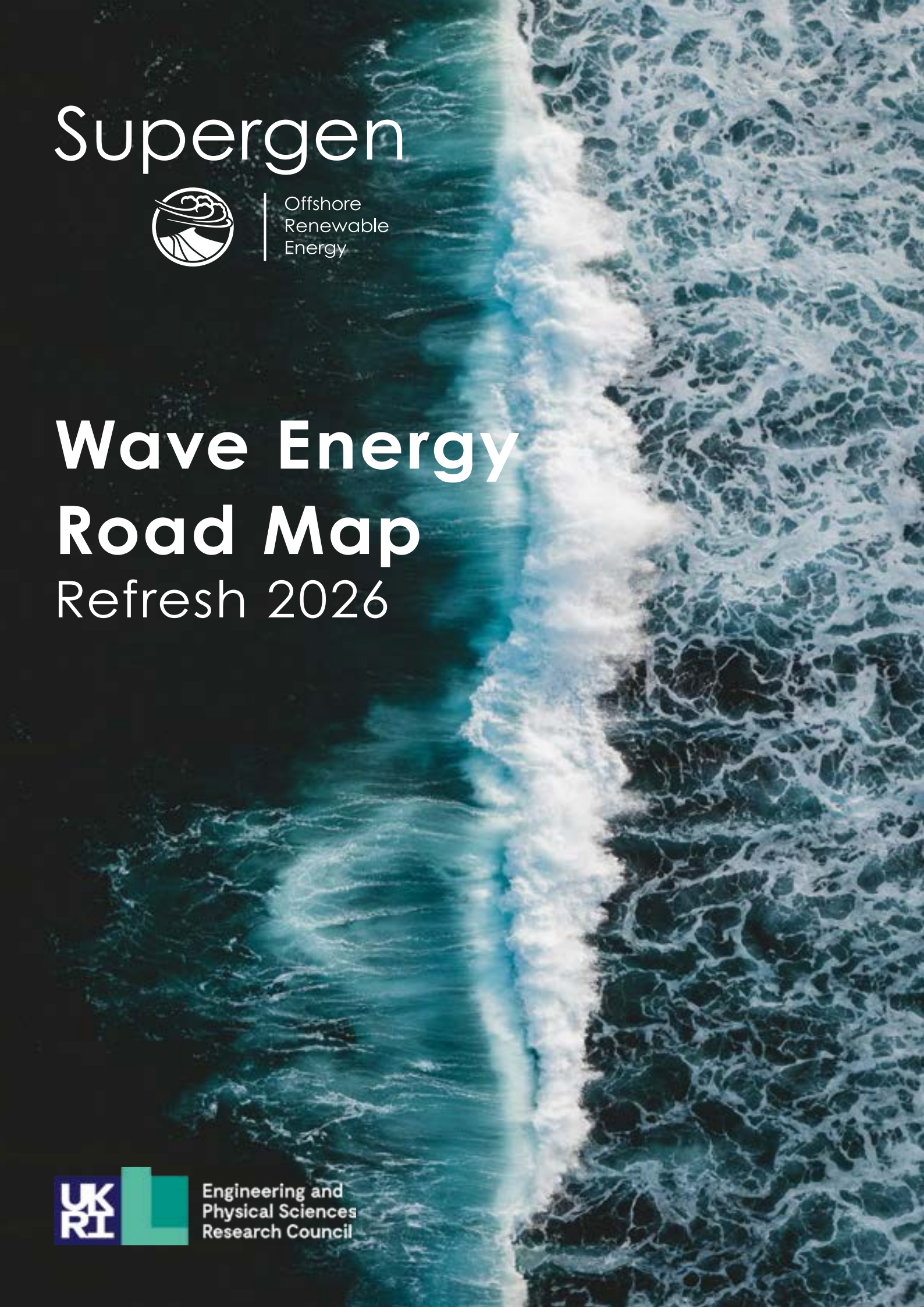
Supergen

Offshore
Renewable
Energy

Wave Energy Road Map

Refresh 2026



UKRI Engineering and Physical Sciences Research Council

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ABOUT THE SUPERGEN ORE HUB

This report was developed by the Supergen Offshore Renewable Energy (ORE) Hub in collaboration with the offshore renewable energy community.

Offshore renewables are a key part of the UK's clean energy transition. As a global leader in offshore renewable technology, with abundant natural resources within its coastline, the UK is well placed to drive this sector forward. The Supergen ORE Hub supports this ambition through strategic research and innovation to accelerate the energy transition and help to mitigate climate change.

The Supergen ORE Hub is a £16.5 million programme funded by the Engineering and Physical Sciences Research Council (EPSRC). It provides ambitious research leadership and fosters collaboration between academia, industry and policy stakeholders to accelerate innovation in offshore wind, wave and tidal energy.

The Supergen ORE Hub is one of three Supergen initiatives created by the EPSRC to deliver coordinated research on sustainable power generation. By championing strategic research priorities in offshore renewable energy and encouraging knowledge exchange, the Supergen ORE Hub seeks to drive a step change across this emerging sector.

The Hub is a collaboration between the universities of Plymouth, Aberdeen, Edinburgh, Exeter, Hull, Manchester, Oxford, Southampton, Strathclyde, and Warwick.

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EXECUTIVE SUMMARY

The Wave Energy Road Map [1], published in 2020, summarised the wave energy sector's views on the steps required to accelerate the sector's development over the next 10-15 years. It was compiled following consultation through scoping workshops and a series of structured interviews with academics, policymakers, funding bodies and industry professionals and is complemented by the *Wave Energy Innovation Position Paper* [2]. The report recommended that, with targeted action, wave energy can meet the previous Government's Clean Growth Strategy tests [3] and provide a significant source of renewable energy and growth for the UK economy.

Since then, the Supergen ORE Hub has published the *Ocean Energy Policymakers Toolkit* [4], which highlights the critical role of research and innovation in taking wave energy beyond the pre-commercial stage and identifies a lack of significant and sustained UK innovation funding for technology developers.

The Resource Potential, Economic Prize and Policy Landscape

As an island nation, the United Kingdom has an abundant marine energy resource.

- The UK has an estimated overall resource of up to 25 GW of wave energy [5].
- There is a market potential for just over 6 GW of wave energy by 2050, based on detailed market allocation analysis of offshore renewable energy by the Energy Systems Catapult [6].
- Associated with this projected 2050 market potential, a University of Edinburgh study [7] found that leading the global wave energy market could add £30 billion to the economy and create more than 50,000 jobs.

The current Labour Party Government committed in its manifesto to 'invest in marine energy' and acknowledges in the recent *Clean Power 2030 Action Plan* that for emerging renewable technologies, the UK's ability to "deploy them at scale could be important to the UK's achievement of longer-term decarbonisation objectives" [8].

The establishment of a Marine Energy Taskforce in 2025 supports these objectives by developing a roadmap to realise the country's marine energy potential. Supported by The Crown Estate and Crown Estate Scotland, the Taskforce will focus on accelerating tidal stream and wave energy deployment while maintaining high levels of UK supply chain content.

The task force's findings are due to be published by the Marine Energy Council and presented to the government in June 2026, informing future policy and sector support [9].

Report Objectives and Scope

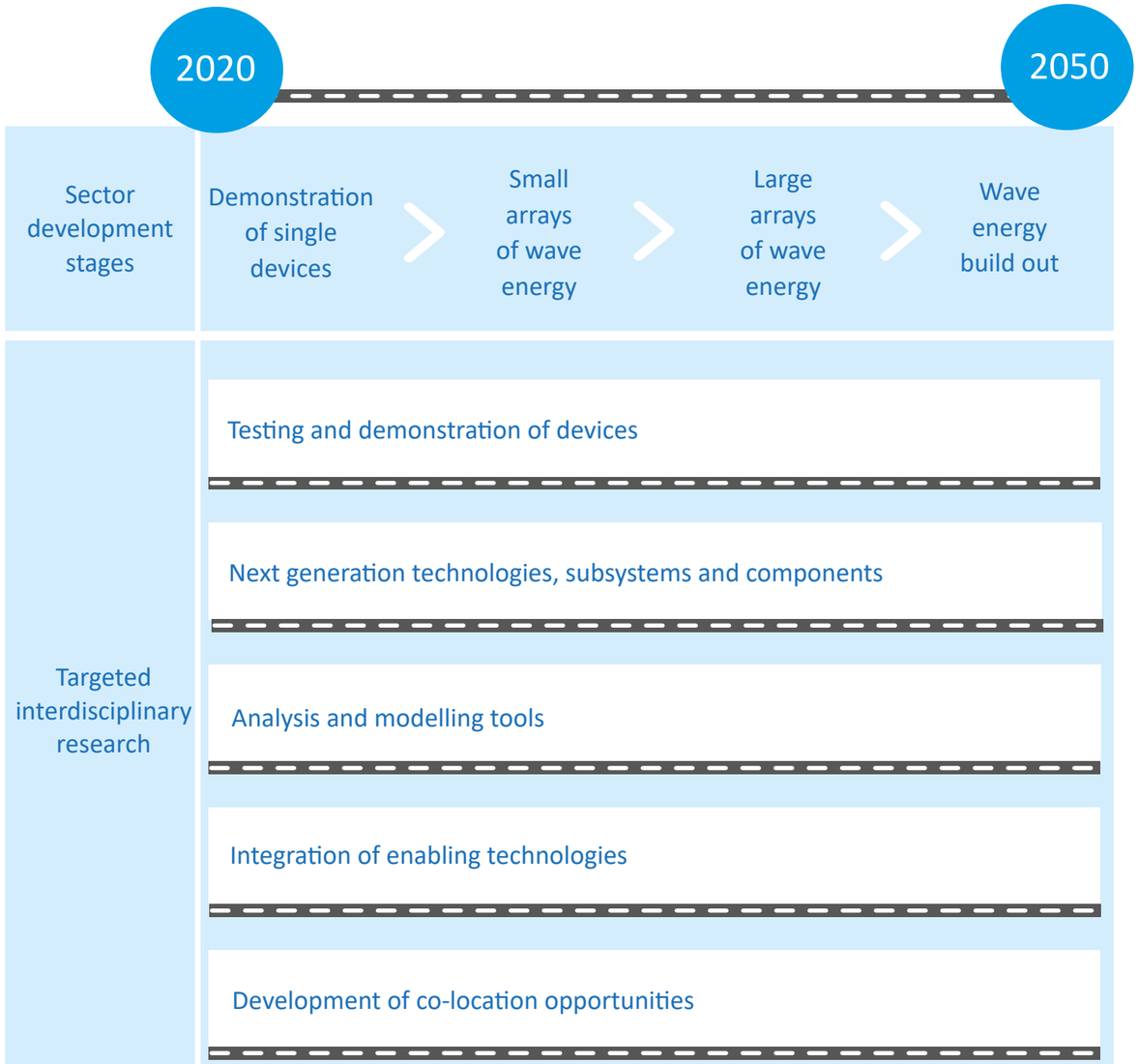
In this report, we draw on workshops and consultation across the wave energy sector to:

- Review the investments in research for wave energy in the UK.
- Assess the progress and impact of this research.
- Identify research challenges, opportunities and gaps.
- Make recommendations for future action in wave energy research and innovation.

Waverider Buoy Recovery
EMEC Test Site

Figure 1: Wave Energy Roadmap Time Line

Actions recommended by this Roadmap are summarised below.



SECTION 1:
Review of research and innovation investment into Marine Energy since 2020

The 2020 Wave Energy Roadmap recommended research activities aimed at achieving a step change reduction in the unit cost of electricity from wave energy in the first ten years to 2030. Here we review the wave energy research investments since 2020, with a particular focus on UK and EU-funded research.

UK Funding

Supergen ORE Hub

The Supergen ORE Hub Flexible Fund supports fundamental and applied research funding to advance strategic priorities within offshore renewable energy across the UK. Since 2019, £4.6 million has been invested into targeted projects involving over 100 industry partners and nearly £6 million in matched contributions.

Of this £4.6m, almost £600,000 has been invested into six wave energy projects producing new research into wave buoy measurements, power take-off design, hybrid integration and flexible membrane wave energy converter (WEC) materials. Two projects have been co-funded by Wave Energy Scotland (WES) in direct energy generation and dielectric elastomer applications in wave energy. Further details of the Flexible Fund projects are available on the Supergen ORE Hub website and are listed in Annex A.

EPSRC Marine Wave Energy Programme

In 2020, following the recommendations of the Wave Energy Roadmap, the EPSRC funded eight projects in a £7.5 million investment to develop and test cutting-edge wave energy technologies to help the UK achieve its Net Zero goal. These projects included impactful research into:

- Bionic adaptive stretchable materials for wave energy converters.
- Flexible responsive systems in wave energy.
- Holistic advanced prototyping and interfacing for wave energy control.
- Mooring analysis and design for offshore WEC survivability and fatigue.
- New generation modelling suite for the survivability of wave energy converters in marine environments, novel high-performance wave energy converters with advanced control.
- Reliability and survivability systems through machine-learning forecasting.
- System-level co-design and control of large capacity wave energy converters with multiple Power Take Offs (PTOs).
- Developing and testing advanced electrical generators for use in WECs.

European Funding

The European Commission has provided considerable funding for marine energy, primarily through its Horizon research funding programmes. The Horizon funding calls are guided by the *Strategic Research and Innovation Agenda* (SRIA), outlining priority research areas for the sector. These programmes have provided significant funding for high-TRL research, including the development of subsystems, plus demonstration of devices and pilot arrays. Over the past five years, the Commission has provided the vast majority of the higher TRL funding for marine energy. In contrast, UK funding is largely focused on early-stage research in wave energy [11], leaving a gap in UK domestic funding to support higher-TRL industry innovation and demonstration.

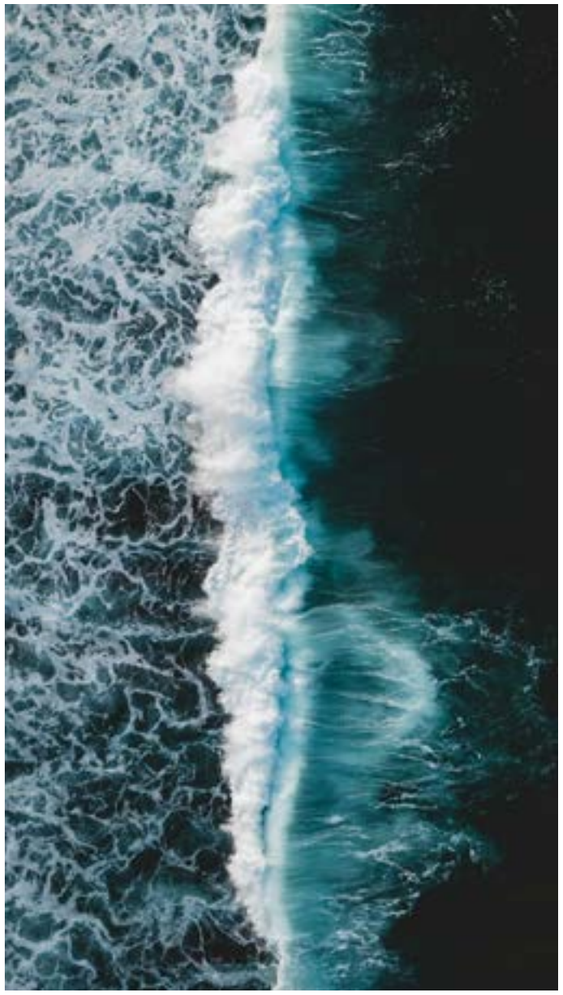
UK & European Ocean Energy Research Priorities

At a European level, the *Strategic Research and Innovation Agenda* (SRIA) sets out research priorities. The *SRIA for Ocean Energy* has a series of main 'Challenge Areas' for research and innovation within the ocean energy sector. These contain a series of 'Priority Topics' with specific objectives and actions required to move the sector towards commercialisation. The document is intended to guide future funding calls, both at a European, country or regional level.

The current *SRIA for Ocean Energy* [10] was published in October 2024, following an 18-month process of review and updates in consultation with sector representatives. This consultation built upon an analysis of funded research, conducted by the University of Edinburgh, as part of the Supergen ORE Hub, in conjunction with the European Energy Research Alliance (EERA), and the Ocean Energy SET Plan Implementation Working Group (OceanSET) [11].

In the development of the *SRIA*, discussions were held with the ocean energy sector through the European Technology & Innovation Platform for Ocean Energy (ETIP Ocean) Technology Working Group. This comprised a wide range of sector representatives from across Europe, with strong representation from the UK. It included a balanced range of technology developers, suppliers, research and academia. These discussions were held through a series of online and in-person workshops with theme breakout groups to discuss any updates required to *SRIA* challenges.

One of the main outcomes of the consultation was that none of the topics were considered fully resolved yet. Some topic areas needed to be adjusted, and a series of new topics added. A set of refocused Challenge Areas and Priority Topics was then developed, aligned to meet the future needs of the sector. The sector's focus should be on both achieving the 2030 targets, whilst also on fostering innovation beyond this horizon, through a pipeline of focused underpinning research.



The current *SRIA* consists of six Challenge Areas, each with three Priority Topics, as summarised below:

I. Design and validation of ocean energy farms

1. Demonstration of pilot farms

2. Demonstration of single devices

3. Design and validation of other ocean energy technologies

II. Next generation of technologies and subsystems

1. Disruptive wave energy devices

2. Innovative PTO and control systems

3. Advanced moorings, foundations and power connections

III. Ocean energy analysis and modelling tools

1. Advanced simulation of ocean energy subsystems and devices

2. Analysis and planning tools for ocean energy farm deployment

3. Modelling and simulation of farm construction and operation

IV. Integration of enabling technologies in ocean energy systems

1. Innovative materials and manufacturing processes

2. Application of the latest instrumentation and sensor technology

3. Use of artificial intelligence and big data

V. Ocean energy market development

1. Application of ocean energy in off-grid markets

2. Demonstrating grid-scale benefits of ocean energy

3. Co-location of multiple technologies

VI. Coordination and sector support actions

1. Coordinating sector efforts (including open data)

2. Accessing and upgrading testing facilities

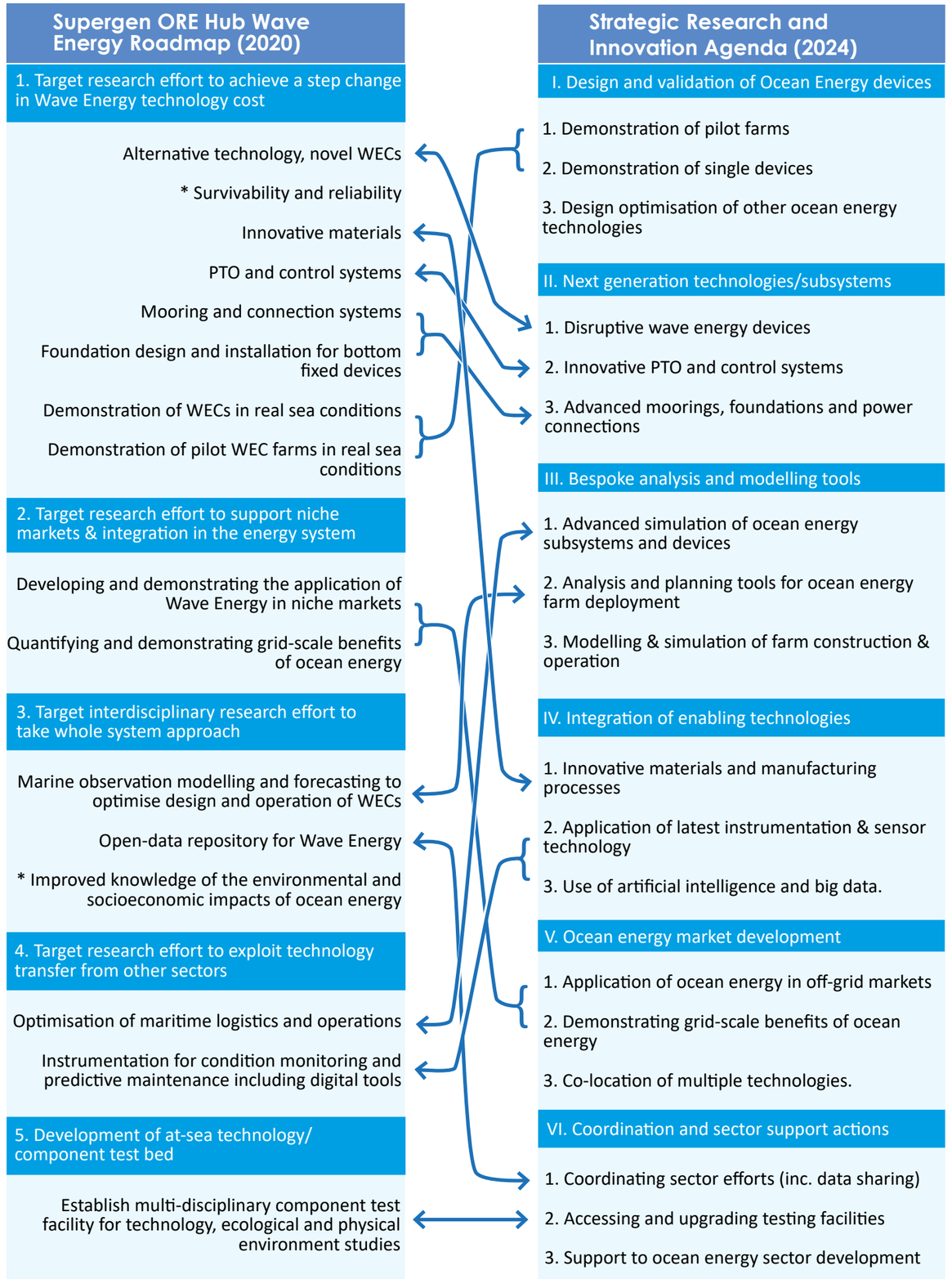
3. Support to ocean energy sector development

Comparison of SRIA and Wave Roadmap Topics

There is significant overlap of the *SRIA for Ocean Energy* topics with the technology challenges presented in the 2020 Wave Energy Roadmap, as shown in Figure 2. Note that some technology challenges, including survivability and reliability, plus environmental and socio-economic aspects, are considered within multiple Priority Topics in the *SRIA*.

Where appropriate, the technology research challenges in Section 2 of this report have been updated to include other topics identified within the current *SRIA*.

Figure 2: Overlap between the Wave Energy Roadmap and the SRIA

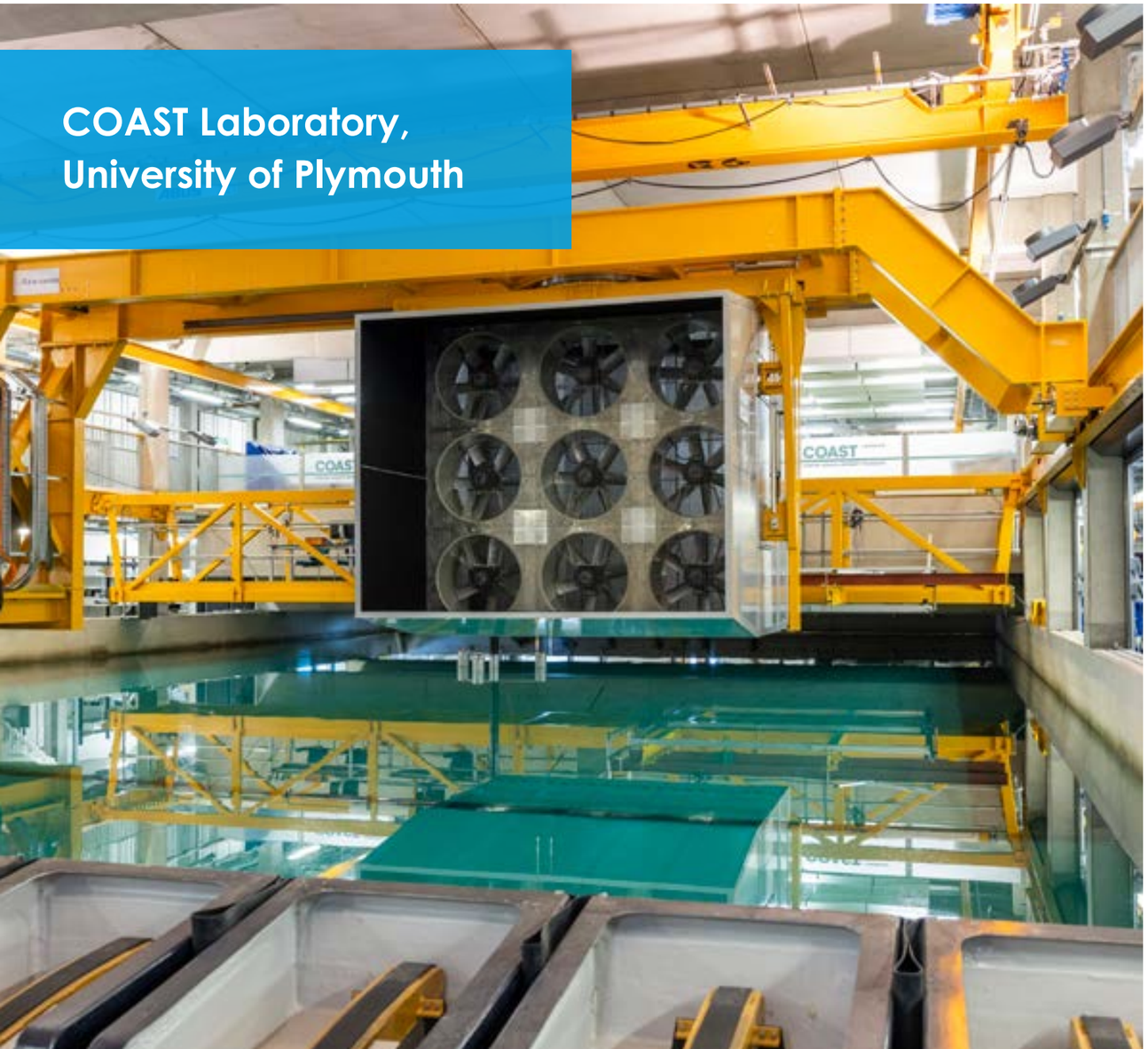


* Survivability and reliability, plus environmental and socioeconomic impacts, are covered in a range of *SRIA* topics

SECTION 2:
Recommended Research Priorities

Although research and innovation is the focus of this report, the development of wave energy will also depend on suitable market support mechanisms, supply chain modernisation, effective regulation and legislation, and cross-sector collaboration and knowledge sharing.

The following recommendations have been collated from a series of consultations with the offshore renewable energy community at focused workshops. Each priority represents an important challenge which is significant to the successful development of the wave energy sector. Most are ongoing challenges requiring continued attention. However, an indication of the timeframe is given, suggesting a short, medium or longer-term status of priority.



1. Research priority: testing and demonstration of devices

Action: Research to address	Outputs: At-sea deployment data and learning for WEC devices and components	Research scope:	Priority timescale:
• Demonstration of single Wave Energy Converters (WECs) in real sea conditions.	• Proven WEC concepts in real sea conditions. • WEC unit cost reduction, reliability & performance demonstrated.	Wave energy specific	Short-medium term
• Demonstration of pilot WEC farms in real sea conditions aligned with targeted measurement campaigns to advance sector confidence.	• WEC project viability demonstrated. • Open-data repository for Wave Energy.	Wave energy specific	Medium term

2. Research priority: support next generation technologies, subsystems and components.

Action: Research to address	Outputs: Cost reduction for WEC or sub-systems	Research scope:	Priority timescale:
• Development of novel WEC concept opportunities. • Prove survivability and reliability of WEC sub-systems.	• WEC design survivability and cost reduction • Improved scalability	Wave energy specific	Short-medium term
• Development of PTO and control systems, including direct generation PTOs. • Use of innovation materials and manufacturing to reduce offshore renewable energy system and sub-system cost. • Develop mooring and connection systems to enhance performance and reduce loads	• Sub-system cost reduction	Cross-cutting	Short-medium term
• Multi-disciplinary component testing of technology, ecological and physical environment studies	• Test data from ACTOR floating offshore test facility for components and sub-systems, and other at-sea test facilities and deployments.	Cross-cutting	Short & long term

3. Research priority: analysis and modelling tools

Action: Research to address	Outputs: Whole system cost reduction, improved confidence in predictions	Research scope:	Priority timescale:
• Multidisciplinary engineering and ecology modelling tools validated by targeted marine observation to optimise through-life design and operation of WEC farms, including socioeconomic impacts.	• Fit for purpose data collection & analysis and modelling tools. • Modelling tools for co-design to optimise for engineering and ecological outcomes. • Open-data repository for Wave Energy.	Wave energy specific	Short-medium term
• Integrated engineering models to maximise design efficiency including physics-based and Artificial Intelligence/Machine Learning (AI/ML) enhanced methods.	• Modelling tools for co-design to optimise for engineering and ecological outcomes.	Cross-cutting	Short-medium term
• Materials degradation models for prediction of component operating life (whilst minimising reliance on physical data).	• Improved confidence in modelling and simulations of component reliability and predictive maintenance.	Cross-cutting	Short-medium term
• Tools for enabling offshore renewable energy farm-scale design including layout and operations optimisation and grid-scale system benefits.	• Improved confidence in modelling and simulations of the environmental and socioeconomic impacts of ocean energy. • Strategic marine planning tools for policy decision-making.	Wave energy/ Cross-cutting	Short-medium term

4. Research priority: integration of enabling technologies

Action: Research to address	Outputs: O&M cost and risk reduction	Research scope:	Priority timescale:
• Development of real-time modelling tools for optimisation of maritime logistics and operations.	• Safe and efficient operations, management and maintenance. • Digital twins for device and farm scale.	Cross cutting	Short-medium term
• Improved reliability of instrumentation for condition monitoring and predictive maintenance including digital tools.	• Enhanced O&M planning	Cross cutting	Short-medium term
• AI/ML enabled modelling and design.	• Design for performance and manufacture	Cross cutting	Short-medium term
• Design tools and standards for safe end of life.	• Circular economy design solutions.	Cross cutting	Short-medium term

5. Research priority: continue to progress development of co-location opportunities

Action: Research to address	Outputs:	Research scope:	Priority timescale:
• Developing and demonstrating the application of co-location with offshore wind, and hybrid systems.	• Wave energy integration role established within the Energy System. • Co-location with offshore wind and hybrid systems including wind, aquaculture, and floating solar. • Energy Islands.	Cross cutting	Medium term

Mocean Energy Blue X Operating at EMEC

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ANNEX A

Supergen ORE Hub Flexible Fund Projects in Wave Energy

Project	Budget	Institution	Principal Investigator	Notes
Accounting for Current in Wave Buoy Measurements	£89,247.00	University of Manchester	Dr. Sam Draycott	FF Call 1 - 2019
Investigation into the coupling of a wave energy converter with a reverse osmosis desalination plant	£99,999.00	Queen's University Belfast	Dr Matt Folley	FF Call 2 - 2020
Advanced, Modular Power Take-Off Design for Marine Energy Converters	£98,840.00	University of Edinburgh	Dr Jonathan Shek	FF Call 2 - 2020
Submerged bi-axial fatigue analysis for flexible membrane Wave Energy Converters	£99,763.00	Swansea University	Dr Mokarram Hossain	FF Call 3 - 2021
An origami inspired wave energy converter through direct energy generation	£102,616.00	University of Oxford	Prof Zhong Yu	FF Call 4 – 2023 £49,221.00 co-funding from WES
Design and development of a new generation of dielectric elastomer generators for wave applications	£100,000.00	University of Manchester	Prof Robert Young	FF Call 4 – 2023 £50,000.00 co-funding from WES

Driving ambitious research and innovation

To accelerate the clean energy transition, the Supergen ORE Hub provides research leadership to connect academia, industry and policy stakeholders and drive innovation in offshore wind, wave and tidal energy.

Visit the Supergen ORE Hub website

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