Towards a low carbon energy future

17th November 2008

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Marine Renewable Energy Current Status and Future Perspectives

Prof Robin Wallace
Institute for Energy Systems
University of Edinburgh

Overview

Marine energy options
UK potential and opportunity for growth
UK marine energy infrastructure
Environmental sustainability
Remaining R&D challenges
A view to the future

Marine Energy Options

Wave	Shoreline
	Near-shore
	Far-shore
Tidal	Range
	Current
Ocean	Current
	Thermal

There are shoreline devices such as the Wavegen Limpet Oscillating Water Column on Islay rated 1 x 250 kW

Marine Energy Options

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Ocean Power Technologies, a UK:US company has launched Powerbuoy, a Point Absorber rated 50 kW in Spanish waters.

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Tidal	Range
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Pelamis Wave Power have just installed three articulated attenuators connected to the Portugal electricity network – rated 3 x 750 kW

Marine Energy Options

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La Rance built 1960s. Peak range 13.5m, average 8m. 24 x 10 MW bulb turbine generators. Annual production 600 GWh, average power 68MW

Marine Energy Options

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Earlier this year OpenHydro installed a 250 kW open flow tidal current turbine in Orkney connected to the network

Marine Energy Options

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Marine Current Turbines SeaFlow has been operating in the Bristol Channel for three years and is rated 300 kW

Marine Energy Options

Wave	Shoreline
	Near-shore
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Tidal	Range
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Marine Current Turbines have just installed SeaGen in Strangford Lough – a twin propeller device rated 1500 kW and connected to the NI network

Marine Energy Options

Wave	Shoreline
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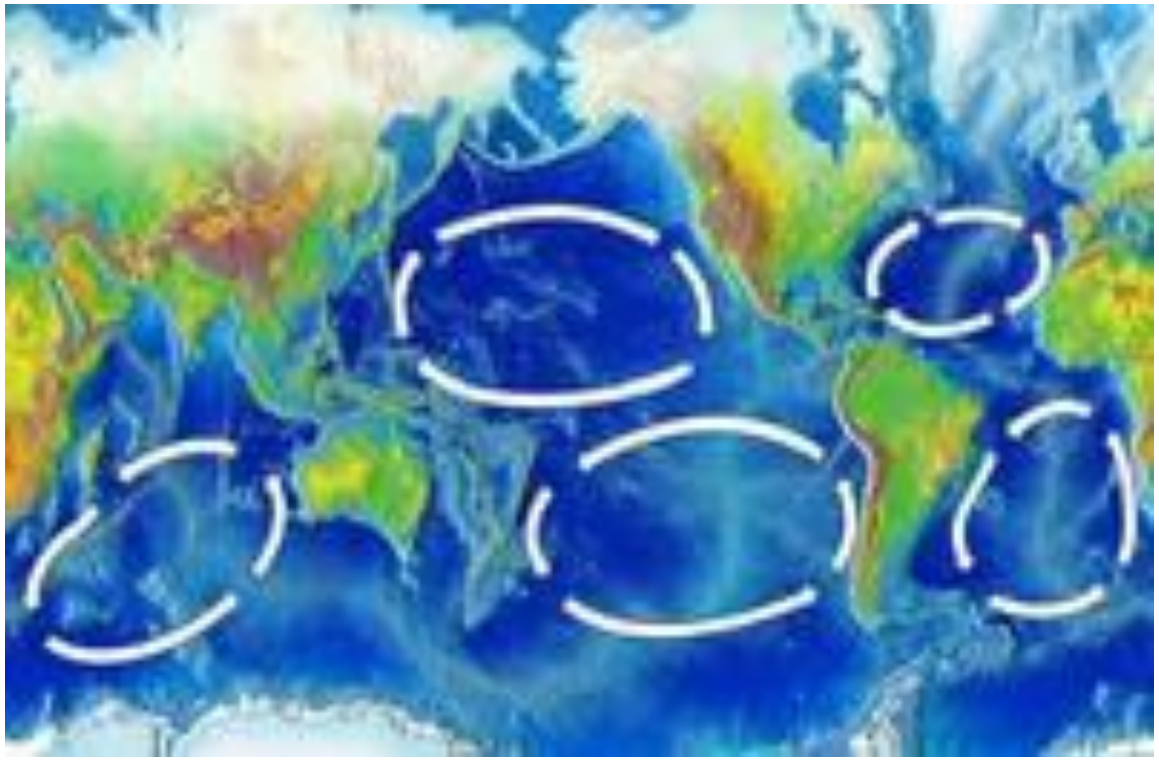

Form on sides of ocean basins carrying warm water from the tropics towards the poles. Enormous, lower intensity resources such as the Gulf Stream, Kuroshio, California Current – exploitation more of a challenge.

Marine Energy Options

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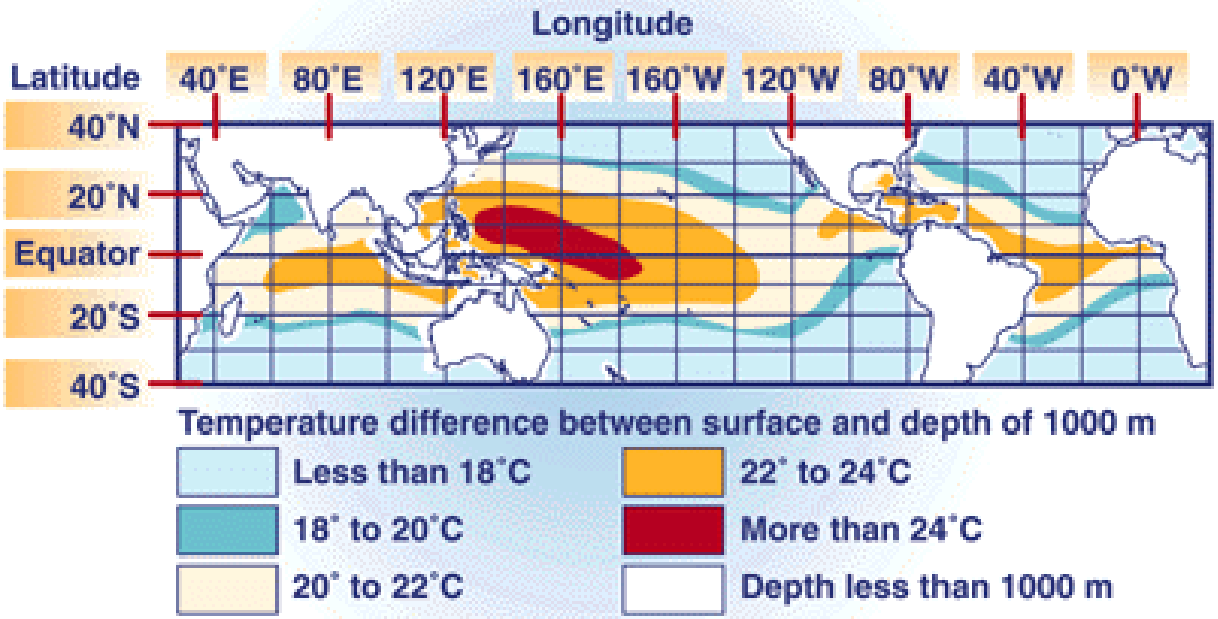
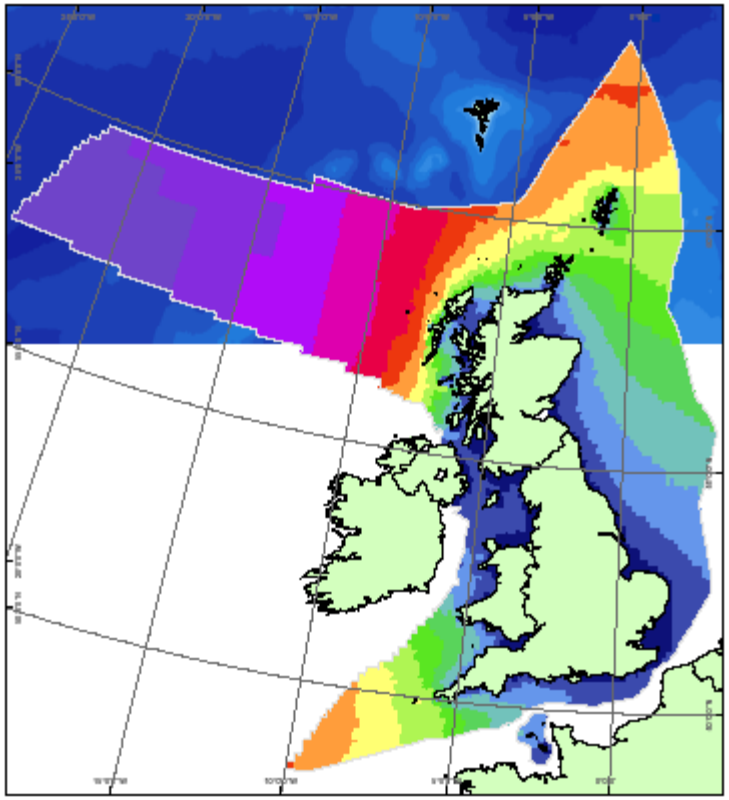
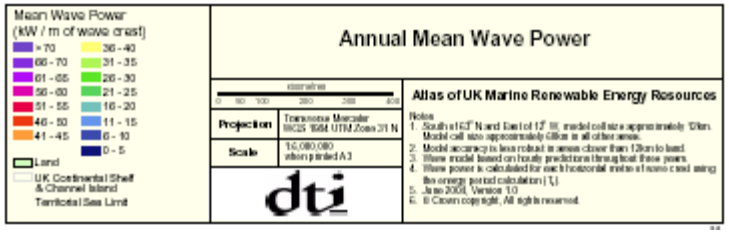


OTEC systems aim to use solar induced thermal gradient to drive a power-producing cycle, where the reachable temperature differs at least 20°C. Largely equatorial.

UK Potential

		(TWh/yr)	(MW)
Wave	Shoreline	0.2	65
	Near-shore	7.8	2600
	Far-shore	50	16000
Tidal	Range		
	Current		

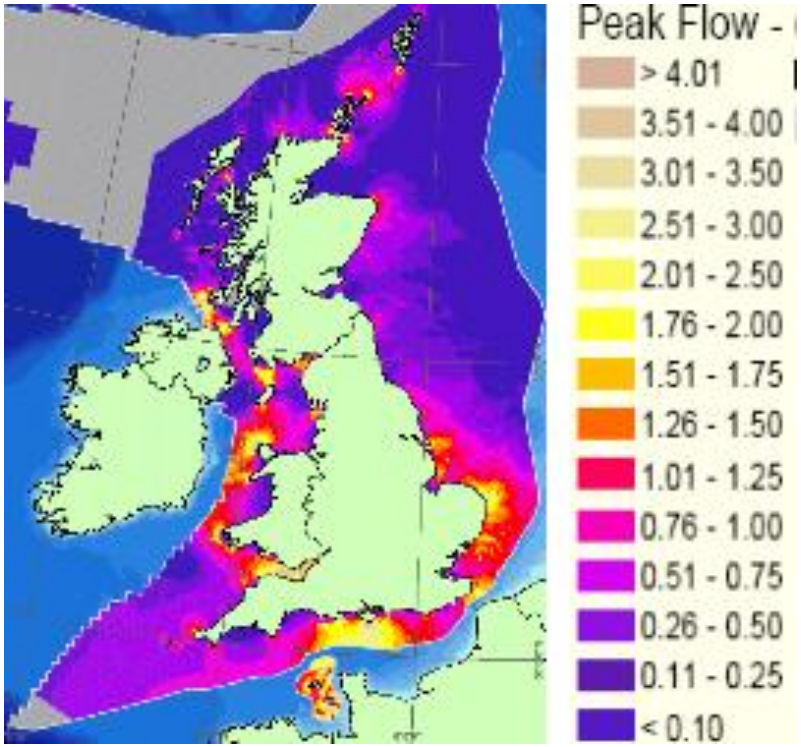




Located at the eastern edge of the Atlantic Ocean the UK has some of the best wave resources in the world.

UK Potential

		(TWh/yr)	(MW)
Wave	Shoreline	0.2	65
	Near-shore	7.8	2600
	Far-shore	50	16000
Tidal	Range	18	~6000
	Current	18	~6000



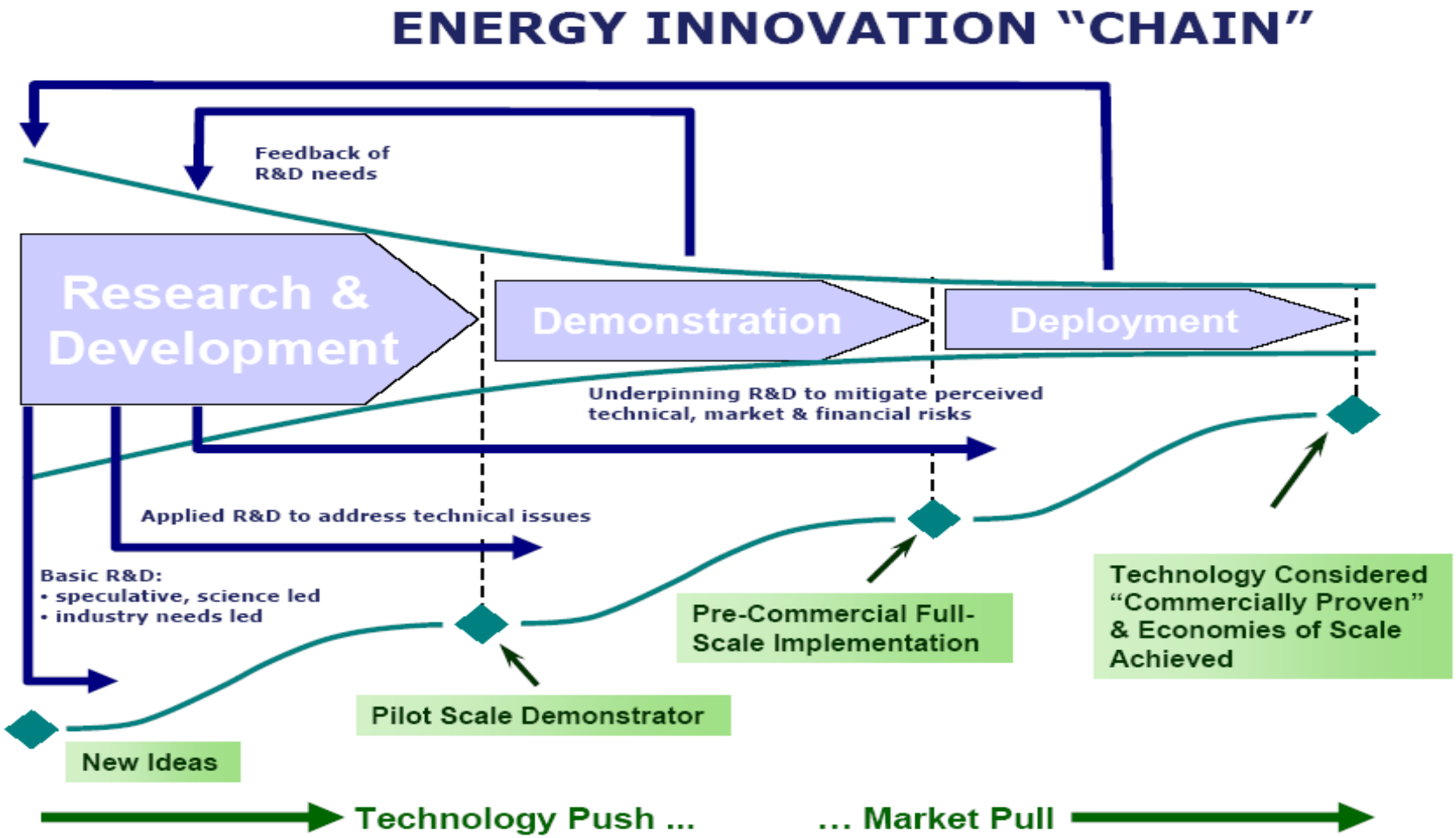
Positioned between the Atlantic Ocean and North Sea, the UK has some of the best tidal current resource in the world.

Resource Assessment

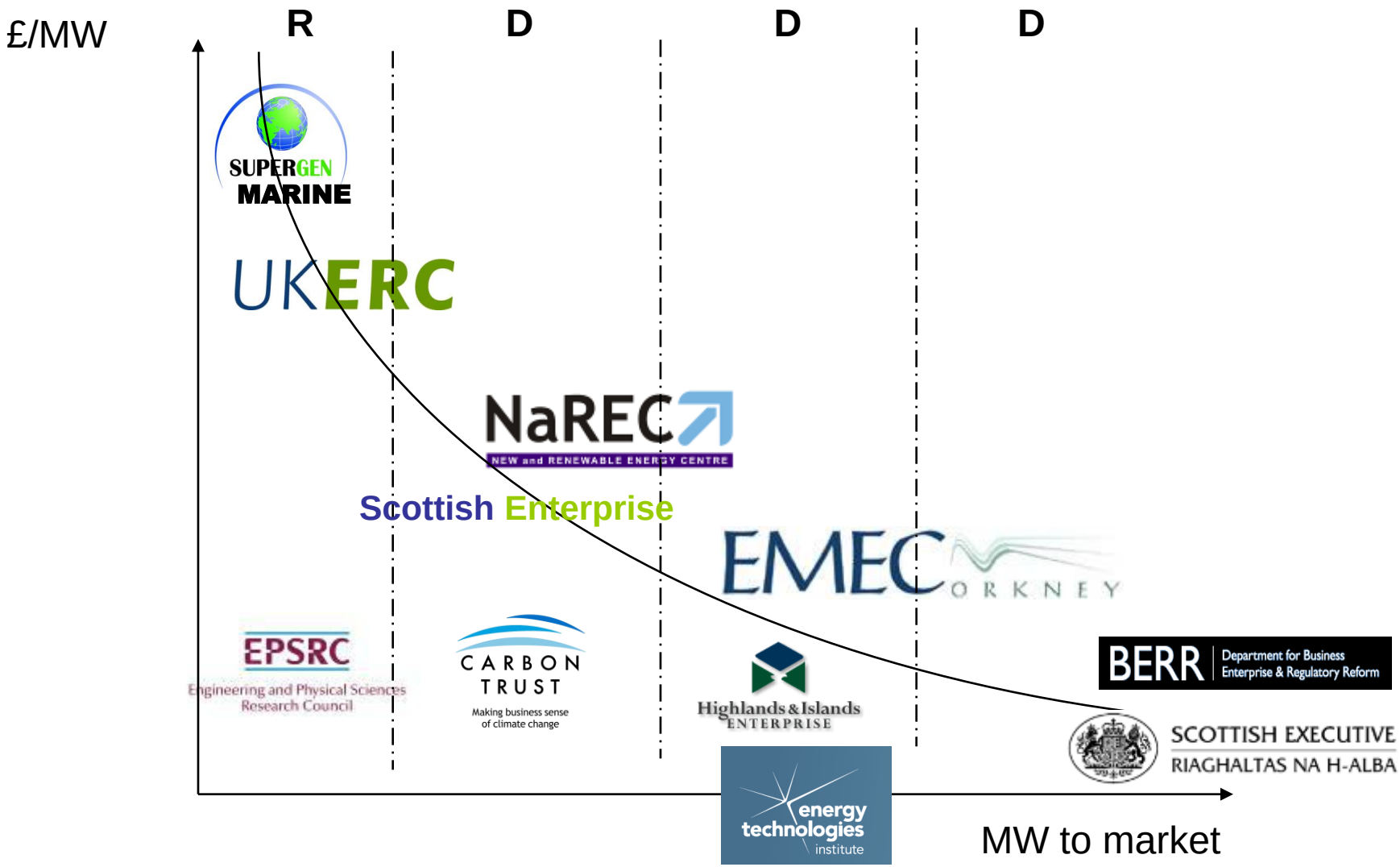
Needs to be considered in four phases:

- **Theoretical resource:** A top level statement of the energy contained in the entire marine resource.
- **Technical resource:** That portion of the theoretical resource that can be exploited using existing technology options.
- **Exploitable resource:** That portion of the technical resource that can be exploited after consideration of external constraints (eg grid accessibility, competing use (shipping lanes, etc.), environmental sensitivity)
- **Economic resource:** That portion of the exploitable resource that is economic to develop subject to the prevailing commercial framework and market conditions.

UK marine energy infrastructure



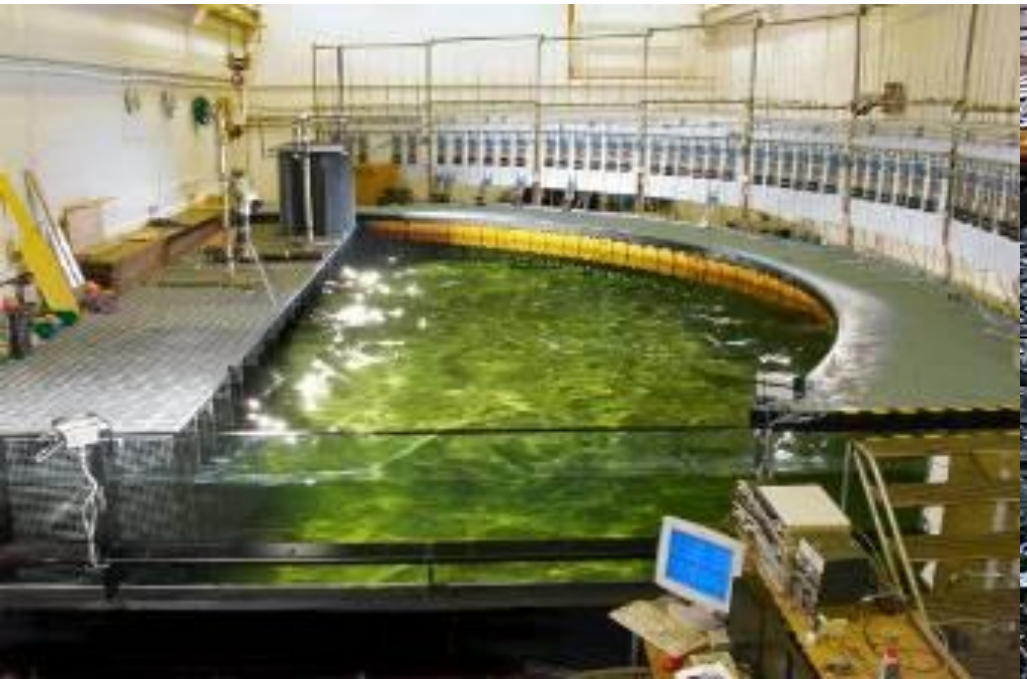
UK marine energy infrastructure



UK marine energy infrastructure

World-class research in 16 universities, including the EPSRC SuperGen Marine Energy Research Consortium

- around 100 academics and research staff
- 12 wave tanks, at least as many wave flumes
- 16 towing or pumped tidal current tanks
- 6-10 other specialised, dedicated labs
- a few have devices under development



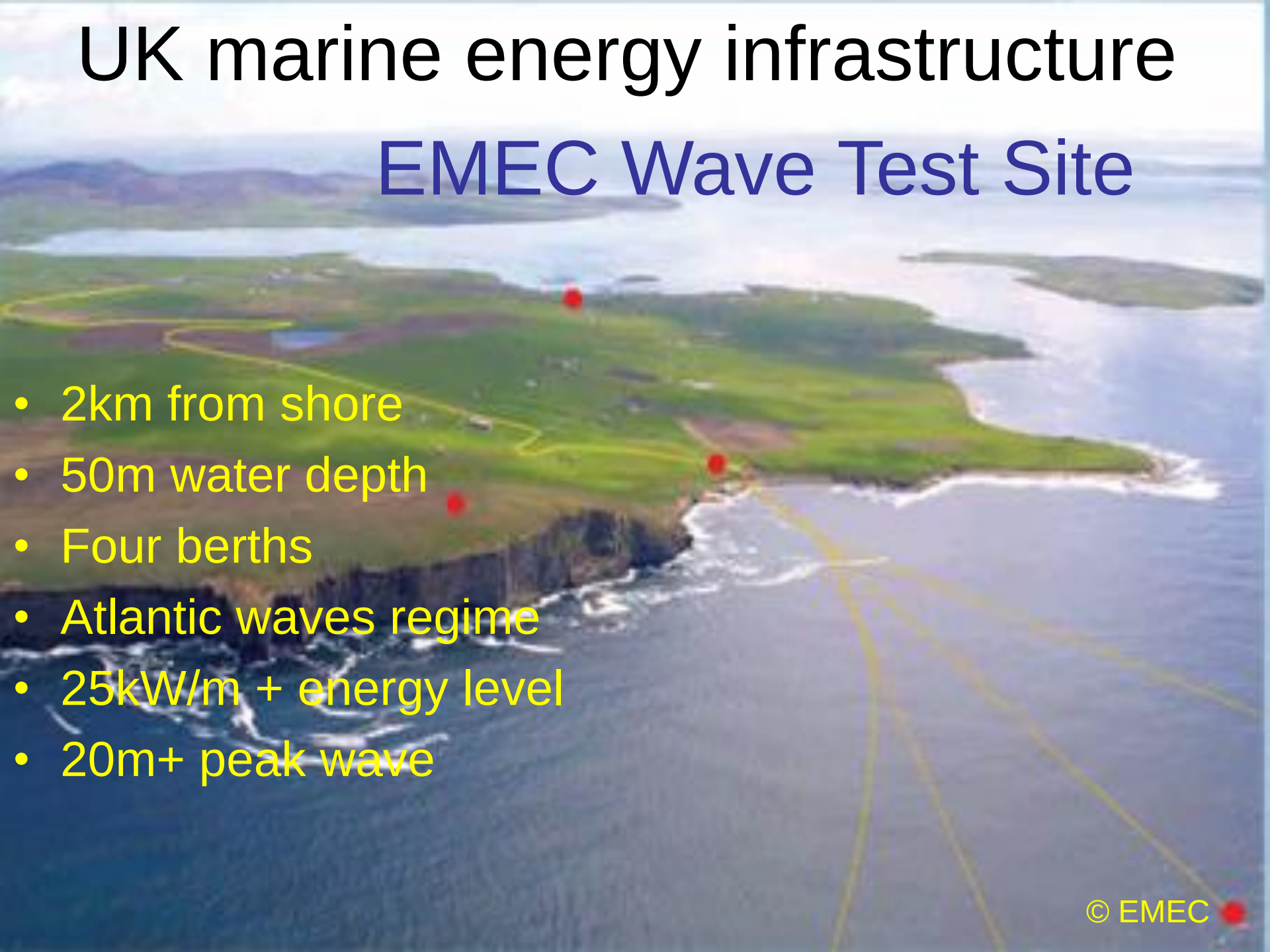
UK marine energy infrastructure

At NaREC in the NE there is a 1/10th scale wave and tidal test facility and blade test centre

There are plans for a commercial Wave Hub in the SW with installation in Spring 2010

UK marine energy infrastructure

EMEC Wave Test Site



- 2km from shore
- 50m water depth
- Four berths
- Atlantic waves regime
- 25kW/m + energy level
- 20m+ peak wave

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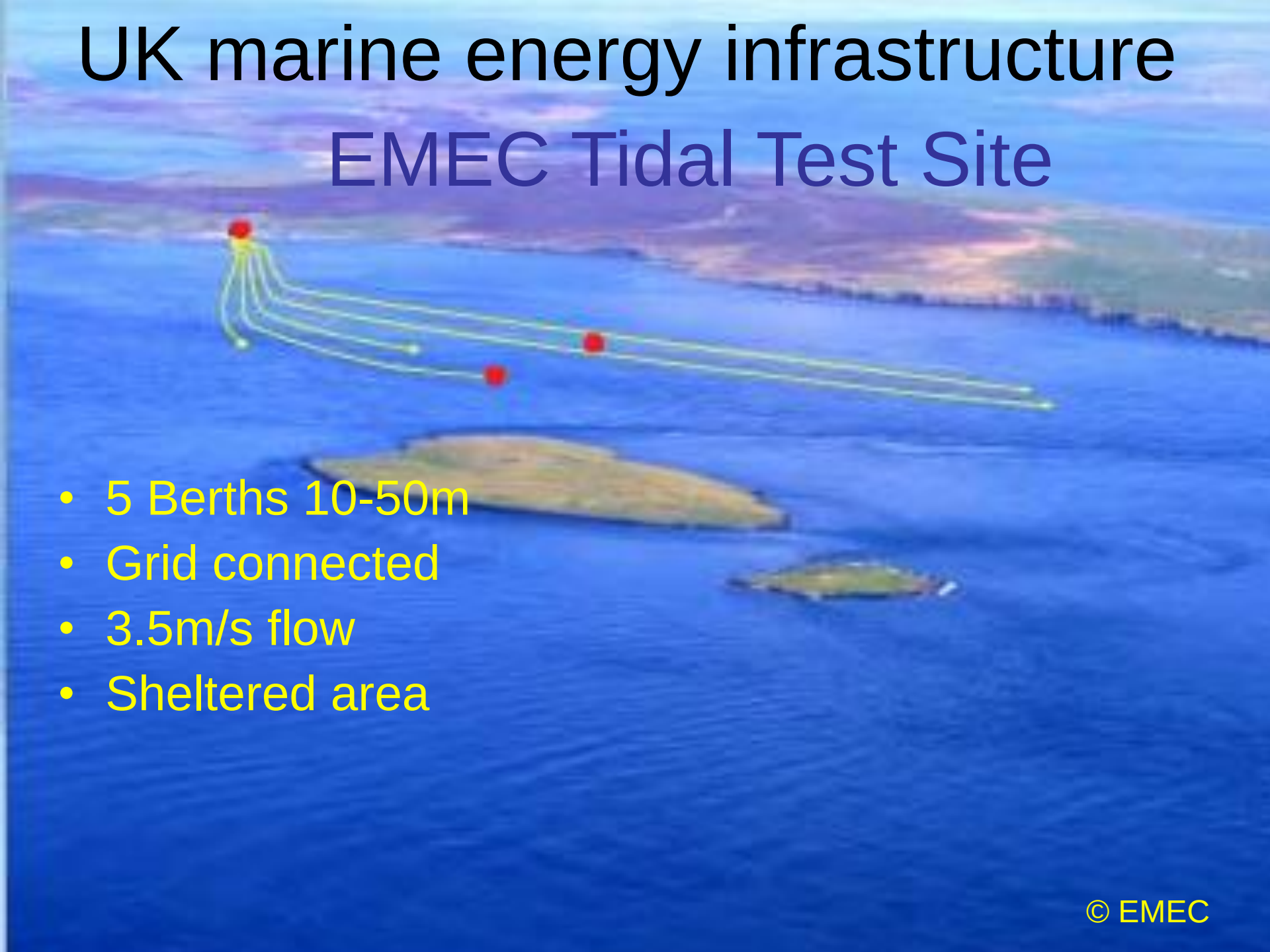
UK marine energy infrastructure

EMEC Tidal Test Site



- 5 Berths 10-50m
- Grid connected
- 3.5m/s flow
- Sheltered area

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Environmental Sustainability

Benthic impacts that will occur during construction, operation & maintenance, decommissioning need to be assessed

– including modifications to

- ecology (habitats and species)
- seascape and coastal landscape
- noise regime
- sediment transport
- water quality
- other users' access

Background and foreground studies essential

Remaining R&D Challenges

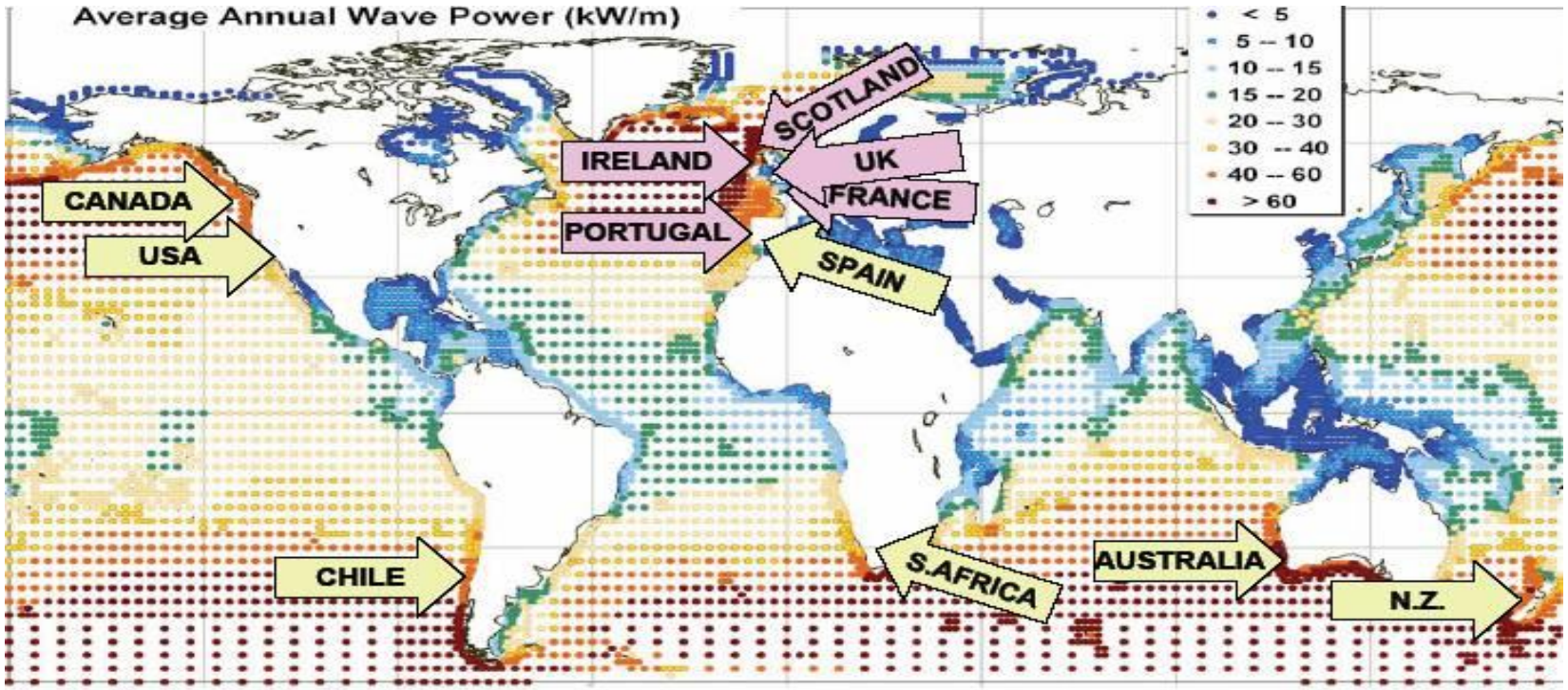
The UKERC Road Map identified research challenges to establish the industry as:

- Availability of test facilities across the range of scales
- Moorings and foundations for progressively deeper water
- Resource spatial and temporal modelling
- Resource:device modelling
- Integrated PTO designs and control
- Installation and O&M techniques
- Industry standards & life cycle analysis
- Design for survivability and yield
- Electricity network infrastructure and technology
- Economic appraisal & policy interaction

SuperGen Marine Energy Research

WS1	Numerical and physical convergence
WS2	Optimisation of collector form and response
WS3	Combined wave and tidal effects
WS4	Arrays, wakes and near field effects
WS5	Power take-off and conditioning
WS6	Moorings and positioning
WS7	Advanced control and network integration
WS8	Reliability
WS9	Economic analysis of variability and penetration
WS10	Ecological Consequences of Tidal & Wave Energy Conversion
WS11	Doctoral Training Programme
WS12	Inreach, dissemination and outreach

A view to the future



Data from the ECMWF (European Centre for Medium-Range Weather Forecasts) WAM model archive -calibrated and corrected by OCEANOR against a global buoy and Topex satellite altimeter database.

As sector has evolved from R&D to an industry, interest in UK and European activity has grown around the world with SuperGen and UKERC assisting in programme development.

A view to the future

There has been considerable progress this decade. The opportunity is not in the near future resource limited. Sustained effort over 2020 and 2050 timescales will mature technology and expand sector world-wide.

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