Direct, distributed, flexible wave energy

A cross-sector collaboration opportunity

Contents

- Wave Energy Scotland introduction

- Current areas of focus
  - Commercialising emerging technology
  - Integration with floating offshore wind
  - Next generation technologies

- Direct, distributed, flexible generation
  - Opportunity & benefits
  - WES R&D support strategy
  - Cross-sector collaboration

Wave Energy Scotland

wave energy SCOTLAND

Established in November 2014 as a subsidiary of Highlands and Islands Enterprise

5 competitive programmes:

Power Take-Offs
Wave Devices
Advanced Controls Systems
Structural Materials
Quick Connection Mooring Systems

300 Organisations
132 Projects

Developing cost competitive wave technology

£50M committed expenditure

Delivering objectives through Research, Development & Innovation Programmes

18 Countries

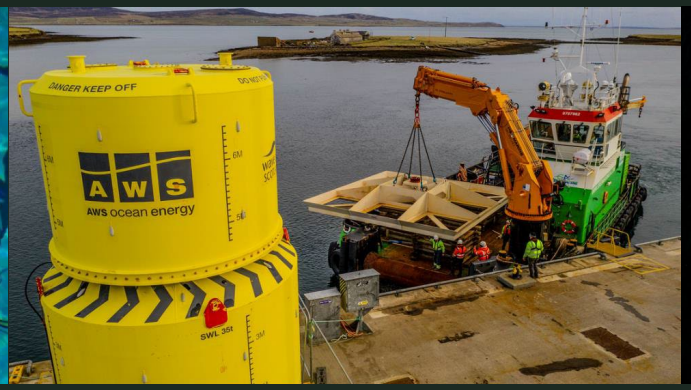
Funded by the Scottish Government

Wave Energy Scotland programme

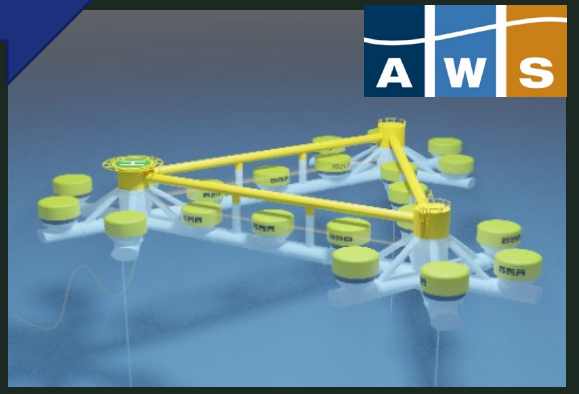
wave energy SCOTLAND

Concept development

Proof-of-concept testing at sea



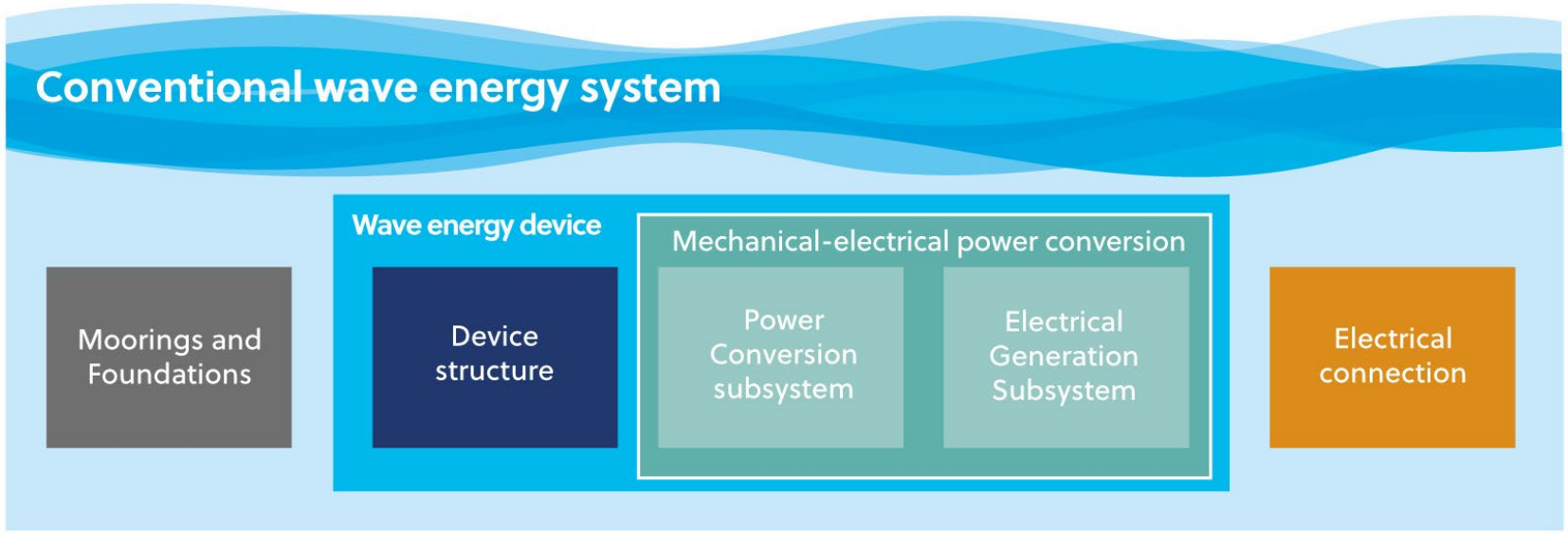
Large-scale demonstration



Scale-up with floating wind

Next Generation wave technology

- Direct, distributed, flexible generation
- Electrostatic generation technologies
  - Flexible properties of polymers, elastomers, and dielectric fluids
  - Variable capacitance metamaterials
  - Waves → stretching, twisting, bending → electrical energy



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Implications for wave energy

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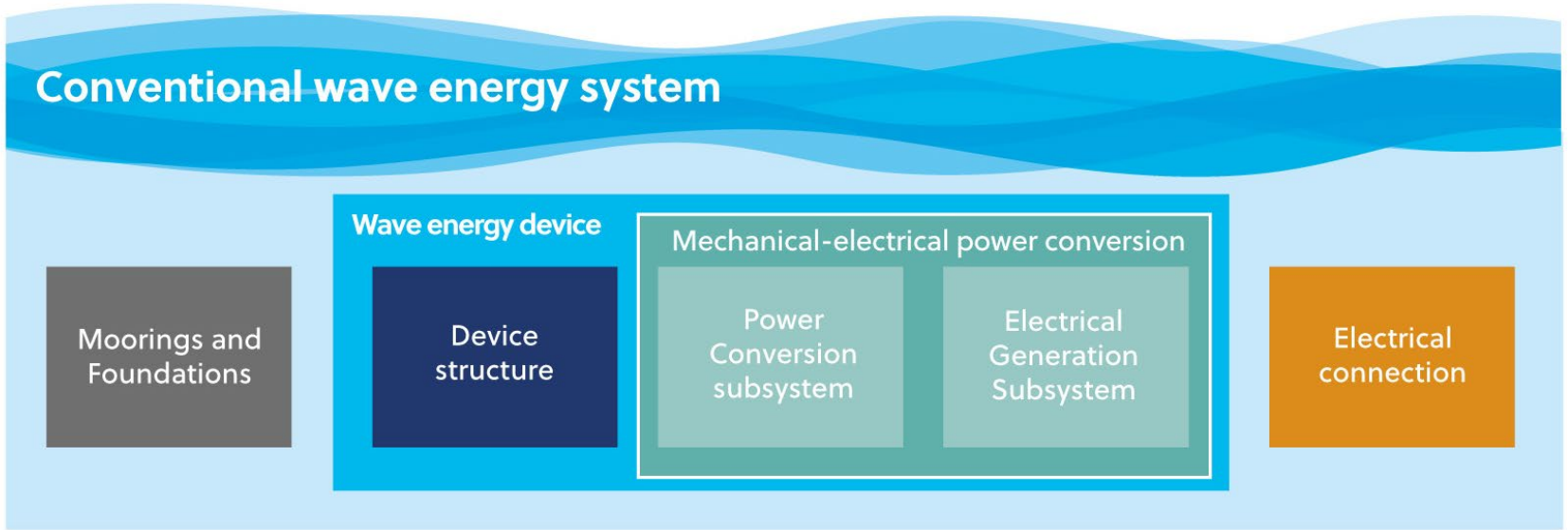
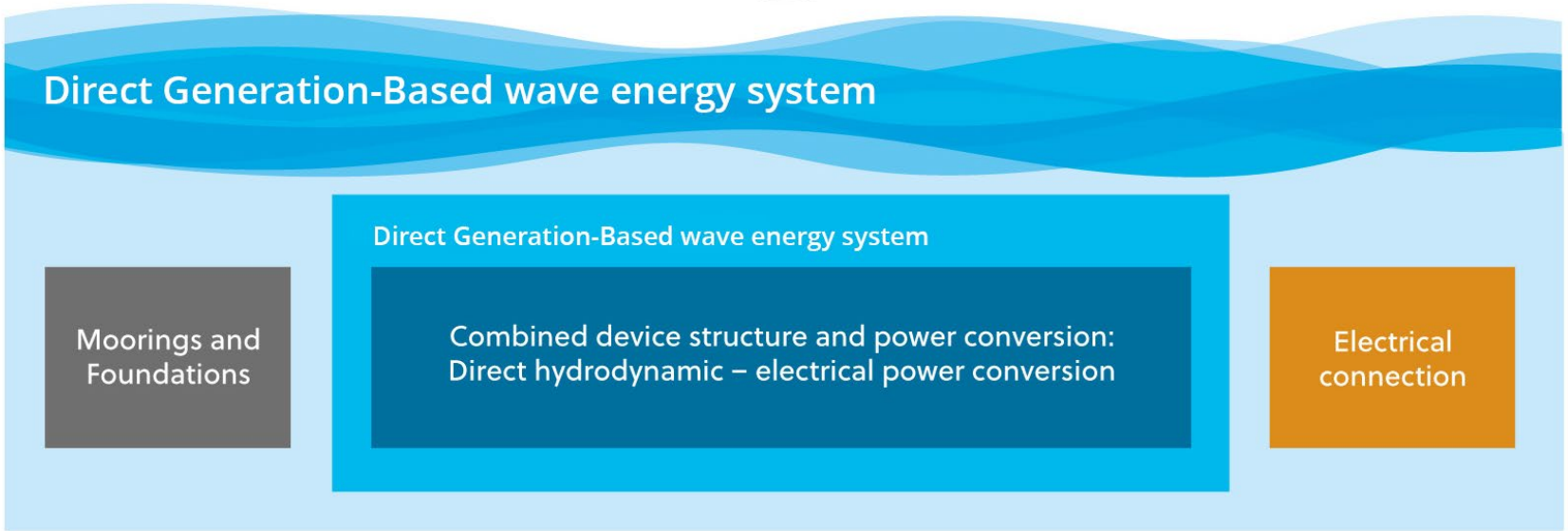


Simplification of wave energy device and impact on LCOE-driver cost centres



Conventional wave energy system

Moorings and Foundations

Wave energy device

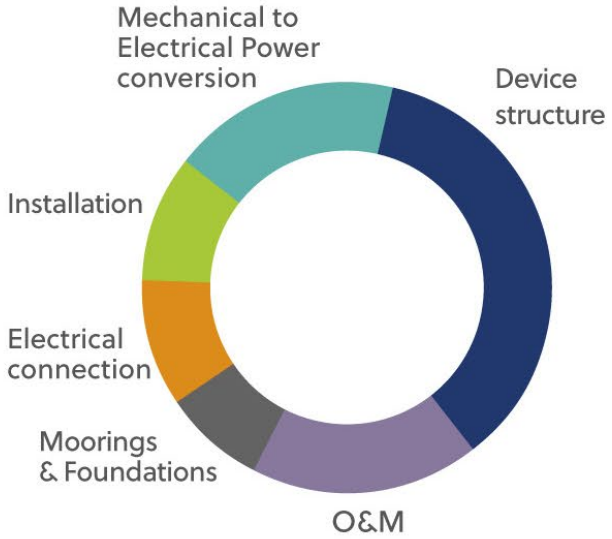
Device structure

Mechanical-electrical power conversion

Power Conversion subsystem

Electrical Generation Subsystem

Electrical connection



Simplification of wave energy device and impact on LCOE-driver cost centres

Direct Generation-Based wave energy system

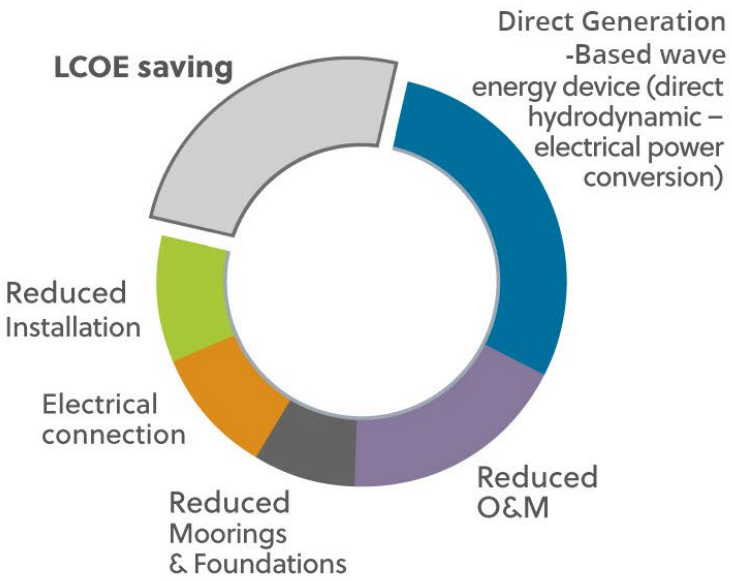
Moorings and Foundations

Direct Generation-Based wave energy system

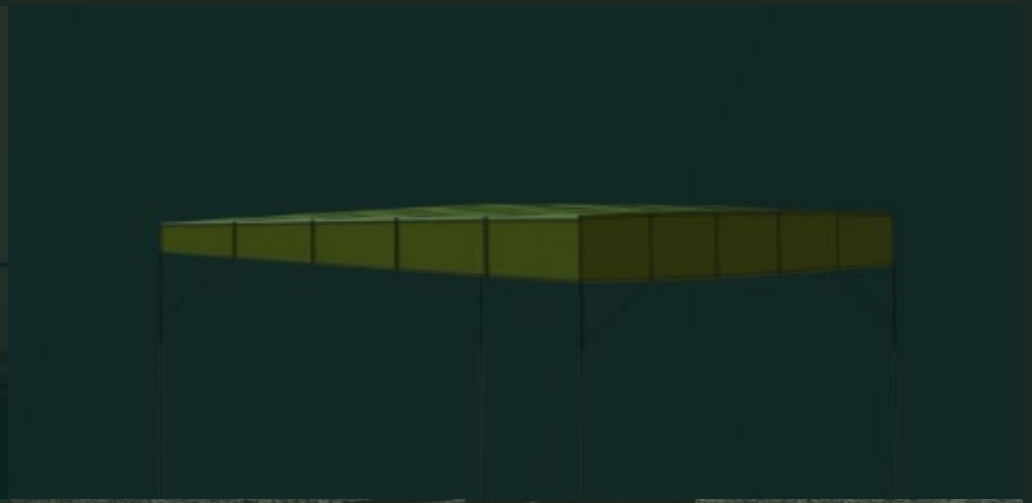
Combined device structure and power conversion: Direct hydrodynamic – electrical power conversion

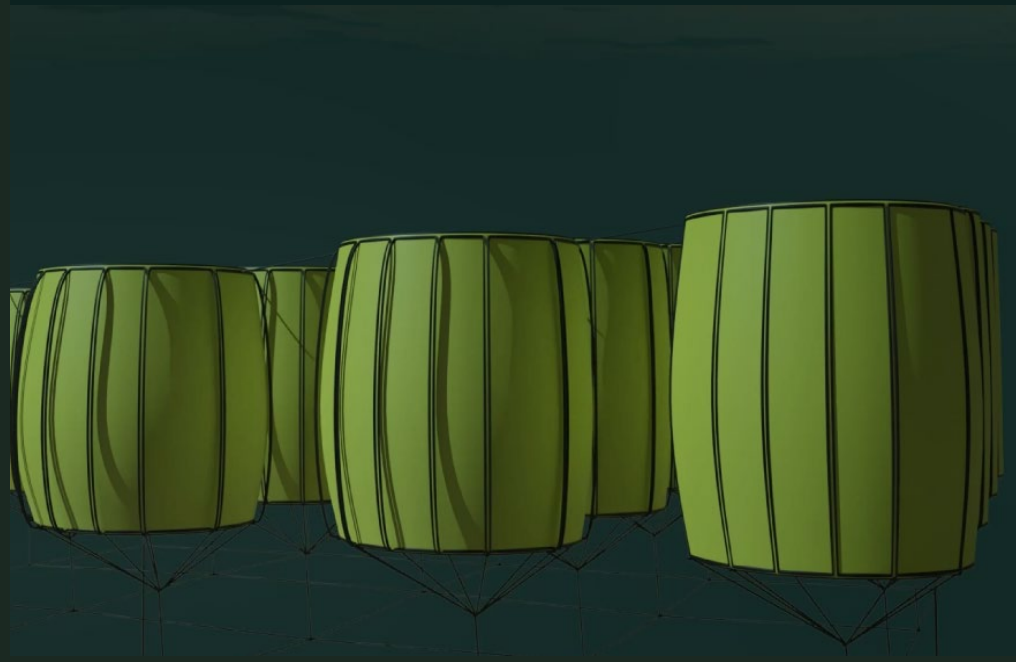
Electrical connection

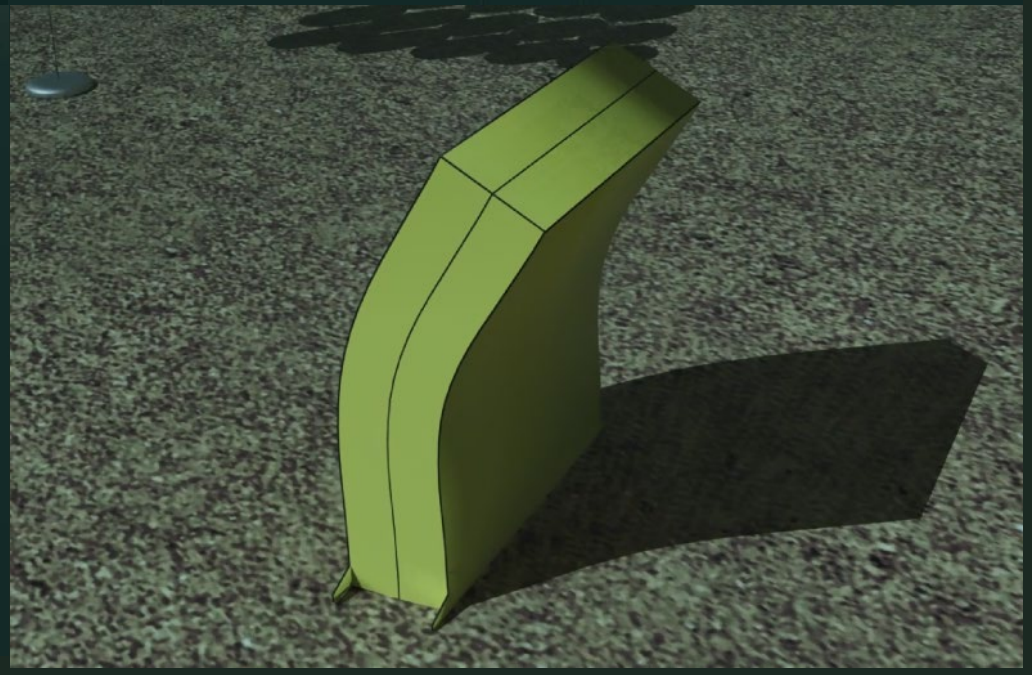
Contributions to LCOE



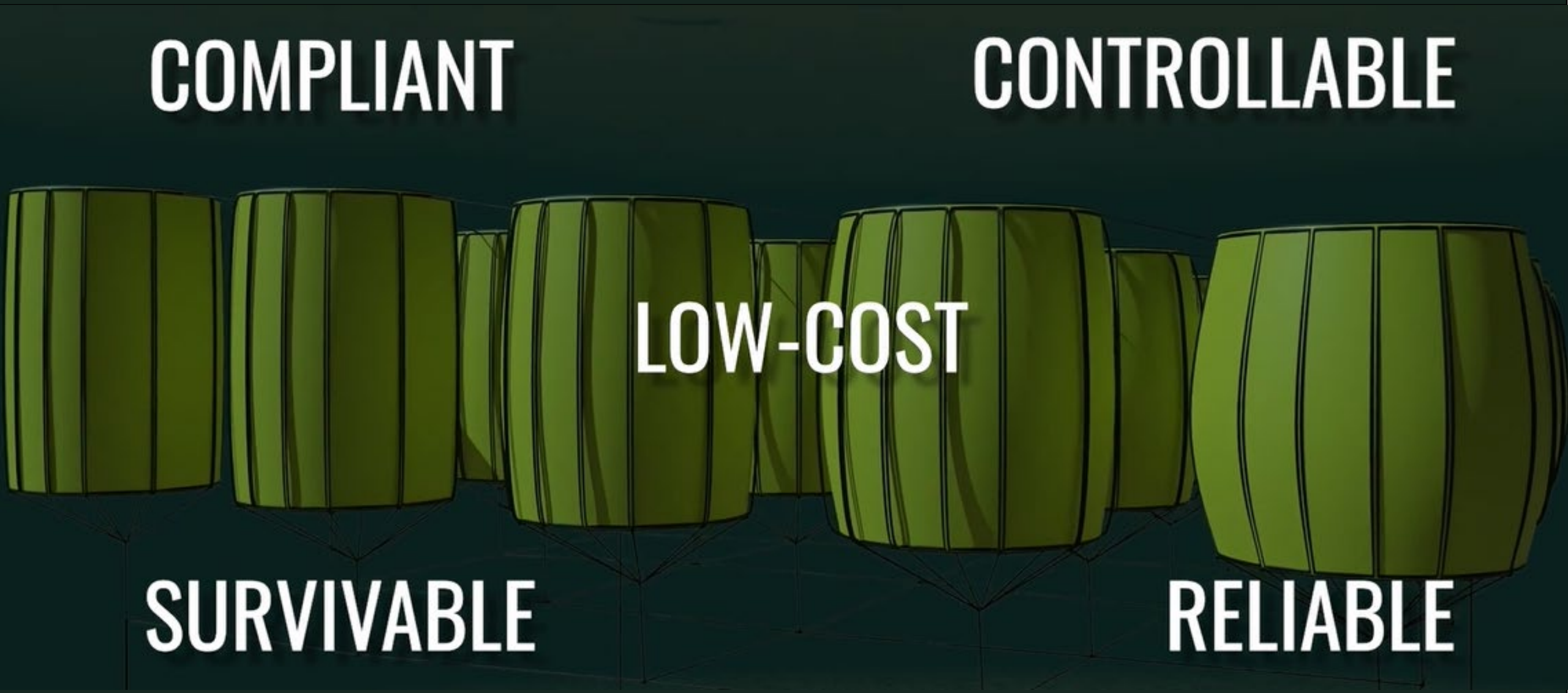
A new class of wave energy converters







Direct, distributed, flexible generation



WES Support Scope

Driving R&D to enable realization of:

- Cell-based/segmented, modular direct generation
  - Scale-up through multiplication
- Distributed generation throughout the device
- Wave device:
  - Minimising non-generating material/components/cost
  - Avoiding high-cost materials
- Flexible materials
- Suitable for repeatable, mass-production processes

Direct Generation Technology Scope

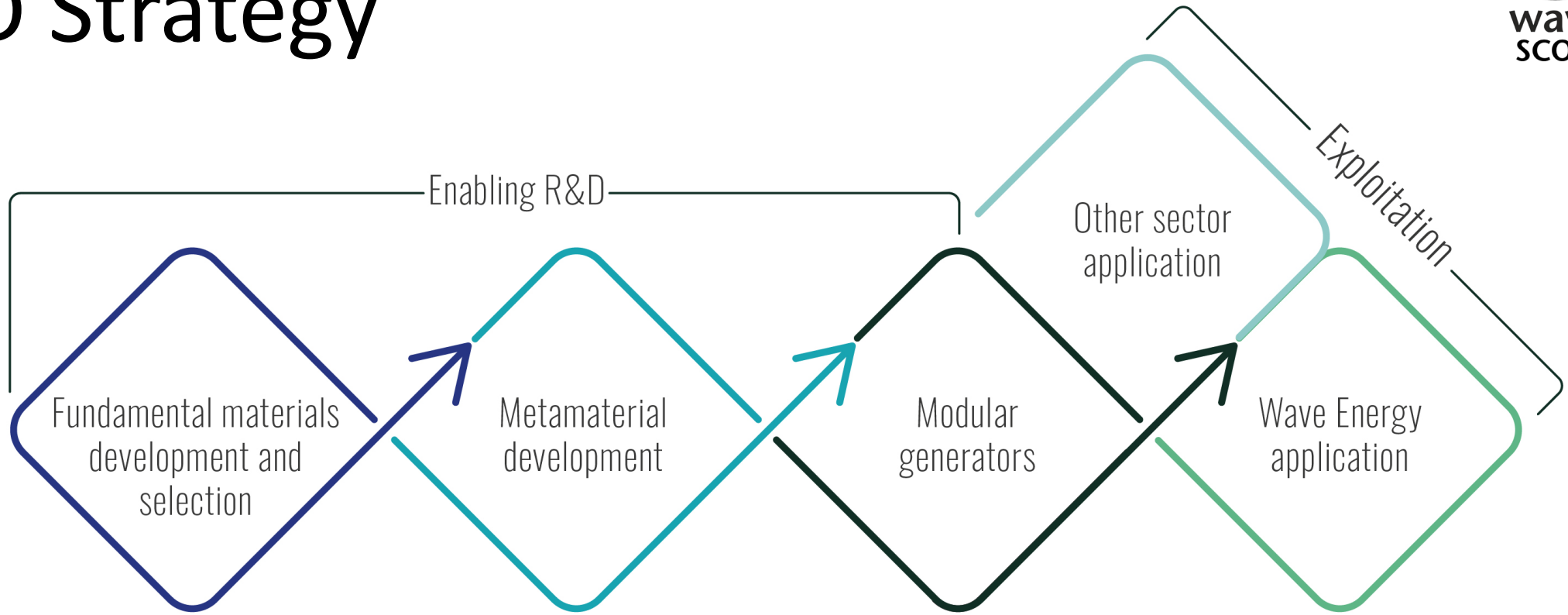
- Landscaping, PhD study and sector collaboration:

- Prioritised technology - variable capacitance metamaterials
  - Dielectric Elastomer Generators
  - Dielectric Fluid Generators

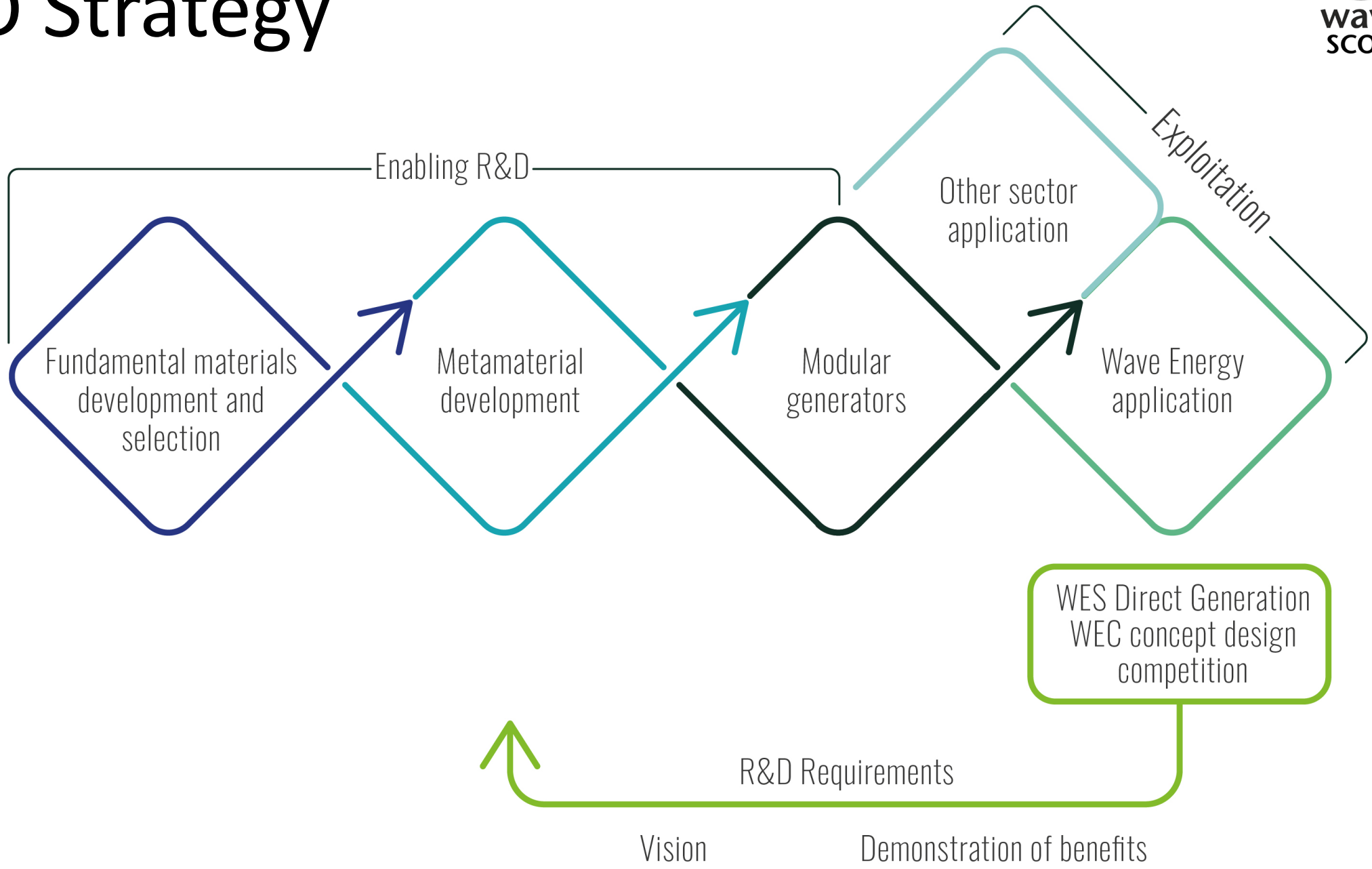
- Transferability
  - Other applications
  - Enabling technologies

Demonstrator on WES stand

R&D Strategy


Enabling R&D
Exploitation
Fundamental materials development and selection
Metamaterial development
Modular generators
Other sector application
Wave Energy application

R&D Strategy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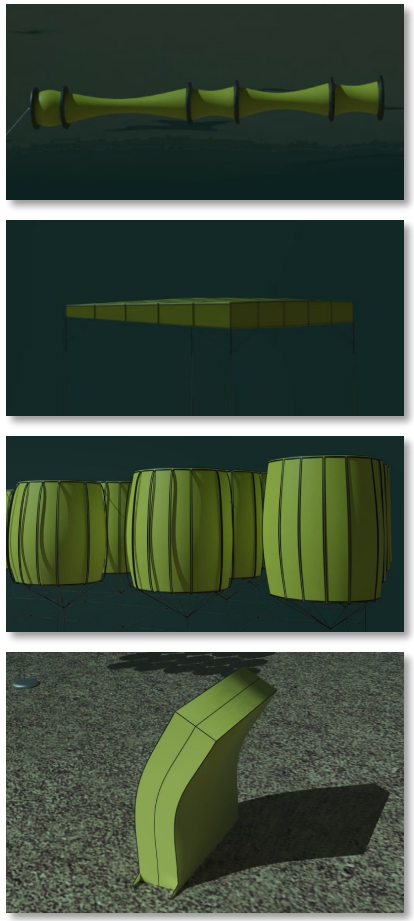
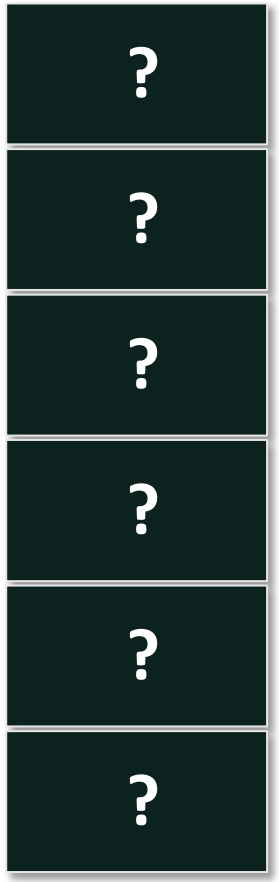
WES Direct Generation
WEC concept design competition
R&D Requirements
Vision
Demonstration of benefits

WES Concept Design Competition

WES concept inspiration



~6 concept design projects

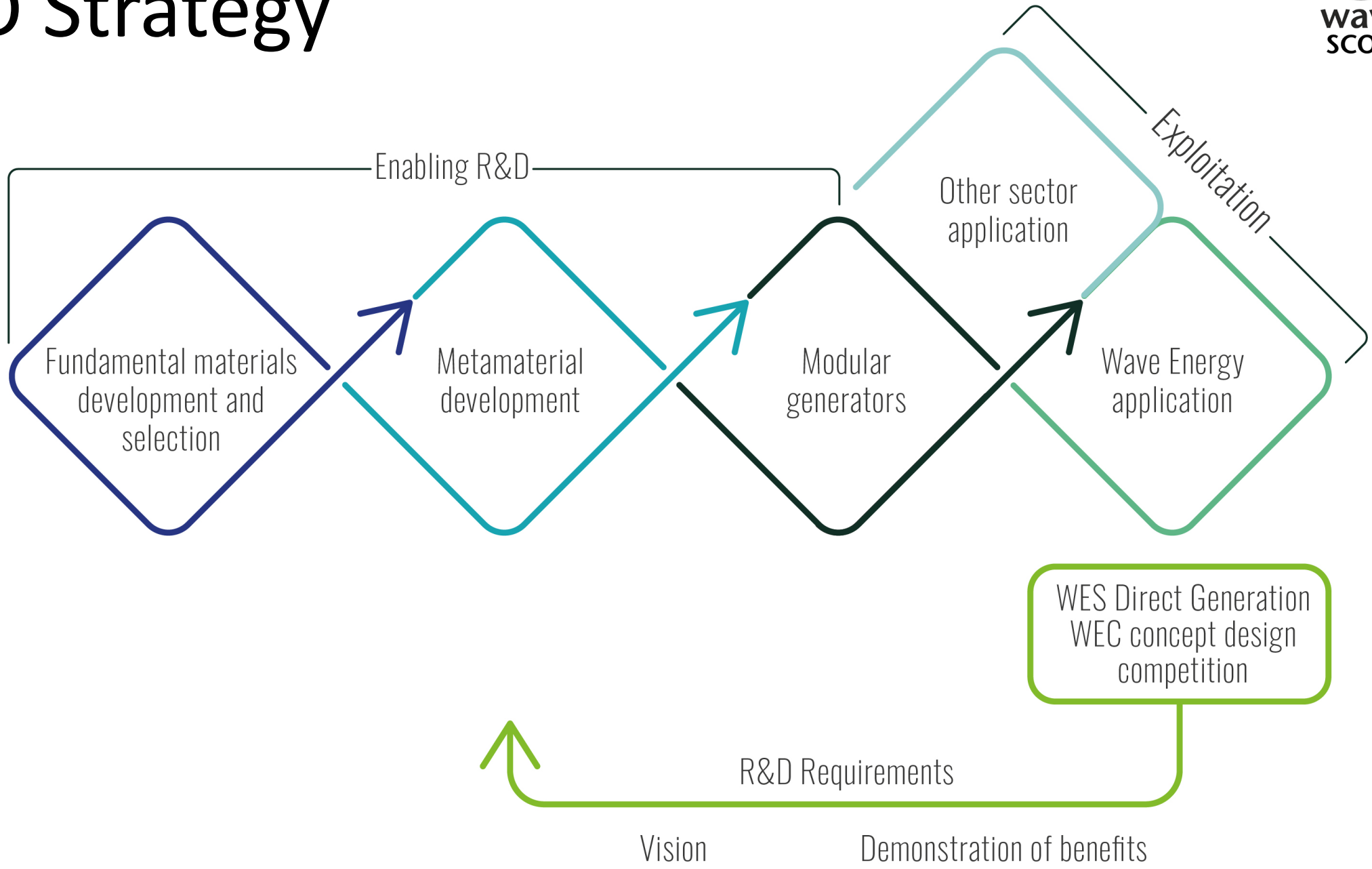


- **Vision**
  - Create novel wave energy system concept
  - Select direct generation technology
    - Cell-based or segmented
- **Quantify benefits**
  - Direct, distributed, flexible wave energy

    vs
  - Existing state-of-the-art
- **Guidance of enabling activities**
  - R&D activities
  - Quantified technology characteristics
- **Teams**
  - Wave energy, elastomers, manufacturing

To be announced Summer 2023 - see www.waveenergyscotland.co.uk

R&D Strategy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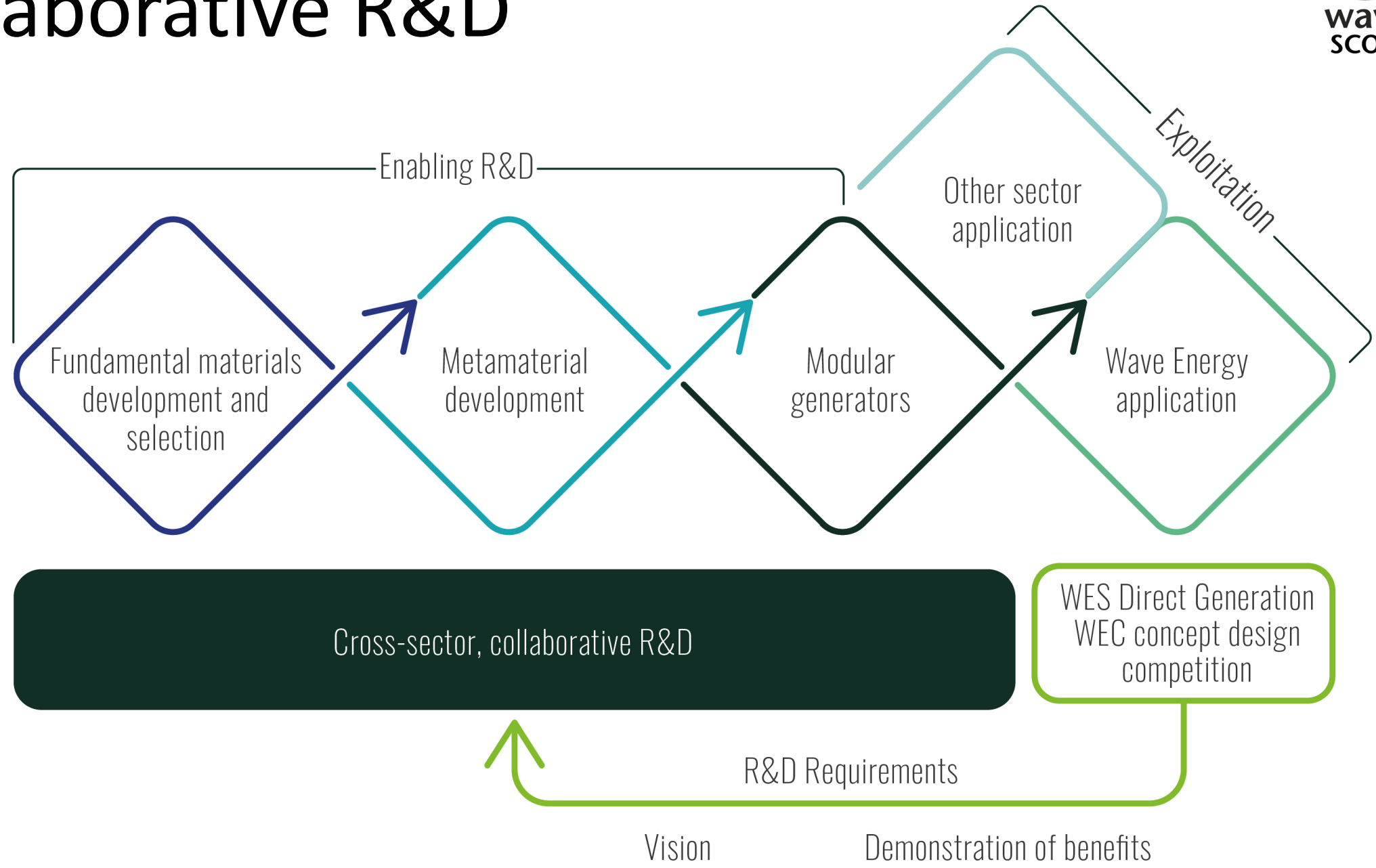
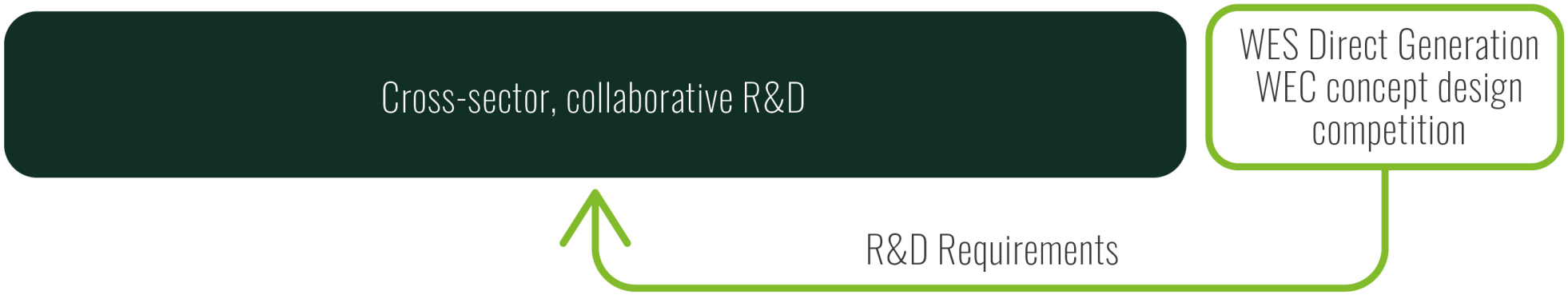
Collaborative R&D





Crossovers

Vision

Demonstration of benefits

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energy-harvesting power-electronics
intelligent-structures resilience actuation
damage-isolation modules
failure lca flexible-electrodes
environment marine
generation fatigue dielectrics
metamaterials uv
sustainability
polymers

Power for Hydrogen production

Other renewable energies

Construction

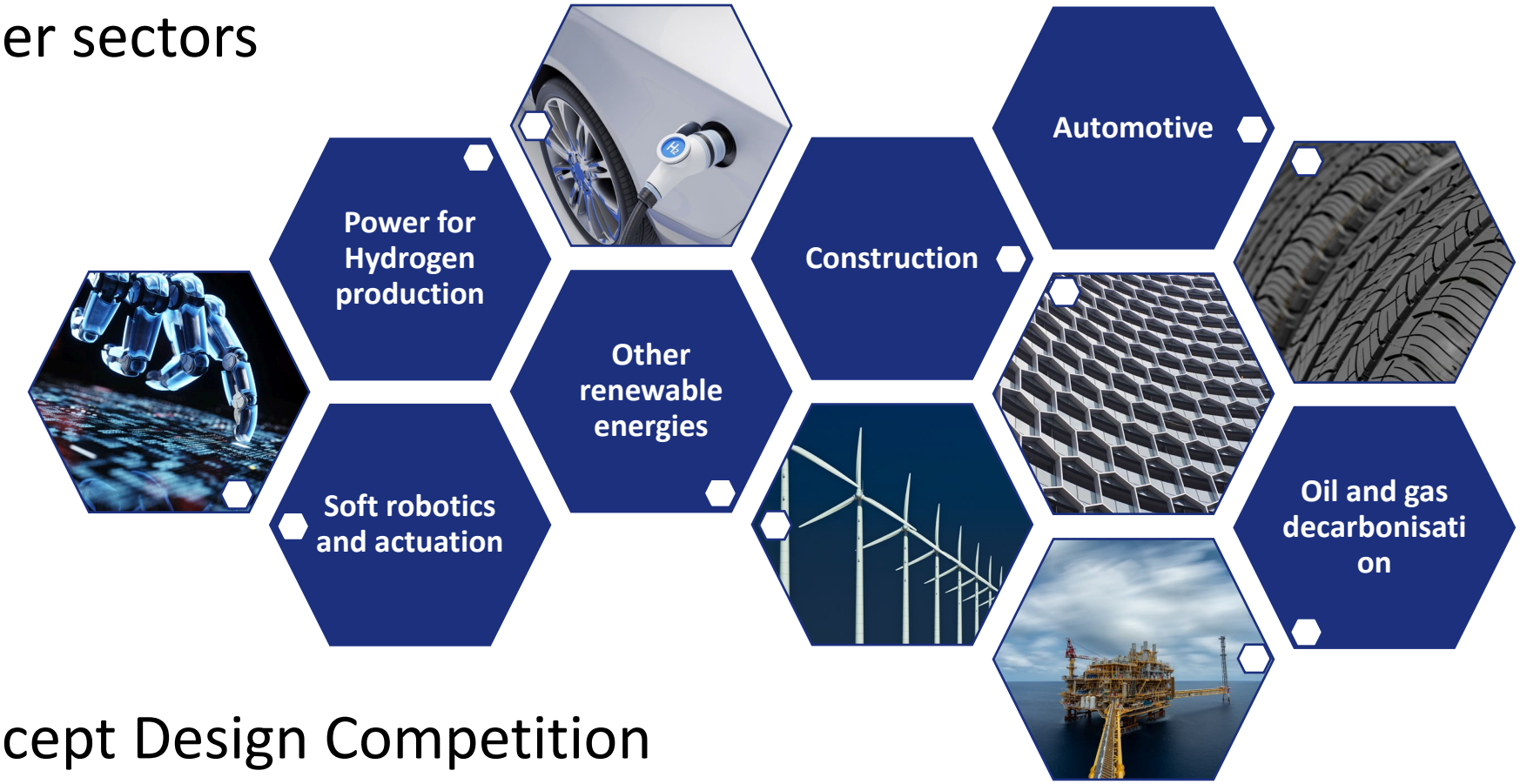
Automotive

Oil and gas decarbonisation

Sectors with potential applications

Seeking

- Partners in wave energy funding calls/projects
- Technology transfer opportunities
- Applications in other sectors



- Participants in Concept Design Competition

Summary

- Direct, distributed, flexible wave energy
  - Enables a new class of wave energy converters
  - Opportunity for significant cost reduction
- WES strategy
  - Concept Design Competition
  - Cross-sector, collaborative R&D in enabling technologies
- Work towards WES-style technology development programme

Please contact us:

jonathan.hodges@waveenergyscotland.co.uk

Updates on WES support:

www.waveenergyscotland.co.uk