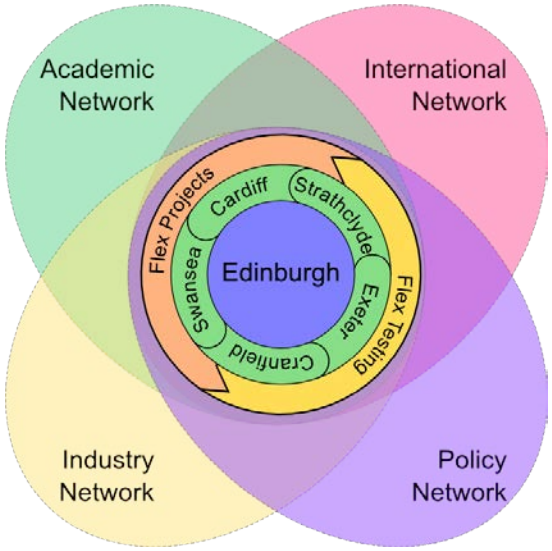
SuperGen 4
UK Centre for Marine Energy Research

UKCMER Structure and Operation

Wallace	PI, Executive Director, Financial Management	
Ingram	CI WP4 Research Director	
Jeffrey	Network and Impact Manager	
Masters	CI WP1	Tidal lead, Wales and Ireland liaison
Brennan	CI WP5	Offshore wind lead, England liaison
Johanning	CI WP2	Wave lead, PRIMare, WaveHub liaison
Johnstone	CI WP3	Environment lead, Scotland liaison
	Flex fund projects (2-4)	



Research Advisory Board: Connor (Nova Innovation); Yemm (Quoceant); Marti (ORE Catapult); Bittencourt (DNV GL); Bradley (ETI); Wilson (SAMS); Bard (IWES Fraunhofer), Mortimer (Sgurr Energy) and Lewis (MAREI).

O'Doherty	CI	Dynamic Loadings on Turbines in a Tidal Array (DyLoTTA)
Williams	CI	Survivability of Floating Tidal Energy Converters (SURFTEC)
Mueller	CI	All Electric Drive Train for Marine Energy Converters (EDRIVE)
Venugopal	CI	Response of Tidal Energy Converters to Combined Tidal Flow, Waves, & Turbulence (FloWTurb).

Research challenges

Predicting and delivering performance – Numerical and physical closure

Understanding the natural resource and predicting energy and economic yield from arrays requires more complex, fully coupled, 3-D and time-varying numerical and physical models. Scale and in-sea measurements must drive development of control systems that increase yield and durability.

Manufacturability & installability of components, subsystems and technologies – Right first time

From component through subsystem to device level there will remain a need to correctly select existing technology, or manufacture and prove new technologies, so that they can be system-integrated, into a fit for purpose device.

Survival and durability under extreme loadings – Avoid catastrophic failure

Components, subsystems, technologies and structures have to be selected or designed and manufactured to withstand the most extreme loadings outside normal operation at least cost.

Increased reliability, operability and maintainability under fatigue loadings – Remain available - Don't wear out

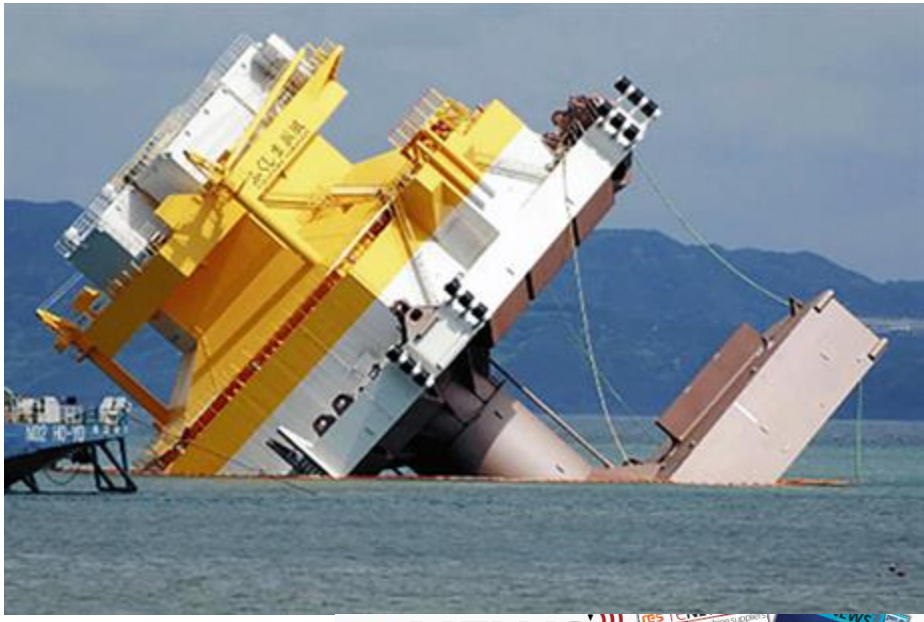
In addition to surviving extremes lifetime energy production must be maximised by extending mean times between failure through better O & M and greater resistance to wear and failure under repetitive loadings.

Economic, social and environmental interaction and affordability – Reduce risk to be acceptable

The lifetime costs of energy have to become competitive with mainstream renewable energy technologies environmental, economic and engineering risks have to be understood, reduced and deemed acceptable.

New Opportunities

News 12 May. JAPAN: An advanced spar foundation for the 5MW FOWT for the FORWARD site near Fukushima has keeled to a 45 degree angle in the seas of Osaka bay in southern Japan



Significant common needs for fundamental to applied research spanning wave, tidal, offshore wind and, now, floating offshore wind energy technologies:

- analysis and performance prediction of fully coupled hydro- aero- and electro-dynamic devices;
- fluid:structure interaction;
- cost effective manufacture, installation, operation and maintenance; survival of extreme and fatigue loadings;
- environmental and economic viability.

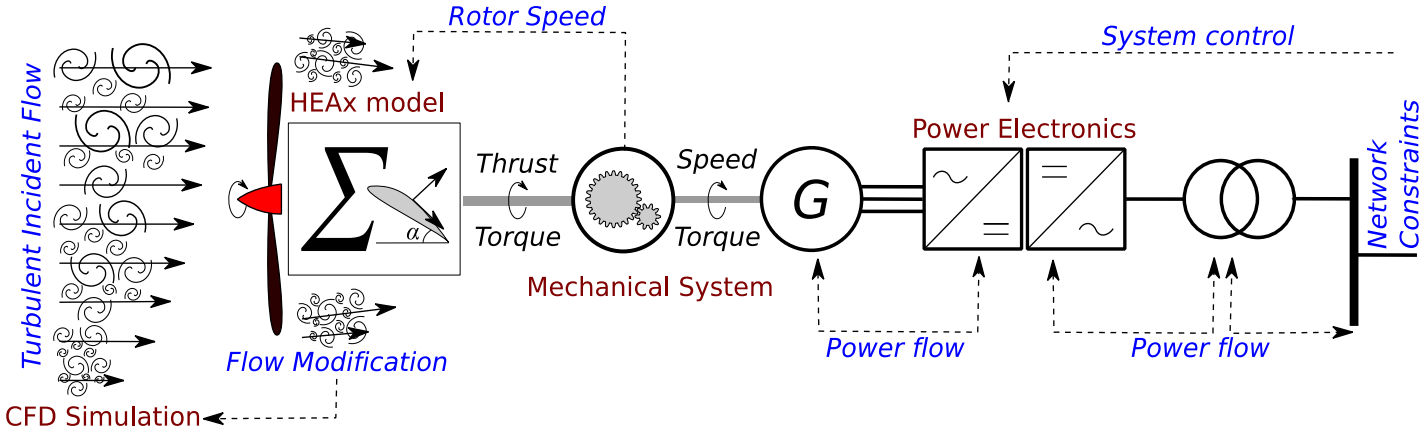
WP1 – Control and Performance

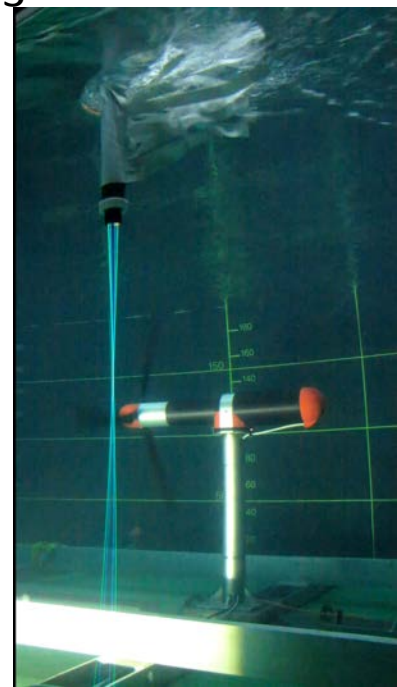
Will couple UoE electromechanical TCCS model to Swansea's unsteady GAD model and extend it to develop a fully bi-directional transient tide-to-wire model.

Will be applied to both single machines and embedded in computational fluid dynamics codes to investigate array interactions.

This will allow investigation and mitigation, through control, of the impact of turbulent flows and wakes on energy yield and loadings within the tidal array and also of the effect of network faults on the hydrodynamic response of TCCs.

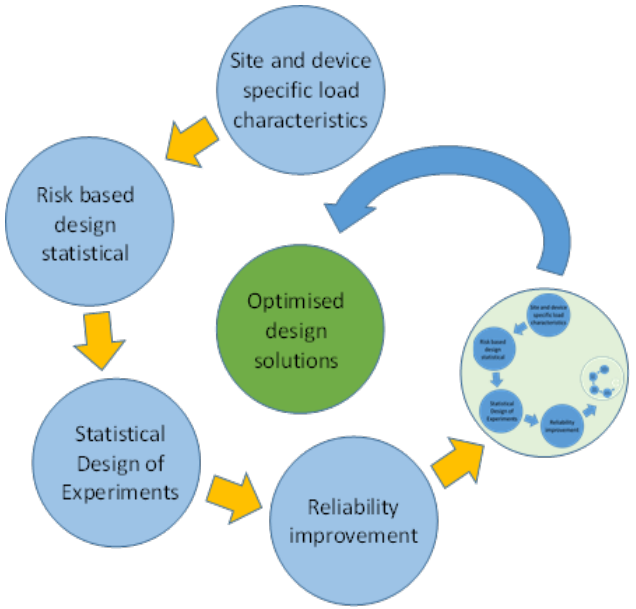
Model results for a single turbine will be compared with those from experiments to be conducted under the FlowTurb and E-DRIVE GC Projects and from Phase 3





WP2 – Risk and Reliability

WP2 will explore applicability and transfer of novel design and test processes, as practiced in other sectors like aviation and transport.



Risk-based design

A move away from traditional deterministic iterative engineering design by combining risk-based and probabilistic reliability methods and mathematical modelling techniques into the design processes to optimise the cost and reliability.

Statistical design of test regimes

Performance and durability testing of individual sub-systems customarily replicates and accelerates in-situ load conditions. The Design of Experiments Method will be used to identify, select and schedule the combinations of governing factors to achieve most representative results in accelerated testing.

Test results will be compared with those from experiments to be conducted under the DyLoTTA GC Project.

WP3 – Extreme loads and survivability

Extreme responses in limiting operational and survival conditions used in "traditional" ship and on- off-shore structure design. WP3 aims to identify and transfer state-of-practice design tools and state-of-the-art analysis tools to predict extreme responses of wind, wave and tidal devices.

The objectives are to:

- identify a set of benchmark extreme load scenarios;
- predict extreme responses in these cases using state-of-practice design tools;
- characterise extreme responses for these scenarios via model testing and
- examine the ability of hi-fidelity analysis tools to predict these extreme behaviours.

Model results will be compared with those from experiments to be conducted under the SURFTEC GC Project

WP4 – Array Interaction

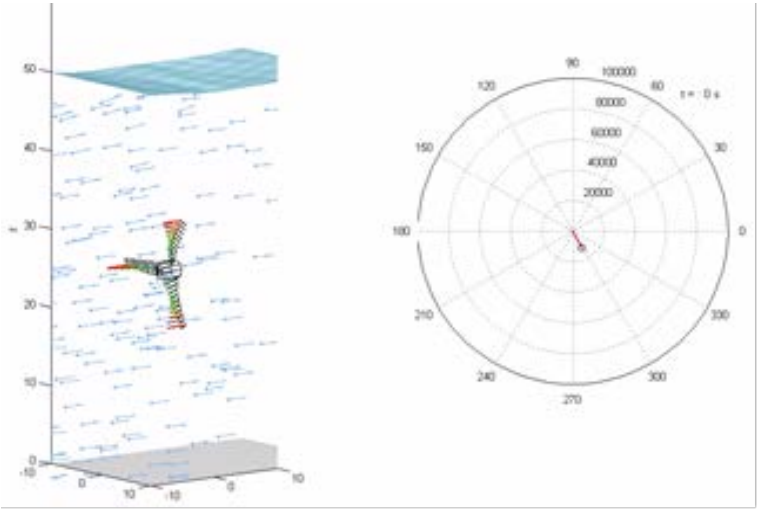
WP4 will develop new understanding

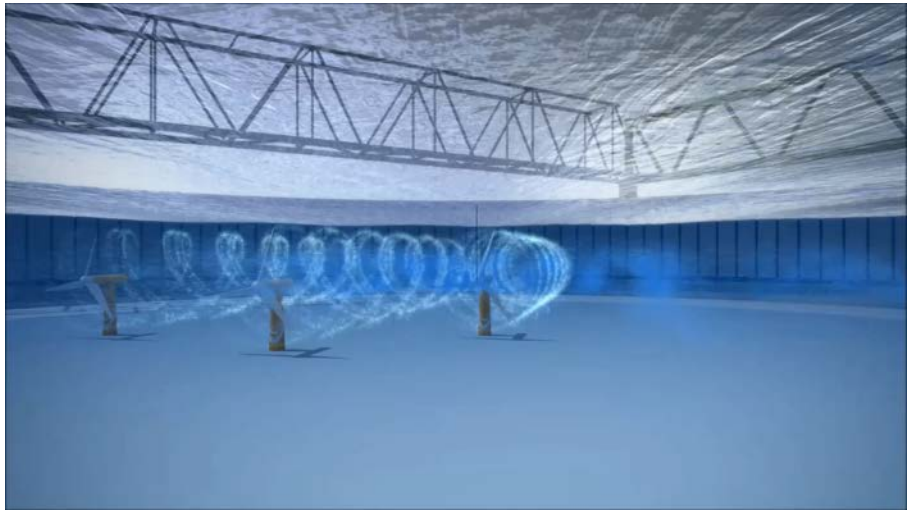
- in the modelling of dynamic flow conditions within tidal streams and
- of the nature of wave-current flow interactions penetrating down the water column and
- their influence on tidal velocities

This will be expanded to investigate the impact on tidal array performance and resulting energy yields.

The GAD CFD and Unsteady, Wave-Coupled BEMT tools will be evolved and verified for their application in tidal array performance assessment, to inform spatial planning in dynamic real-sea tidal flows to maximise energy yield.

Model results for an array of three turbines will be compared with those from experiments to be conducted under the FlowTurb GC Project, and from Phase 3+

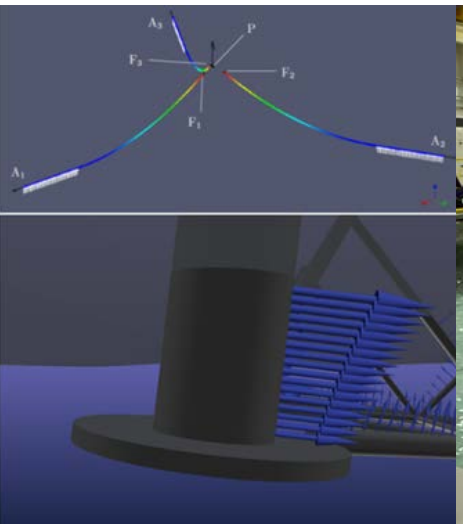


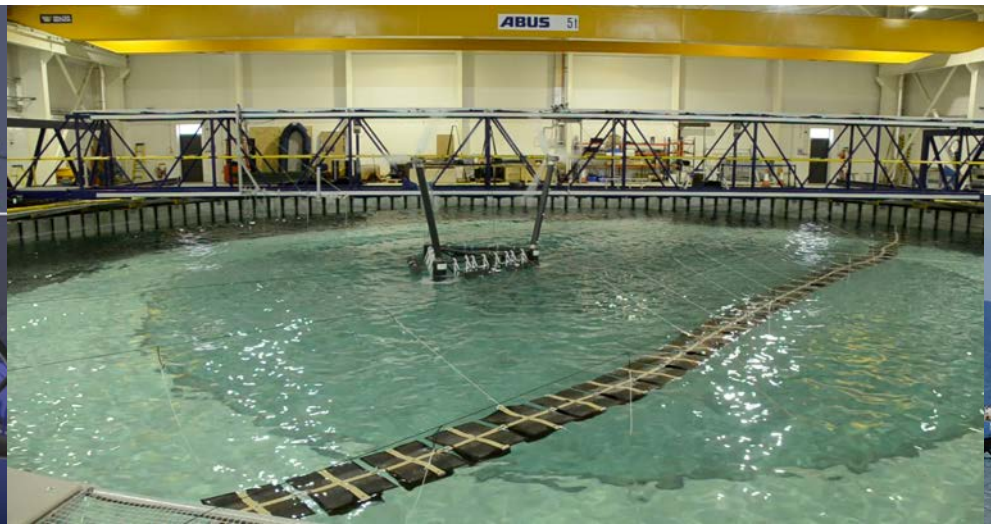


WP5 – Materials and Structural Integrity

To move on from first generation concepts and practices and to help achieve cost competitive ORE structures and structural components, WP5 will

- critically review materials and fabrication methods currently used in Offshore Renewable Energy
- explore contemporary materials used in other applications (nuclear, aerospace, shipping etc.,) and their ability to resist service stresses and
- more accurately and reliably define the loading regimes and structural dynamic responses giving rise to local stresses and
- develop new analytical methods to assess structural integrity taking account of the fluid:structure interaction and mooring dynamics integrated with device motion to determine whole structure response and loads





Flexible Funding

- WP8 will further engage the UK academic community, by competitively awarding up to £250k to connect and integrate the capacity and facilities of other universities in two 12 month projects aligned with selected WPs. This would run months 7 -18.
- Through UKCMER engagement with Wave Energy Scotland we now have a commitment to match fund up to another £250k to sponsor more flex projects.
- We expect to further gear that contribution with industry match funding of the projects that are jointly supported on a 'thirds-model' similar to that of the ORE Catapult.
- We will run a competition for access to the FloWave Facility in 4 one-week-long experimental-science campaigns.

Vision for SuperGen Marine UKCMER Hub Extension

UKCMER will **continue** to

Conduct *world-class* ***fundamental and applied research*** *that assists the wave, tidal and offshore wind energy sector to accelerate deployment and ensure growth in generating capacity towards 2030 and 2050 targets.*

Expand *and operate an inclusive* ***marine network*** *of academic researchers, industry and policy partners and international collaborators.*

Provide *the highest quality of* ***policy engagement and knowledge transfer*** *to sustain pride, sense of purpose and momentum in the sector.*

Lead*, by example, initiatives in the new SuperGen Era*

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