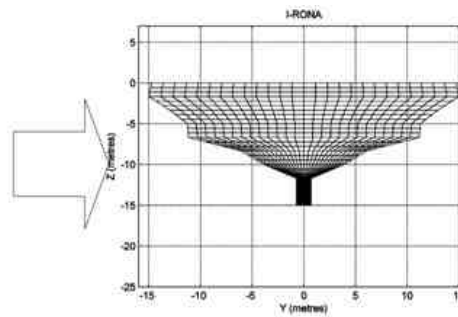


WS2: Optimisation of collector form

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



$$F_C = 8.36$$



$$F_C = 11.39$$

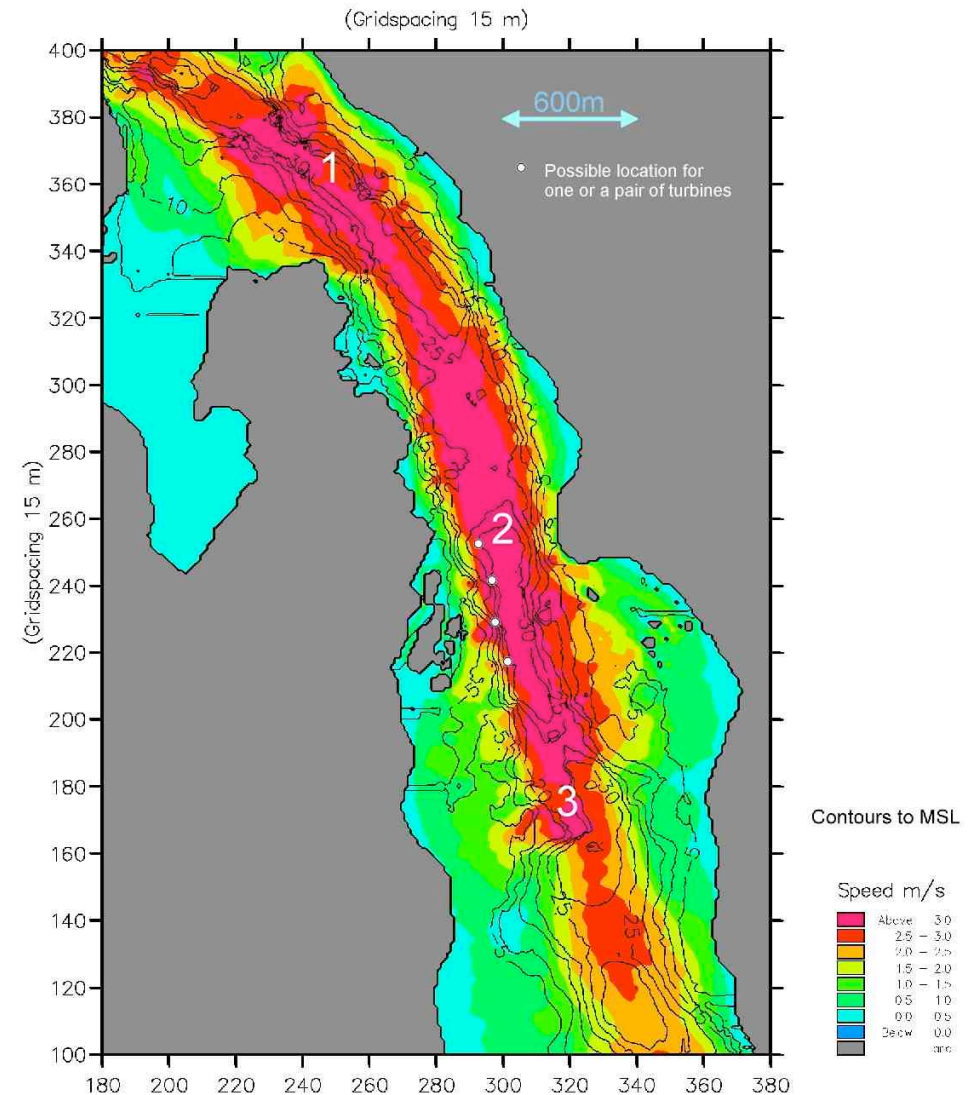


WS3: Combined wave and tidal effects

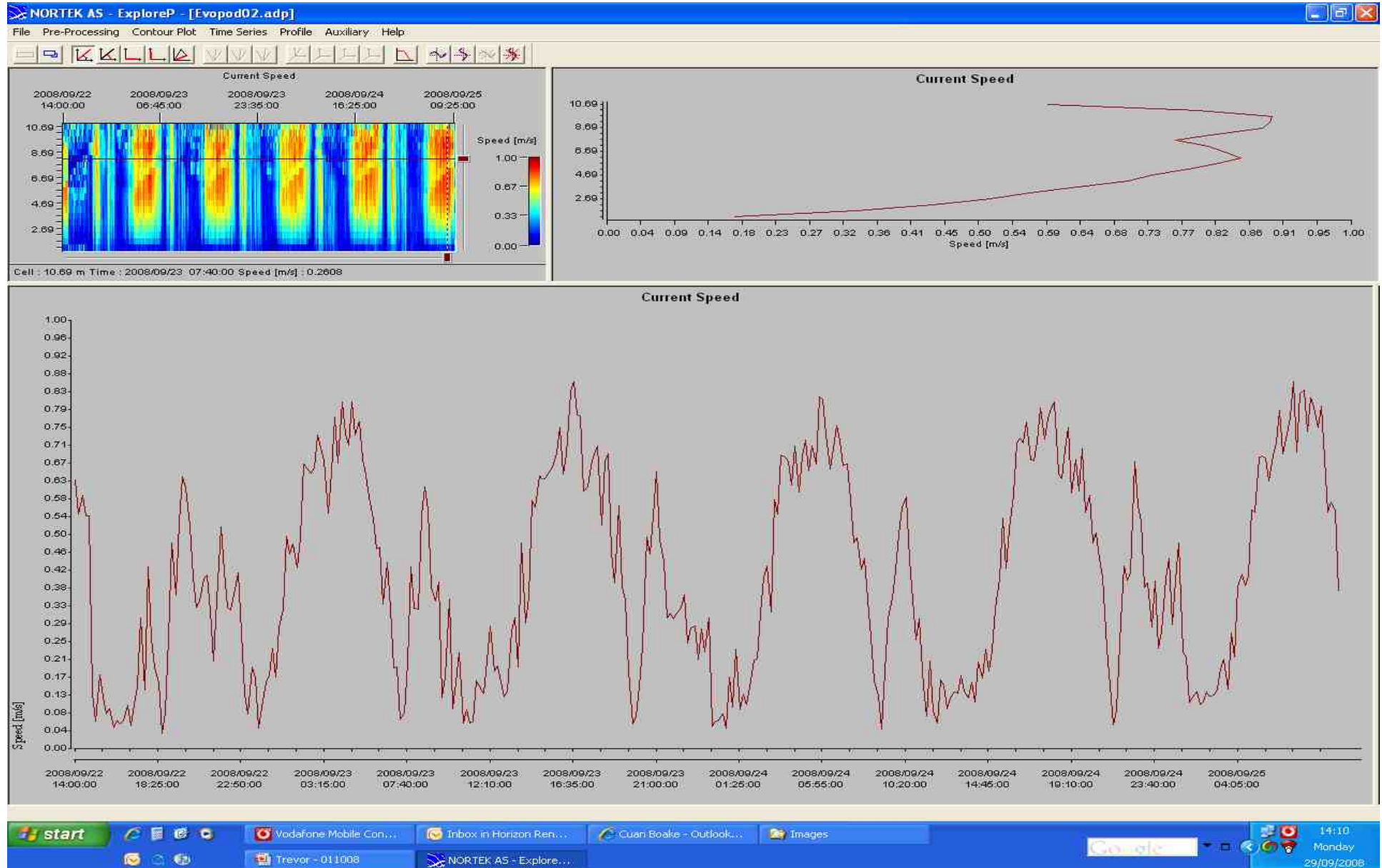
Tidal devices operate in waves. Wave converters operate in currents!

This work is advancing design, prediction and test procedures to recognise this.

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



WS3: Combined wave and tidal effects

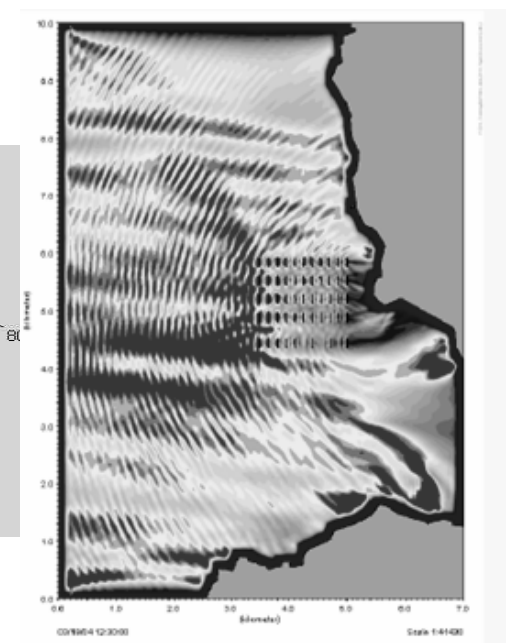
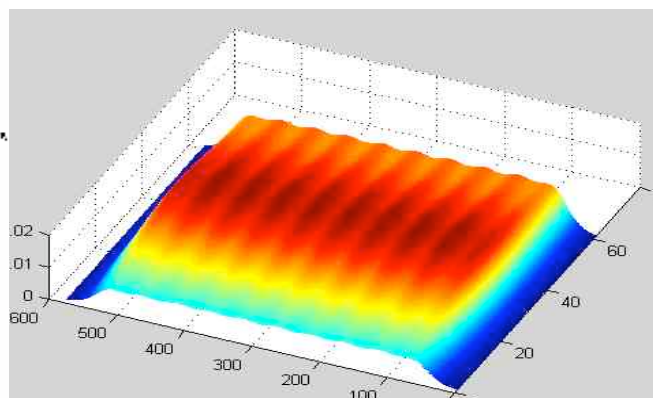
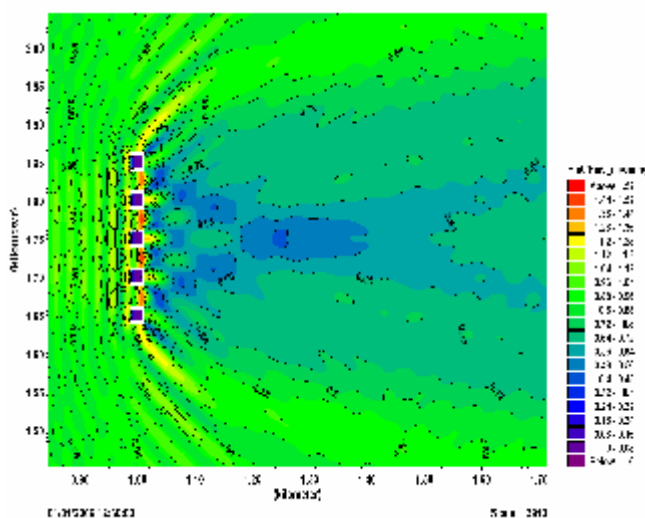


WS4: Arrays, wakes and near field effects



Array interactions will affect the design and performance of both tidal current and wave converters – individually and collectively.

This work is determining the local impact of multiple devices on the energy flux environment and on each other to identify optimal configurations and control strategies for arrays.



WS5: Power take-off and conditioning



The PTO system must be designed from the outset in an integrated manner

This work is integrating structural, magnetic, thermal and electrical designs to optimise performance and cost



WS6: Moorings and positioning

Establishing methods for safe and economic station keeping of arrays, taking account of loading in combined wave, current and winds

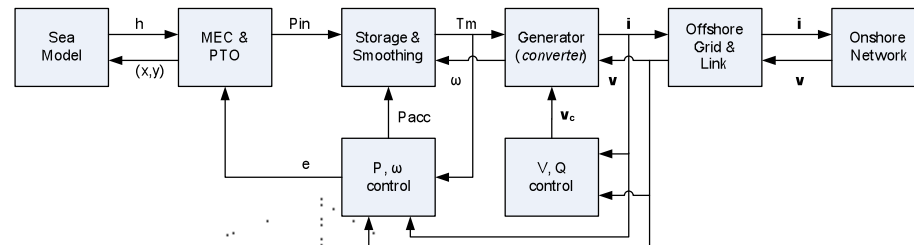
Video



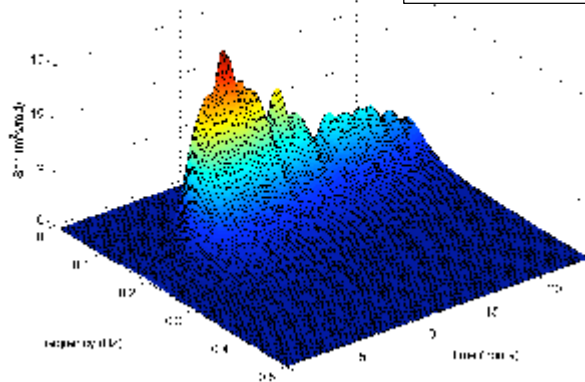
WS7: Advanced control/network integration



Developing continuously adapting control techniques to optimise energy extraction and survivability. Interaction of arrays of devices with actively controlled distribution networks assesses impact.



Video



WS8: Reliability



Establishing effective methods to quantify the reliability of marine energy converters even in the scarcity of industry-specific component failure rates and environmental data.

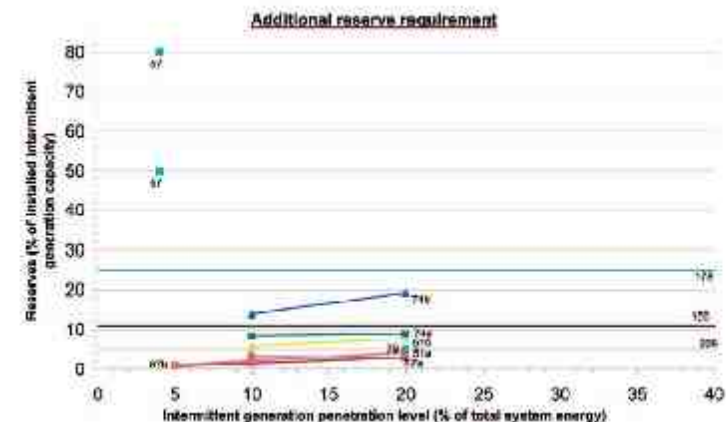
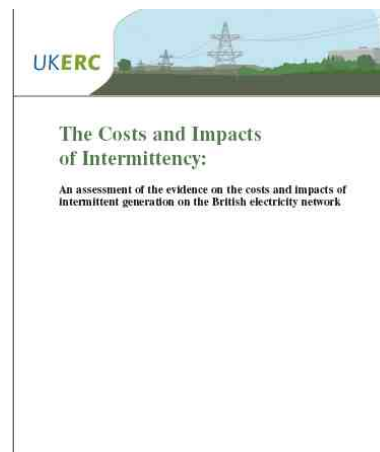
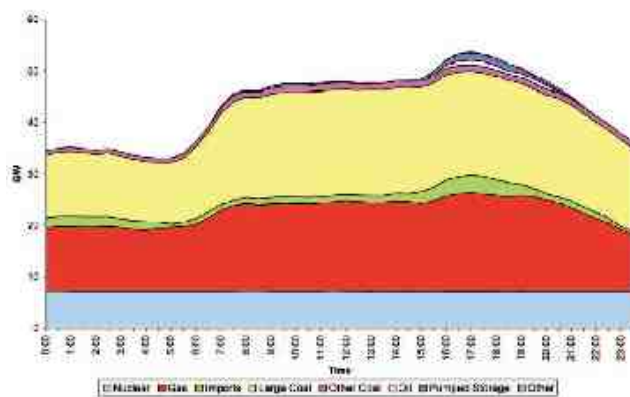
Exploring the effect of changing maintenance strategy on availability in arrays.



WS9: Economic analysis of variability and penetration



Predicting the pattern and timing of future uptake of marine energy by the market, recognising its nature and location recognising the variability of generation and peripherality of sites - *and the sensitivities of these to changing economic conditions*



WS10 - Ecological Consequences of Tidal and Wave Energy Conversion



Establishing the principal ecological consequences of the extraction of tidal and wave energy in coastal and offshore zones.

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*



Doctoral Training Programme



Aim: To re-vitalise the supply of trained scientists and engineers for the academic, industrial and infrastructure sectors of marine energy.

It operates across core and affiliate universities.



Doctoral Training Programme



Workshop Programme

Month	Topic	Venue
Feb 2008	Wave Hydrodynamics	Edinburgh
Jun 2008	Marine Ecology and Field work	Orkney
Sep 2008	Economics	Glasgow
Feb 2009	Electrical Networks, Connection and Conditioning	Edinburgh
Jun 2009	Tidal Hydrodynamics	Belfast
Sep 2009	Electrical Machines	Edinburgh
Winter	Career development, writing for publication	Lancaster
Spring	Moorings and Fixings	Edinburgh
Summer	Environmental consequences	Belfast
Winter	Commercialisation and Entrepreneurship	TBC
Etc		

Doctoral Training Programme



Getting to Grips with the Marine Environment

- Marine Resource Assessment of North of Scotland
- Contrasting Planning Approaches on Land and Sea
- Development impacts on marine biodiversity and fishing
- Field Work on nearby shores



Workshop Invitation

A sunset over the ocean with a white wake in the bottom right corner. The sun is low on the horizon, casting a golden glow across the sky and water. The sky is filled with soft, colorful clouds in shades of orange, pink, and purple. The water is dark blue with white foam from the wake in the bottom right corner.

- Workshops are mandatory for SuperGen funded students
- Open invitation to other marine energy groups

Internationalisation



MOUs with: Dalhousie Canada, Florida Atlantic and UMASS USA, New Zealand and Dalian China

Engaged with Federal, State and Governmental initiatives in many of these countries – CMER, MREC

Staff, student and facilities exchange

Staff on the UK mirror committee for TC 114 and project managing IEC standards

Initial and ongoing discussions: Chile, Norway, South Africa, Taiwan and Korea

