



In a “Nutshell”



Supergen Highlights of Year 2



Professor Ian G Bryden
Institute for Energy Systems
The University of Edinburgh



EPSRC

Engineering and Physical Sciences
Research Council





Work Stream 1

Numerical and physical convergence

- Dynamic calibration of wave gauges and no contact laser wave gauge
 - Allowing robust measurement of non-linear waves!
- Proving of the “shape tape” at $\frac{1}{4}$ scale in Hannover
 - Allows simultaneous time and space domain wave measurement
- Development of numerical floating WEC model using industry standard CFD code
- Identification of shortcomings in commercial CFD code when modelling long duration wave propagation



Work Stream 2

Optimisation of collector form

- Evolving device shapes for heaving/surging wave energy converters using GA
- Implementation of robust modelling and optimisation procedures, recognising the stochastic nature of the GA evolutionary processes
- Preliminary “best” evolutionary solutions identified for a surge/pitch based energy converter



Work Stream 3

Combined wave and tidal effects

- Construction and calibration of wave models for physical tank testing
- Development of robust numerical tidal device models
- Identification of 2nd order current influence on wave devices
- 1/10th scale test programme on tidal current device model in moving and still water
 - Highlighted significance of the support structure on wake development
- Procedures for the discrimination of wave and turbulence influence on ADCP records



Work Stream 4

Arrays, wakes and near field effects

- Quantification of wave array interactions on energy conversion in 1/20th scale tests
- “Decision gate” technique to guide tidal system numerical modelling and to quantify parameter influences
- Enhancement of understanding of scale effects in combined wave-current seas
 - Possible new scaling parameter!
- Linking of device-array-geographic scale understanding to facilitate determination of practical & technical resources



Work Stream 5

Power take-off and conditioning

- Detailed appraisal of electrical power take off systems
- Design tools to guide the development and design of new generation PTOs
- Design and construction of a new “wet” linear test rig
- Experimental investigation of elastomeric bearings in an air-cored machine
- Validation of thermal models of the generators



Work Stream 6

Moorings and positioning

- Five 1/20th scale heaving buoys tested under combined influence of waves and currents in Trondheim.
 - 500 GB of test results, photos and video
- Experimental verification of numerical mooring simulations
- EIA for array deployment in Marlfield Bay completed and application to deploy three devices approved
- Moored Evopod tidal device tested in Strangford Narrows



Work Stream 7

Advanced control/network integration

- Radical time domain PTOs models incorporated into existing control structures.
- A new classification system developed for WECs, based on system physics.
- Validation of the numerical wave propagation models
 - Even at intra-array scales
- Demonstration of power output smoothing for appropriate wave array configurations



Work Stream 8

Reliability

- Development of detailed schematic turbine representations, to enable realistic representations of sub-assemblies.
 - Applied to the SeaGen and the Evopod to compare the use of the methodology between the two different machines
- Deterministic models used to evaluate the probability of failure of turbine blades and mooring systems
- Conventional approaches extended due to significant uncertainties in the major factors of influence.
 - The failure rates are treated as random variables, with their distributions forecast using Monte Carlo simulation.



Work Stream 9

Economic analysis of variability and penetration

- Levelised cost comparisons for marine and other technologies
 - Uses DTI (2006) assumptions and the “banding” of ROCs.
- Portfolio theory analysis of the economic efficiency of the mix of electricity generation technologies
 - Based on the core scenarios of the UKERC 2050 projections.
 - Also to analyse electricity generation in Scotland to 2020
- Methodology developed to estimate local impact of renewable energy projects
 - Case study for a peripheral economy, considering the local economic benefits from the local community taking a share in the ownership



Work Stream 10

Ecological consequences of tidal and wave energy conversion

- Data assessments from benthic surveys prior to and following deployment of SeaGen.
 - No significant differences found for three downstream sites
- Long term field studies
 - ADCPs and light loggers deployed to assess kelp growth
 - 12 month programme under different wave and current exposures
- Lab tests on flow effects on nutrient uptake and growth rates
- Bayesian modelling to inform EMEC wave site monitoring
 - To differentiate changes arising from the removal of energy from those due to seasonal changes and from climate change



And Finally



- Machines are in the water, generating electricity and exporting into grids
- This would not have been possible without pioneering research
- Experience in the water is identifying new research challenges all the time
- The sector knows a huge amount more than it did even two year ago but there is much still to be done and a lot to be found out.