Offshore Renewable Energy: Powering the future

Professor Deborah Greaves OBE

UNIVERSITY OF PLYMOUTH

Supergen

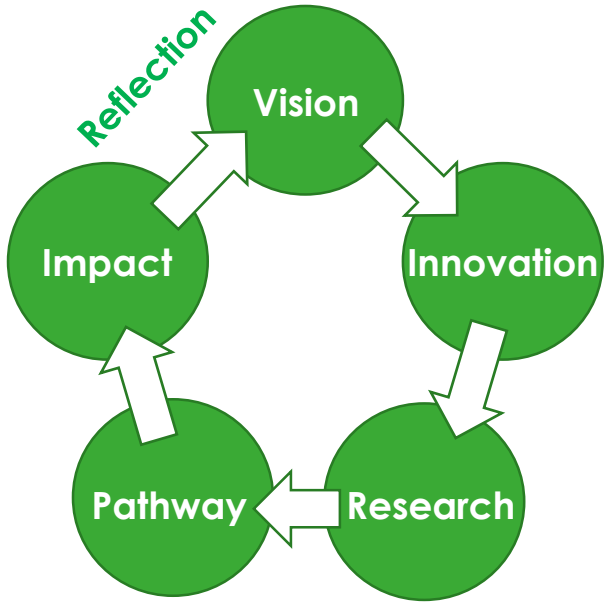
Offshore Renewable Energy

Introduction

Professor Deborah Greaves OBE

University of Plymouth

Vision



- To bring together and stimulate synergistic adventurous research that **supports and accelerates** the development of offshore wind, wave and tidal technologies for society's benefit; working closely with industry
- **Whole systems approach**: be central to the UK ORE community, bringing together shared skills and expertise, allowing transfer of fundamental knowledge, shared learning and use of resources for inter-disciplinary research
- **Clustering**: Differing maturities of wave, tidal and offshore wind allow rapid advances towards deployment and societal benefit through timely sharing of expertise, strategies and best practice between the three sectors

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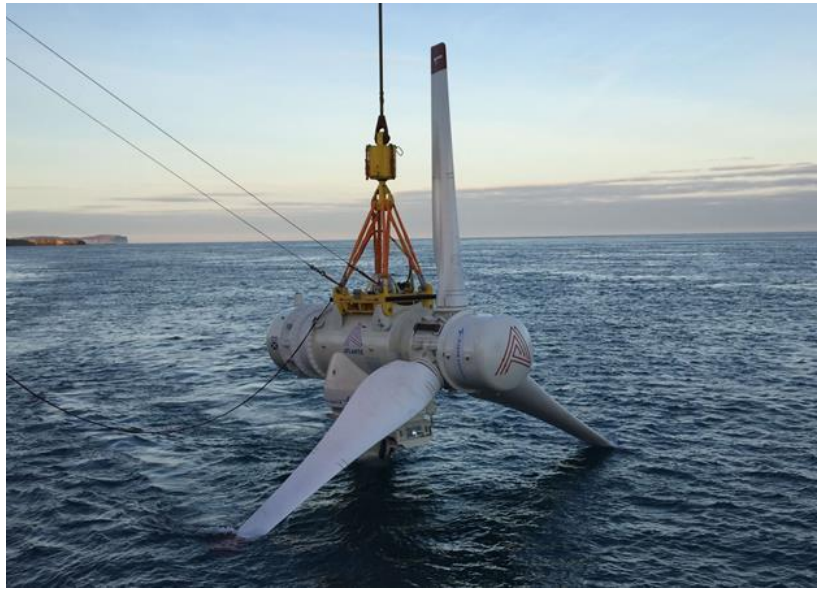
Marine (Wave and Tidal)

- UK a global leader in wave and tidal energy.
- Potential to provide 15 – 20% of current UK electricity demand by 2050.
- Tidal – Meygen, the world's first multi-turbine tidal stream energy project - 6MW capacity installed in 2016, increasing to 398MW by the early 2020s.
- Wave energy - a resource of a scale similar to OW.
- But still at early stage of development with many different concepts under investigation
- Technology concepts are naturally location-specific.



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Offshore Wind

- UK waters amongst the best Offshore Wind resources globally.
- A well developed and commercialised technology across shallow waters.
- Over 7GW of installed capacity, 7GW more in construction – target 20% of UK energy during 2020s.
- Now amongst cheapest forms of energy – strike price as low as £57.50/MWh.
- Floating Offshore Wind (FOW) the next big development.
- 30MW Hywind FOW pilot now in operation, Buchan Deep, 25 – 30km offshore of Peterhead, Aberdeenshire.

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Engineering and research synergies across ORE…

WAVE

WIND

TIDE

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Funding

One of three Supergen Programmes – commencing 4th phases.

- Offshore Renewable Energy
- Bioenergy
- Networks

Funded by EPSRC

4 Year Package to 2022

ORE Hub merges former Phase 3 Hubs of Marine and Wind.

- Core Research
- Management and Networking
- Flexible funding

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Structure

Our Management Group

Bringing together shared skills and expertise, allowing transfer of fundamental knowledge, shared learning and use of resources for interdisciplinary research.

Supergen ORE Hub Director
Prof. Deborah Greaves
University of Plymouth

+9 Co-Directors:

Each Partner University brings a combination of research and technical expertise.

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Why is the EPSRC investing in Offshore Renewable Energy?

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Energy Transformation

- Developing renewable energy is essential to combatting climate change, and protecting the natural environment for future generations
- Need to reduce greenhouse gas emissions and diversify energy sources.
- 2008 Climate Change Act 80% carbon emission reduction by 2050
- EU Legally binding target for 15% of energy from renewables by 2020 in UK.
- 30% electricity from renewables by 2020

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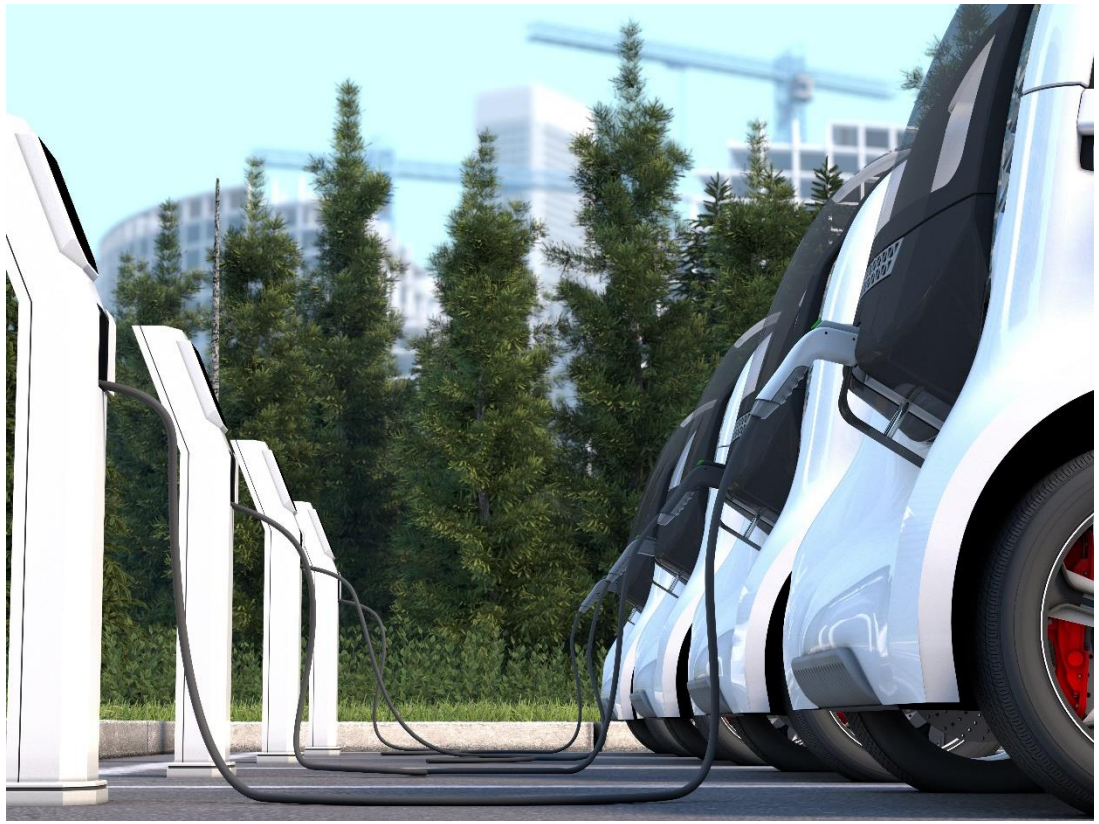
Our Energy Future

- Electrification and digitilisation
- New business models
- 25% of UK electricity from renewables in 2nd quarter of 2015, and exceeded coal generation for the first time.
- UK wind farms produced more power than coal on 263 days in 2017, first full day without any coal power
- Wind generated 19.1% of UK's electricity in the 1st quarter of 2018



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Why Offshore Renewable Energy?

- ORE potential is vast
- UK is at the forefront of the sector
- A natural solution to UK requirements
- Locally available
- Energy security
- An important export market
- Significant GVA benefits to UK economy

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What is the Supergen ORE Hub?

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Our Mission

- The Supergen Offshore Renewable Energy Hub provides **research leadership to connect** academia, industry, policy and public stakeholders, **inspire innovation** and maximise societal value in offshore wind, wave and tidal energy.

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Objectives

- provide ‘Visible Research Leadership’
- Inspire
  - execute, publish and inspire distinctive and ambitious world class research through the **core research programme**
  - facilitate a programme of co-ordinated UK led research through the **flexible fund**
  - become a ‘beacon for equality, diversity and inclusion (EDI)'
  - support development of early career researchers (ECR)
- Connect
  - be a respected voice for policy makers and a trusted partner for industry
  - have strong international collaboration
  - take a whole systems approach to ORE

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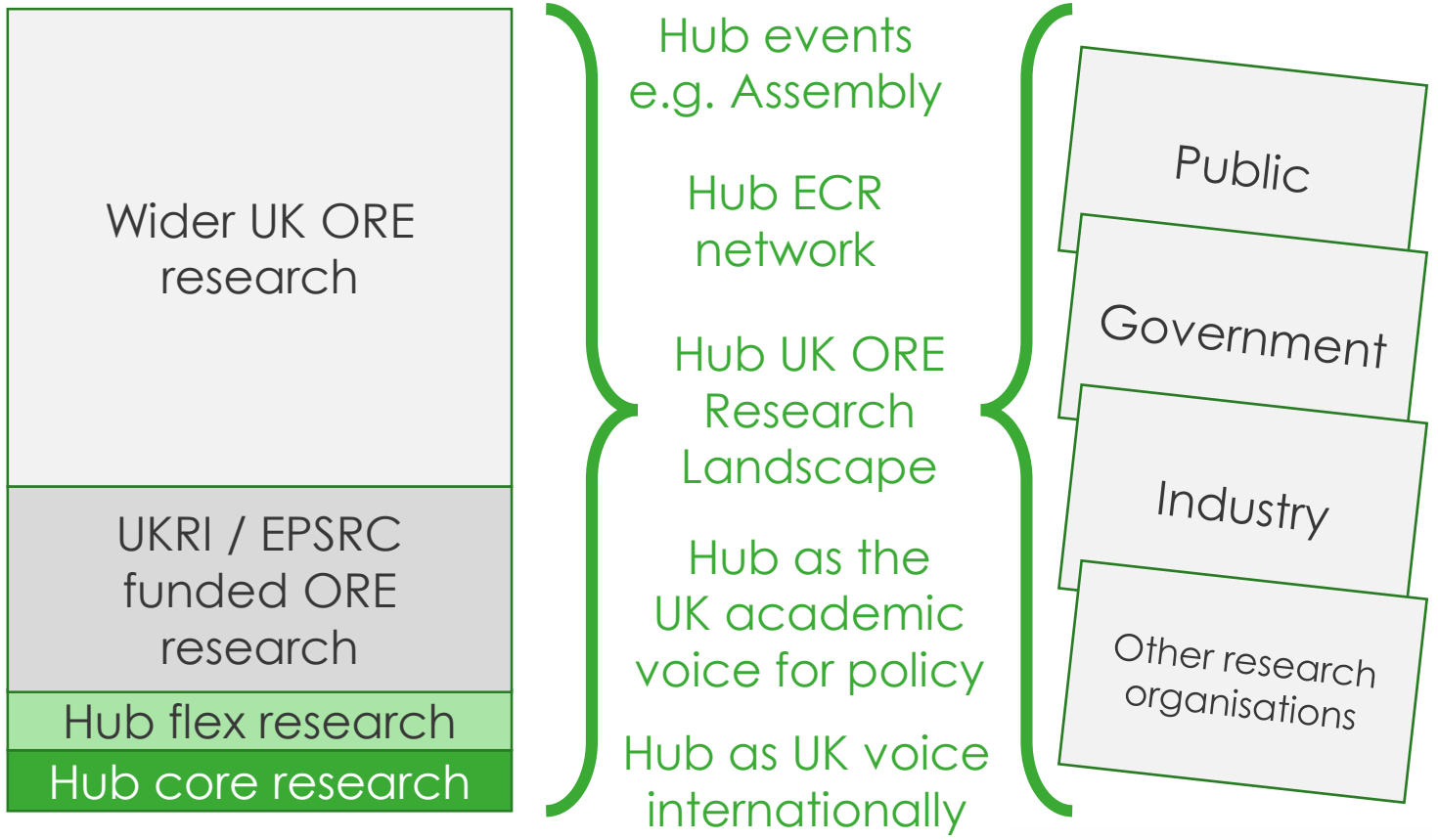
Leadership

- Inspire
  - Research Landscape
  - Flexible funding
  - Resource prioritisation
- Connect
  - Assembly and events
  - ECR network
  - Research Landscape
  - Influence policy – voice for sector



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Consultation and Engagement

- Challenge Workshops One each for Marine, Offshore Wind and ORE.
- Attended by 176 stakeholders from industry, academia and government.
- Review of existing status and development roadmaps.

Aspect	Key Drivers/Opportunities
Resource (incl. Arrays)	Access remotely – predict more accurately
Turbine (W&T)	Upscale Cost efficiently
Power Take Off	Raise Efficiency and Reliability
Electrical Connection	Raise reliability and reduce cost
Substructure	Upscale cost efficiency
Installation	Reduce cost & weather dependence
Operation/ Maintenance	Assess/perform remotely/ autonomously
Environmental Impact	Identify long term, predict accurately

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Supergen ORE Research Landscape

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Who is the research landscape for?

- Industry, policymakers, the public
  - To provide easy access to sector research knowledge
  - To influence research efforts – shape the landscape, set challenges
- Academia
  - To promote and publicise research activities and outcomes
  - To provide easy access to sector research knowledge
  - To focus research efforts and proposals
- ORE Supergen Hub and EPSRC
  - To assist prioritisation of research resources, including flexible funding

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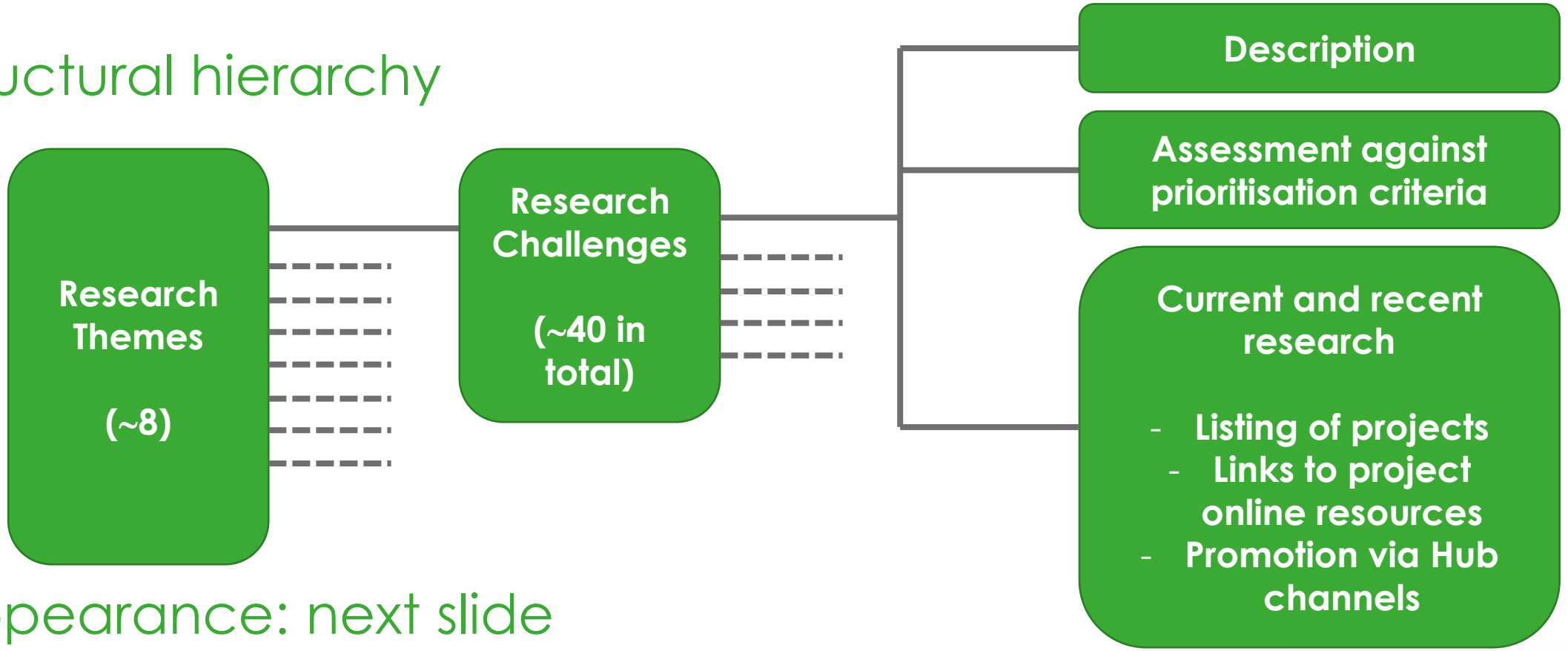
What will it look like?

- Structural hierarchy



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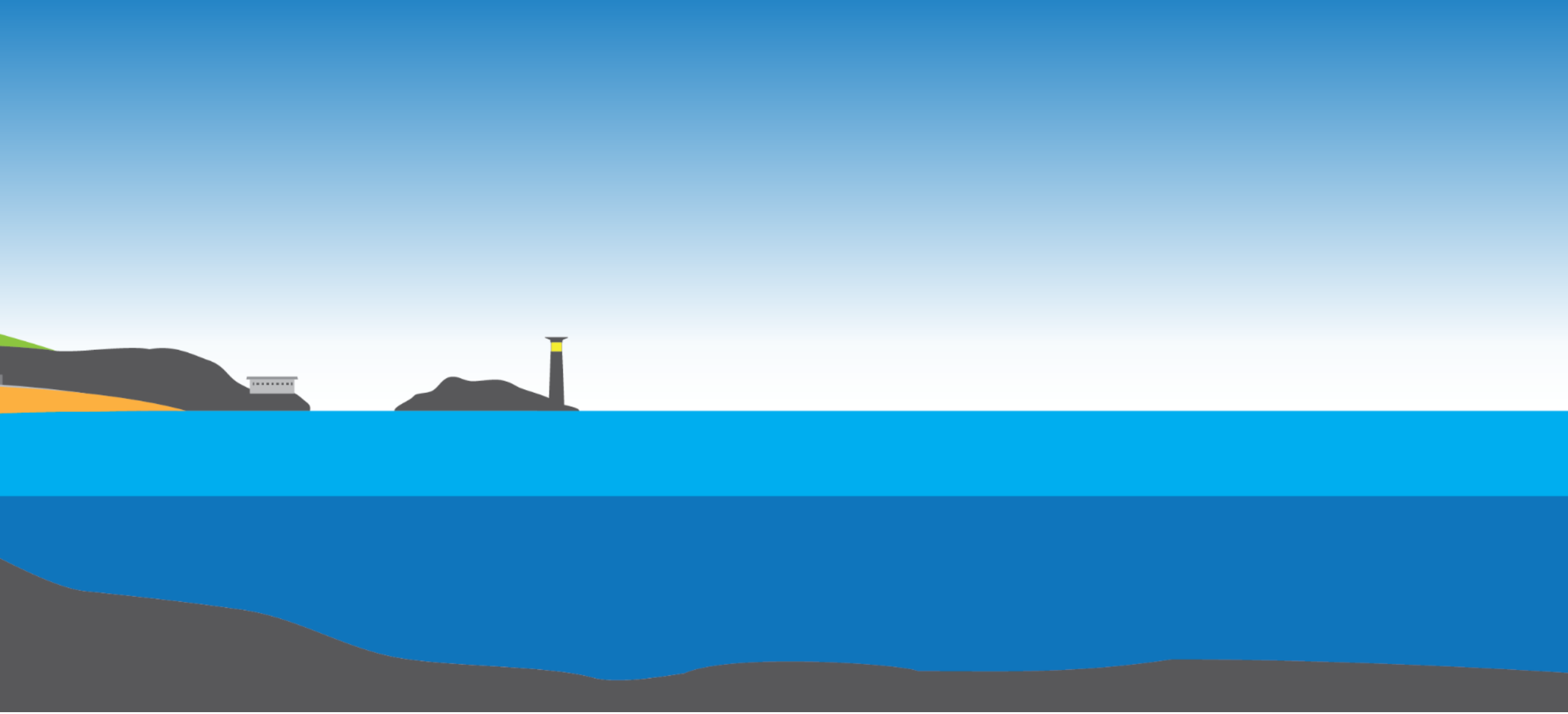

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Link

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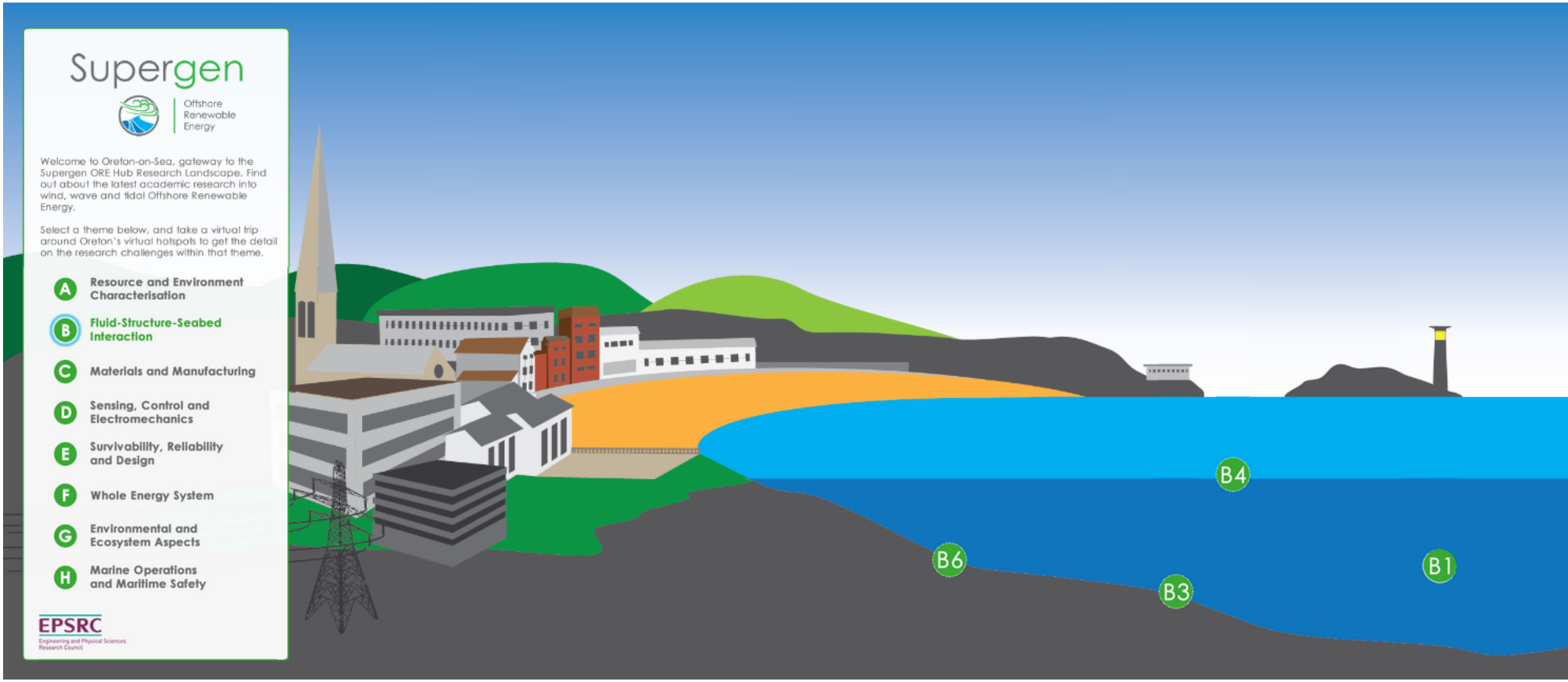

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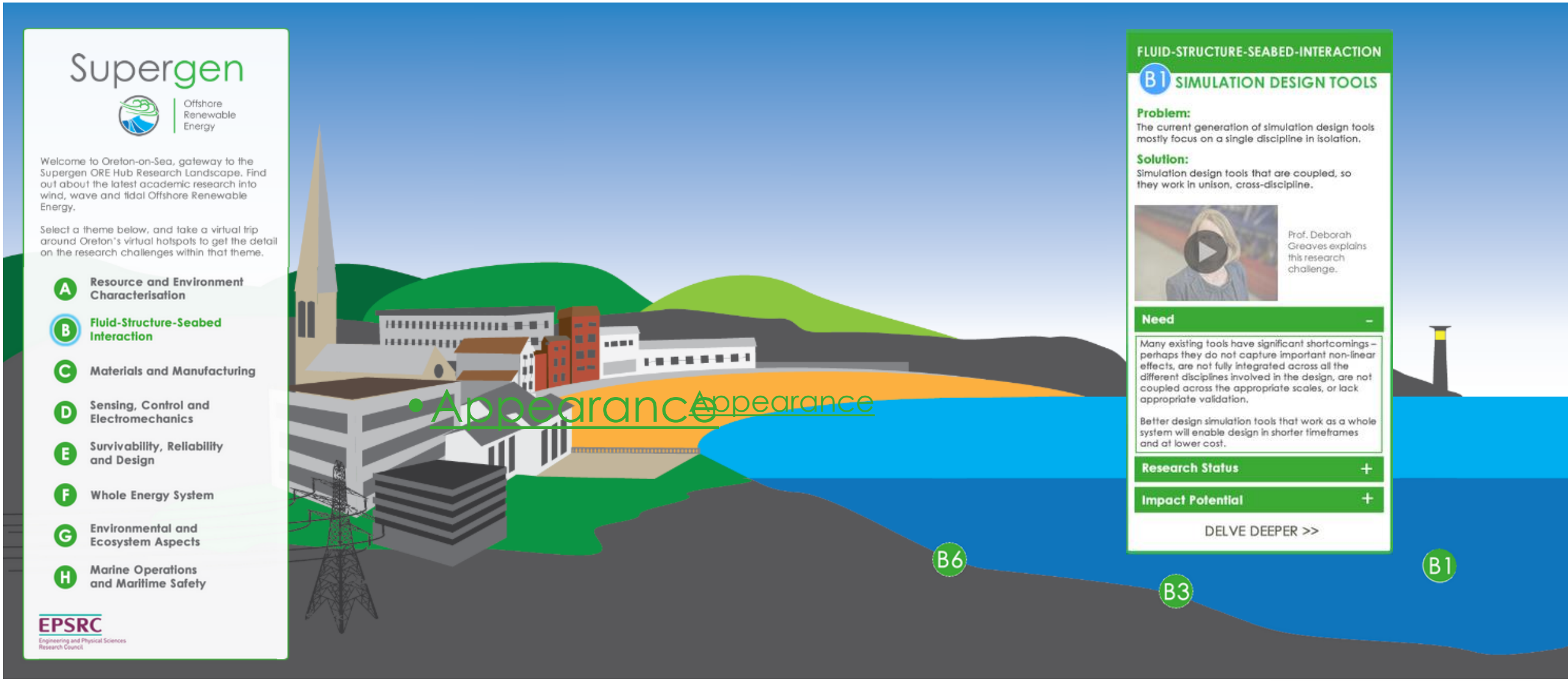

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Research Alignment Group

- PIs of ORE research projects funded by RCUK and other sources if UK led
- Representatives from key infrastructures
- Composition will change depending on the ORE research portfolio
- RAG workshops to discuss research progress and to help review and update the Supergen ORE Hub UK Research Landscape.
- Identify potential cross over research synergies and opportunities for transfer between sectors, both within and external to ORE

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Impact - Our Advisory Board

- Common stakeholders across offshore wind, wave and tidal
- Strong industry involvement through active **Advisory Board** of stakeholders from across ORE disciplines, representing Research, Industry, Government, Academia, Innovation and Third Sector
- Independent review of ORE Hub progress against objectives
- Support growth of ORE – for future energy transformation
- Working with the ORE Catapult and the Offshore Wind Innovation Hub to disseminate information to industry and link challenge owners, SMEs and academia

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Networking

- ORE Supergen Network builds on the Supergen Marine and Wind hubs of world-class research capability
- Annual Assembly and an annual Conference Networking Event, organised alongside a major UK ORE conference
- **Internationalisation** strategy to capitalise on synergies and leverage effort and to raise the profile of UK research and industry capabilities in ORE within the global community
- Cross – Hub activities in overlapping areas Engaging with other programmes, connecting them to the ORE community.

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Early Career Researchers

- Active engagement programme for early career academics, PDRAs and final year PhD students
  - Supergen ORE Hub ECR network
  - Mentors provided to key ECRs including PDRAs
  - Links to other existing networks (e.g. INORE, EWEA) and the wider community
  - Outreach activities to develop the pipeline of ORE researchers
- Specialist research fund for ECRs – flexible and small sums to allow independent projects to be developed
- Specialist skills training through dedicated workshops and master-classes, focused on technical specialisms as well as career advancement activities.

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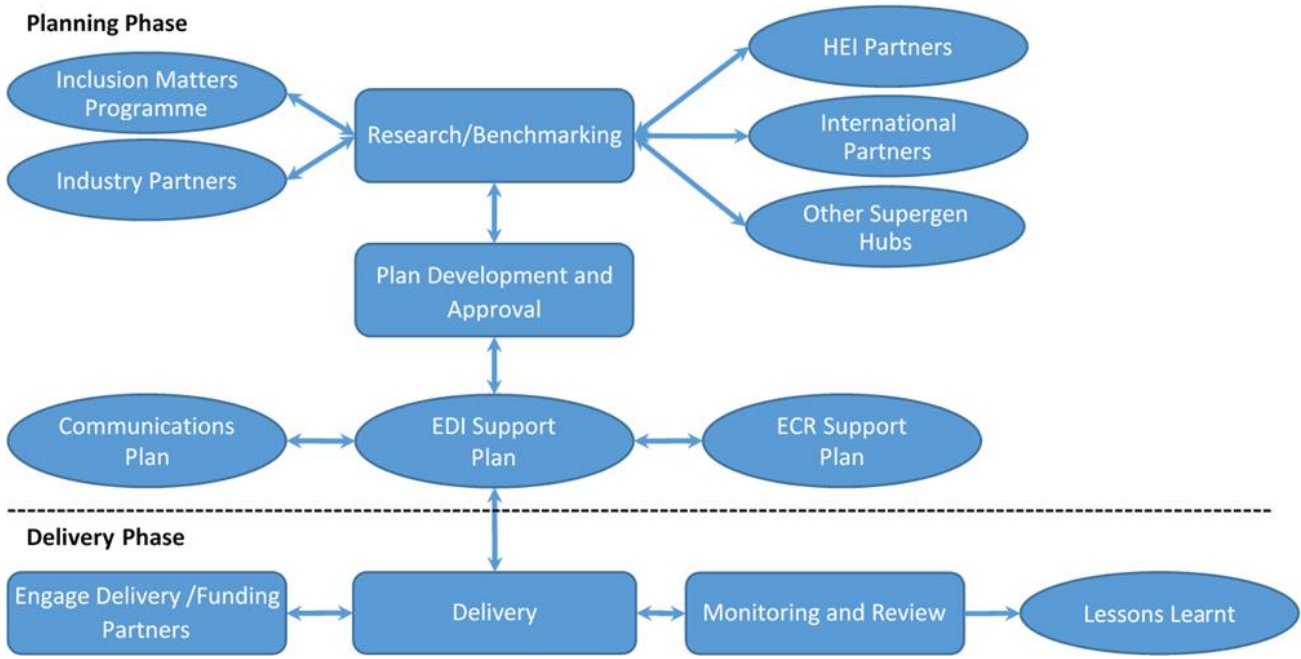
Equality, Diversity and Inclusion

- Create a supportive environment through recruitment, selection, support and mentoring
- Promote EDI in the ORE Hub and the wider STEM community by partnering with industry and other stakeholders
- Monitor effectiveness through annual reviews
- Working with other Supergen Hubs



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Aspirational future ORE Systems

A large scale floating ORE Farm

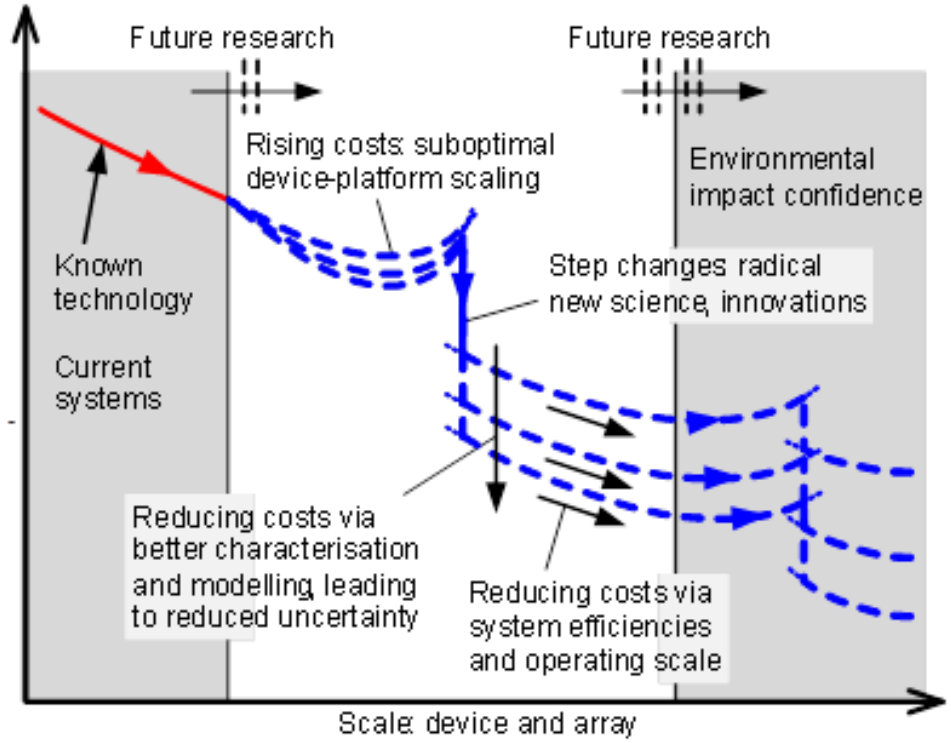
- A multi-GW floating ORE farm, unlocking ORE beyond the water depths currently targeted, and creating a step change in farm scale via innovative new engineering systems.

Scaled-up and safe exploitation of tidal streams

- Reliable, predictable and commercially performing arrays that are ecologically acceptable.

Viable farm-scale wave energy

- Scaled, multiple, commercially affordable wave devices.



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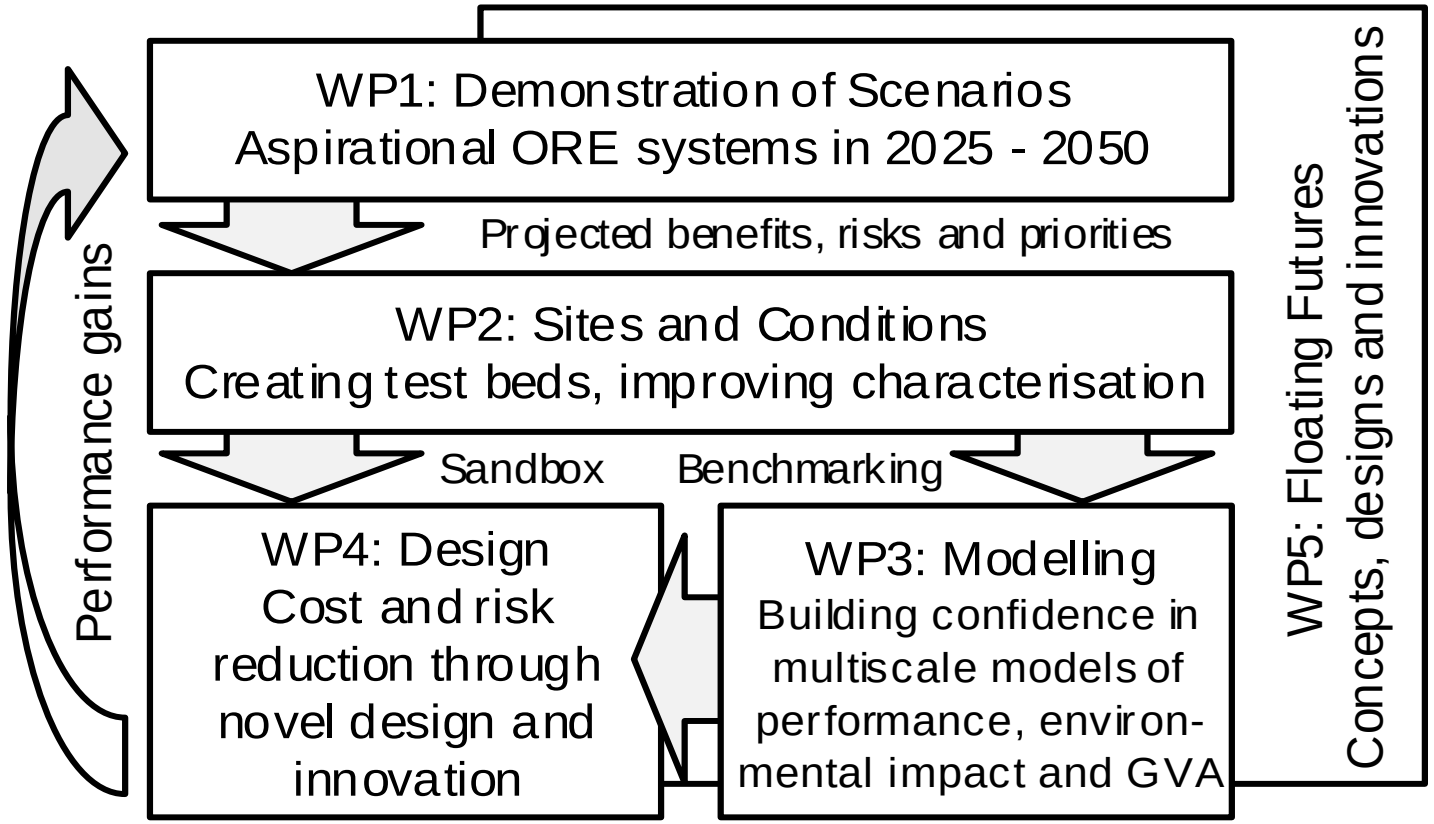
Core Research



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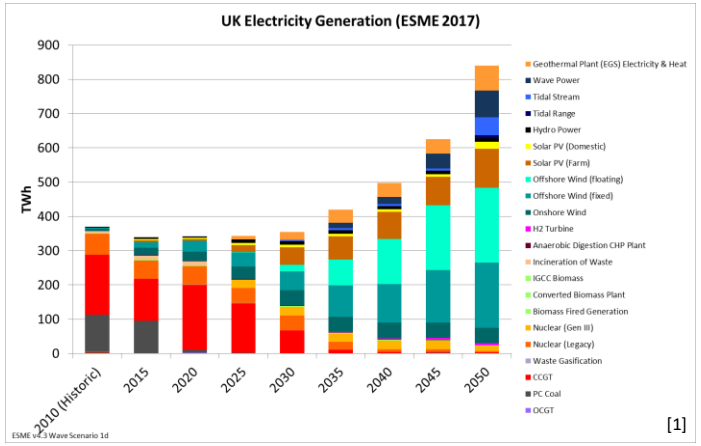
WP1 : Deployment Scenarios

Aspirational ORE systems in 2025-2050

T1.1 Deployment scenarios

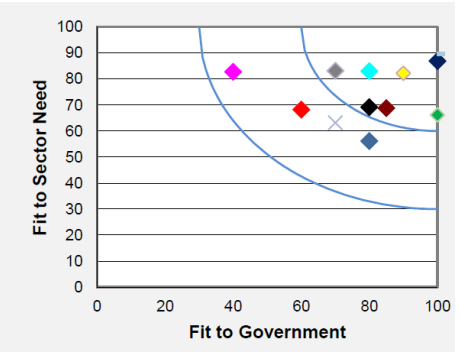
- T1.1 outlines characteristics of deployment scenarios;
- Energy system models (e.g. ESME, TIMES) will estimate realistic deployment scenarios;
- Energy system models will determine optimum energy mixes to produce most energy whilst minimising cost and negative consequences;
- The model will mix the quantities of each technology and their locations in the optimisation.



[1]

T1.2 Technology innovation

- T1.2 identifies the technology innovation required to achieve the scenarios set out in T1.1.
- T1.2 will investigate the practicalities of expanding the range of deployment locations to achieve higher capacity targets.
- It will investigating how devices, arrays, subsystems and substructures, electrical conditioning and transmission methods need to change and innovate.
- T1.2 activities will inform the energy system models employed in T1.1, iteratively improving the accuracy of the deployment scenario estimates.



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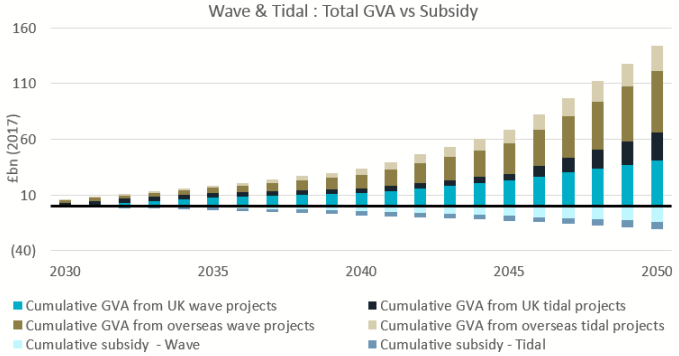
T1.3 Assessment metrics

- T1.3 evaluates the Gross Value Added (GVA) to the UK economy and number of job years created of wave and tidal industry developments;
- T1.3 also investigate how the ORE industries will engage with, reinvigorate and ultimately benefit economically marginalised coastal communities;
- Opportunity to the UK to develop wave and tidal industries to take advantage of the UK and global wave and tidal resource.



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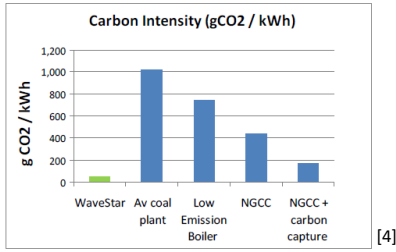
T1.4 Ecological assessment

- T1.4 investigates the ecological impacts of the AOS scenarios from T1.1 and T1.2.
- T1.4 will identify and use approaches for evaluating how devices, array design and O&M activities affect the environment.
- The Life-Cycle Cost Assessment (LCA) methodology will be used to determine:
  - Global Warming Potential (GWP);
  - Energy Return on Investment (EROI);
  - Energy Payback Time (EPBT).



[4]


[5]

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[1] ETI ESME Modelling
[2] SI Ocean, Ocean Energy Technology: Gaps and Barriers
[3] University of Edinburgh and ORE Catapult, "UK Wave and Tidal Industries, The Case for Intervention", 2018. Available: www.policyandinnovationedinburgh.org
[4] G. Dalton, D. Madden and M. C. Daly, Life Cycle Assessment of the Wavestar, Ninth International Conference on Ecological Vehicles and Renewable Energies (EVER), 2014
[5] Available: https://tatil.uz/blog/show/maldivy-podvodnye-priklyucheniya-na-kurorte-jumeirah-dhevanafushi

WP2 : Sites and Conditions

- A set of Virtual Sites aligned with opportunities identified in WP1 - for use by research stakeholders.
- To provide a set of benchmarks to evaluate ORE systems and components, at all technology readiness levels, to validate and improve techniques and designs.
- A sandbox for development of components and systems.
- Each built from a combination of real and synthetic data, selected based on the alignment between available data, the opportunities targeted in WP1, and the aims of the research in WPs 3 and 4...

Motivation for WP2: *Industry and Academia, lack a bridge between idealised tank/tunnel testing and realistic field conditions. WP2 addresses this limitation, better enabling the testing of devices, arrays and sub-systems in realistic conditions – with research efforts directed to WP1 objectives.*

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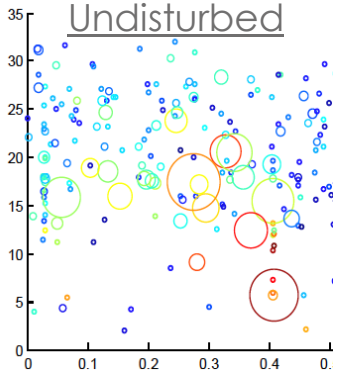
WP3 : Modelling across scales

Synthesis and extension of local unsteady metocean conditions:

- Onset conditions for representative sites and for in-array design
- Regional-scale array effects across alternative operating points
- Disruption to marine populations responding to turbulence changes

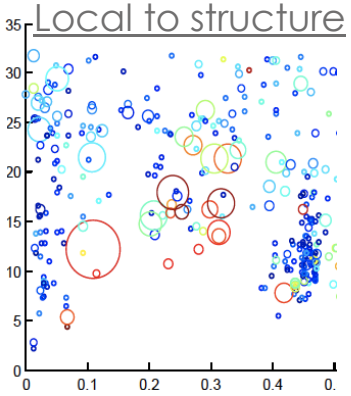
Fish shoal densities at tidal site

Undisturbed

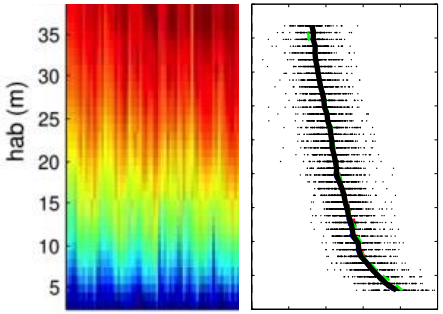


Shoals relocate in response to flow

Local to structure

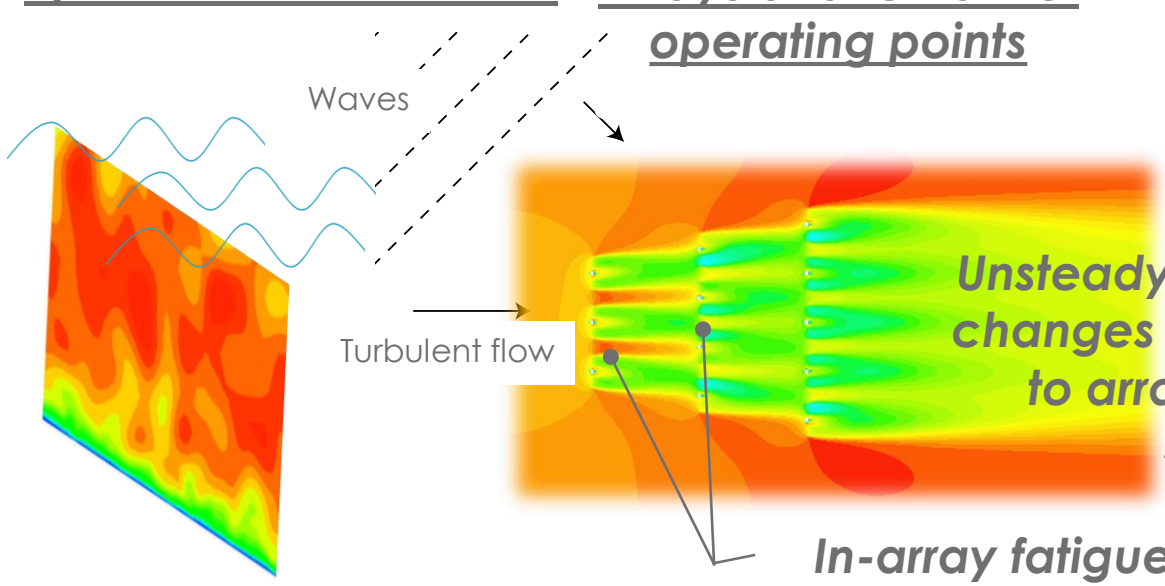


Measured Site conditions



Synthesis of onset flows

Arrays at alternative operating points



Unsteady flow changes local to array

-- to predict --

changes to marine populations

In-array fatigue design

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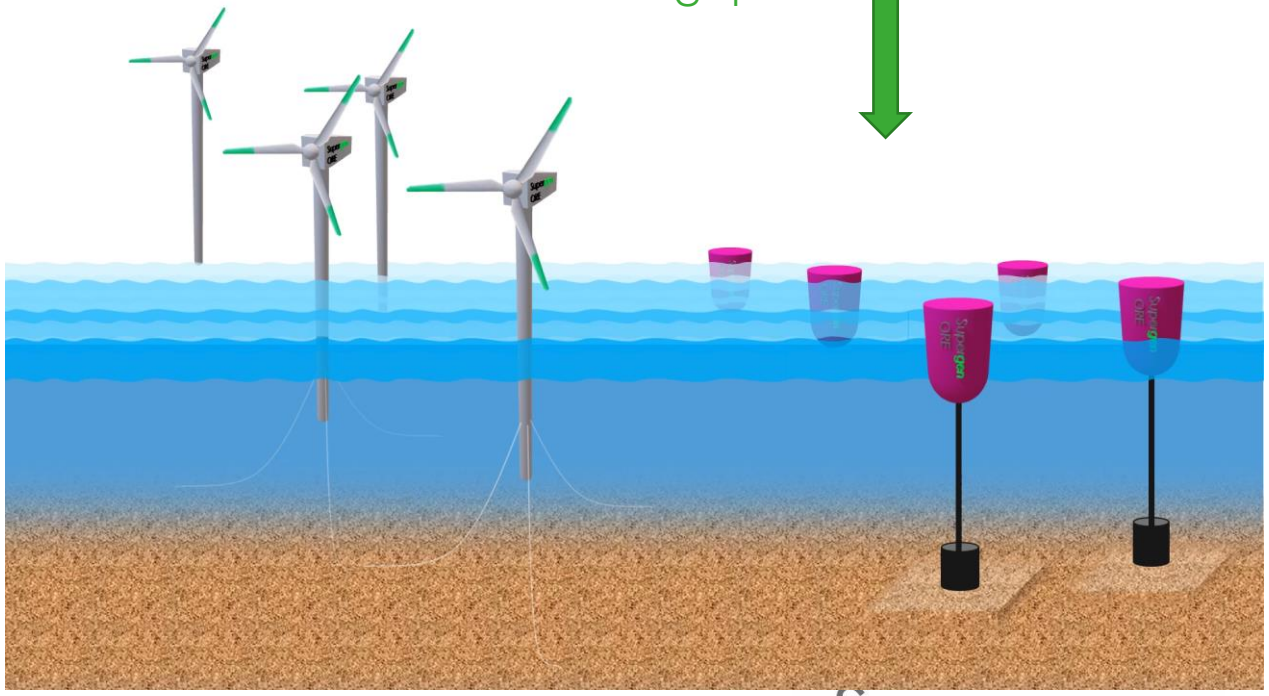
WP4: Design

Aim: to develop and validate tools required for performance and reliability assessments of floating ORE systems, enabling technology convergence and LCOE reduction

- Knowledge inherited from oil and gas platform or onshore wind farm can be applied.
- Key challenge is to combine dynamic enhancement of energy conversion with structure survivability, under stochastic environmental loads.
- Probabilistic design approach will be explored to predict extreme loads and responses for system optimisation.
- Design criteria for ORE systems will be reported.

Floating ORE farms vs traditional marine structures

Inheritances and gaps?



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WP5: Floating Futures

Aim: Assess floating solutions for ORE with the potential for very large installations (e.g. 50MW platforms), deployable across a large range of water depths (50m →∞) and further from shore, reducing offshore human intervention in a cost efficient and environmentally less intrusive manner.

T5.1 Limitations in scale and depth for floating offshore renewable energy platforms

T5.2: Expandable and reconfigurable floating arrays systems

Research will consider engineering, materials and environmental considerations along with operational and safety opportunities.

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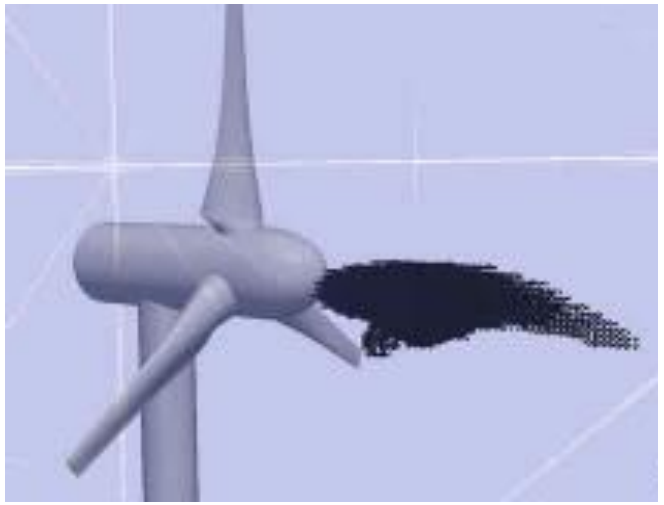
Flexible Fund Overview

- Flexible fund allocated to **seed-corn** new projects developing the science, engineering and technology to deliver ORE
- It will be used to adapt and react to changes in the energy landscape and respond to new research outcomes, as well as drawing in expertise from other disciplines outside of the hub
- **Leverage** the flexible fund through co-funded calls with industry, international funders, WES, ORECAT
- Combining flexible funds across Supergen hubs in cross-cutting areas



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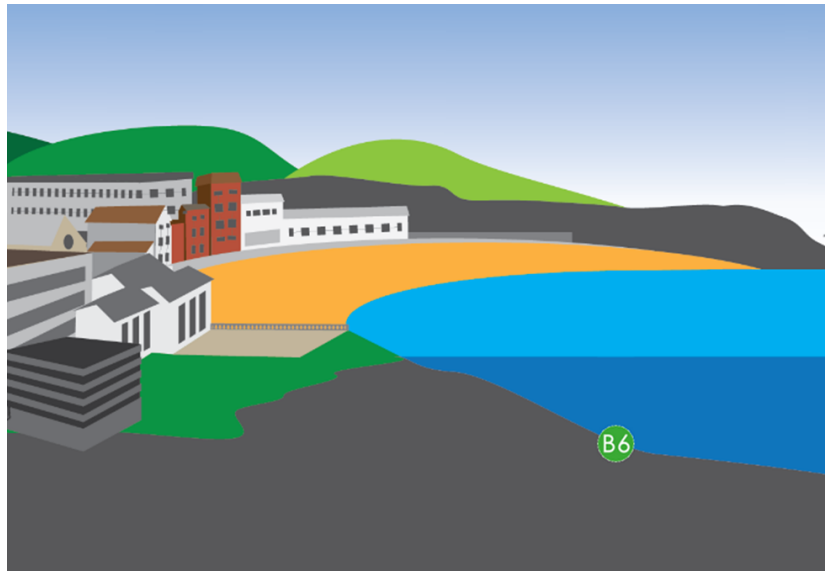
Flexible Fund Process

- Calls targeted to address research challenges identified in the **ORE Hub Research Landscape**
- **Calls for proposals** – expected annually with the first call expected in March 2019.
- Applications assessed for technical excellence and match to the ORE hub programme
- Proposals will be **peer reviewed**, ranked and funding decisions made, drawing on the Hub co-Directors, Advisory Board, International experts and wider ORE community.
- Applicants must be **eligible** for RCUK funding and PI and CIs on the Supergen ORE hub may not apply.
- Launched through the Supergen ORE Network and Website



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Early Career Researcher Fund

- A **flexible, enabling research fund** for Early Career Researchers (Early Career Academics and PDRAs),
- Small awards, ranging up to £5k (30-50 awards expected),
- that supports **skills development** and **small research activities** (e.g. discrete activities / small equipment leading to new lines of research, support for national / international collaborations, industrial secondments, public awareness, outreach).
- Primary objective is to Personal Development of the ECRs
- ***Light touch process*** but with the rigour of ***peer review*** provided by the hub directors and established academics and industry personnel.
- **Calls for proposals** – Approx. every 4 months. (First call March 2019)

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