14th ewtec 2021
European Wave and Tidal Energy Conference Series
PLYMOUTH
5th–9th SEPTEMBER 2021

EWTEC 2021 SIDE EVENT

Supergen ORE Hub wave & tidal showcase

Wednesday 8 September 2021

17:00 - 18:30 BST

Hybrid event

Online & at the University of Plymouth

Supergen Offshore Renewable Energy

UKRI Engineering and Physical Sciences Research Council

Agenda

17:00 – 17:05 Welcome – Professor Deborah Greaves (University of Plymouth)

17:05 – 17:45 Wave and tidal energy research in the Supergen ORE Hub

Professor Deborah Greaves (University of Plymouth) and Professor Richard Willden (University of Oxford)

17:45 – 18:25 Launch of the Unsteady Loading Tidal Turbine Benchmarking Study

Professor Richard Willden and Dr Sam Tucker Harvey (University of Oxford) and Professor James Gilbert (University of Hull)

18:25 – 18:30 Close – Professor Deborah Greaves

Supergen

Offshore Renewable Energy

UKRI Engineering and Physical Sciences Research Council




- Research that **supports and accelerates** the development of ORE technologies for society
- **Whole systems approach**: allowing transfer of fundamental knowledge, shared learning and use of resources for inter-disciplinary research
- **Clustering**: Marine (wave and tidal) and offshore wind sharing of expertise, strategies and best practice
- **Networking**
- **Flexible Funding**
  - Seedcorn funding for projects aligned with the hub.
- **Impact**
  - Early Career Researcher Support
  - Equality, Diversity and Inclusivity Support
  - Industry Partnership
  - Policy Engagement

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www.supergen-ore.net

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University of Plymouth · University of Aberdeen · University of Hull · The University of Edinburgh · University of Southampton · The University of Manchester · University of Exeter · The University of Warwick · University of Oxford · University of Strathclyde

Supergen Home - Supergen ORE

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Supergen Offshore Renewable Energy

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Home | About | Impact | Funding | Research Landscape | ORE Facilities | ECR Community | News & Events

Welcome to the Supergen ORE Hub

We provide research leadership to connect academia, industry, policy and public stakeholders, inspire innovation and maximise societal value in offshore wind, wave and tidal energy.

Find out more




Supergen Home - Supergen ORE | Research Landscape - Supergen | Home - Supergen ORE Landscap

landscape.supergen-ore.net

Supergen

Offshore Renewable Energy

Hide panel

Select a research theme below to highlight current research challenges on the virtual landscape, then select a number to discover more information about current research challenges within each theme.

Themes

- A Resource and Environment Characterisation
- B Fluid-structure Seabed Interaction
- C Materials and Manufacturing
- D Sensing, Control and Electromechanics
- E Survivability, Reliability and Design
- F Operations, Management, Maintenance and Safety
- G Environmental And Ecosystem Aspects
- H Marine Planning and Governance

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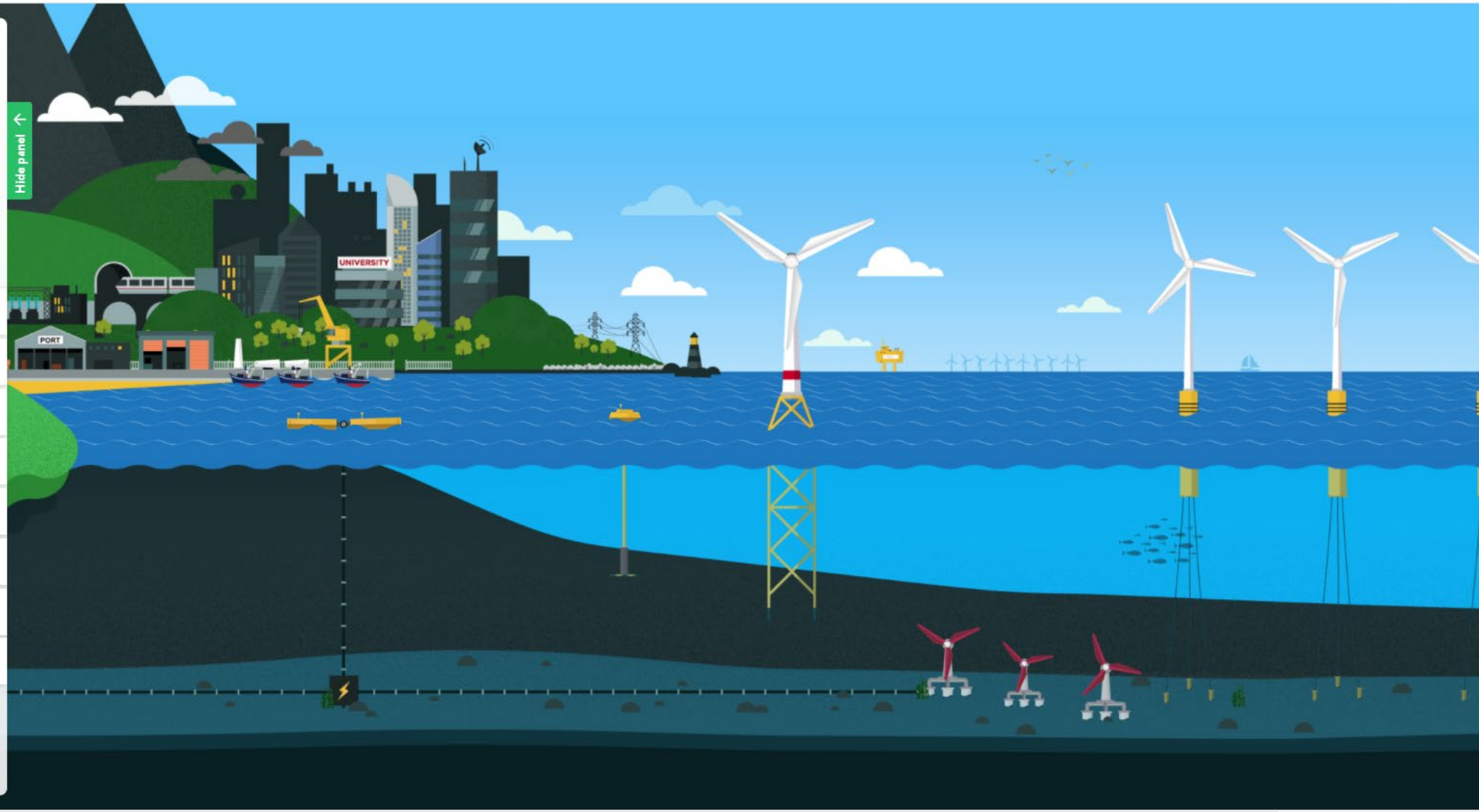
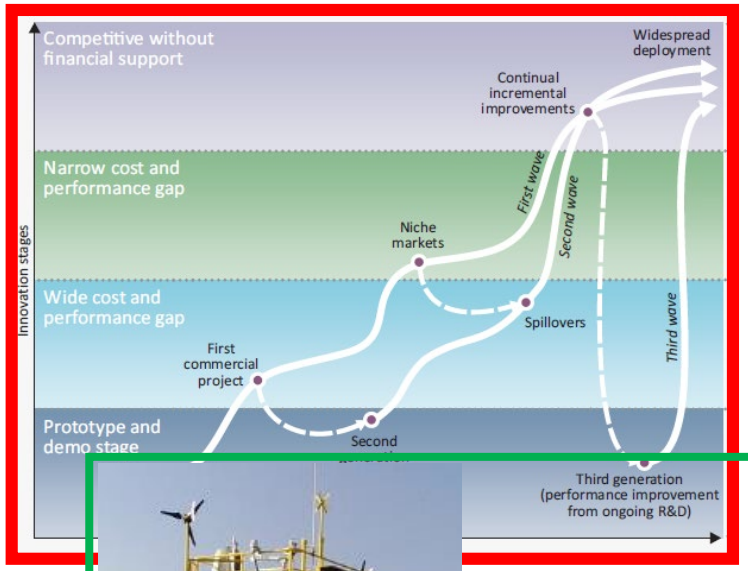
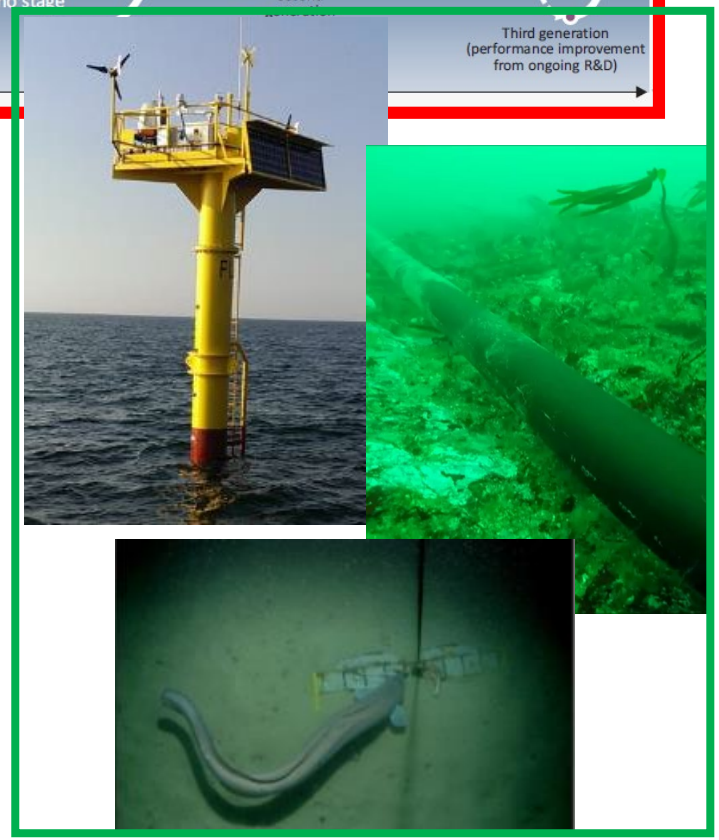
The Supergen ORE Hub is part of the wider Supergen Programme funded by the Engineering and Physical Sciences Research Council.



Supergen Offshore Renewable Energy

Core Research





WP1: Demonstration of Scenarios
Aspirational ORE systems in 2025 - 2050

Projected benefits, risks and priorities

WP2: Sites and Conditions
Creating test beds, improving characterisation

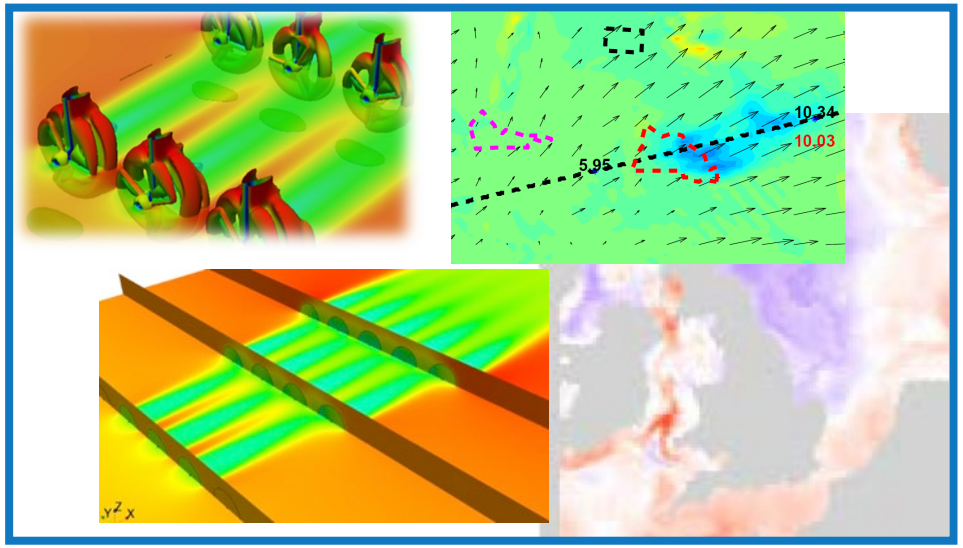
Sandbox Benchmarking

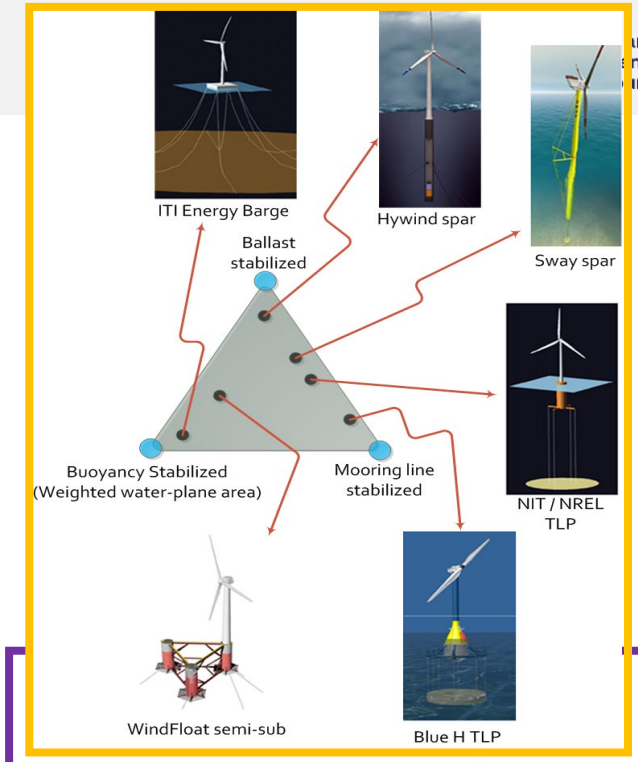
WP4: Design
Cost and risk reduction through novel design and innovation

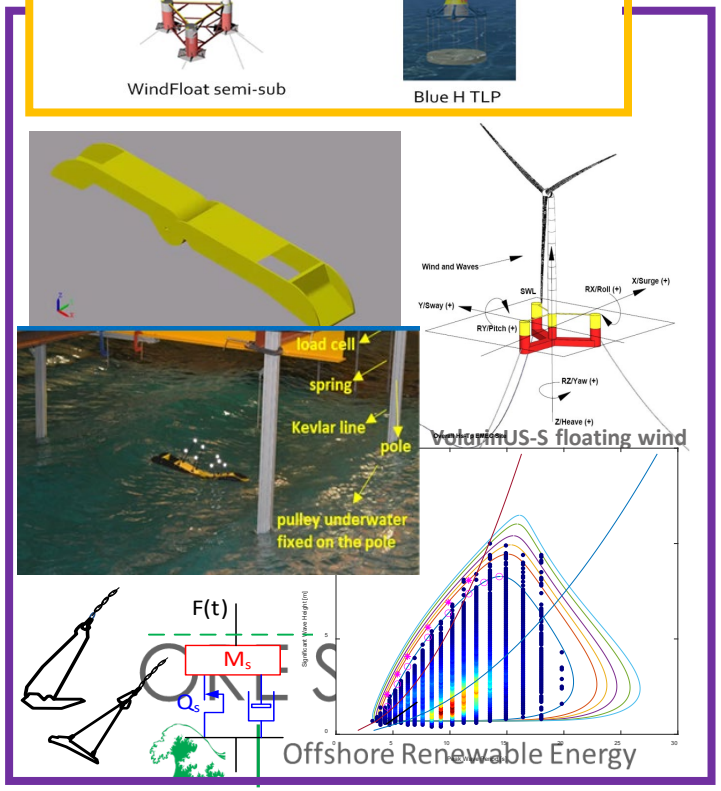
WP3: Modelling
Building confidence in multiscale models of performance, environ-mental impact and GVA

Performance gains

WP5: Floating Futures
Concepts, designs and innovations







Flexible and ECR Funding

- 30 projects, £3m *Flexible Funding* in three rounds
- £2.6m in industry match
- Two-stage blind review process undertaken
- Collaboration with ORE Catapult in Round 2 and ORE Catapult's Floating Offshore Wind Centre of Excellence (FoW CoE) in Round 3
- Awarded three rounds of *ECR Research Funding*
- 25 projects at a total of £130,000 invested
- Designed to be a flexible fund for ECRs to support small activities in developing ECR career skills and/or research.

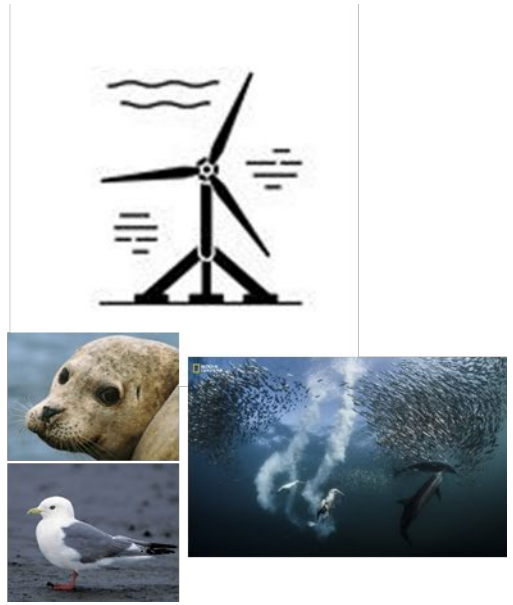
Find out more:
www.supergen-ore.net/flexible-funding

"The Catapult's network of Research Hubs, covering wind turbine blades, electrical infrastructure and powertrains, works to align industry-driven innovation priorities with applied academic research so that we can drive new products and services into the sector, improving productivity and efficiency and reducing energy costs. Aligning our relevant research priorities with Supergen ORE's Flexible Funding calls is a win-win – encouraging vital collaboration between industry and academia to solve many of the technology challenges facing the offshore renewable energy sector today."
Paul McKeever, Head of Electrical Research for ORE Catapult and Chair of the Supergen ORE Hub Industry Advisory Board

"The FoW CoE is delighted to be involved with the Supergen ORE Hub's Flexible Funding scheme. This funding will allow projects to support the development of strategic relationships between academic partners and supply chain organisations, and the acceleration the commercialisation of floating offshore wind."
Ralph Torr, Programme Manager at ORE Catapult

Theme A: Resource and Environment Characterisation
Theme G: Environmental and Ecosystem Aspects

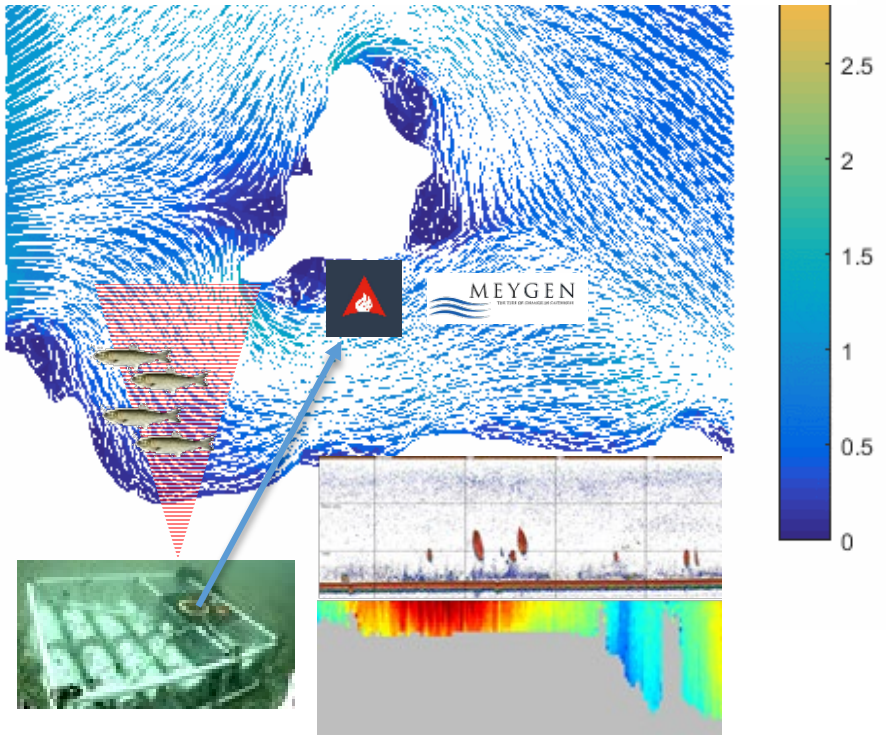
- Better measurement techniques for forecasting and resource characterisation
- Improved modelling tools for resource and loading assessment
- Resource and environmental characterisation in physical modelling facilities
- Long-term sediment transport measurement and modelling
- Fit-for-purpose approaches to environmental monitoring
- Development of population level environmental impact models
- Ecosystem Modelling



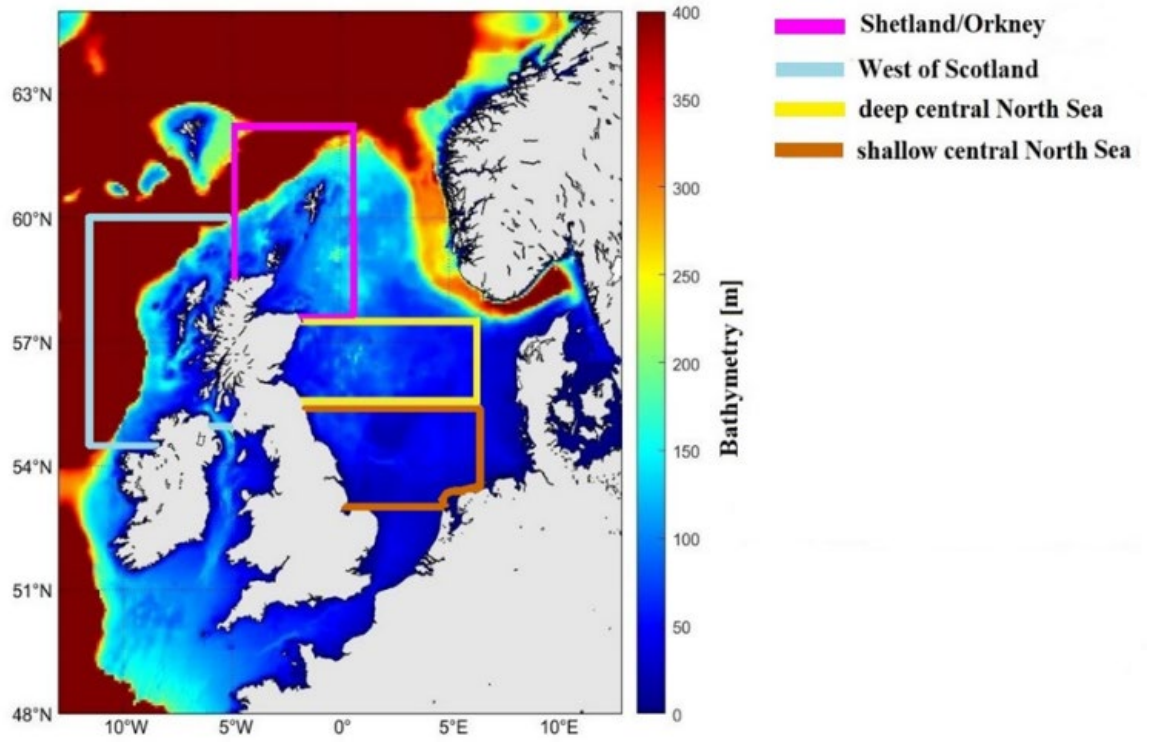
Landscapes A & G : CORE

Fine scale to large scale physical/ecosystem aspects (WP1-5)

3D Hydro Dynamic, ADCP and Acoustic Fish School from MeyGen Tidal site



Whole UK waters information for Offshore wind, wave and tidal in contrasting large habitat /ecosystem types



Theme A: Flexible Fund Projects (£100k)

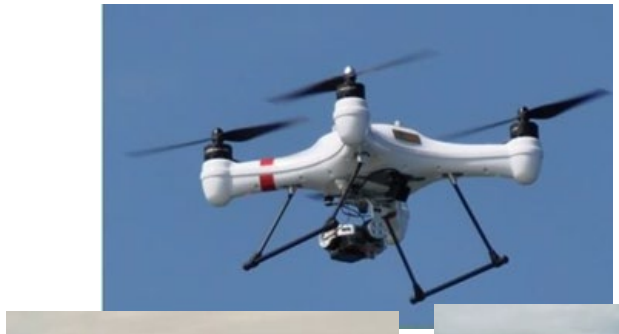
- Flow measurement for accurate tidal turbine design. *Anna Young, University of Bath*
- Accounting for Current in Wave Buoy Measurements. *Sam Draycott, University of Manchester*
- Veers' Extension to Non-neutral Incoming Winds (VENTI). *Marco Placidi, University of Surrey*
- V-SCORES (Validating Surface Currents at Offshore Renewable Energy Sites). *Benjamin Williamson, University of Highlands and Islands*
- WTIMTS - Wave-Turbulence Interaction and Measurement for Tidal Stream. *Alison Williams, Swansea University*
- FASTWATER: Freely-Available mesoScale simulation Tool for Wave, Tides and Eddy Replication. *Brian Sellar, University of Edinburgh*

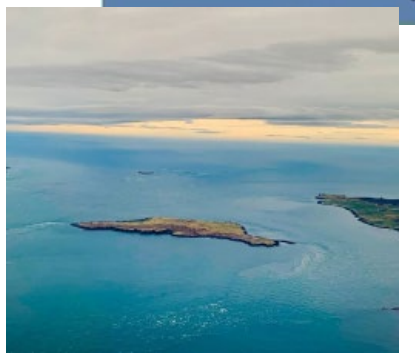
Landscapes A & G : Flexi Funds

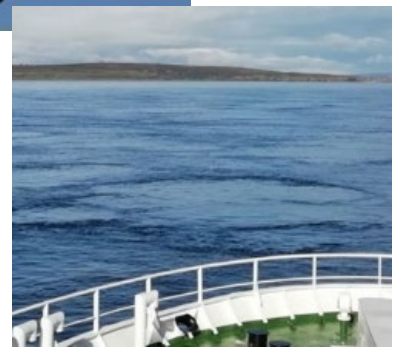
Validating Surface Currents at ORE Sites

(V-SCORES)

Dr Benjamin Williamson, ERI



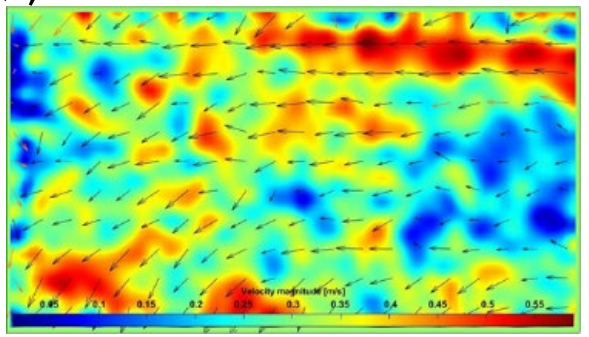




A cost-effective, low risk, rapid measurement technique.

Validation of surface current mapping tools using drones as compared to ADCP, ADV, and drifters

Translation of surface to water-column currents



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Swansea University
Prifysgol Abertawe

Prifysgol Bangor University

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Theme A: Early Career Researcher Projects (£5k)

- Enhance knowledge of the complex fluid dynamics involved in tidal turbine farms as well as to understand the additional physics required to simulate wind farms operating in atmos. *Pablo Ouro, University of Manchester*
- Going where modern technology cannot: novel adaptions of conventional approaches to record seabird behaviour and fish communities in tidal stream environments. *James Waggitt, Bangor University*
- Multi-use platforms at sea (MUPS): an innovative way to manage offshore space and reduce coastal anthropic pressure. *Jonathan Demmer, Bangor University*
- Directionally Spread Surface Wavepackets subject to an Abrupt Depth Transition (ADT). *Samuel Draycott, University of Manchester*
- Reducing economic and environmental trade-offs between offshore wind and fisheries. *Lilian Lieber, Queens University Belfast*
- Dynamic Subsea Power Cables in Offshore Renewable Energy - the Impact of Marine Growth. *Andrew Want, Heriot Watt University*

Landscapes A & G : ECR Projects

Dynamic Subsea Power Cables in Offshore Renewable Energy – the Impact of Marine Growth

Dr Andrew Want and Dr Rachel Nicholls-Lee

Aims: to better understand how marine growth impacts the functionality and vulnerabilities of dynamic subsea power cables used in floating wind and marine renewable energy technologies.

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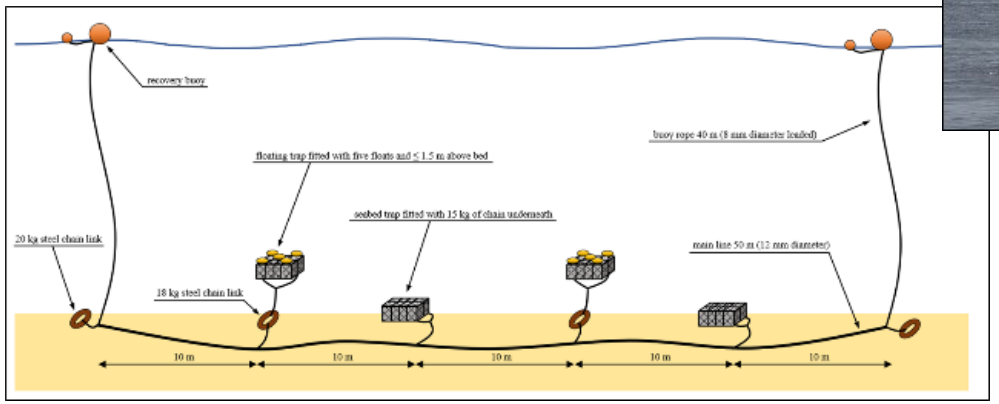
Landscapes A & G: ECR Projects

Novel adaptions of conventional approaches to record seabird behaviour and fish communities in tidal stream environments

Joint project: Dr James Waggitt and Dr Shaun Fraser

Modified fish-traps document benthic fish-communities at dive locations and times: Diversity and Size



'**Bino-cam**' to record diving behaviour of foraging seabirds

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PRIFYSGOL BANGOR UNIVERSITY

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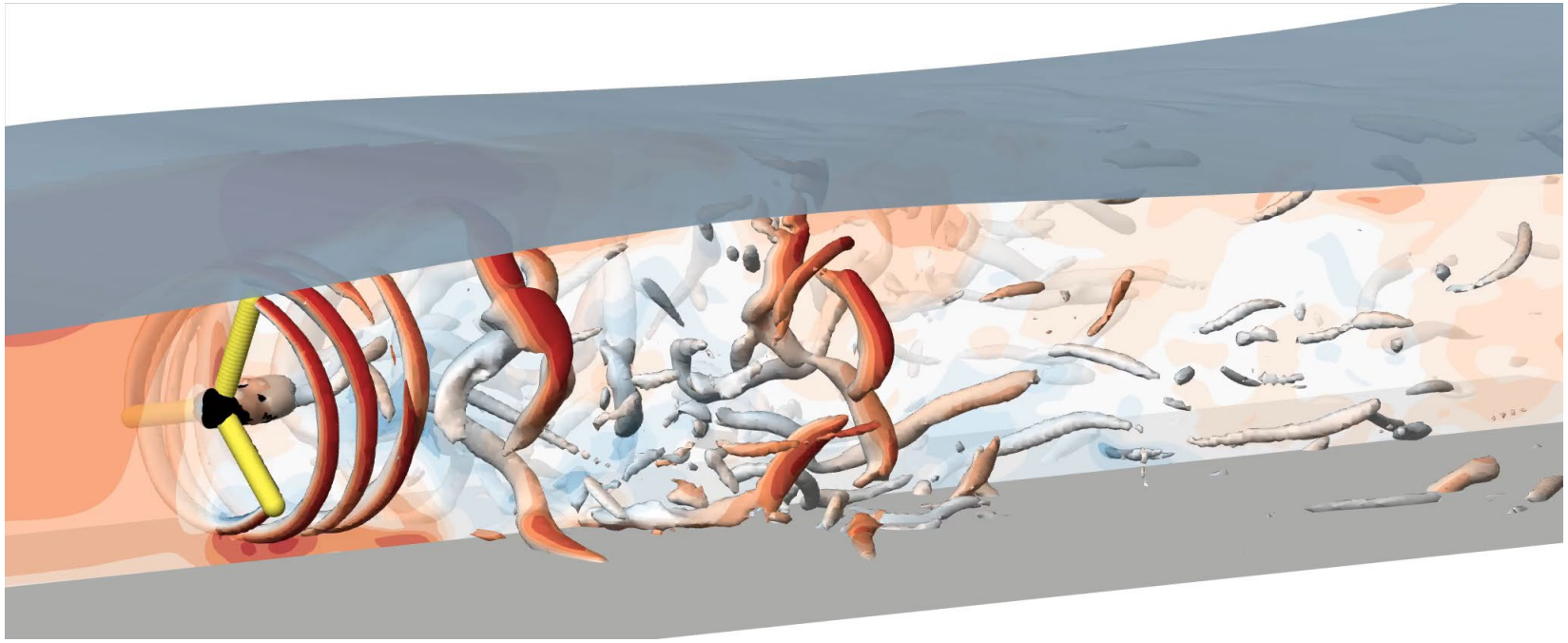
Landscapes A & G : ECR Projects

The impact of waves on tidal turbines:

Dr Pablo Ouro

Large-Eddy Simulations (LES) are performed using the state-of-the-art Digital Offshore FArm Simulator (DOFAS)

Investigating the complex turbulent flow of wave and tide.



MANCHESTER 1824
The University of Manchester

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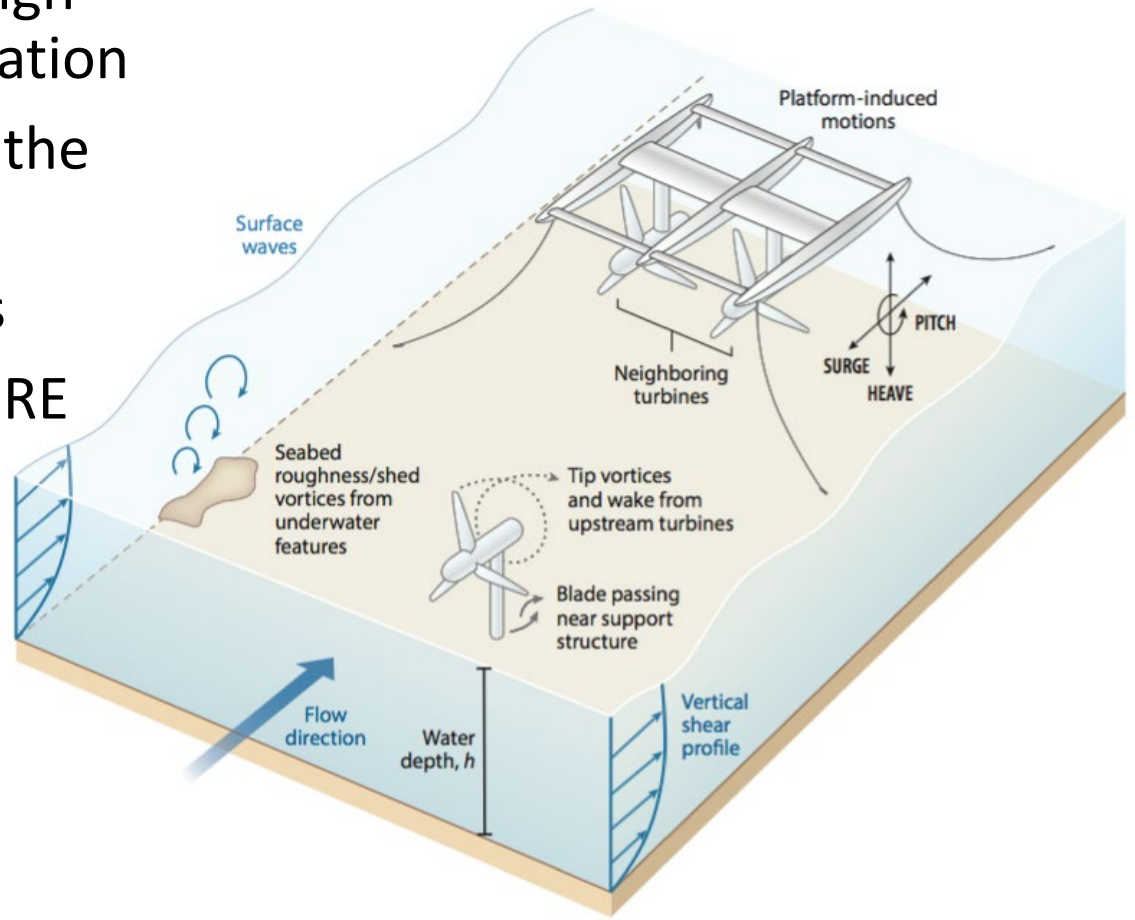
Theme B: Fluid Structure Seabed Interaction

- Realistic fluid-structure-seabed design tools that work together, not in isolation
- Novel device concepts – rethinking the mechanism of energy extraction
- Moorings, anchors and foundations
- Multi-purpose hybrid systems for ORE and ocean resources
- Design of reliable cabling systems



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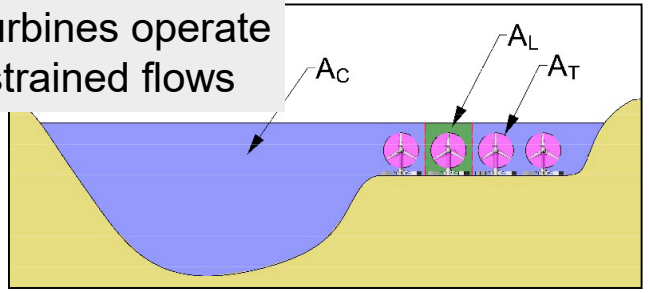
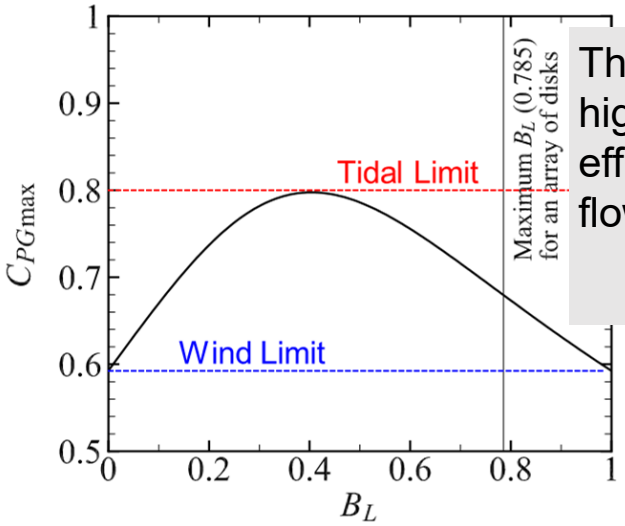
Novel Device Concepts

- **Question**: How to use the native environment to enhance performance?
- Theoretical modelling to deliver ***constructive interference design*** concept.
- Numerical modelling and large scale laboratory testing demonstrate ~10-20% performance gains, with **modelled LCoE reduction of ~10%**.
- Working with developers to implement designs.

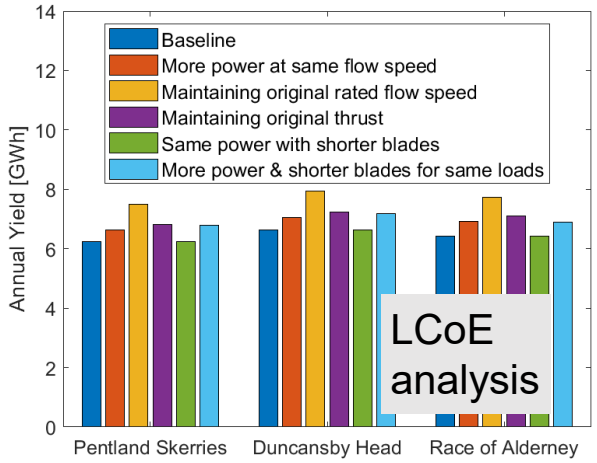
Tidal turbines operate in constrained flows



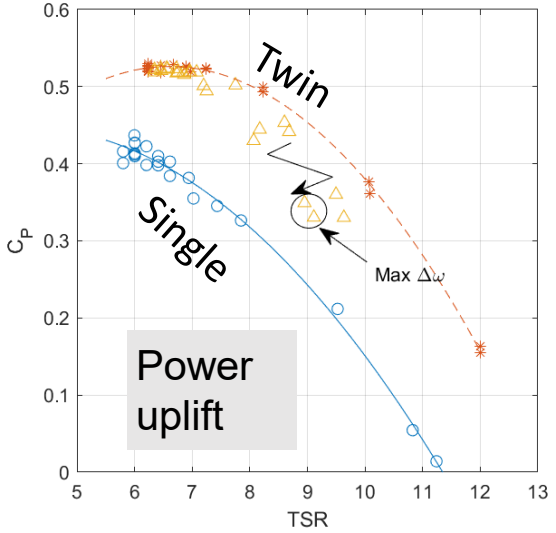


Theory gives higher limit of efficiency in tidal flows

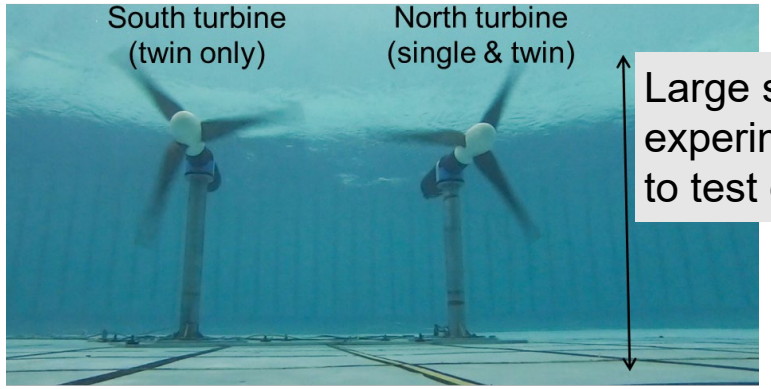
$C_{P\max} = 0.798$



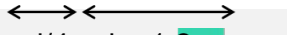
LCoE analysis



Power uplift



Large scale experiments to test design



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Theme B: Flexible Fund Projects (£100k)

- ALPHA: Numerical Analysis of Laterally Loaded Piles Divided in Chalk. *Stavroula Kontoe, Imperial College London*
- Impact of in-service oscillatory movement on insulation reliability of AC and DC cables serving offshore platforms. *Tony Lujia Chen, University of Manchester*
- Cable scour from fluid-seabed interactions in regions of mobile sedimentary bedforms. *Martin Austin, Bangor University*
- Submerged bi-axial fatigue analysis for flexible membrane Wave Energy Converters. *Mokarram Hossain, Swansea University*
- Cost Effective Methods of Installing Offshore Wind Infrastructure. *Marcin Kapitaniak, University of Aberdeen*
- SharEd Anchor Multidirectional Load Envelopes with Strength Synthesis (SEAMLESS). *Benjamin Cerfontaine, University of Southampton*

Theme B: Early Career Researcher Projects (£5k)

- Development of Integrated Anchor model via Industry Engagement. *Katherine Kwa, University of Southampton*
- Measuring Wave Modulation by a Large Offshore Wind Farm. *David Christie, Bangor University*
- Analytical and experimental modelling of a floating/submerged elastic disk. *Siming Zheng and Simone Michele, University of Plymouth*
- Investigating the installation of innovative suction caisson anchors to support offshore renewable energy structures, a feasibility study. *Moura Mehravar, Aston University*

Theme C: Materials and manufacturing

- Integrity in the marine environment (corrosion, fatigue, coatings etc.)
- Serial (volume) manufacturing of complex structural systems
- Design for safe and cost-effective installation methods
- New materials and coatings
- Recycling/reuse of composites

Theme C: Flexible Fund Projects (£100k)

- Recycling Composite Wind Turbine Blade for High-Performance Composite Manufacturing. Lui Yang, *University of Strathclyde*
- Advanced, Modular Power Take-Off Design for Marine Energy Converters. Jonathan Shek, *University of Edinburgh*
- COrrosion And fatigue protection of offshore wind Turbine structures using additive manufacturing technology (COATing). *Ali Mehmanparast, Cranfield University*
- Development of Thermoplastic Composite Tidal Blades for Enhanced End of Life Recycling and Lower Cost Manufacturing (ThermoTide). Dipa Roy, *University of Edinburgh*
- Physics-informed machine learning for rapid fatigue assessments in offshore wind farms. *Nina Dethlefs, University of Hull*

Theme C: Early Career Researcher Projects (£5k)

- Offshore floating foundations using self-sensing carbon fibre textile-reinforced concretes. *Shanshan Cheng, University of Plymouth*
- Hygro-thermal effects on the translaminar fracture toughness of composite laminates. *Ganapathi Ammasai Sengodan, University of Bristol*
- Damage tolerant hybrid composites for safer and higher performance composite offshore wind turbine blades. *Stephanie Ordonez Sanchez, University of Strathclyde*

Theme D: Sensing, control and electro-mechanics

- Control of ORE farms
- Smart Sensor System Use
- Drive Train Design
- Power Electronic Conversion

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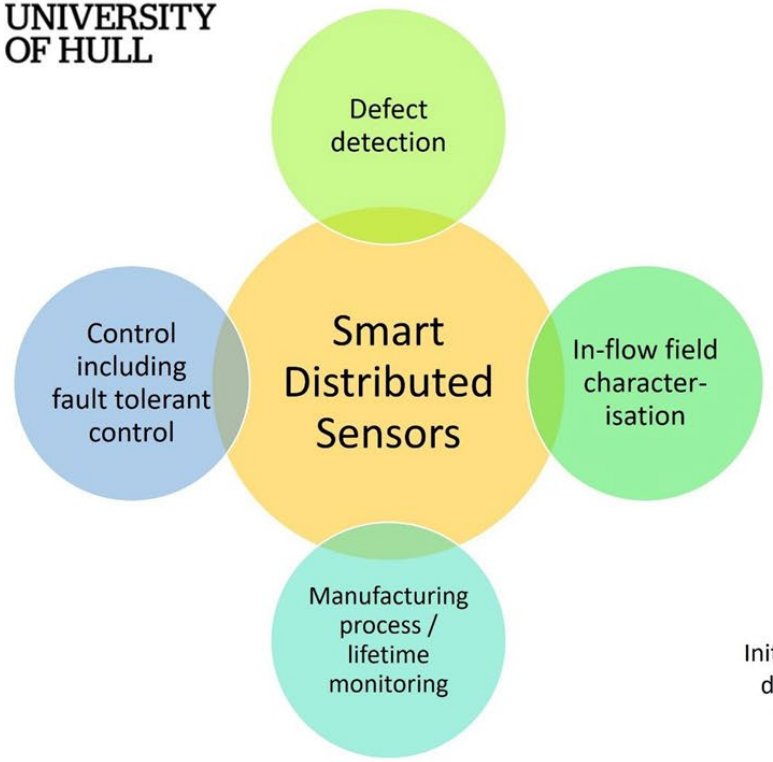
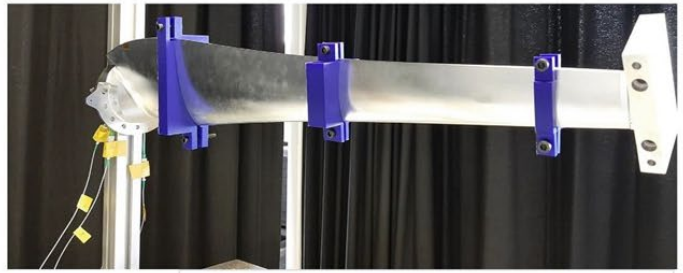
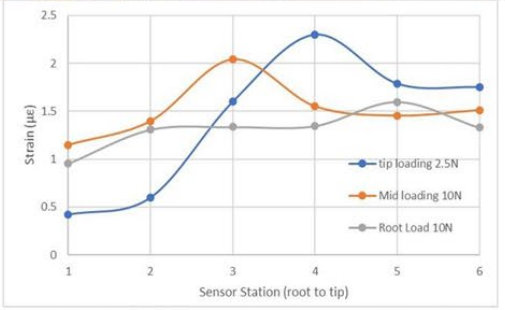


Tidal Turbine blade with 24 fibre optic strain sensors



Initial trials demonstrate detection of different loading conditions



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Theme D: Flexible Fund Projects (£100k)

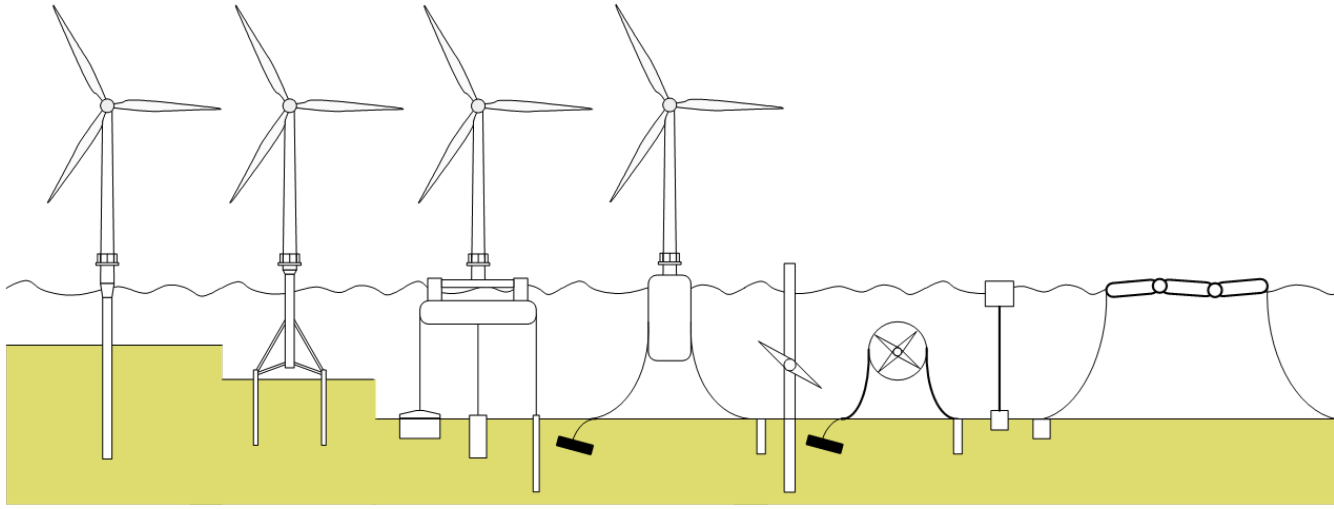
- Enhancing Control Capability of ORE Systems for Stress Management and Grid Support. Li Ran, *University of Warwick*
- Smart piezoelectric metamaterials for partial discharge monitoring. James Windmill, *University of Strathclyde*
- A hybrid and scalable digital twin for intelligent direct drive powertrain condition monitoring. *Alasdair McDonald, University of Edinburgh*

Theme D: Early Career Researcher Projects (£5k)

- Wide-Bandgap-Enabled Dynamic Braking System for Grid Integration of Offshore Wind Farms. *Saeed Jahdi, University of Bristol*
- Structural health monitoring for wind turbine blades via graphene self-sensing adhesive layer joining fibre-reinforced plastics. *Maozhou Meng, University of Plymouth*
- Aeroelastic Modelling and Predictive Control of a 20-MW Offshore Wind Turbine. *Yinan Wang, University of Warwick*
- Innovative and cross-disciplinary wave energy research, aiming to develop a revolutionary Smart Control Algorithm (SCA). *Saishai Dai, University of Strathclyde*
- Innovative and cross-disciplinary wave energy research, aiming to develop a revolutionary Smart Control Algorithm (SCA). *Ian Laird, University of Bristol*
- Upgrade of Power_electronic Grid Emulator to Multi-Channel System and High Current Continuous Power Semiconductor Testor. *Paul Judge, University of Edinburgh*

Theme E: Survivability, Reliability and Design

- Higher and more consistent reliability through risk-based design
- Extending limits to operation or performance by mitigating extreme actions
- Innovative sub-systems to provide higher and more consistent reliability and better performance
- Sustainable whole-life design methods
- Design tools for arrays
- Whole systems approaches to operate large scale ORE



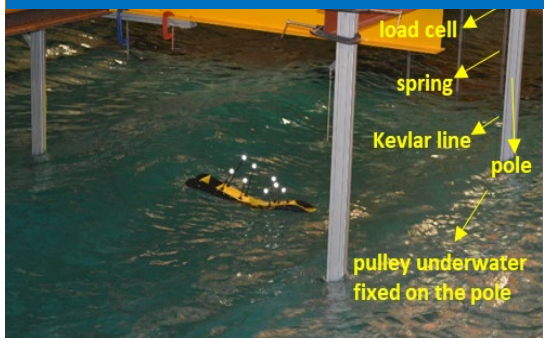
ORE Design

Aim:
Develop and validate methods and tools needed for the design and evaluation of floating ORE technologies

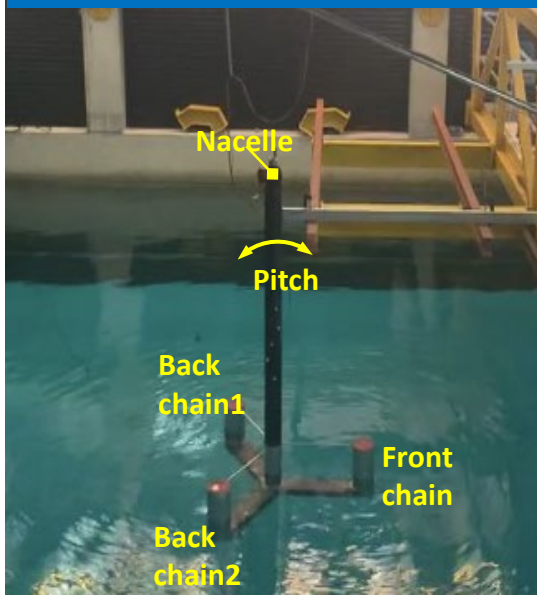
Objectives:

- Design extreme waves (long and short profiles)for critical load cases of floating ORE structures
- Evaluate methodologies and their applicability to different device types and critical modes
- Make recommendations on Design standards for floating ORE

1/20th Mocean hinged-raft WEC: 3-line taut moored

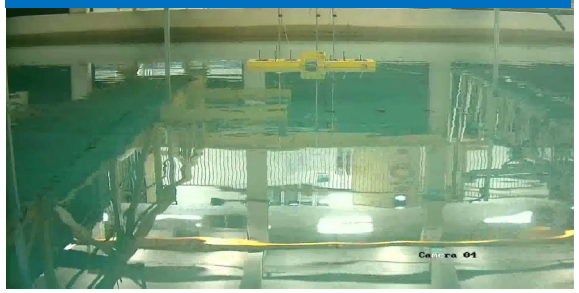


1/70th Umaine VolturnUS-S Reference Platform for IEA 15 MW wind

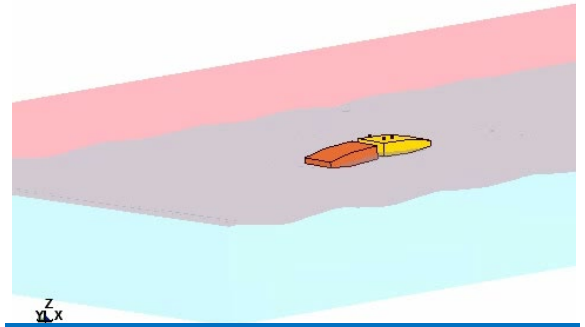


1/50th X-MED buoy: 1-line taut moored

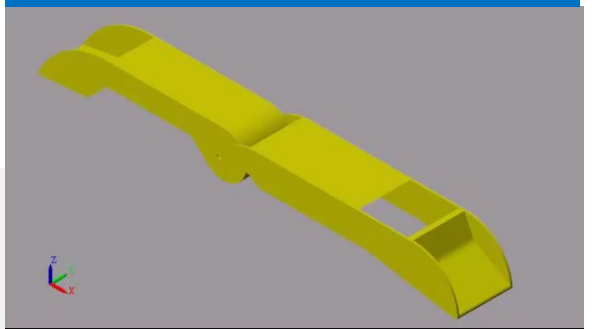
1/50th hinged-raft:4-line taut moored



CFD hinged-raft



WEC-Sim model of Mocean Energy WEC



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Theme E: Flexible Fund Projects (£100k)

- Passive control of wave induced platform motions for semi-submersible FOWTs. *Ling Qian, Manchester Metropolitan University*
- Novel approaches for physical model testing of floating wind turbine platforms. *Sandy Day, University of Strathclyde*
- Investigation into the coupling of a wave energy converter with a reverse osmosis desalination plant, *Matt Folley, Queens University Belfast*
- LoadTide – fatigue assessment of tidal turbine blades. *Jeffrey Steynor, University of Edinburgh*
- Improved models for multivariate metocean extremes (IMEX). *Ed Mackay University of Exeter*
- iDRIVE: Intelligent driveability forecasting for offshore wind turbine monopile foundations. *Brian Sheil, University of Oxford*

Theme E: Early Career Researcher Projects (£5k)

- Let's be blunt and drop the mic! An experimental study of very thick flatback airfoils. *Marinos Manolesos, Swansea University*
- Hydrodynamic performance and survivability of an oscillating water column wave energy converter subjected to steep and breaking waves. *John Samuel, University of Plymouth*
- Parametric study for flapping foil system for harnessing wave energy. *Liang Yang, Cranfield University*
- A novel, robust, nearshore wave energy converter for remote communities. *Rachel Nicholls-Lee, University of Exeter*
- Industrial secondment for tank testing and validation of optimised wave energy converters, *Anna Garcia-Teruel, University of Edinburgh*

Theme F: Operations, Management, Maintenance and Safety

- Analysis of remote sensing and condition monitoring data
- Use of autonomous systems for inspection
- Data and digital cyber security
- Increased use of automation to reduce risk in installation and operations and Maintenance (O&M)

Theme F: Flexible Fund Projects (£100k)

- Autonomous Biomimetic Robot-fish for Offshore Wind Farm Inspection. *Mark Post, University of York*
- Satellite Climate Observation for Offshore Renewable Energy Cost Reduction (SCORE). *Encarni Medina-Lopez, University of Edinburgh*
- Demonstrating a machine learning system to integrate metocean data, sensor networks, and model output for improved coverage and accuracy. *Ajit Pillai, University of Exeter*

Theme F: Early Career Researcher Projects (£5k)

- Computer-aided definition of the O&M strategy. *Giovanni Rinaldi, University of Exeter*

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Article

Development of Modular Bio-Inspired Autonomous Underwater Vehicle for Close Subsea Asset Inspection

Wael Gorma [1], Mark A. Post [1,*], James White [1], James Gardner [1], Yang Luo [2], Jongrae Kim [3], Paul D. Mitchell [1], Nils Morozs [1], Marvin Wright [2] and Qing Xiao [2]

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Abstract: To reduce human risk and maintenance costs, Autonomous Underwater Vehicles (AUVs) are involved in subsea inspections and measurements for a wide range of marine industries such as offshore wind farms and other underwater infrastructure. Most of these inspections may require levels of manoeuvrability similar to what can be achieved by tethered vehicles, called Remotely Operated Vehicles (ROVs). To extend AUV intervention time and perform closer inspection in constrained spaces, AUVs need to be more efficient and flexible by being able to undulate around physical constraints. A biomimetic fish-like AUV known as RoboFish has been designed to mimic propulsion techniques observed in nature to provide high thrust efficiency and agility to navigate its way autonomously around complex underwater structures. Building upon advances in acoustic communications, computer vision, electronics and autonomy technologies, RoboFish aims to provide a solution to such critical inspections. This paper introduces the first RoboFish prototype that comprises cost-effective 3D printed modules joined together with innovative magnetic coupling joints and a modular software framework. Initial testing shows that the preliminary working prototype is functional in terms of water-tightness, propulsion, body control and communication using acoustics, with visual localisation and mapping capability.

Keywords: underwater robotics; biomimetic AUV; biomimetic propulsion; 3D seafloor reconstruction; acoustic communication

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1. Introduction

The use of offshore wind power will play an essential role in our future electricity generation. It is forecast that by 2050, 12 percent of the world's primary energy supply will come from wind energy, and 20 percent of this will come from offshore wind [1,2]. However, ongoing wear and corrosion from the harsh sea environment drives up cost and introduces downtime to this renewable and clean energy source [3]. To ensure reliable production, regular inspection tasks during high seas up to 100 m depth need to be performed in a cost-effective and safe manner [4]. These tasks are currently being conducted largely using Remotely Operated Vehicles (ROVs), which generally need tethers and a human operator, or using Autonomous Underwater Vehicles (AUVs), which are limited in their accessibility and maneuverability [5,6]. To extend AUV intervention ability and perform critical inspection tasks, they need to be efficient and flexible in operation. A fish-like AUV with a bending body of a spinal column design that is able to mimic propulsion techniques of living fish can provide efficient thrust at minimum swimming velocities, and higher maneuverability in limited spaces during sensor data acquisition.

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