Ryan Davidson

Business Development Lead, CalWave

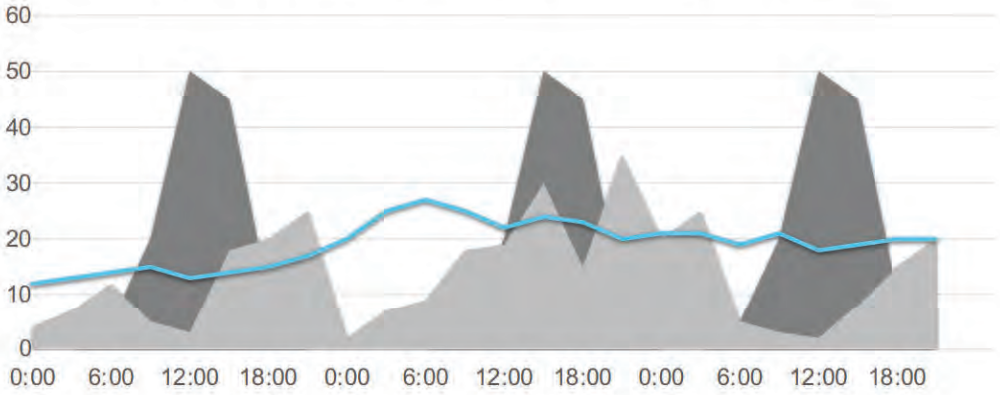

CALWAVE
Unlocking the Power of the Ocean


CALWAVE
CalWave's Vision:
Unlocking the power of ocean waves to secure a clean energy future

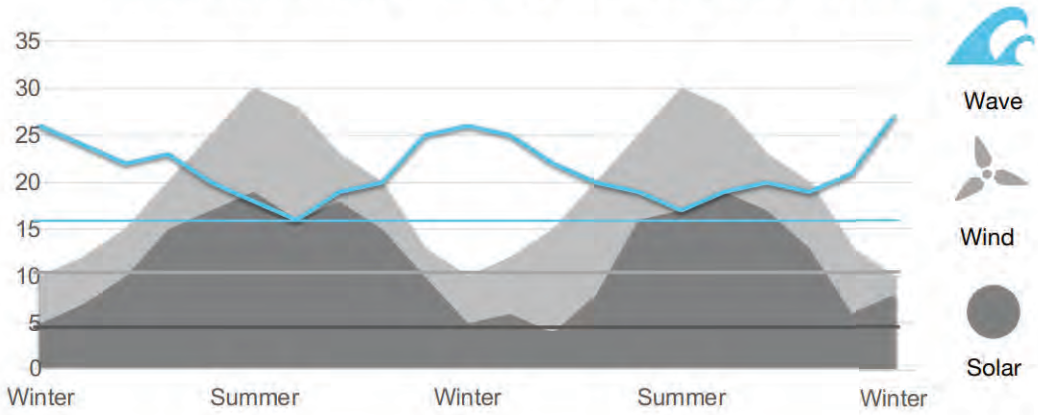
CALWAVE

Wave power is more consistent, predictable, and energy-dense than both solar and wind power.

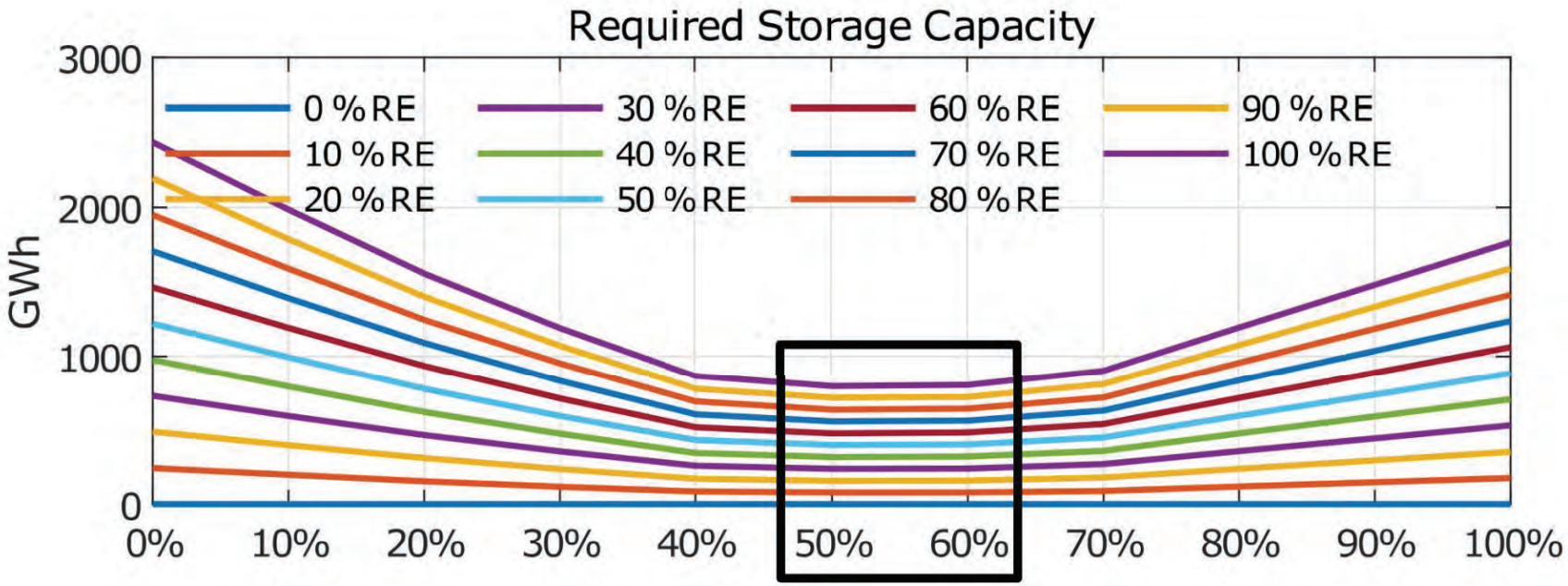
Daily variability of renewables



Annual variability of renewables



Required storage capacity is always minimized when marine renewable energy makes up 50-60% of our renewable energy portfolio.



Source: PNNL

CALWAVE

Differentiation

Surface devices

Bottom devices

Efficient

+

Effective Shut Down

CALWAVE

CALWAVE

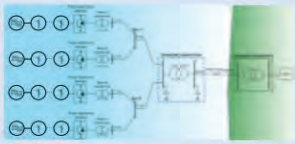
Our xWave Technology

Key Features

- Operates fully submerged
- Autonomous shutdown
- Scalable farms (1 to 500+ MW)
- Over 40% capacity factor
- Designed to operate 20+ years
- O&M lower than offshore wind

CALWAVE

Timeline

PHASE	2015-20	2021-22	2022-23	2024	2025	2026+
	Design, Dry testing	Open-ocean pilot, SD	Design, project development	Staging full-scale deployment	Full-scale deployment	Global expansion
COMPANY HIGHLIGHTS	cyclotronroad Activate WAVE ENERGY PRIZE Breakout Labs 1517 SOA 	U.S. DEPARTMENT OF ENERGY AUTODESK. HIGHTIDE FOUNDATION MICHELIN Greentown Labs LAUNCH ALASKA Google for Startups 	U.S. DEPARTMENT OF ENERGY THIRD DERIVATIVE RMI CNBC nationalgrid Baker Hughes ABS 	x200 PacWave construction EPC and offshore wind project developer partnerships 	x200 PacWave deployment Technology certification for first-of-a-kind project financing 	Serial production and commercial rollout Larger utility-scale farms and project financing Either standalone farms or co-located with offshore wind 

$22M secured from the US Department of Energy

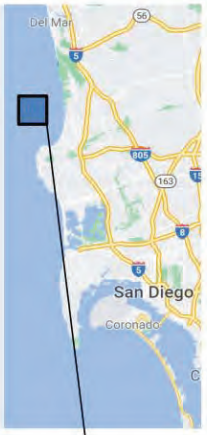
2021-22 San Diego ocean pilot – US record

Location: SIO, San Diego

Duration: 10 months

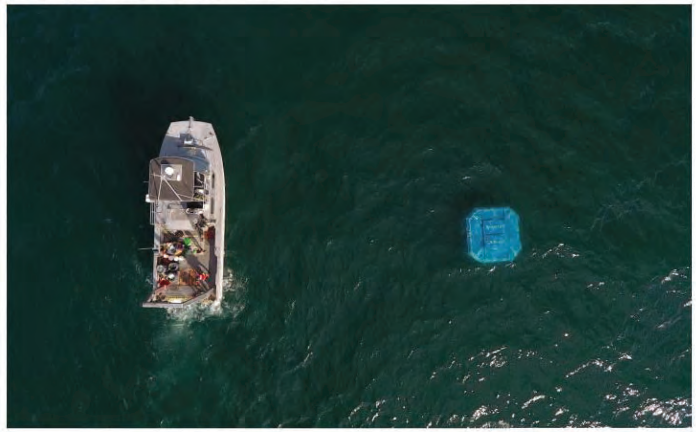
Pilot campaign goals:

- TRL 7
- Performance
- Reliability

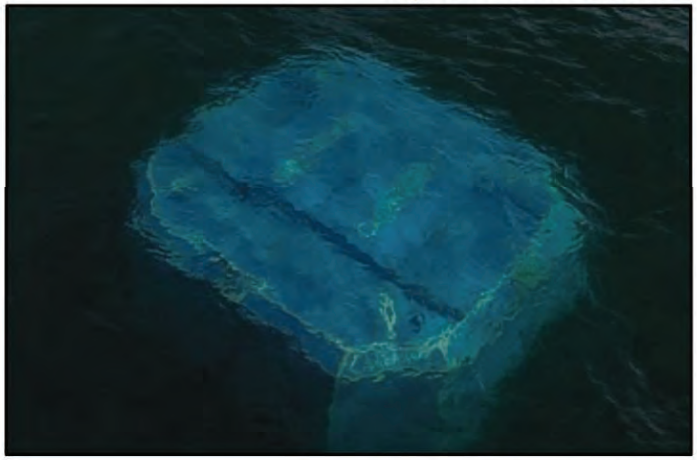


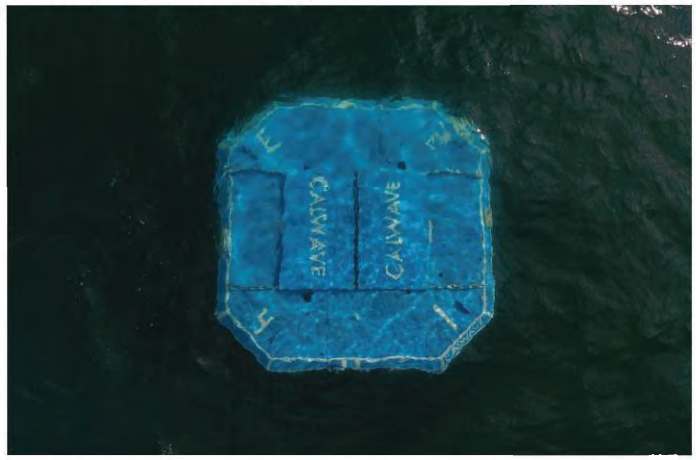
Scripps research pier, CalWave deployment site

Installation and maintenance on the surface

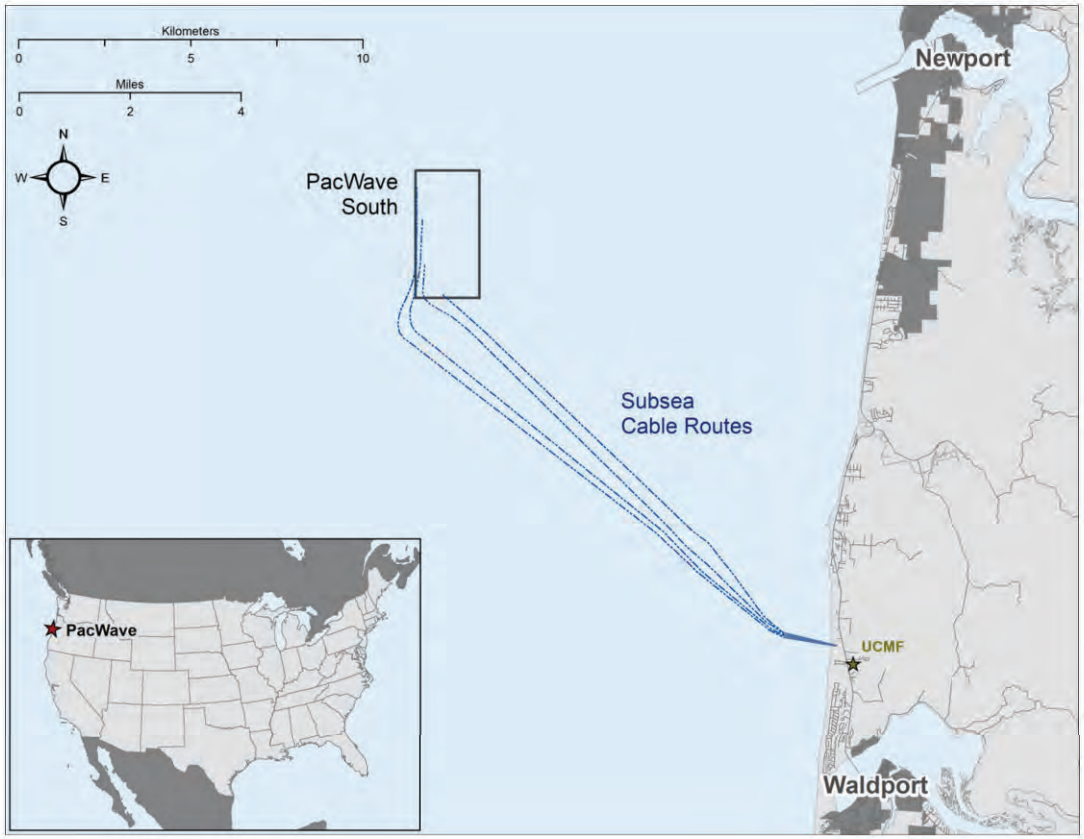


Operates and shelters fully submerged





CALWAVE



2025 deployment at PacWave test site

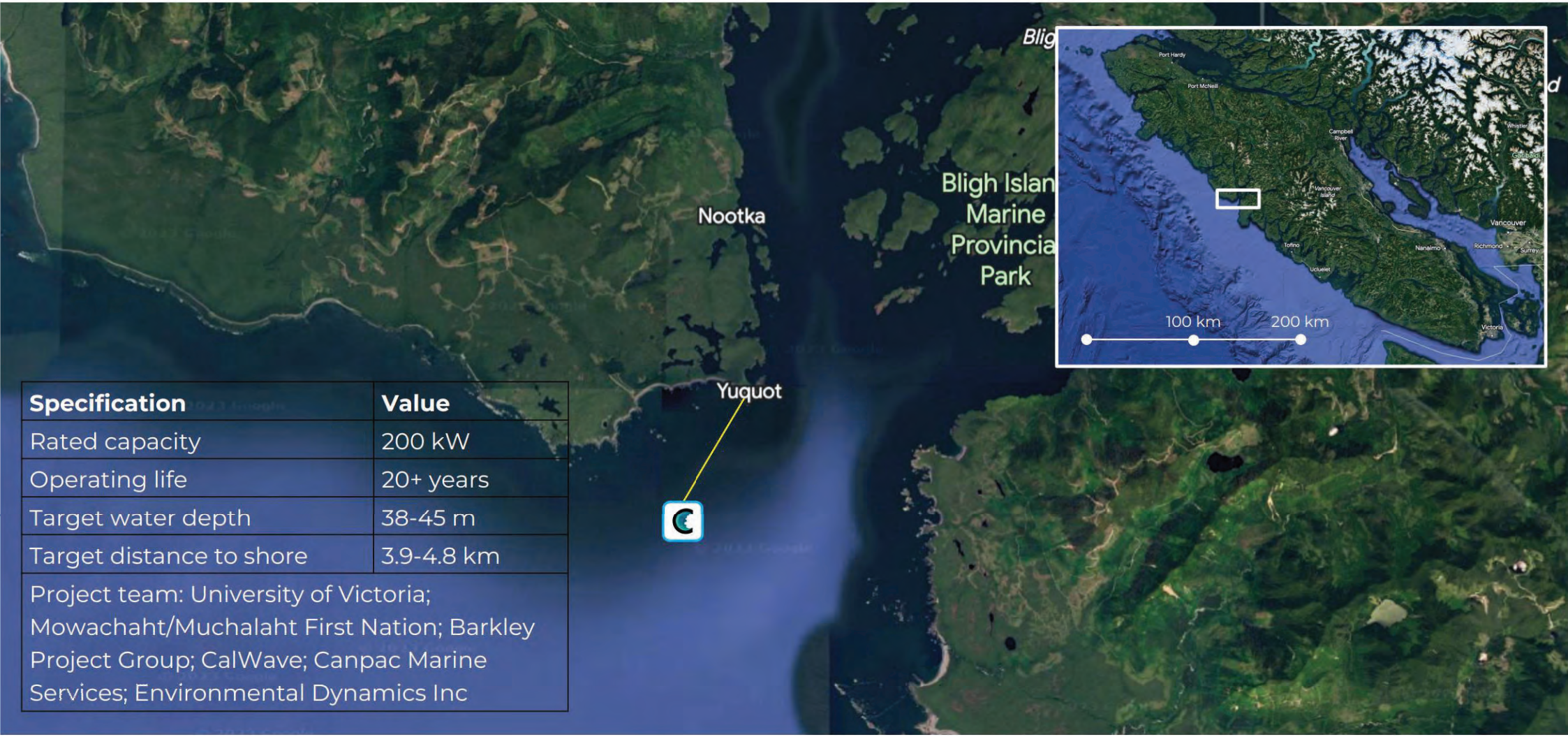
Newport, Oregon

2025-2027

- DOE-funded pre-permitted test site
- Operate x200 for two years
- Grid-connected PPA
- Four berths of 5 MW each

CALWAVE

Yuquot, BC



Specification	Value
Rated capacity	200 kW
Operating life	20+ years
Target water depth	38-45 m
Target distance to shore	3.9-4.8 km

Project team: University of Victoria; Mowachaht/Muchalaht First Nation; Barkley Project Group; CalWave; Canpac Marine Services; Environmental Dynamics Inc

Expanding to New Zealand


Stage 1
2026-27
Indigenous-led and other microgrid projects
CALWAVE
Chatham Islands
Stewart Island


Stage 2
2028+
Utility-scale and offshore wind co-location projects
Auckland
Waikato
Taranaki
CALWAVE


CALWAVE
Join us on our mission!
www.calwave.energy
ryan@calwave.energy
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CALWAVE
7 AFFORDABLE AND CLEAN ENERGY
13 CLIMATE ACTION
8 DECENT WORK AND ECONOMIC GROWTH
11 SUSTAINABLE CITIES AND COMMUNITIES
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Lisa MacKenzie

Marketing & Communications Manager

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The role of test centres
in supporting innovation and technology development

Lisa MacKenzie
Marketing and Communications Manager

EMEC's journey

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An innovation catalyst

pioneering the transition to a clean energy future





Reducing the time, cost, and risk of progressing low carbon technologies to market.

Bridging the innovation valley of death

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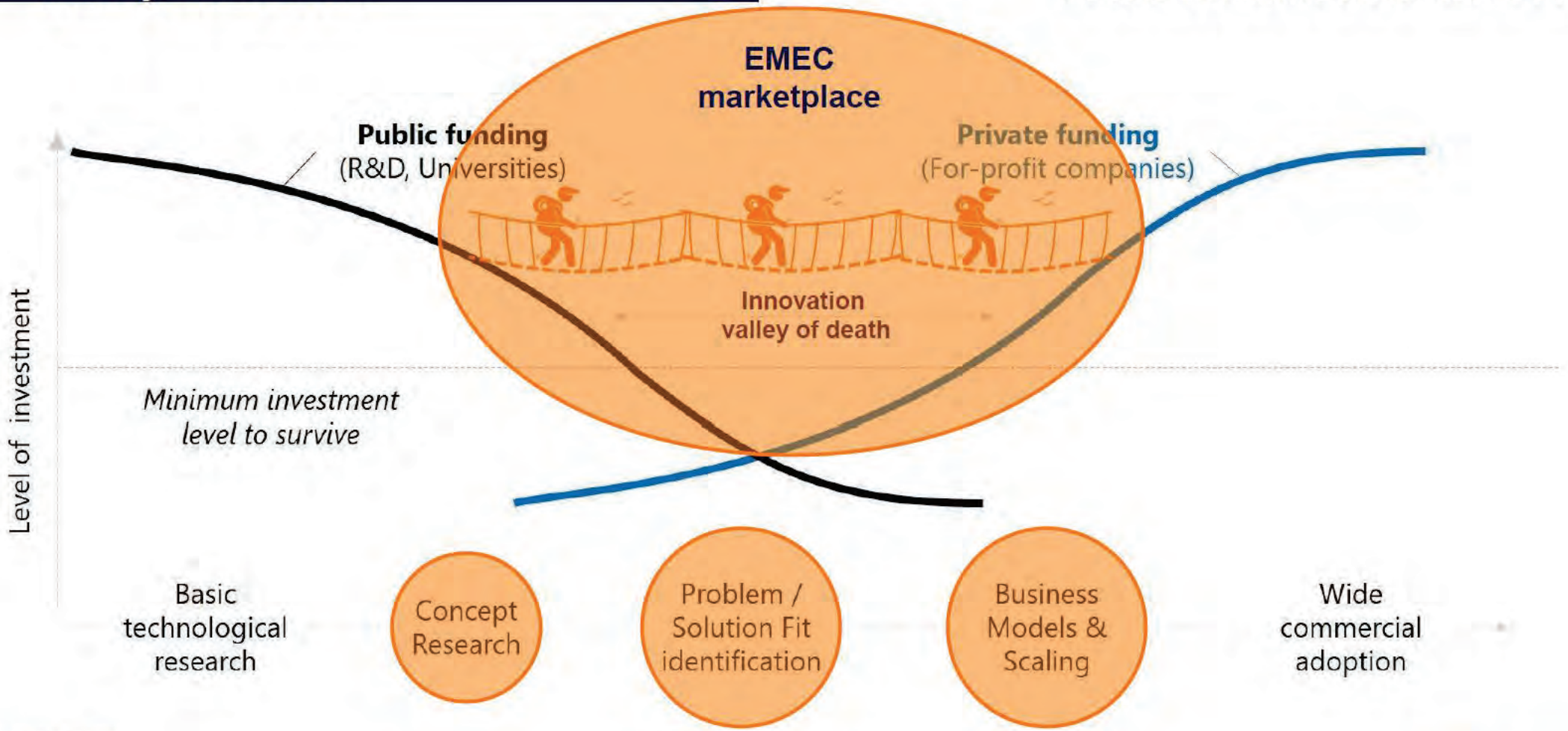

idea to value.com

UK resource

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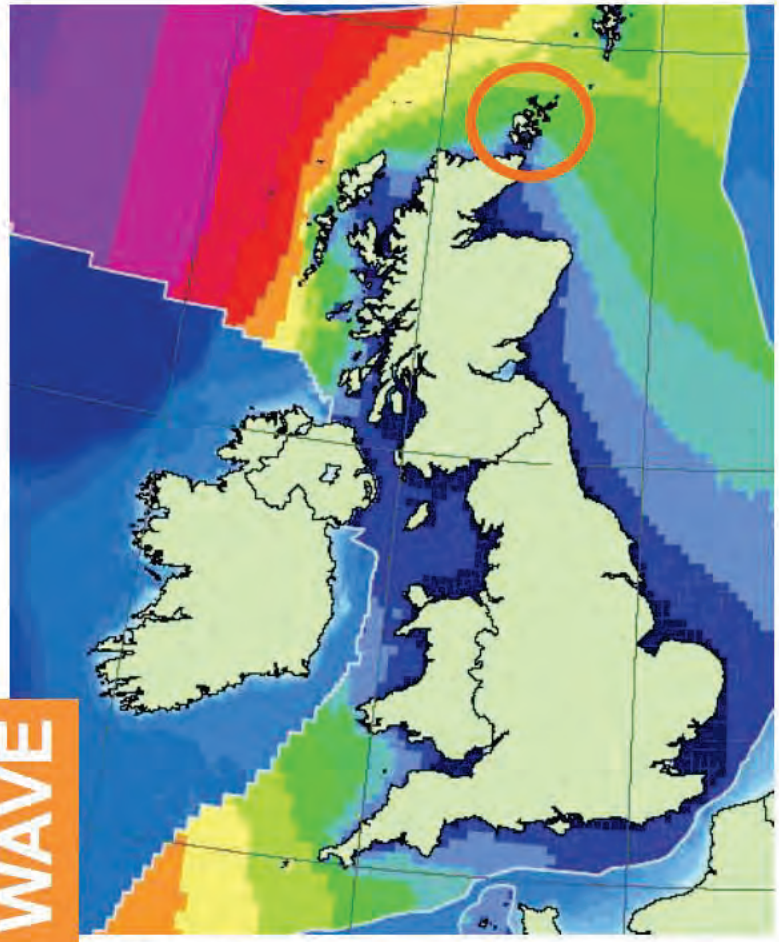
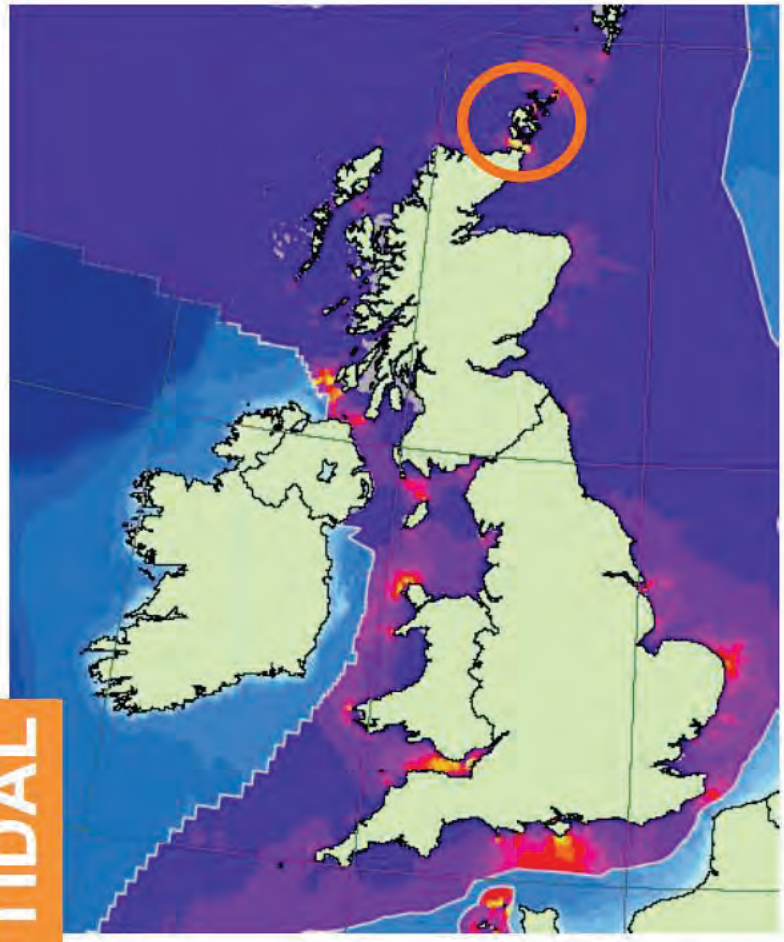


WAVE

35% of Europe's wave energy potential



TIDAL

50% of Europe's tidal energy potential

Why Orkney?

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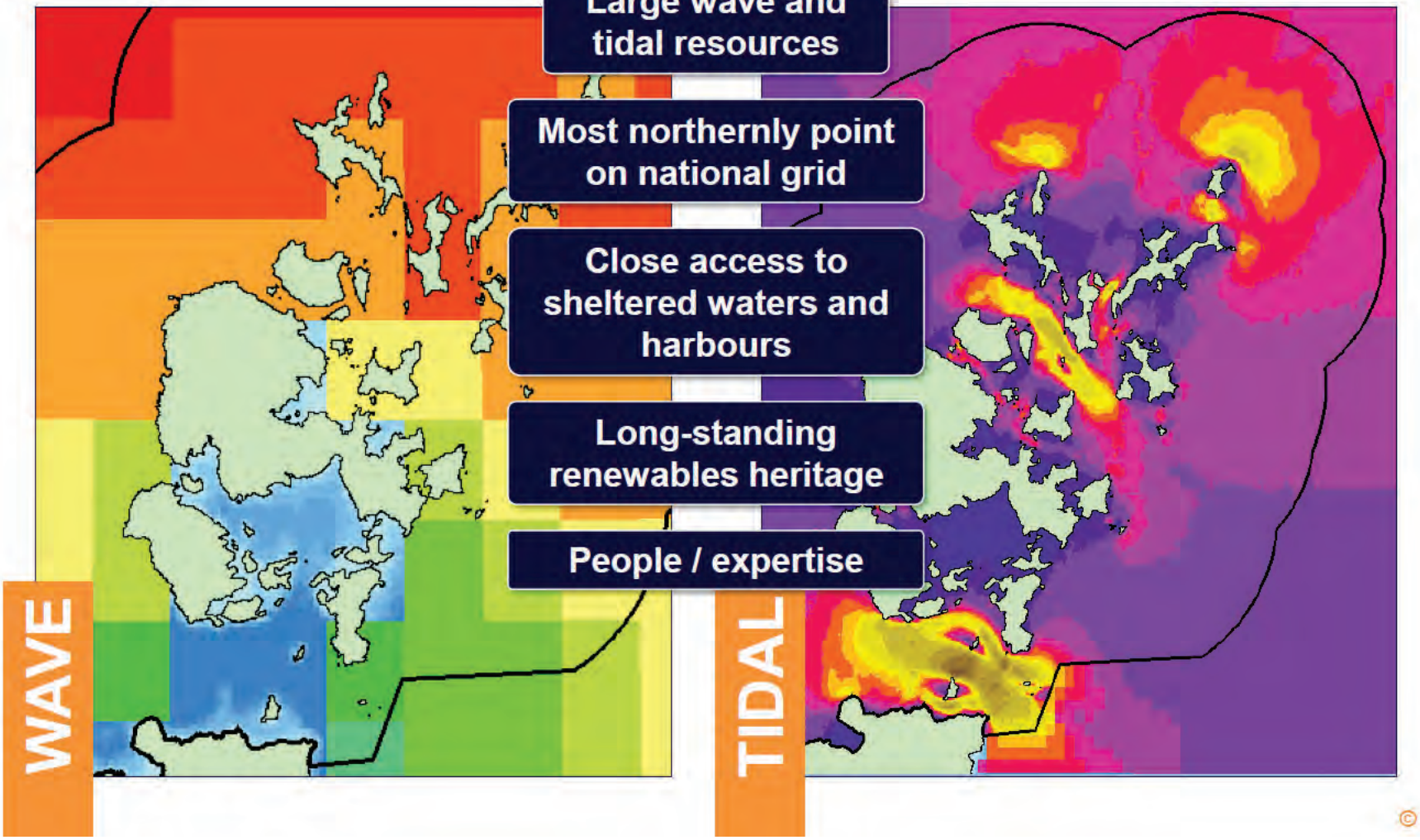
- Large wave and tidal resources
- Most northernly point on national grid
- Close access to sheltered waters and harbours
- Long-standing renewables heritage
- People / expertise



Ocean energy demonstration sites

1. **Fall of Warness**
   Grid-connected tidal test site
2. **Billia Croo**
   Grid-connected wave test site
3. **Shapinsay Sound**
   Scale tidal test site
4. **Scapa Flow**
   Scale wave test site
5. **Floating Wind**
   Grid-connected floating wind test site (planned)

Hydrogen demonstration sites

6. **Caldale**
   Hydrogen production and storage plant
   Vanadium flow batteries
7. **Kirkwall Pier**
   Fuel cell
8. **Kirkwall Airport**
   Combined heat and power unit (CHP)

EMEC offices

9. **Stromness**
   Headquarters
10. **Kirkwall**
    Satellite office

Grid connected test sites

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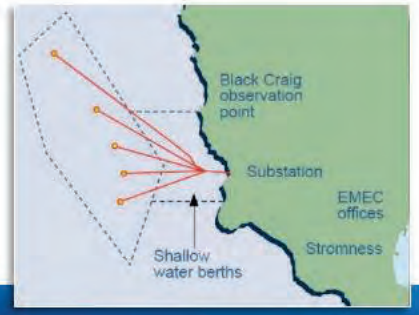
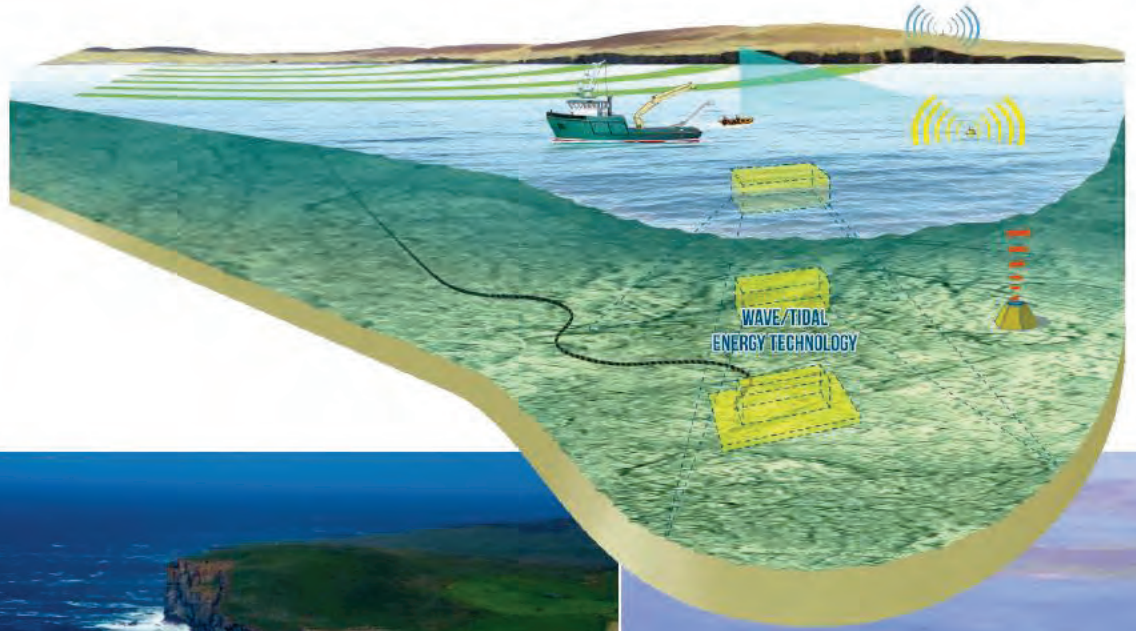
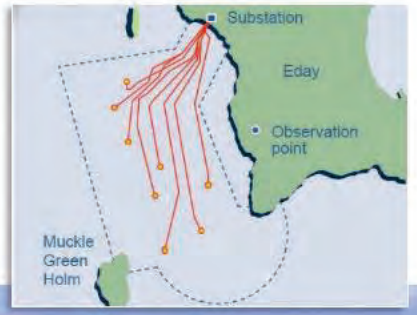
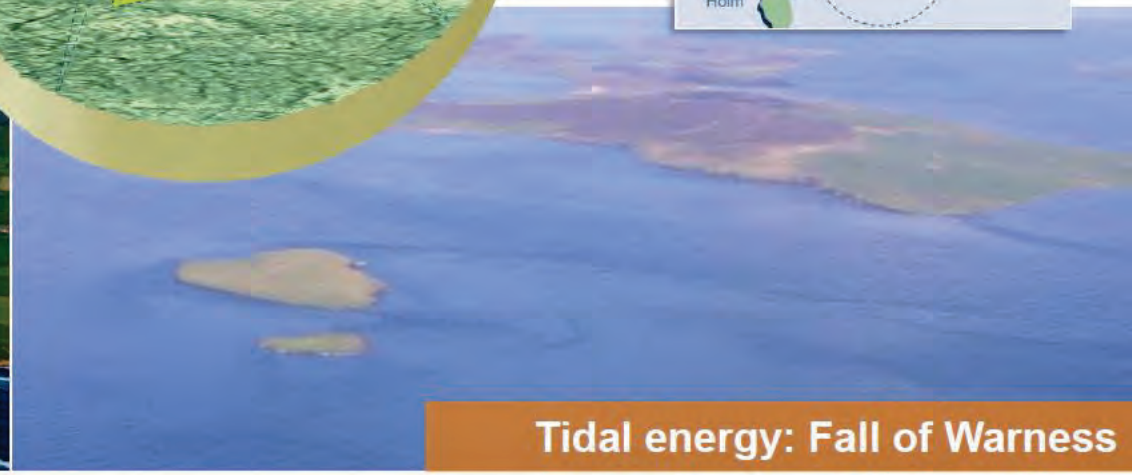






Wave energy: Billia Croo



Tidal energy: Fall of Warness

Scale test sites

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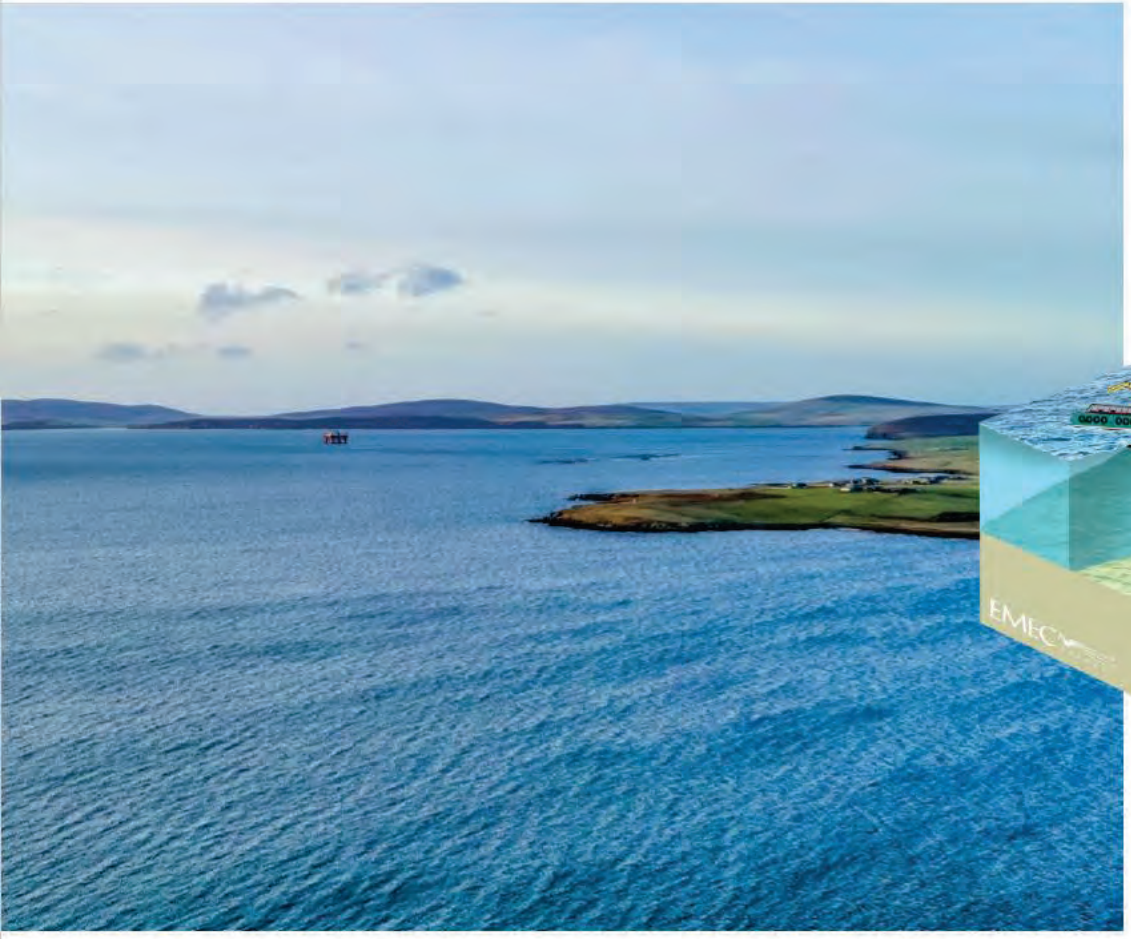

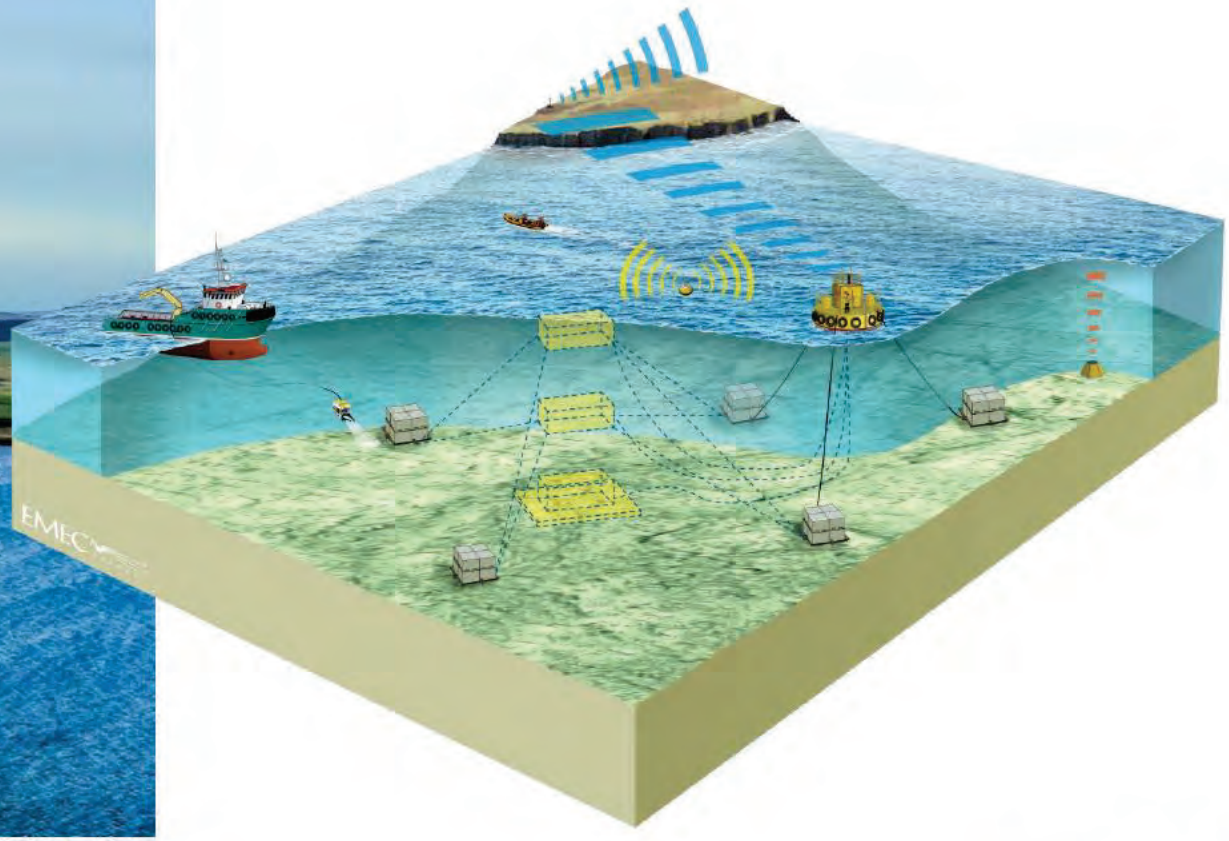

Ocean energy demos

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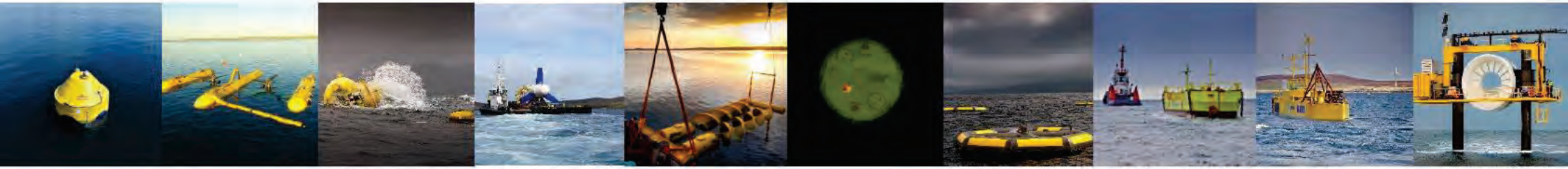
35 devices

22 developers

11 countries



In Orkney now

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TIDAL

ORBITAL
MARINE POWER

Magallanes
Renovables

WAVE

mocean energy

wave energy
SCOTLAND

Iterative testing

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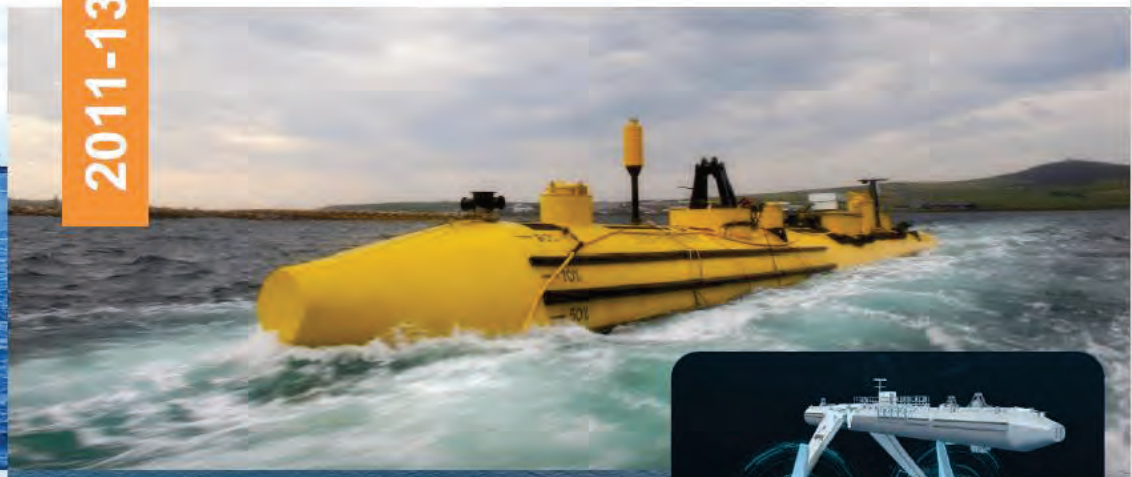
2010

2011-13



2016-18

2021-24+

Real-sea learning

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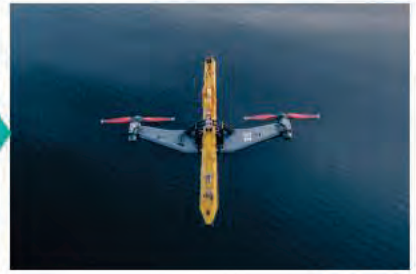
- Installability
- \+
- Survivability
- \+
- Reliability
- \+
- Maintainability
- \+
- Operability
- =
- Cost effectiveness





R&D projects

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Environmental monitoring


Subsystems


Tool development


Components

Versatile test site

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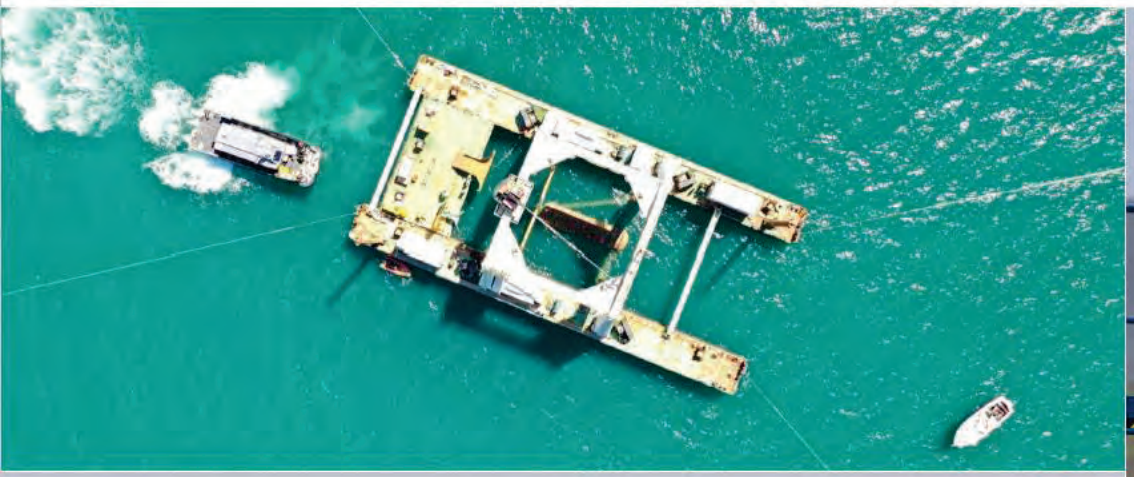

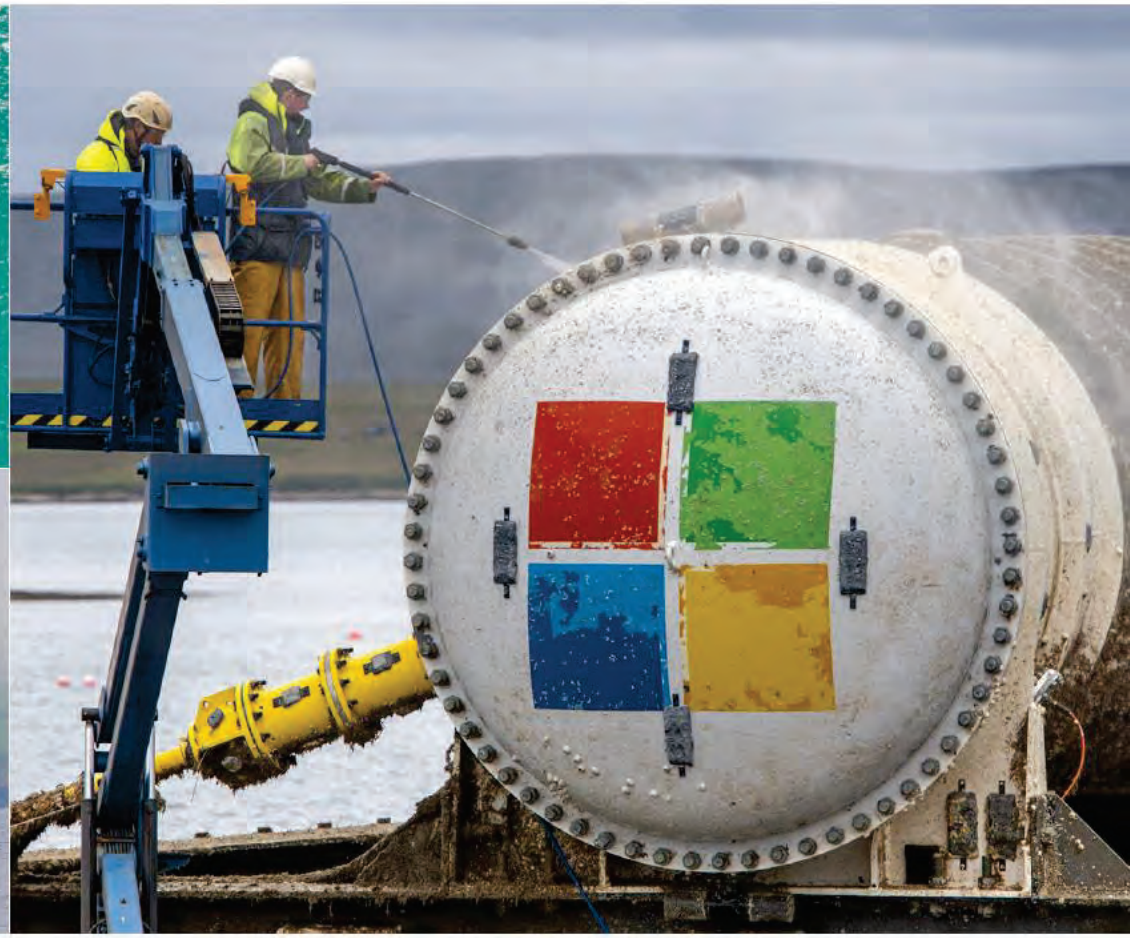

International collaboration

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International collaboration

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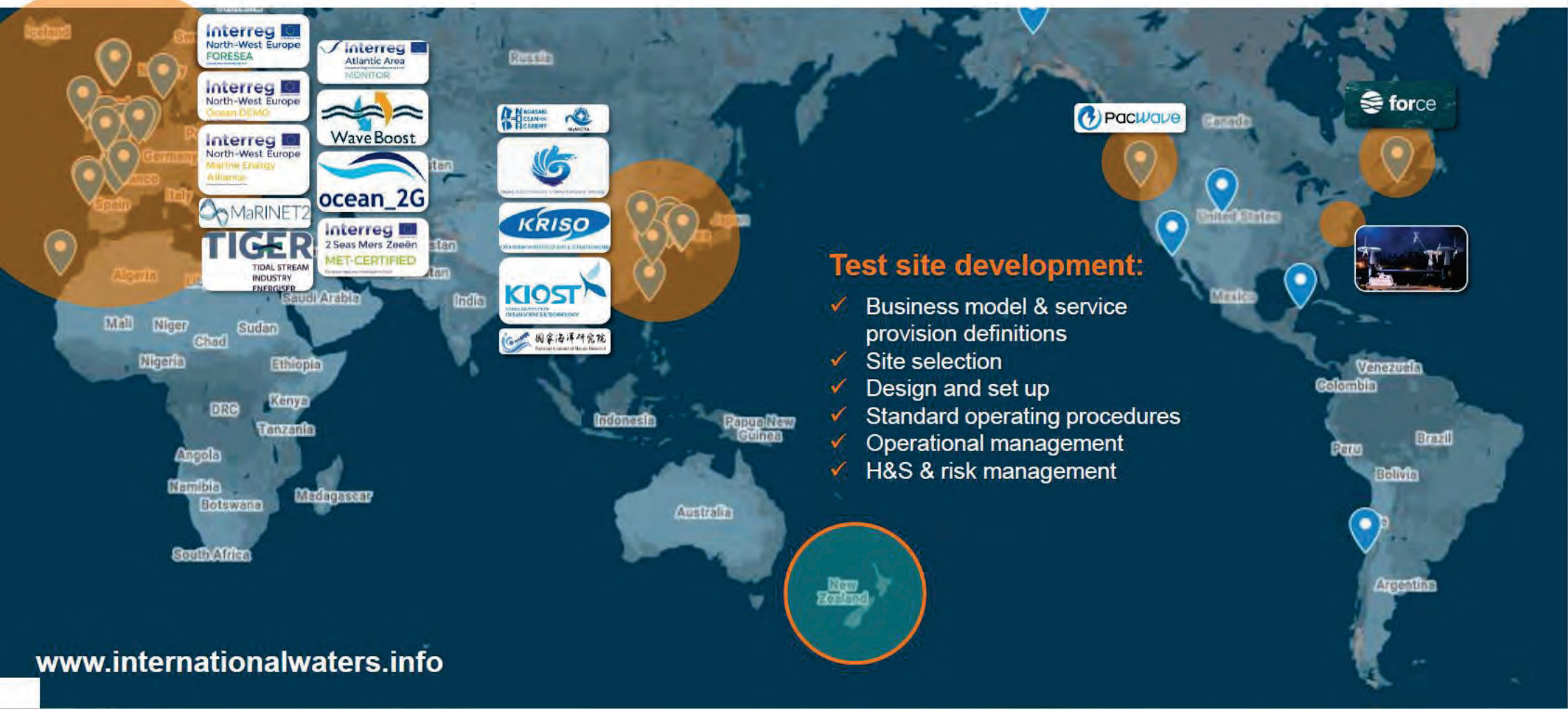

www.internationalwaters.info

What next?

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Tidal energy arrays

ORBITAL MULTI-TURBINE TIDAL ARRAY TO BE DELIVERED IN NEW EU PROJECT

Posted by EMEC on Wednesday, October 25, 2023

9.6 MW tidal turbine array to be conne

Orbital, along with sector leading project partne
Programme to deliver a multi-turbine tidal ener

NOVA INNOVATION 4 MW TIDAL ARRAY BOUND FOR EMEC

Posted by EMEC on Wednesday, November 29, 2023

Nova Innovation has won EU funding for a 4 MW, 16 turbine, tidal energy farm that will be home to the largest number of tidal turbines anywhere in the world.

The tidal energy array will be deployed at the European Marine Energy Centre's (EMEC's) Fall of Warness tidal test site in Orkney, Scotland.

Wave energy demonstrations

MOCEAN ENERGY SECURES EUROPEWAVE FUNDING FOR WAVE ENERGY DEMO AT EMEC

Posted by EMEC on Tuesday, September 5, 2023

Wave energy
deploy a 250k
test site in Ork

OCEANENERGY SIGN UP TO EMEC WAVE ENERGY TEST BERTH

Posted by EMEC on Wednesday, May 10, 2023

The CECR, the world's largest capacity floating wave energy device. Credit: OceanEnergy

Irish wave energy developer, OceanEnergy, has signed up to demonstrate its OE35 floating wave energy converter at the European Marine Energy Centre (EMEC) in Orkney, Scotland.

Offshore wind R&I

WHITE PAPER DETAILS NEEDS CASE FOR UK NATIONAL FLOATING WIND TEST CENTRE

Posted by EMEC on Wednesday, December 13, 2023

The European Marine Energy
published a white paper set
the UK.

£1 MILLION OFFSHORE WIND PROGRAMME LAUNCHES INNOVATION CALL

Posted by EMEC on Monday, December 11, 2023

A £1 million research and innovation (R&I) programme is searching for novel solutions to help deliver offshore wind faster, cheaper and at lower risk.

The first in a series of innovation calls has opened for applications, with up to £300,000 available to projects.

20 years of impact

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UK

£370 MILLION
GVA TO UK ECONOMY

540 FTE
SUPPORTED

SCOTLAND

£263 MILLION
GVA TO SCOTTISH ECONOMY

406 FTE
SUPPORTED

ORKNEY

£130 MILLION
GVA TO ORKNEY ECONOMY

224 FTE
SUPPORTED

SHOPPING LOCAL

97%
EMEC SPEND IN UK

67%
EMEC SPEND IN SCOTLAND

50%
OVER £30 MILLION
EMEC SPEND IN ORKNEY

TOP 20
EMPLOYER IN ORKNEY

R&D

365
R&D PROJECTS OVER 20 YEARS

EMEC INVOLVED IN
£538 M
R&D PROJECTS SINCE 2016

£49.5 M
SECURED DIRECTLY BY EMEC

A JUST TRANSITION | FAIR • INCLUSIVE • LEAVE NO ONE BEHIND

Pioneering the transition to a clean energy future

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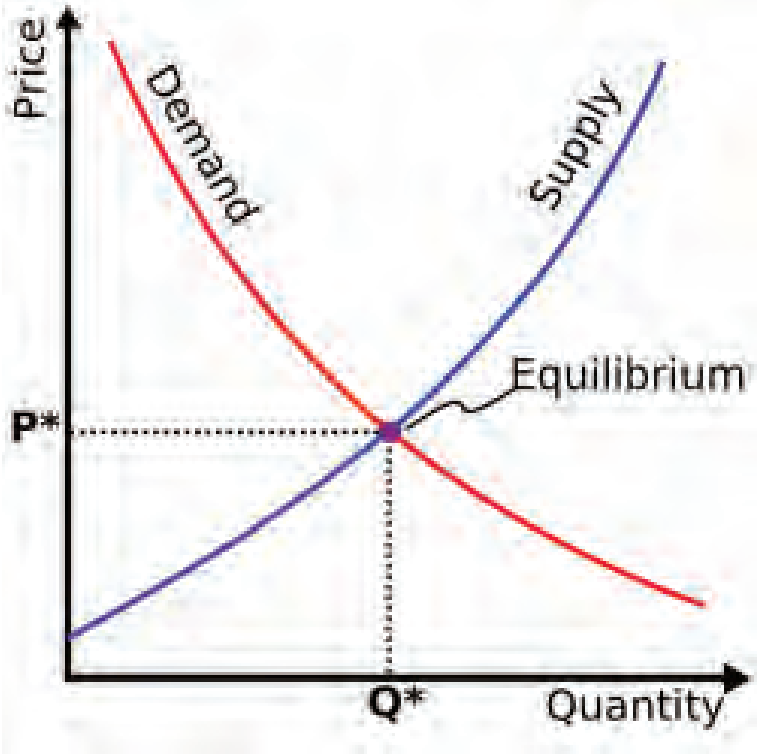
An innovation catalyst

pioneering the transition to a clean energy future

Lisa MacKenzie
Marketing and Communications Manager
lisa.mackenzie@emec.org.uk


venture
TARANAKI
Te Puna Umanga
Ara
Ake
Future
Energy
Development
Kevin Hart
CEO, New Zealand Wind Energy Association


new zealand
wind energy association
Wind
Aotearoa
New Zealand
Offshore Renewable Energy Forum
2024
Hāwera
20 – 21 March
Global supply chain and workforce challenges
Kevin Hart | Chief Executive, New Zealand Wind Energy Association



new zealand
wind energy association

Fun Fact 1

2 TW

Global wind energy capacity by 2030, double the capacity in 2023, supplying 17-19% of the world's electricity

new zealand wind energy association

Fun Fact 2

328 GW

Offshore wind capacity forecast by 2030, from 64 GW in 2023… a five-fold increase

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Fun Fact 3

574,175

Number of technicians the wind sector will need over the next 4 years, a 17% growth… 79% will be driven by the offshore wind market

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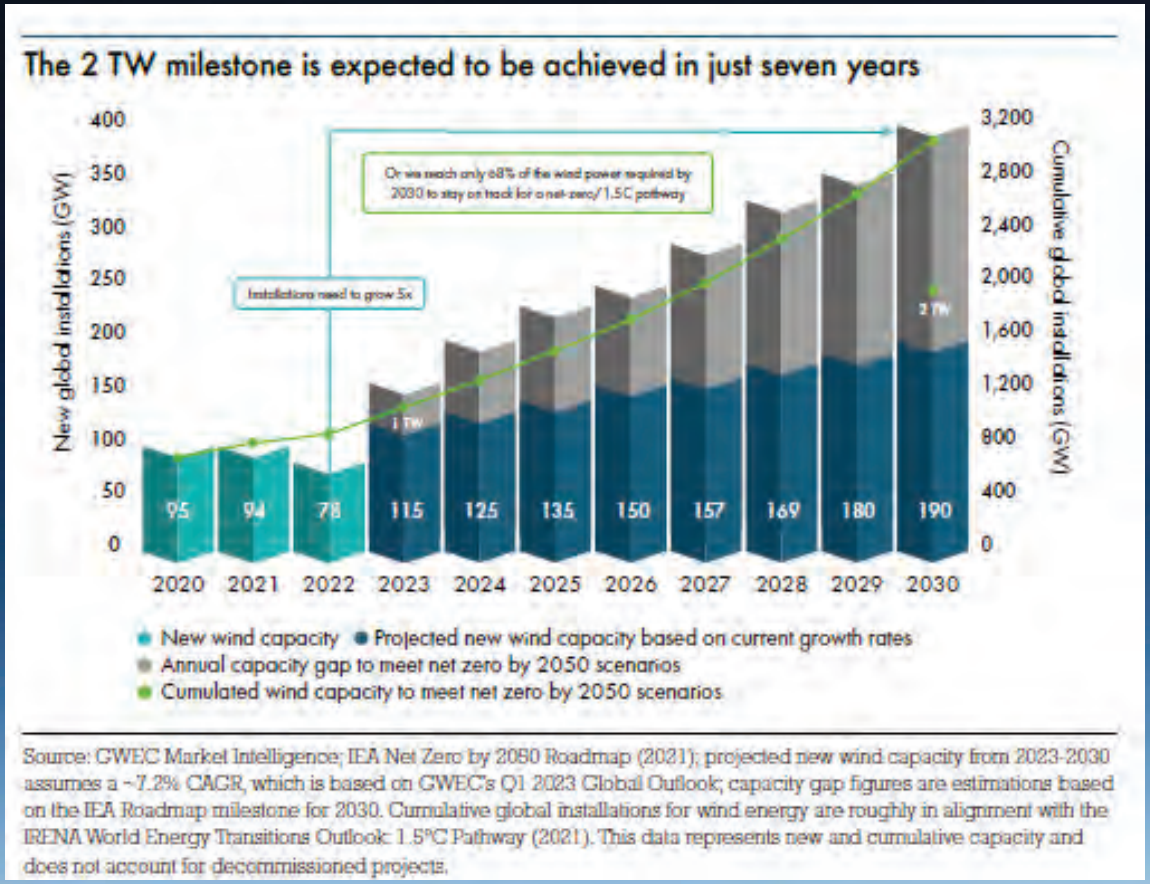
Demand – Wind Energy

- By 2030, worldwide wind energy capacity is forecast to be 2 TW, a 15% CAGR from 2020
- **Offshore** wind capacity achieves a **32% CAGR**
- But… total wind energy installation needs to triple by 2030 to achieve a 1.5ºC pathway



Source: GWEC Market Intelligence; IEA Net Zero by 2050 Roadmap (2021); projected new wind capacity from 2023-2030 assumes a ~7.2% CAGR, which is based on GWEC's Q1 2023 Global Outlook; capacity gap figures are estimations based on the IEA Roadmap milestone for 2030. Cumulative global installations for wind energy are roughly in alignment with the IRENA World Energy Transitions Outlook: 1.5°C Pathway (2021). This data represents new and cumulative capacity and does not account for decommissioned projects.

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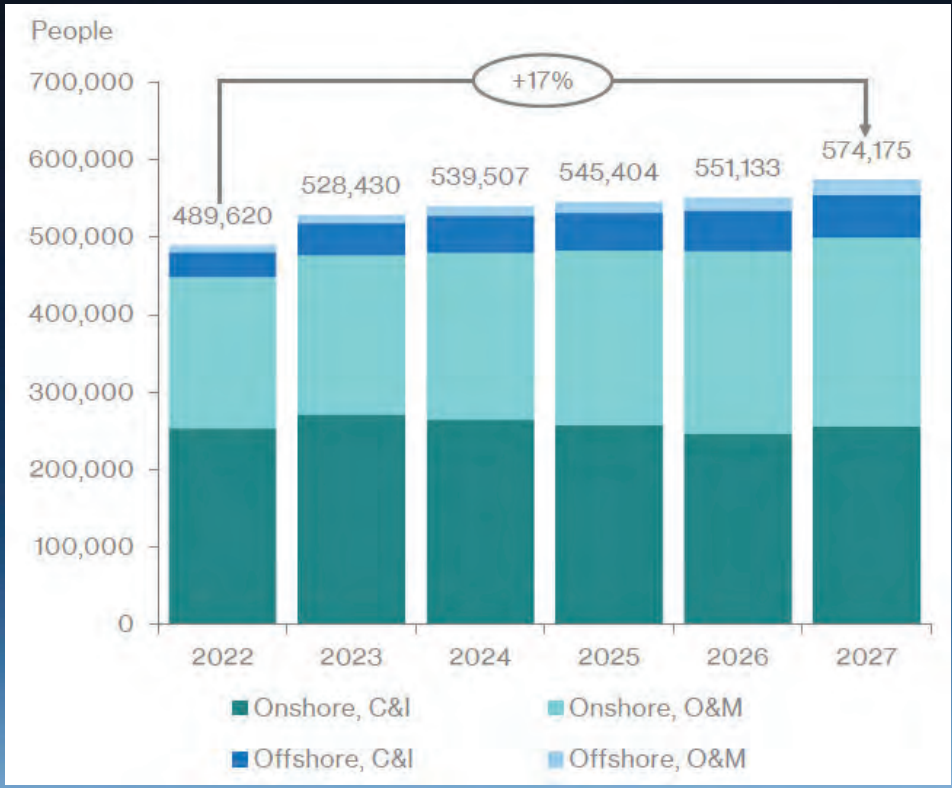
Demand - Workforce

- The wind workforce will grow faster for offshore wind (79%) than onshore (12%) to 2027, a trend expected to continue well into the next decade.
- While an initial skills need will exist for Construction & Installation (C&I) technicians, the primary skills needed beyond 2030 will be in Operations & Maintenance.
- Oceana will need a 17% increase in entry-level people over the next 4-5 years



Source: Global Wind Energy Council 2023 Report,

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That means… we can't compete based on our size!

Aotearoa Global Market Share

2030 = 0.13%

Double Wind Capacity by 2030*

* Based on Aotearoa NZ's wind energy capacity increasing from 1.26 GW in 2024 to 2.5 GW by 2030; plus, the global wind capacity forecast of 2 TW by 2030

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Supply

Theme	Critical materials					Key components								Assembly		Offshore wind enablers		
Subject	Rare Earths*	Steel Plate*	Copper	Concrete	Carbon Fiber*	Gearboxes*	Generators*	Blades*	Power Converters*	Castings*	Towers*	Foundations*	Cables*	Onshore nacelles*	Offshore nacelles*	Installation vessels*	Ports*	Workforce
Global level criticality	●	◔	◔	○	◑	◕	◑	◑	◔	◕	◑	◑	◔	◔	◑	◑	◑	◕

	Demand vs supply analysis 2023-2030 (MW)							
	2023e	2024e	2025e	2026e	2027e	2028e	2029e	2030e
Europe	5148	2916	6527	9598	10808	16225	20465	26400
China	8000	12000	14000	15000	15000	15000	15000	15000
APAC excl. China	1769	1569	3884	2696	3256	5030	5535	6995
North America	533	936	2335	3535	4500	4500	4500	4500
LATAM	0	0	0	0	0	0	0	1350
Global	15450	17420	25746	30829	33564	40755	45500	54245

Source: GWEC Market Intelligence, September 2023

● Sufficient ● Potential bottleneck

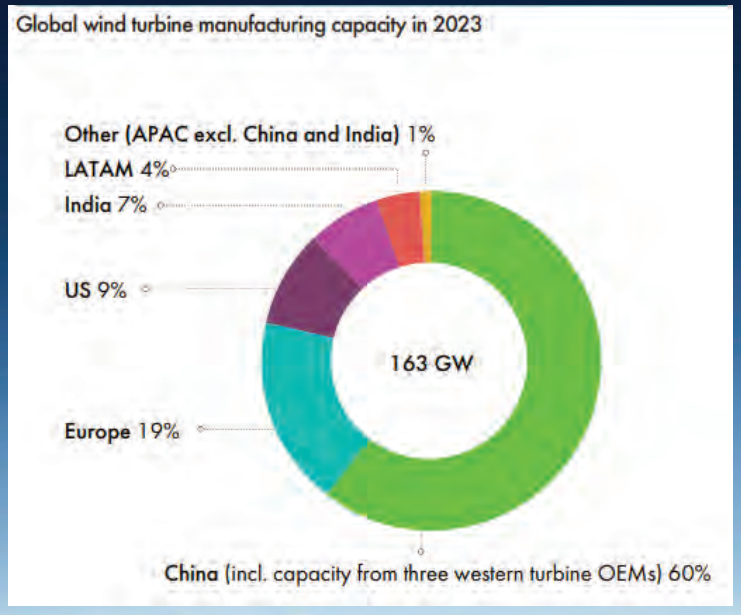
Offshore Only

- Offshore supply chain constraints begin in 2025 for US, and 2026 in Europe where demand vastly outstrips supply.
- In APAC (excluding China), constraints begin in 2027.
- China is the world's leading wind turbine manufacturing base, and the largest production hub for key components and rare earth materials, providing 70% of global supply chain.
- China's supply chain is unconstrained due to the significant manufacturing supply chain base enabling it to be a net exporter, however domestic demand for offshore wind rapidly increases as China strives for 80% renewable electricity by 2050.

new zealand wind energy association

Supply Future - Turbine Nacelle Manufacturing Capacity in 2023

Since establishing a local wind supply chain in 2008–2010, China has not only become the world's leading wind turbine manufacturing base, but also the largest production hub for key components and materials.



Global Nacelle Facilities	China	Europe	India	USA	LATAM	APAC	Africa/ ME	Total
Onshore Existing	77	16	13	4	6	3	1	123
Offshore Existing	**20**	**5**	**0**	**0**	**0**	**4**	**0**	**30**
Onshore Proposed	17	0	2	0	0	0	0	19
Offshore Proposed	**47**	**1**	**0**	**3**	**0**	**4**	**0**	**55**

Offshore Nacelle Facilities in China - 67% increasing to 85%

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Prices

- *Offshore Levelised Cost of Energy (LCOE) has steadily declined since 2009, now on par with coal fired generation… but*
- *Prices in Europe & US are rising due to the supply vs demand imbalance, inflationary pressures, and continued supply chain constraints, resulting in some projects being deferred or cancelled.*
- *China's large turbine supply base has kept domestic prices steady but domestic demand is forecast to catchup with supply by late 2030.*

Beyond 2030, the supply vs demand imbalance is uncertain

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Risk factors affecting the supply chain uncertainty

1. High demand volatility, i.e. COP28 triple renewable energy by 2050
2. European & US supplier hesitation to scale-up due to constrained access to raw materials
3. The innovation curse… rapid technological advances, leading to reduced quality outcomes and lower (some negative) margins to OEM's
4. OEM's are consolidating, focusing on larger, secure and trusted markets… emerging and low volume markets are becoming less attractive
5. Geopolitical escalation, increased cross-border conflict reducing trade, increased shipping channel constraints

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Summary

Competition for wind energy resources are rapidly increasing

but…

The equipment providers are heavily constrained by access to raw materials, high inflationary costs, limited people resource pools and historically low (to negative) margins

resulting in…

A supply-demand imbalance!

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Summary - what can we do now in Aotearoa?

1. Collaborate and work in close partnership with each other, embrace partnership participation with local Iwi-Māori and our communities.
2. Extend our collaboration into Australia and Asia, build close relationships to establish *regionalised* supply hubs.
3. Make Aotearoa NZ an easy place to do business… send ‘bankable’ demand signals to the market to build confidence and increase predictability.
4. Address regulatory barriers to develop ports, grids & bridges/roads
5. Develop and train our people *now* to support this future; standardise our training methodologies.

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Bill Mundy

Associate Director Partnerships and Growth, Federation University

Federation University

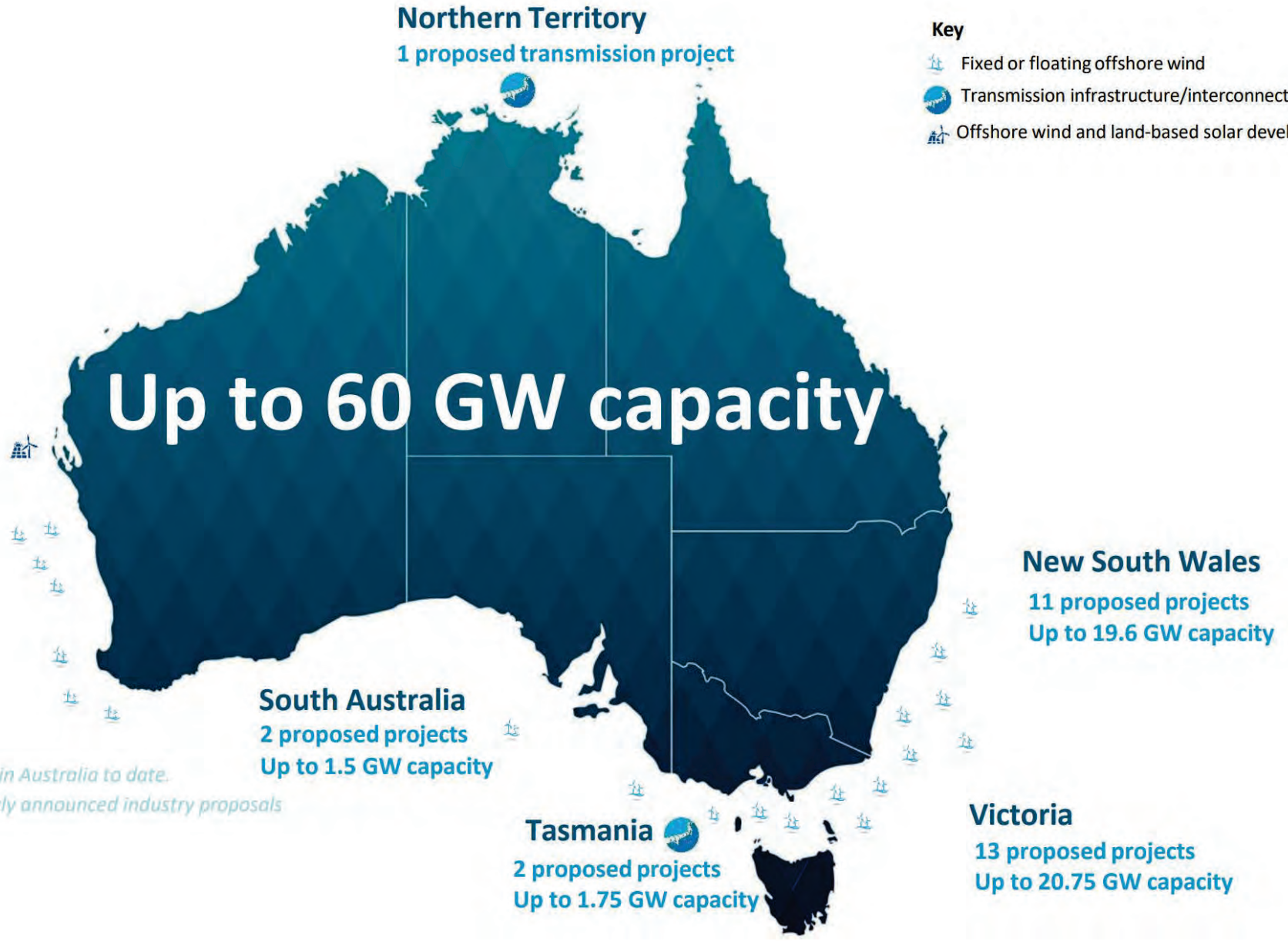
Developing Australia's Wind Energy Workforce a Fed Uni perspective

Bill Mundy

Associate Director Partnerships and Growth

20/03/24

Interest in Australia



Note: No licences have been granted in Australia to date.

Potential projects are based on publicly announced industry proposals

Last updated December 2022

Federation University

So how many jobs??

https://www.staroftheSouth.com.au/jobs-guide

https://engage.vic.gov.au/vejp

https://www.premier.vic.gov.au/victorias-clean-economy-workforce-driving-net-zero

https://gwec.net/market-intelligence/resources/

https://www.myalupoffshorewindfarm.com.au/wp-content/uploads/2023/12/Skyborn-Renewables-Australian-Job-Guide.pdf

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Federation University Perspective

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What is APRETC ??

GWO Training

Certificate III Engineering Composites (Blade Technicians)

Wind Turbine Technician Training (BZEE)

Dual Quals

Engineering

Project Management

Business

Environmental Sciences

Microgrids and Renewables

Community Energy

Hydrogen as a future fuel

Net Zero Initiatives

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What's coming from a HE Perspective in 2024

Needs to be local people studying taking regionally located jobs

Key needs in Engineering, PM's, Legal, Finance and Engagement

Dual Qualifications

- Federation and USQ – Certificate III Electrotechnology and Bachelor of Electrical Engineering (Electrical and Information Engineering) (Honors)

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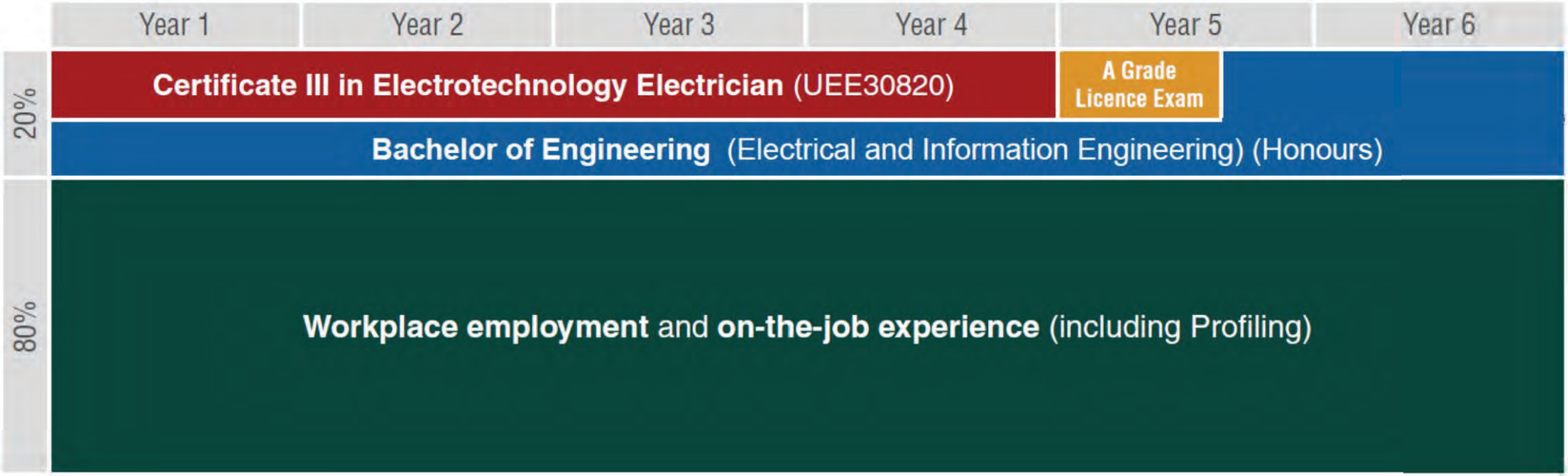
Dual Qualifications: Timeline and study load



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Future training opportunities

- Wind Turbine Technician Apprenticeship – Mechatronics
- Bespoke industry training using assets in place built for purpose
- International accreditation
- APAC delivery / partnerships

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Thank you for listening!!

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