

WAVE ENERGY SCOTLAND

Tim Hurst – WES Conference

May 2022



WES PROGRAMME REVIEW

WES Annual Conference

3 May 2022

FUNDED BY



Scottish Government
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wave energy
SCOTLAND

The logo for Wave Energy Scotland, featuring a stylized blue wave above the text 'wave energy' in green and 'SCOTLAND' in blue.

HIE
Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 'n nan Eilean

The logo for Highlands and Islands Enterprise (HIE), featuring a stylized green and blue house-like shape above the text 'HIE' in blue, and the full name in English and Gaelic below.

Overview

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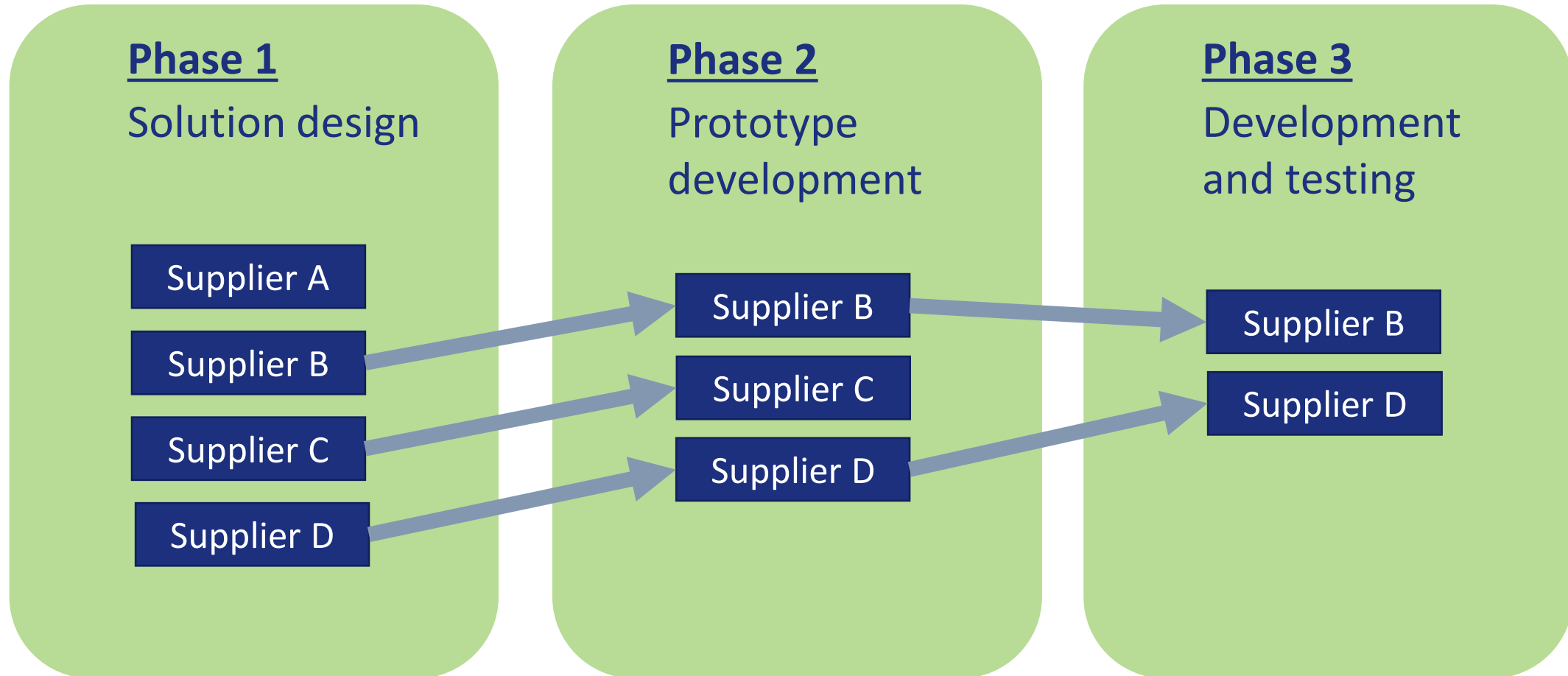
Scottish Government
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WES Objectives

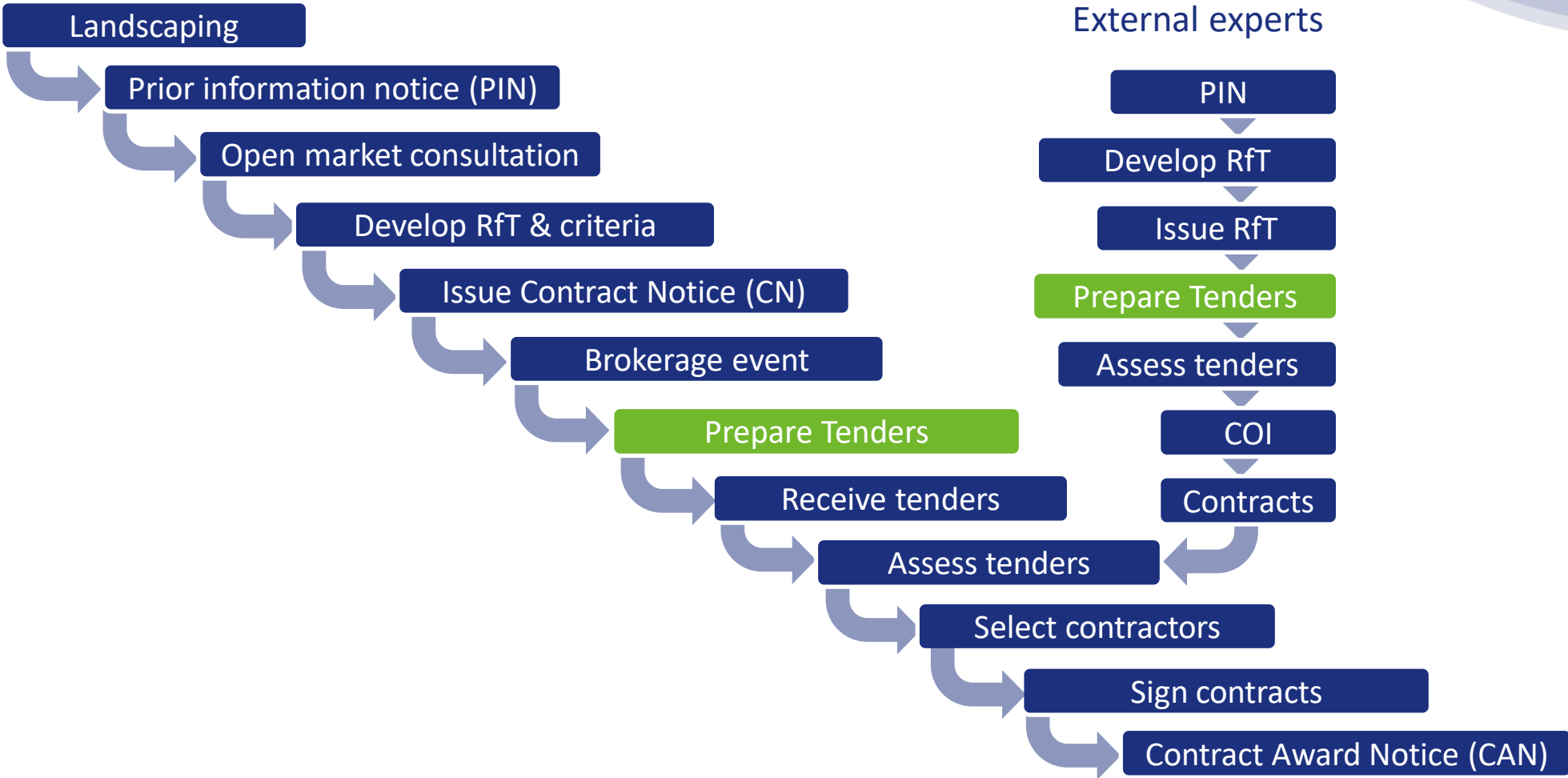


- Enable technologies to reach commercial readiness
- Ensure learning gained from support for wave device development and deployment to date is retained and used to benefit the wave energy industry
- Avoid duplication in funding, encourage collaboration between companies and research institutes and foster greater standardisation across the industry
- Ensure value for money from public sector investment
- Promote greater confidence in the technical performance of wave energy systems in order to encourage the return of private sector investment

R&D Pre-commercial procurement



Programme launch process



Programmes overview



Power Take-
Offs

Novel Wave
Energy
Converters

Structural
Materials

Control
Systems

Quick
Connection
Systems

Europe
Wave

Programmes Overview



Power Take-Offs

Novel Wave Energy Converters

Structural Materials

Control Systems

Quick Connection Systems

Europe Wave

Programmes Overview



Power Take-Offs

Novel Wave Energy Converters

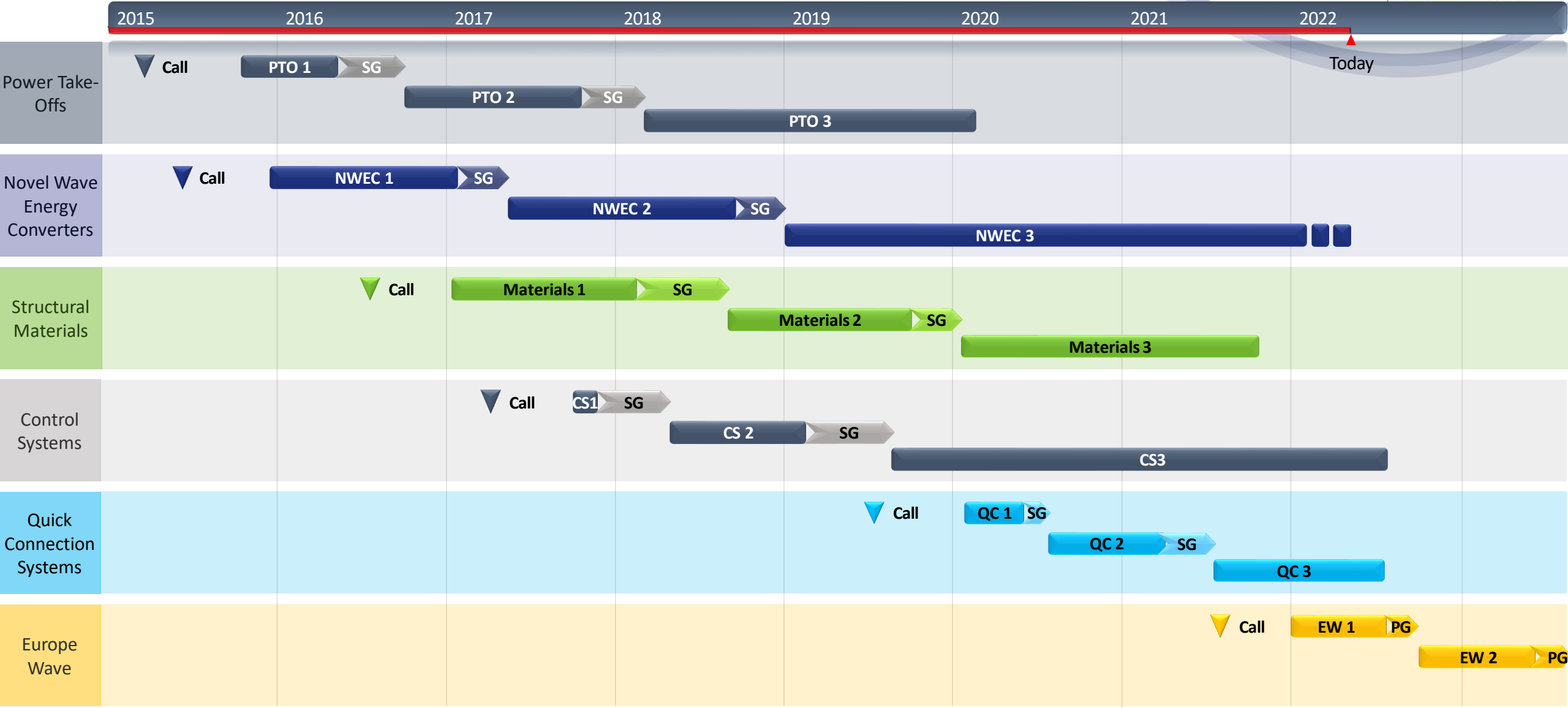
Structural Materials

Control Systems

Quick Connection Systems

Europe Wave

Programmes Overview





PTO Programme

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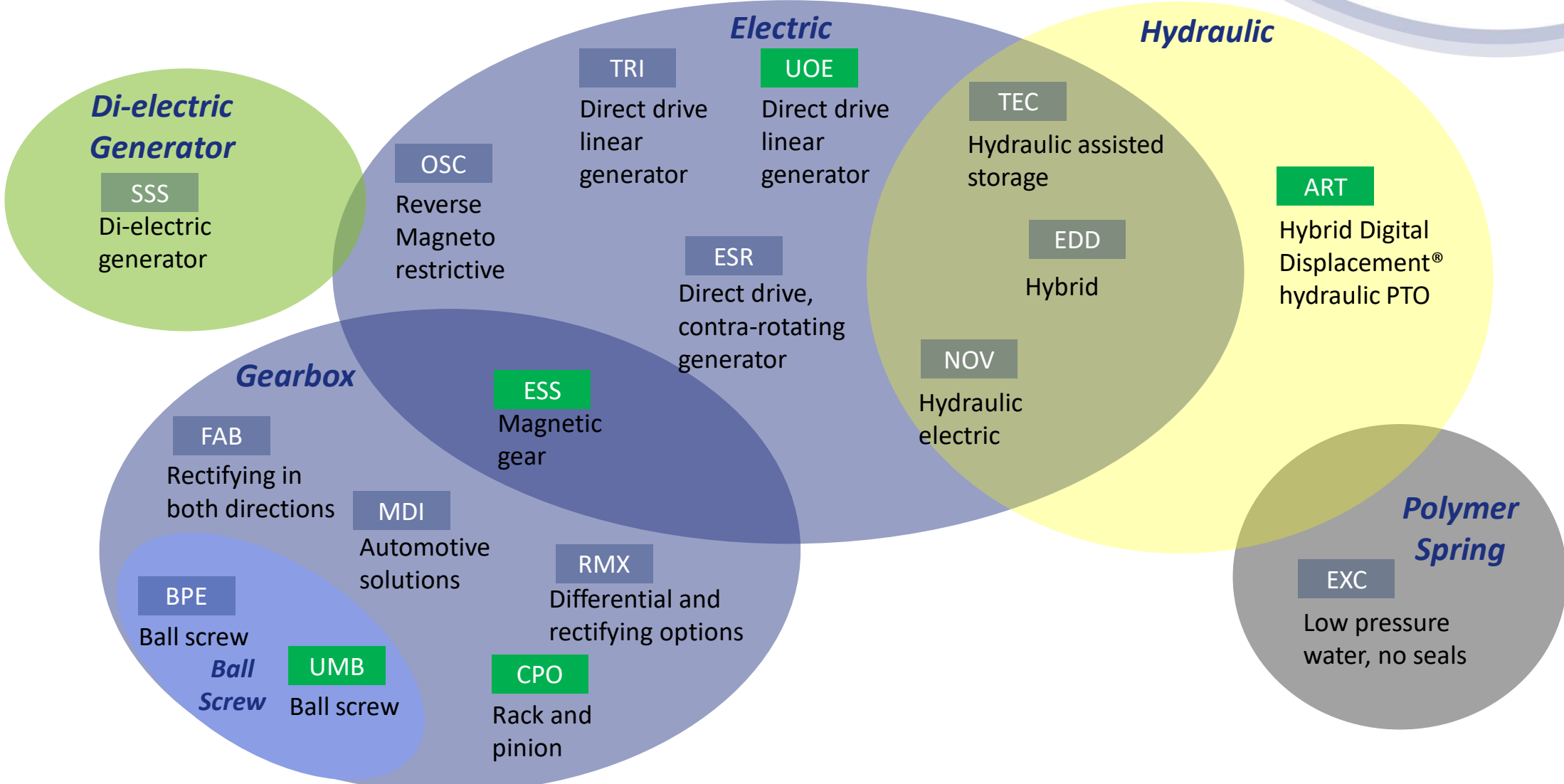
PTO programme objective



Support investigations into the feasibility of sound and innovative PTO technologies for wave energy sector

Particularly interested in feasibility of transferring energy conversion technologies from other sectors into the wave energy sector

PTOs Technologies



PT3-ART

wave energy
SCOTLAND

HIE
Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 'n nan Eilean



ARTEMIS 
INTELLIGENT POWER

Hybrid Digital
Displacement[®]
hydraulic PTO for
wave energy

PT3-CPO



HiDrive - A direct drive PTO for resonant Wave Energy Converters

PT3-ESS



Power Electronic
Controlled Magnet
Gear (PECMAG)

PT3-UMB

wave energy
SCOTLAND

HIE
Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 'n nan Eilean



Emerge
(Reciprocating Ball
Screw Generator)

PT3-UOE



THE UNIVERSITY
of EDINBURGH



C-GEN novel
direct drive
linear generator

NWEC Programme

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NWEC Objectives



Focused on prime mover and structure.

Collaboration and technology transfer from other sectors is actively encouraged.

Support truly novel devices which have not been developed and characterised before. Also, existing device concepts which have previously progressed to higher levels of maturity but where significant improvement potential has been identified

WEC Types

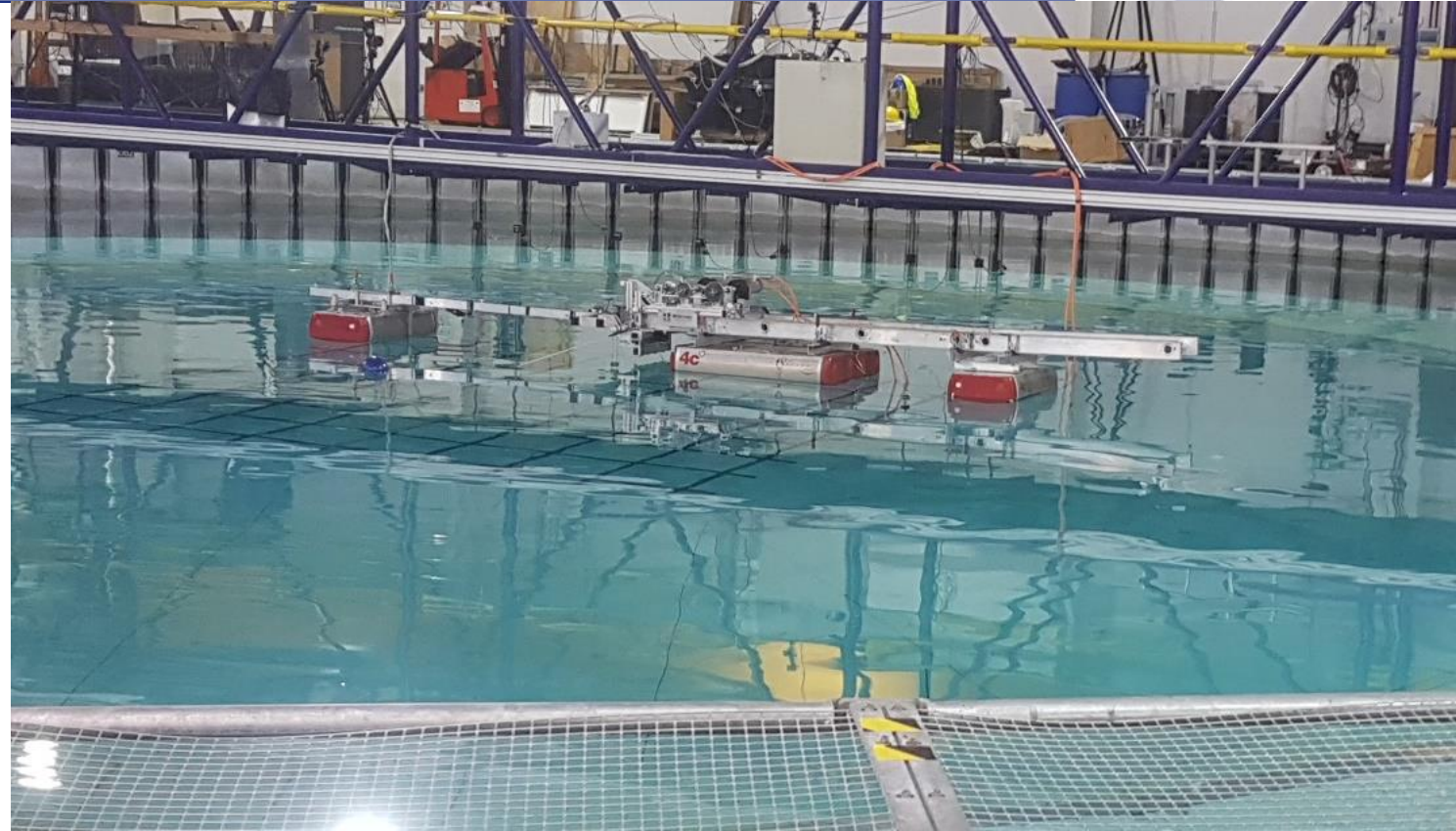
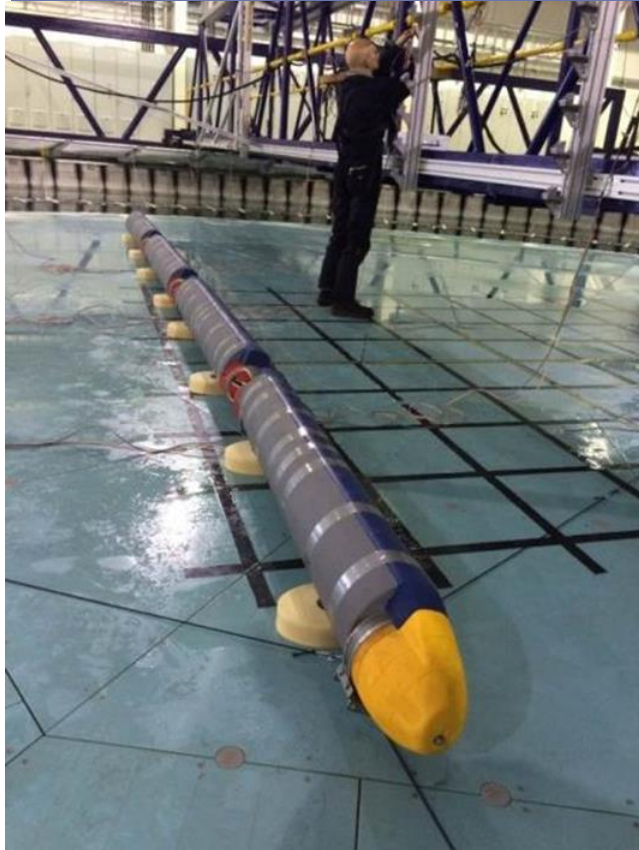
Floating
Subsea



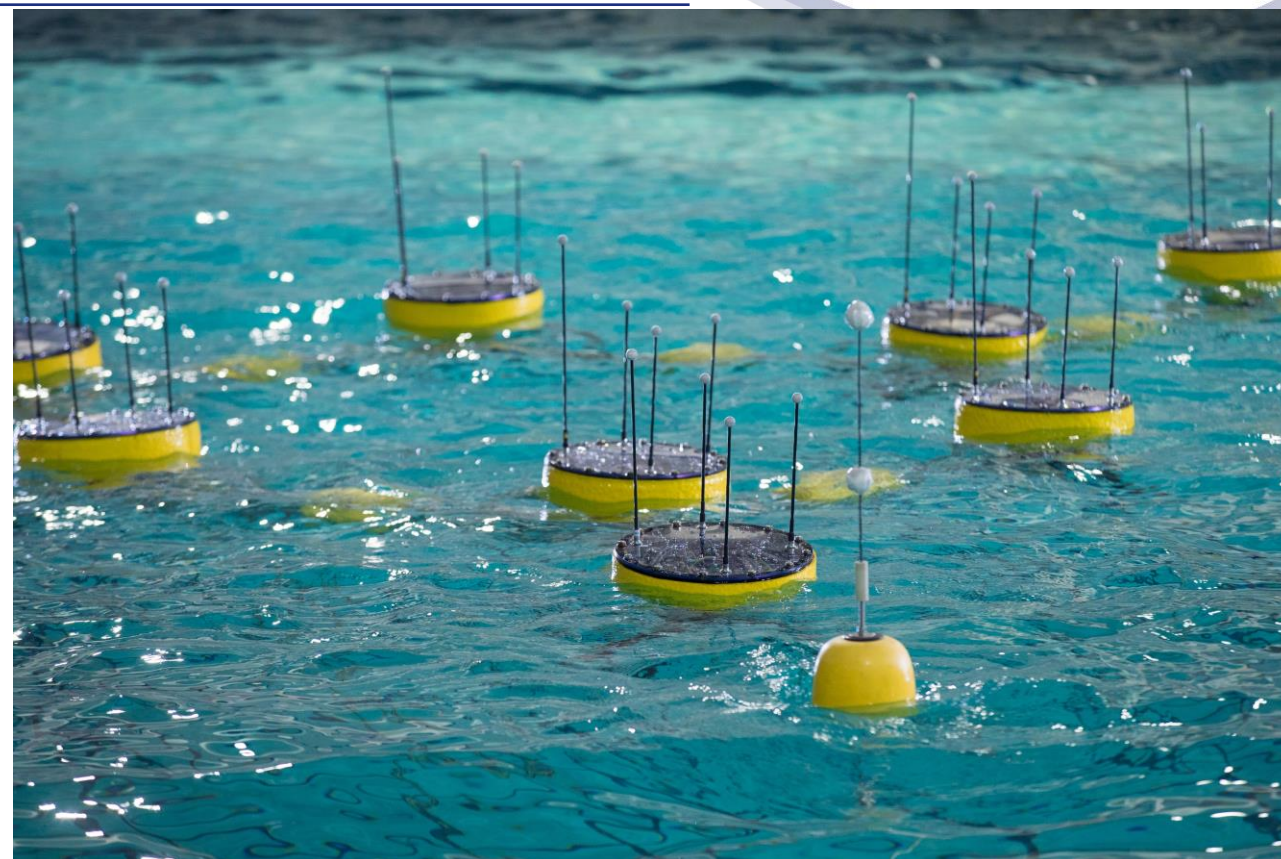
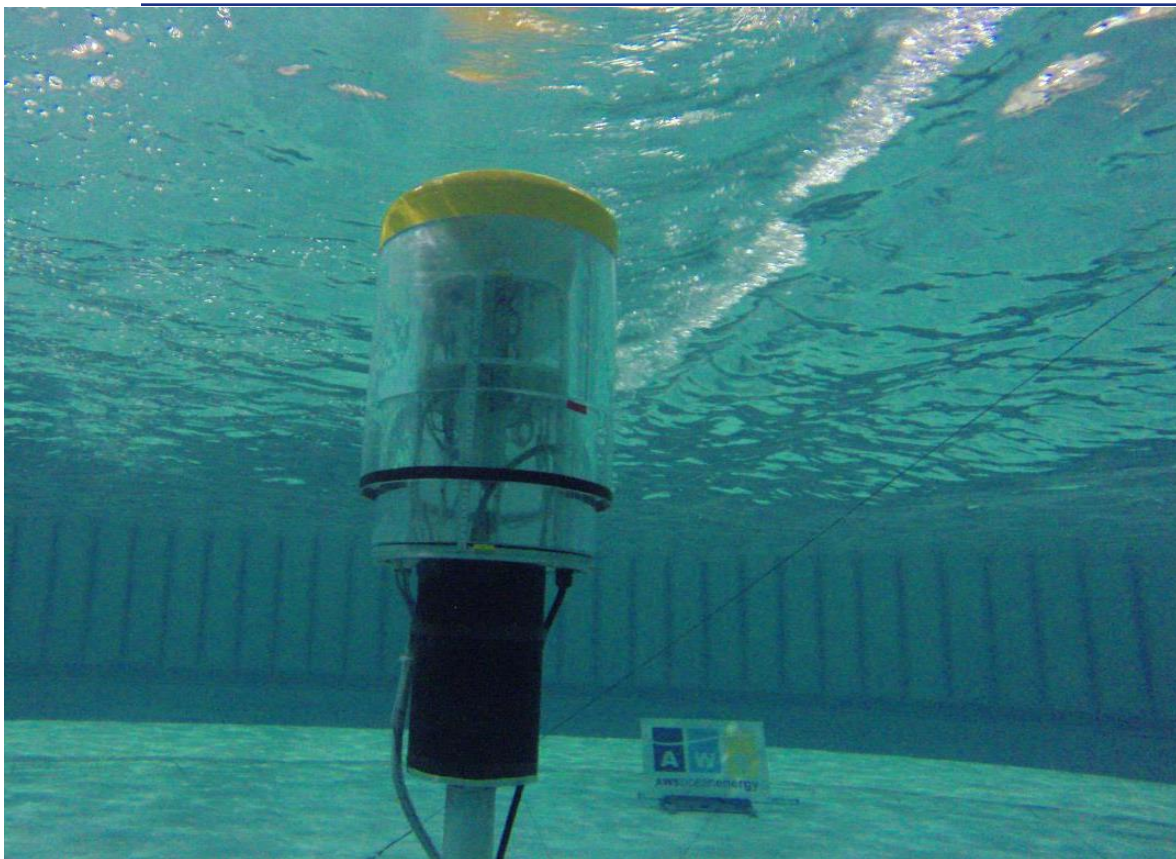
Wave tank testing



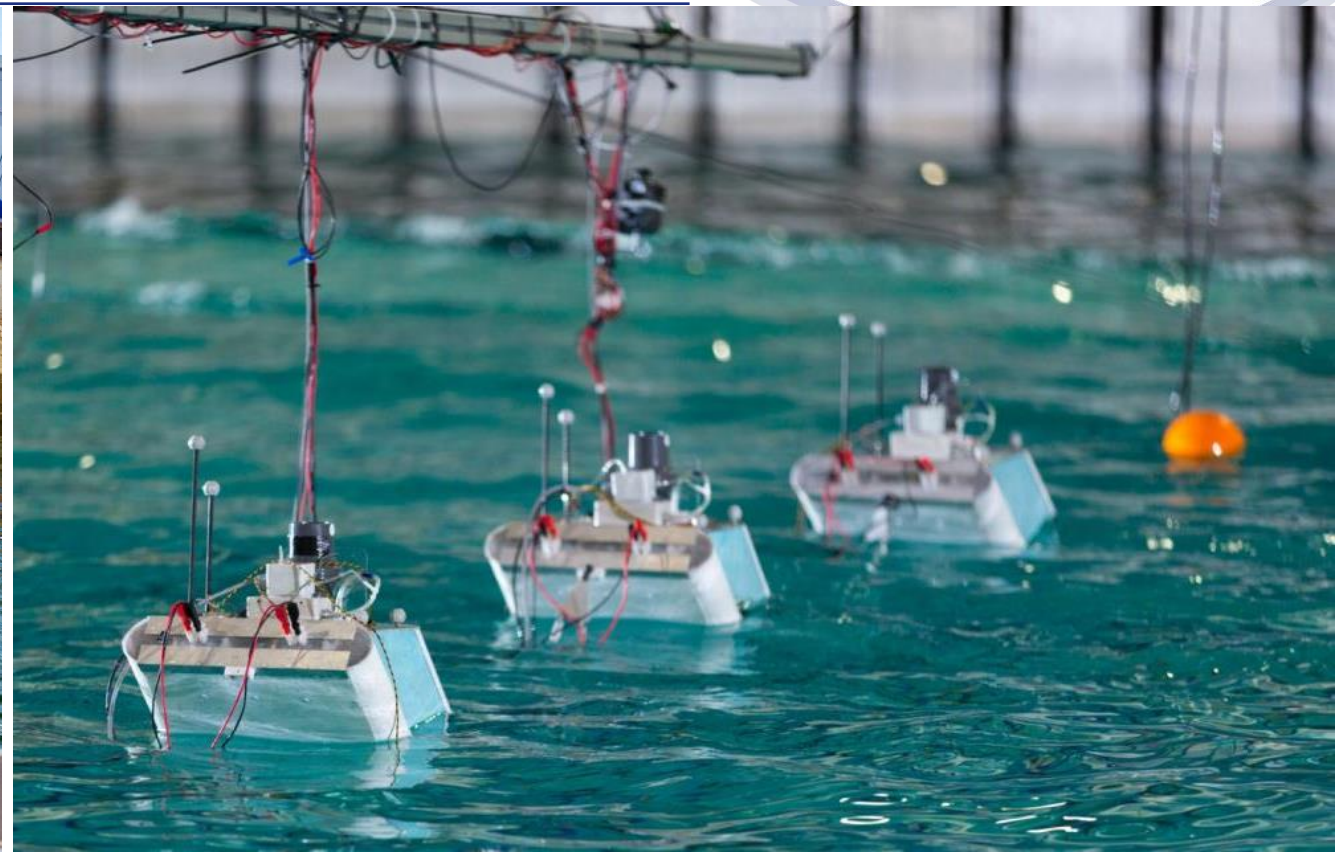
Wave tank testing



Wave tank testing



Wave tank testing



NW31-AWS



Archimedes
Waveswing™
MK V

NW3-MOE



Blue X wave energy
device



Materials Programme

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Materials programme objective



Investigate whether it is possible to make a step change impact in LCOE by constructing WEC devices from alternative materials.

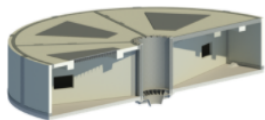
MT3-ARP

Convex

ARUP

Arup Convex (Concrete Viability Explorer) is a decision-making tool, which allows developers to explore the use of concrete in their WEC designs.

Use this tool to learn more about the advantages of using concrete, and important considerations for technical feasibility, construction and installation.



[Continue to the tool](#) →

Alternatively, [see results](#) based on default inputs
[Download](#) tool documentation

Why consider concrete?

Concrete has high compressive strength, and is combined with carbon steel bars which provide additional tensile strength. The steel is contained a set distance from the surface of the concrete (the 'cover') which protects the encased steel from corrosion and hence improves durability.

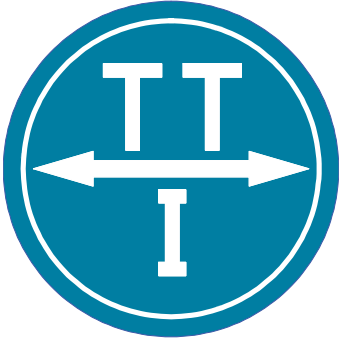
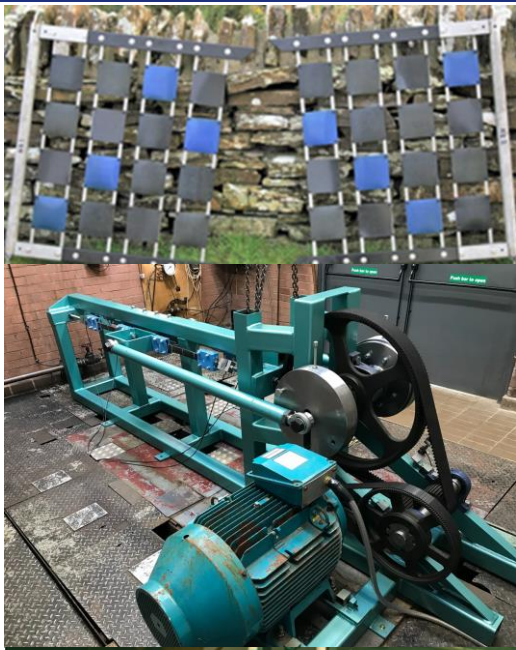
Reinforced concrete has a lower unit cost and superior durability compared to steel in the offshore environment. It is also a well understood material and can take advantage of a mature supply chain.

ARUP

CREATE - Concrete as a Technology Enabler



MT3-TTI



netbuoyTM
TTI Marine Renewables

Control Systems Programme

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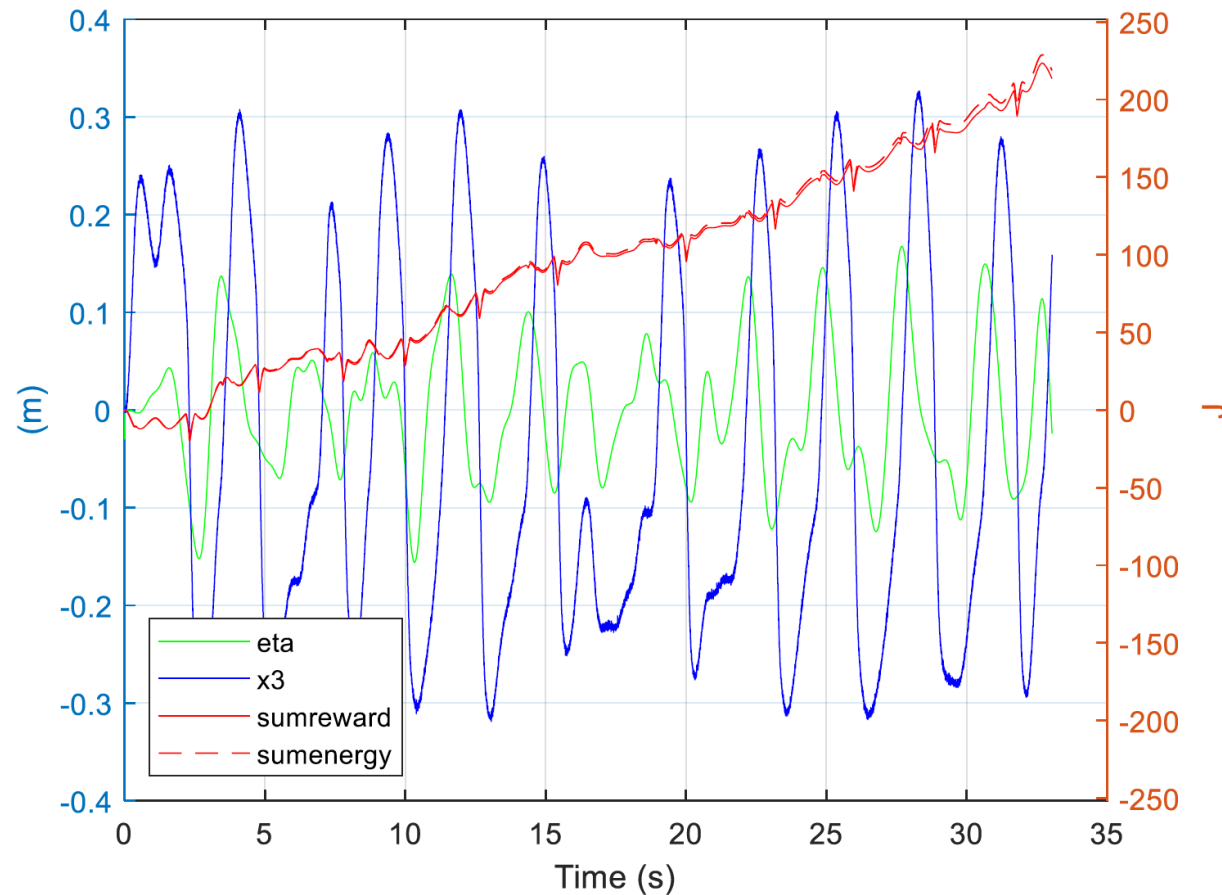
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Control Systems Objectives



Design, develop and demonstrate advanced control systems for WECs and sub-systems which will deliver improvements in performance, affordability, survivability and reliability.

CS3-MXS



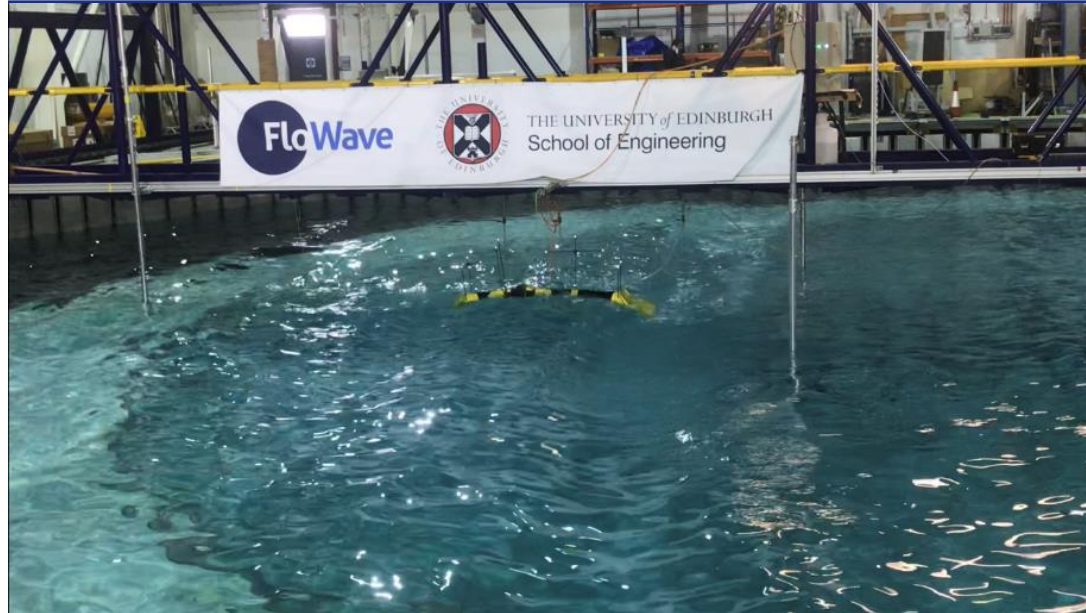
MaxSim

Cost of Energy
Optimised by
Reinforcement
Learning

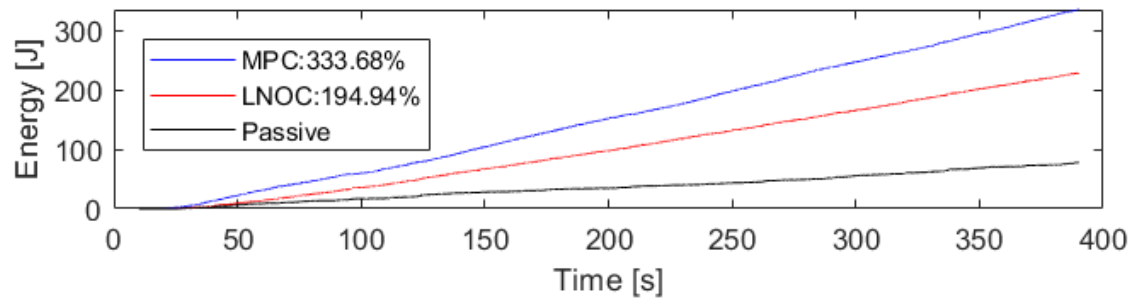
Surface elevation, buoy heave, cumulative energy, and reward for run with offline trained policy



CS3-QMU



Adaptive Hierarchical Model Predictive Control of Wave Energy Converters



Quick Connection Systems Programme

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QCS Programme



Objective

To reduce the duration, cost and risk of offshore operations for prototype wave energy converters by supporting projects to design and develop a quick connection and disconnection system between a device and its moorings and/or electrical system.

QC3 AOE



Pull And Lock Marine
(PALM) Connection
System

QC3 BFE



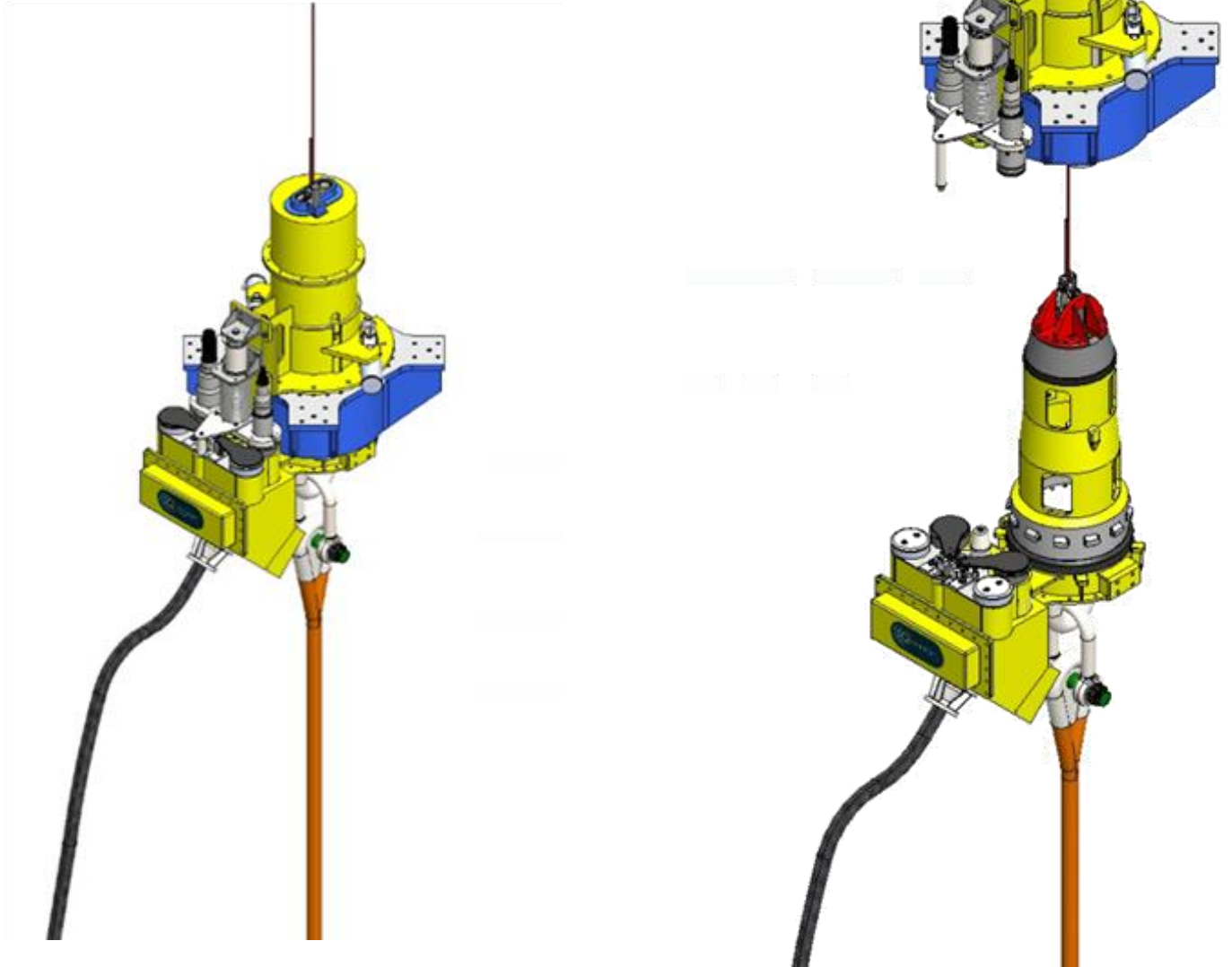
C-DART Quick Connection System



QC3 QUO

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Q-Connect

Visits

Click to add text

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Site visits



Site visits



Site visits



Site visits



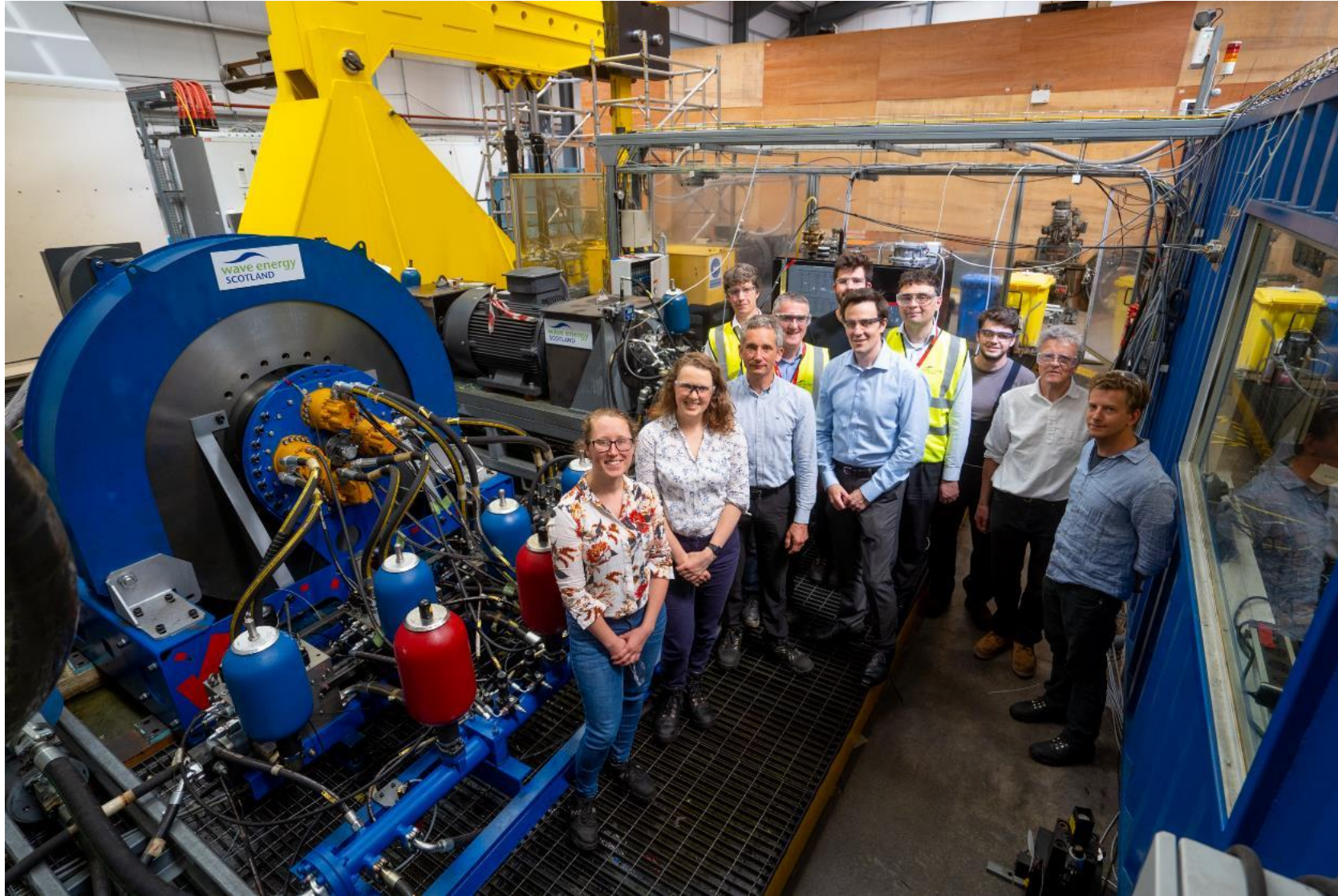
Site visits



Site visits



Site visits



Site visits



Site visits



What we have achieved

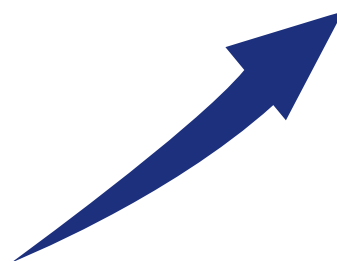


What we have achieved

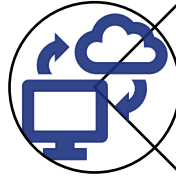


Technology

- New technologies being developed



What we have achieved



Technology

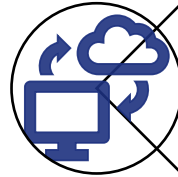
- New technologies being developed



Knowledge

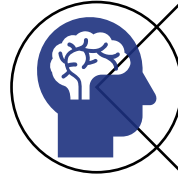
- Greater understanding of the potential and limitations of technologies

What we have achieved



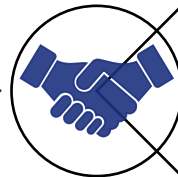
Technology

- New technologies being developed



Knowledge

- Greater understanding of the potential and limitations of technologies

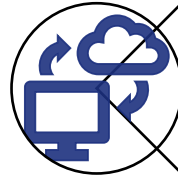


Collaborations

- 275 separate organisations, across 18 different countries

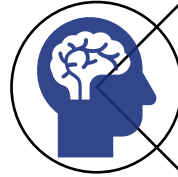


What we have achieved



Technology

- New technologies being developed



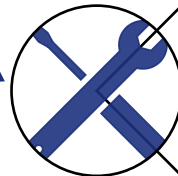
Knowledge

- Greater understanding of the potential and limitations of technologies



Collaborations

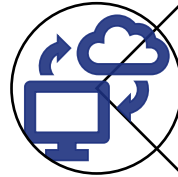
- 275 separate organisations, across 18 different countries



Standards & open access tools

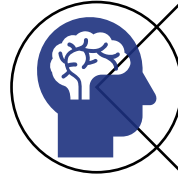
- Standard framework for evaluating technology

What we have achieved



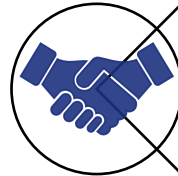
Technology

- New technologies being developed



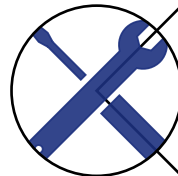
Knowledge

- Greater understanding of the potential and limitations of technologies



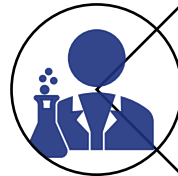
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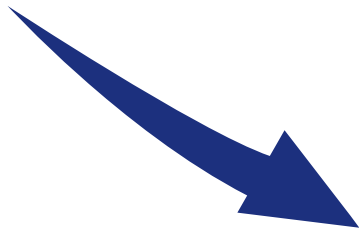
Standards & open access tools

- Standard framework for evaluating technology



Practical experience

- Generally understanding the challenges of deploying wave energy technology



Technology

- A wealth of new technologies ready to be exploited in PTOs, NWECS, Quick Connections, Structural Materials and Controls
- Acquisition of Pelamis and Aquamarine Power intellectual property for the benefit of the wave energy sector
- Adoption of technology from other sectors including aerospace and oil & gas which may not have been applied in the wave energy sector
- Guided technologies towards commercial readiness within a structured framework with a focus on key Evaluation Areas
- Increased the confidence in the technical performance of wave energy sub-systems



Knowledge



- Greater understanding of the potential and limitations of wave energy sub-systems
- Learnings all publicly available on the WES Knowledge Library which has ensured the knowledge gained from supporting for wave device development and deployment is used to benefit the wave energy industry
- Avoided duplication in funding by openly sharing project progress and outcomes publicly to help the wave energy sector as a whole
- Multi-disciplinary teams in WES projects means knowledge gathered from academics, industry, test sites, research centres and O&M operators all synthesized together giving many perspectives on the challenges of wave energy

Knowledge Library

Wave Energy Scotland is managing the most extensive technology programme of its kind in the wave energy sector. The Knowledge Library provides access to key information and documents generated through this world leading commercial and academic research & development.

Collaborations



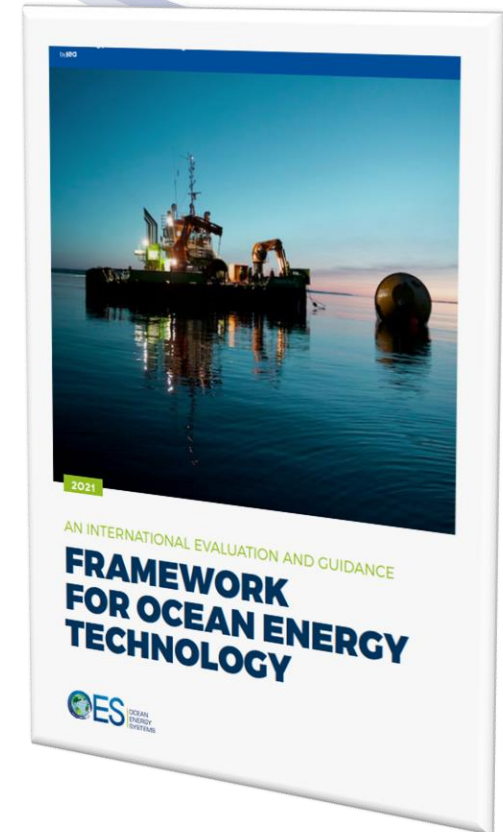
- Encouraged collaboration between companies and research institutes to foster greater standardisation across the industry with multi-disciplinary teams
- 275 separate organisations, across 18 different countries
- Brokerage events built collaboration and teams stayed together throughout projects
- International projects
- Partners on EU projects: DTOceanPlus, EuropeWave, OceanSET & SEETIP Ocean



Standards and Open Access Tools



- The WES Programme demonstrated a standard framework for evaluating technology
- The creation of the IEA-OES framework with international consensus on metrics
- Contribution to IEC Technical Specifications using experience from the WES Programme
- Contribution to standard practice for testing through Knowledge Capture reports
- DTOceanPlus, The Scenario Creation tool and the WES O&M Simulation Tool



International
Electrotechnical
Commission



IDCORE ENGD - OPERATIONS AND MAINTENANCE SIMULATION TOOL

O&M Simulation Tool

Practical experience

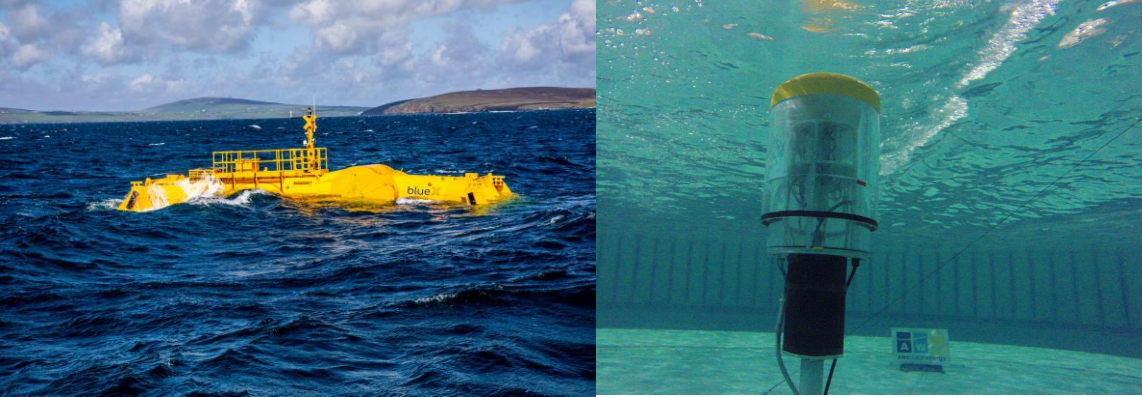


- Practical knowledge gained from advanced lab testing, tank testing and open water deployments
- Experience working with marine operators and understanding the challenges of installation and recovery
- Lessons from other aspects such as designing for maintainability, biofouling etc.
- Learning reducing risk for future deployments and demonstrating technology progresses the sector towards commercialisation



Future opportunities

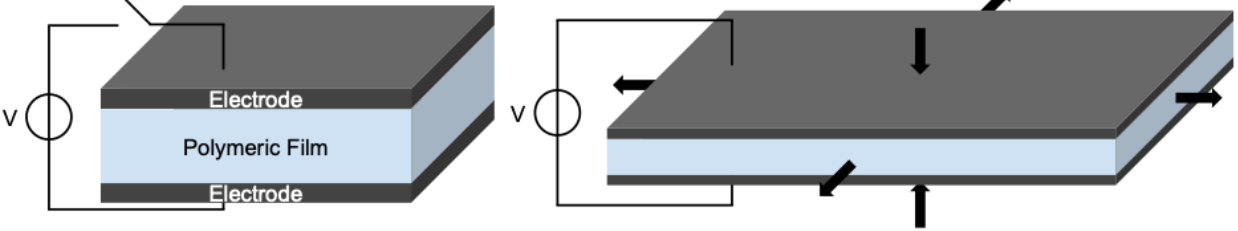
Helping to facilitate array deployment



Developing supply chains



Direct generation



THANK YOU

David Langston and Jillian Henderson

3rd May 2022

