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A marine deployment pathway for Scotland

Chaired by Claire Mack,
Chief Executive, Scottish Renewables



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Chief Executive, Scottish Renewables

Richard Arnold

Policy Director, Marine Energy Council

Tim Hurst

Managing Director, Wave Energy Scotland

Caitlin Byers

Development Manager (Integration & Transition),
Crown Estate Scotland



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Gillian Martin MSP

Minister for Energy

The Scottish Government



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EMEC Showcase

Chaired by Matthew Finn,
Commercial Director, EMEC





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Beth Dickens

Director and Founder

Quoceant



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Evolution of Wave Energy – the legacy of the world's first offshore wave energy generation

SR Marine Conference 2023

Beth Dickens

The Evolution of Wave Energy – The Pelamis Journey



The Evolution of Wave Energy – The Pelamis Journey



A World First - August 2004



The Journey Continues



The Team Grows



The Team Grows

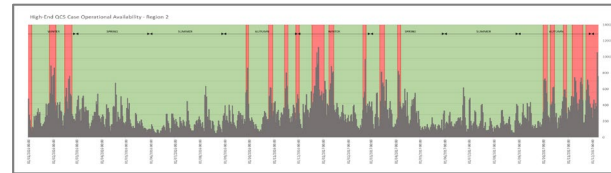
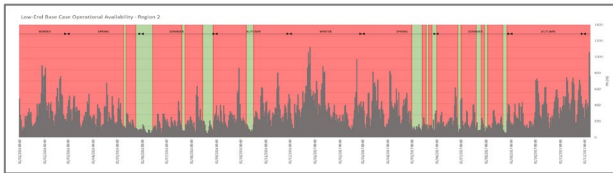
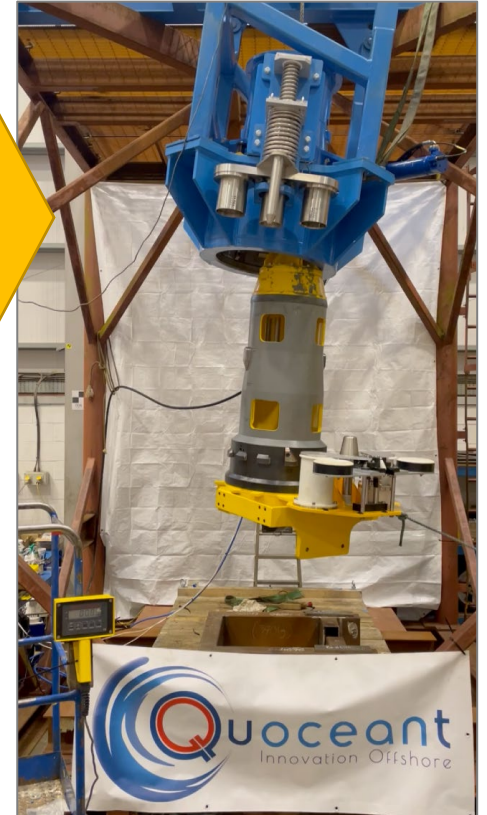


The Team Grows

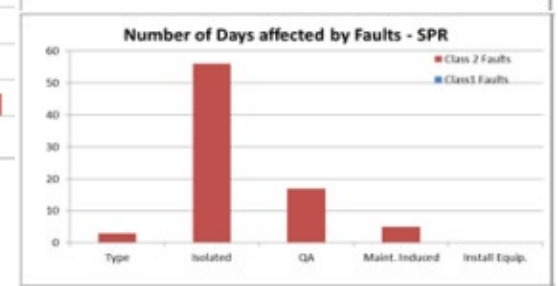
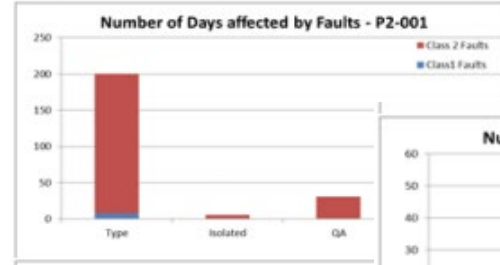




So Many Lessons Learnt!



So Many Lessons Learnt!



Pelamis Class of 2014 - The Legacy



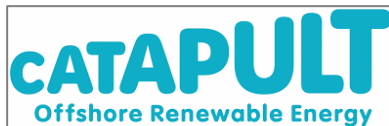
MAXSIM



EMEC
THE EUROPEAN MARINE ENERGY CENTRE LTD



NOVA
INNOVATION



Danfoss



SSE
Renewables



YAVIN FOUR
CONSULTANTS



ORBITAL
MARINE POWER



OW
OCEAN WINDS



BlueFloat
ENERGY



gravitricity



sequentec



SynchroStor
The future of Long Duration Energy Storage

EMEC Class of 2014 - The Legacy



MAXSIM



CAELULUM

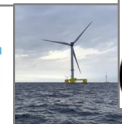
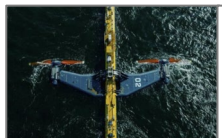
IN YANG A
marine projects



SEA ENERGY ANACONDA



YAVIN FOUR CONSULTANTS



SynchroStor
The future of Long Duration Energy Storage

EMEC Class of 2014 - The Legacy Continues



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Chair

Marine Energy Council



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EMEC SHOWCASE FROM TESTING TO CFDS

Scottish Renewables

25th May 2023

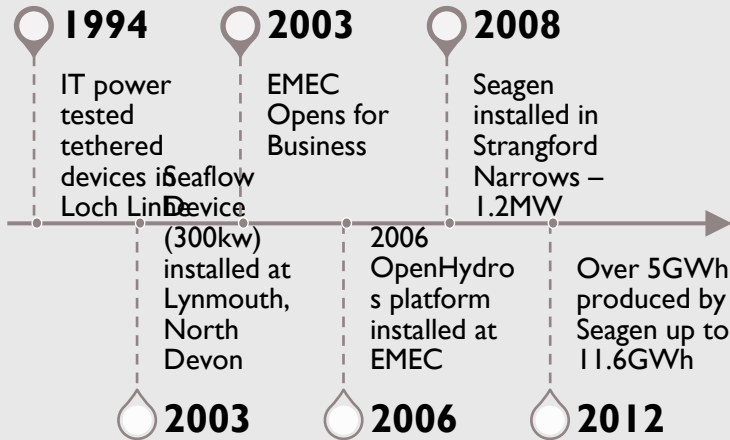


Marine Energy Council

- Set up April 2018 to meet challenge of political position on marine renewables.
- Progression from the ORE Cost Reduction Strategy Advisory Group.
- 40+ organisations - developers, academia, test centres, industry associations.
- Introduction of concept of an IPPA and reinvigoration of the CfD for revenue support.
- Focus on seeking industry consensus, collaboration and political engagement.

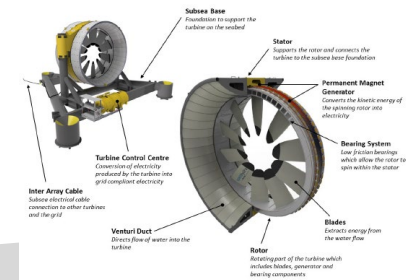
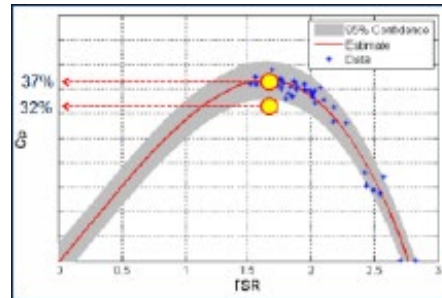
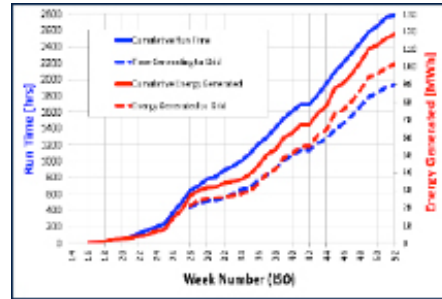
Opportunity to influence energy policy for marine energy

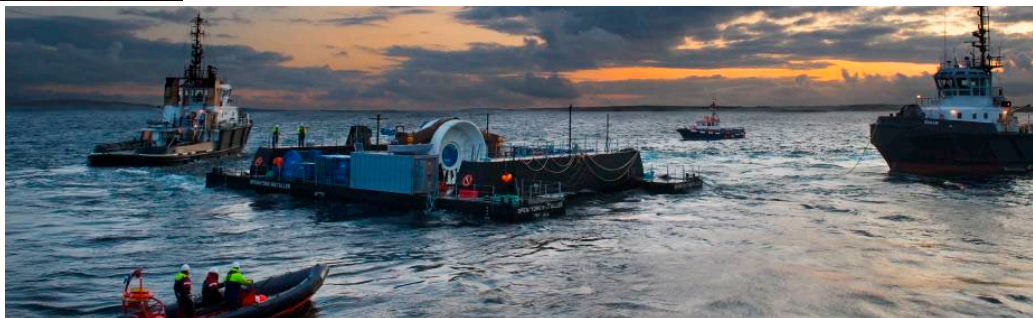
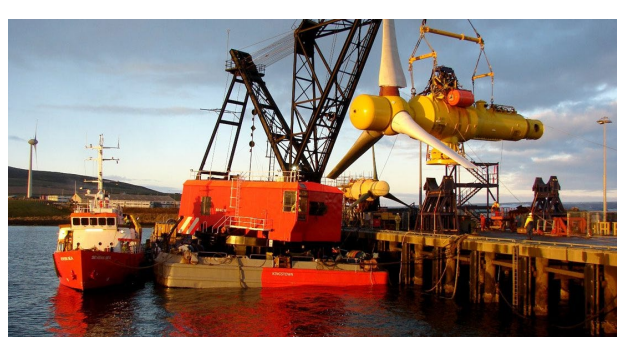
1994 – 2003 Early Implementation



Turbine testing

- OpenHydro tested at the European Marine Energy Centre (EMEC) since 2006; grid connected in 2008.
- 2014/15/16 testing focused on new power convertor (ABB) and in-house developed control system:
 - Over 11,500 hours testing of current turbine.
 - 16% improvement in turbine efficiency.





2008 - 2013

OpenHydro installed a subsea gravity base foundation

Andritz Hydro installed the HS 1000 IMW turbine at EMEC

Alstrom ReDapt installed a IMW turbine at EMEC

2008

2010

2011

2011

2013

2013

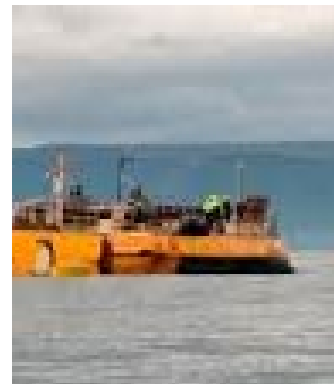
TGL installed Deepgen

Atlantis installed the AR 1000 turbine at EMEC

Voith Hydro IMW HyTide turbine at EMEC

Wave History

- Aquamarine power – 300-800kw Oyster
- Pelamis – P1 and P2
- AW Energy – Wave Roller
- Mocean
- CorPower
- Seatricity
- Seabased
- Well-Oy
- Laminaria



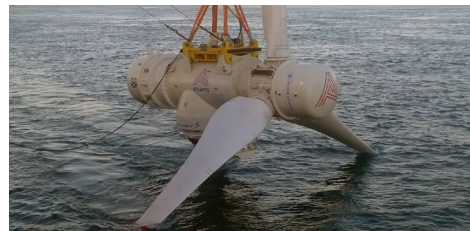
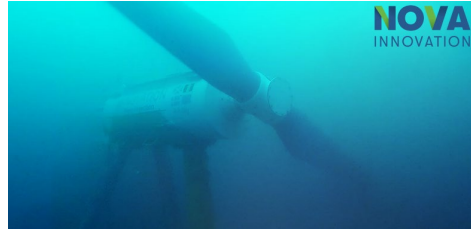
UK Tidal Energy – Current Position

- The UK made significant early progress in wave and tidal (2005 onwards)
- Significant Government and public investment to date (EMEC £34m, WaveHub, Pembroke Dock Marine, R&D funding), leasing rounds and demonstration zones.
- Removal of the marine energy ‘ring fence’ in the 2019-2021 CfD allocation rounds.
- 2017 saw the Clean Growth Strategy & Industrial Strategy set out the policy positions.
- Marine sector – need to provide evidence on performance, cost reduction and collaborate.
- 2018 – ORE Cost Reduction report, MEC established, notable downturn in marine activity in UK.
- 2019-2021 – significant consultations with the UK Government.
- 2022 – **AR ringfence of £20m – delivering 41MW capacity @£178MWh**
- 2023 - £10m ringfence in annual auctions.



Global Opportunity

- Ocean Energy worth £76bn by 2050
- Over 50GWh on UK grid
- 1 GW leased sites
- High UK content – 80-95%
- LCOE costs set to match other forms of renewables.
- UK geographically diverse supply chain supporting a global market.
- 1 GW potential in UK waters
- Technology reaching higher TRL levels

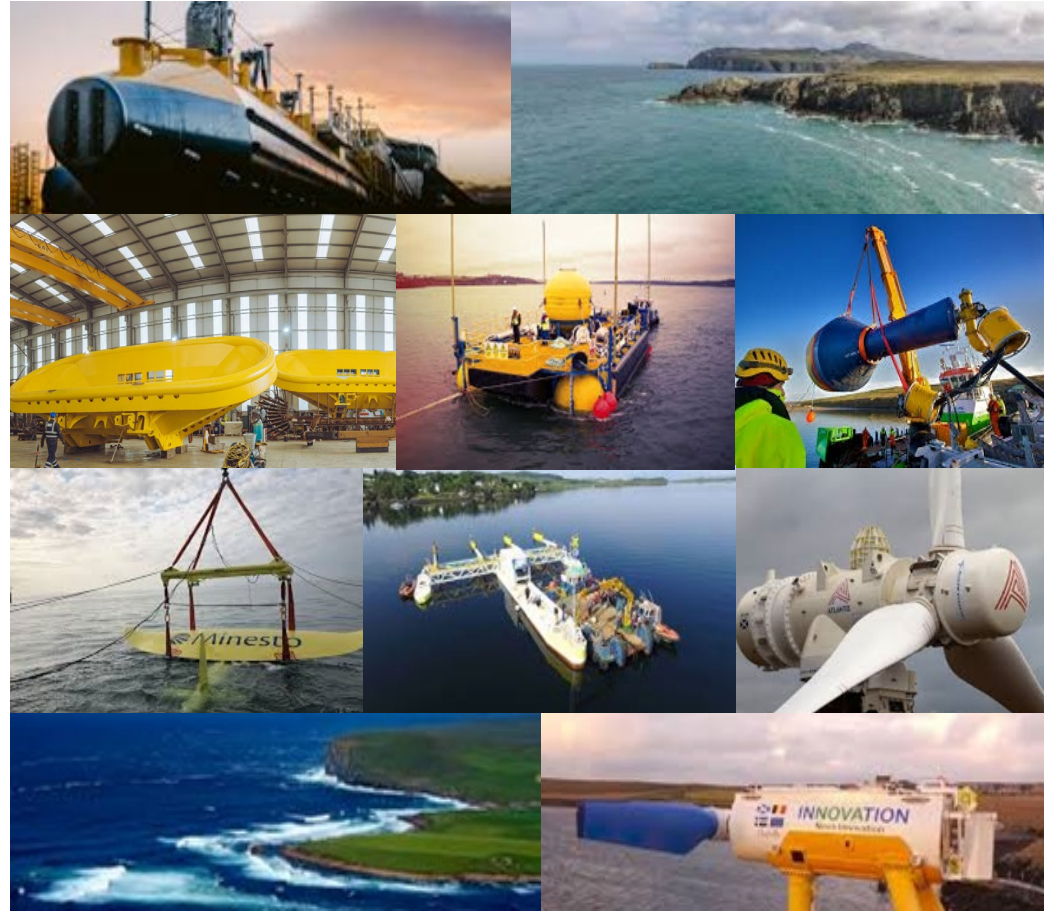


Marine Energy Future

Unlocking the Tidal
Stream Industry in
the UK



- 1GW shared target for Marine Energy
- Evidence and shared collaboration on cost and reliability
- Route to Market through CfD Allocation Round 6 – continuity required.





THANK YOU

May 2023

s.barr@marineenergycouncil.co.uk



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Tim Warren

Operations Director

Blackfish Engineering Design



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BLACKFISH

INNOVATIVE ENGINEERING **DESIGN**
FOR A SUSTAINABLE **FUTURE**

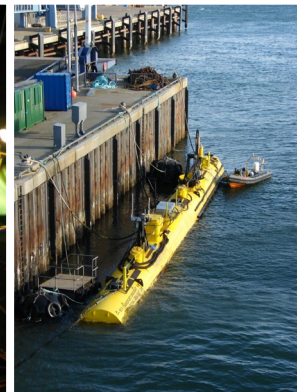
Tim Warren, Operations Director



500kW TIDAL TURBINE



1MW TIDAL TURBINE





TIDAL STREAM

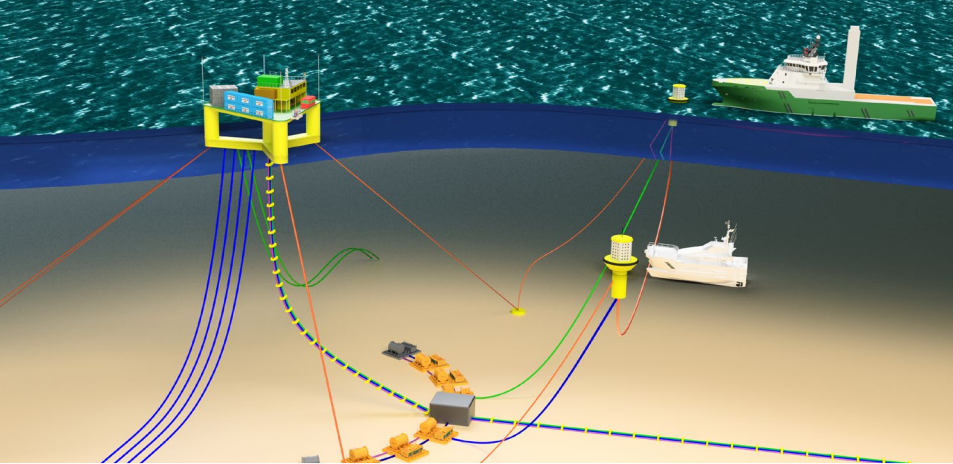
TGL TRIPOD REMOVAL



EMEC FLOW TEST PLATFORM



WAVE



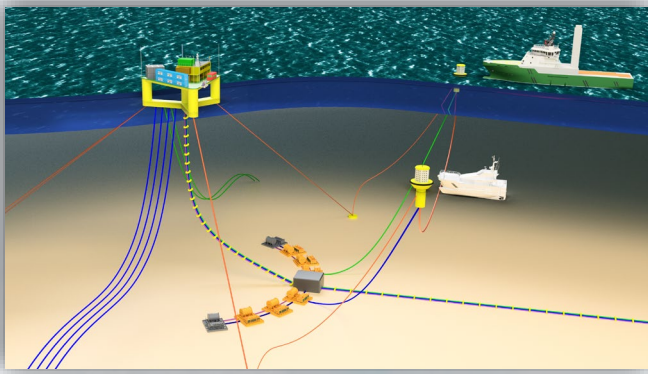
**INTEGRATED ENERGY SYSTEMS
DECARBONISING OPERATIONS**



WAVE AND TIDAL ARRAYS

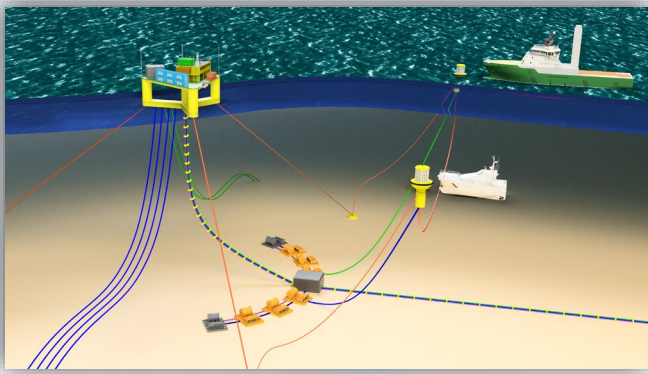
WIND AND WAVE CO-LOCATION





BLACKFISH





BLACKFISH



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Commercial Director, EMEC

Beth Dickens

Director and Founder, Quoceant

Sue Barr

Chair, Marine Energy Council

Tim Warren

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Leaders' Debate: next step or step change?

Chaired by Morag Watson
Director of Policy, Scottish Renewables



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Andrew Scott

Chief Executive Officer

Orbital Marine Power



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Gavin McPherson

Associate Director of Policy & Research
Nova Innovation



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TIDAL ENERGY

Powering a Better Future



We design, build and sell tidal energy turbines

Nova Innovation – 2022/23 in numbers

1st turbine exported to Canada

1st turbine deployed in France

World 1st subsea multi-turbine hub

Doubled the Shetland Tidal Array

6 turbines deployed in a single array

7 years continuous monthly operation

58,000+ generating hours (& counting)



Winner 2018:
European Union
SME of the Year



Winner 2018:
Outstanding Project
Award



Shell
Springboard



NOVA
INNOVATION



EnFAIT – doubling the size of the Shetland Tidal Array



ELEMENT – first Nova turbine deployment in France



GHOST – Green H₂ & O₂ from Sustainable Tidal Energy



Tidal power in Scotland – what next?

Scotland has all the cards

- Huge tidal energy **resource**
- World-leading tidal **projects**
- World-leading **technology** developers
- Strong Scottish **supply chain**
- **Public and political** support

Action needed

- **Grid** – connect & manage
- **Consents** – faster, more proportionate approach
- **Finance** – fix/replace CFD



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David Taaffe

Chief Operating Officer SAE Renewables



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MeyGen Project Overview

SAE Renewables

Scottish Renewables Marine Conference 2023

About SAE Renewables

SAE are a Scotland headquartered developer of renewable energy projects. We strive to collaborate to deliver our projects and we are passionate about the role we play in the fight against climate change.

We have experience of all stages of the project lifecycle from early development through to commercial operations and maintenance. We are a technology agnostic developer, focussing on maximising project valuations for the benefit of the climate, the industry and all our stakeholders.

Key projects and development businesses in our portfolio:

- **Uskmouth Sustainable Energy Park** – over 450MW of Battery Energy Storage System (“BESS”) projects under development with land and grid capable of hosting over 1GW of BESS.
- **MeyGen** - 6MW operational tidal stream project with expansion potential to 398MW including co-location of large scale BESS.

Strategy: to be a global leader in the creation of new, sustainable energy projects for the benefit of our planet.



MEYGEN - The world's largest tidal stream energy project



398_{MW}

Seabed lease

86_{MW}

Offshore consent

6_{MW}

Installed capacity
MeyGen 1

28_{MW}

CFD awarded
MeyGen 2

243_{MW}

Grid connection
agreement

53_{GWh}

Generated to date



MeyGen 1



Phase 1A - History

Construction work commences at the onshore site in January. Subsea cable installed in September

2015

MeyGen achieves ROC accreditation upon initial commissioning of turbines

2017

World's first 50GWh of electricity from a tidal power plant generated to grid

2023

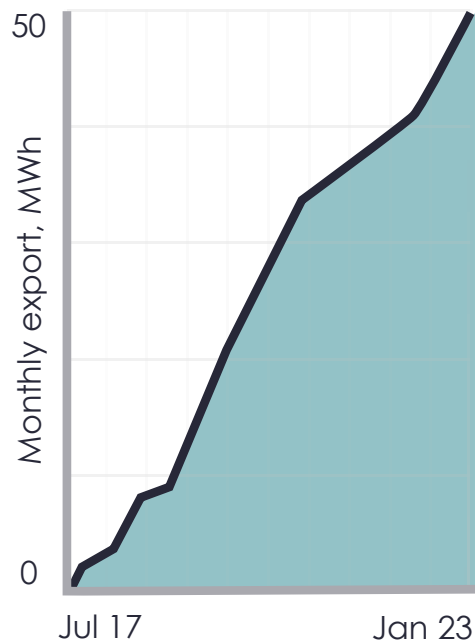
2014 Financial close is achieved for £51.3 million funding for the project in September

2016 Grid connection energised in June. Installation of all turbines complete in November

2018 MeyGen officially enters 25 year operations phase in April



MEYGEN – Phase 1A – 5 years operations



53 GWh

Generated to grid

72%

Of all UK tidal energy production

3.7 k

Homes powered p.a. since 2018

28.2 kT

of CO2 Saved

52 months

TTG 3 continuous running

£35 m

Benefit to UK to date



MeyGen 2

MEYGEN – Phase 2



28_{MW}

Currently planned
expansion

£178.54

Per MWh CFD
awarded

03/27

target
commissioning date

34_{MW}

MeyGen capacity
on completion

What is needed to de-risk and accelerate roll out?



CFD BUDGET – AR5 budget was set at half the amount of AR4. Future budgets need to increase to ensure the larger projects get built, to reduce costs and enable a sufficient pipeline of projects to allow the industry to develop commercially.

LINE OF SIGHT – We need assurance from the UK Government that the ring fence will continue long term to allow tidal stream to compete, and to incentivise long lead-time project development investment to ensure increasing amounts of capacity is CFD ready.

COMMERCIALISATION SUPPORT – We need support to help the industry be commercialised and project finance ready;

- How and when can turbine suppliers provide bankable warranties and what support can government provide?
- Operational experience needs to enable all risks insurance at reduced costs.
- A pipeline of projects is required to influence manufacturing and define the prize.
- Market conditions need to be created to incentivise technology agnostic project development.

The tidal industry needs to rapidly position itself to be as commercially attractive to investors as established utility scale renewable energy projects.



Thank you

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Ian Crossland

Commercial Director

Mocean Energy



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Green Energy out of the Blue

Ian Crossland

Commercial Director
ian.crossland@mocean.energy
+44 (0)7717 346156

Prepared for Scottish Renewables

May 25th, 2023

www.mocean.energy



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Who are Mocean Energy?



- Founded in 2015, second generation wave energy company, building on past commercial & technical experience
- >£10m invested in technology development and commercialisation, 80% of that through public support
- In 2021, **we launched our prototype, Blue X;** selected over competition by sector experts
- We are 22 industry leaders; from 8 nationalities
- Proud Scottish heritage

A group of 15 people, including men and women of various ages, are standing in a line on a paved area. Behind them is a large, yellow, cylindrical wave energy prototype. The prototype has the Mocean Energy logo and the text "wave energy SCOTLAND" on its side. The background shows a cloudy sky and some industrial structures in the distance.

Vision: People living in harmony with the ocean and each other through sustainable technology.

The Challenge of Waves

So far, the technical and commercial challenges of wave energy have not been fully solved.

\$ Cost of energy

Survival at sea

Capital intensity

But they started from the wrong place ...

- ❑ 10 years from idea to making commercial impact
- ❑ Too many technologies – confusing landscape – need for common understanding of value & greater convergence
- ❑ End-users race to be second
- ❑ Restricted access to pilots and demo's
- ❑ A renewed understanding between investors, adopters and technology developers
- ❑ Ready access to pilot and demo projects – de-risked & accelerated time-to-demo pathway in order to enable commercial adoption
- ❑ Government to create and maintain a sense of urgency, signal intent & incentivise near-term deployment

2500 days to **2030**

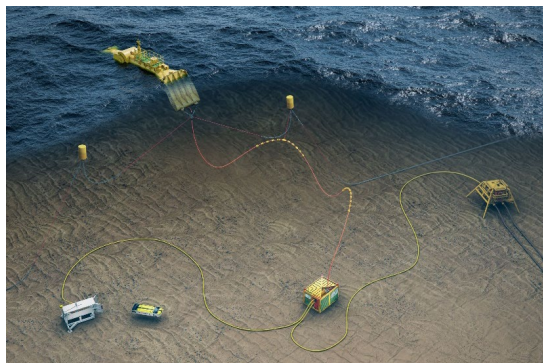
9800 days to **2050**

Courtesy of EIC NSDC May 2023:

Roadmap to scale



Our design process, learning by doing, and revenues from early products accelerate the successful development of larger scale devices across markets. Our **technology is scalable**, both in device size and number.



blue**STAR**



Small-scale: 10's kW

Subsea tiebacks, CCS tiebacks, residential robotics, marine awareness.

First commercial projects: 2024/25

Saving 10,000+ TCO2 / project



blue**HORIZON**



Mid-scale: 100's kW

Islands, small platforms, offshore aquaculture, vessel charging.

First commercial projects: 2027/28

Saving 200,000 TCO2 / year ¹



blue**HORIZON**



Grid-scale: MW's

Combined wind-wave farms, large offshore platforms, islands.

First commercial projects: 2030+

Saving 100,000,000 TCO2 / year ²

Collaboration

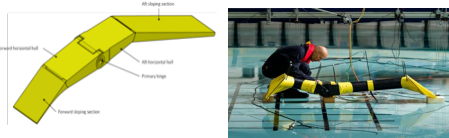
What collaboration should look like..... start small, go big!

Decarbonisation pathway



NWEC (Novel Wave Energy Converter) programme launched

2015



TechX Programme – Cohort 3 kick off

2019



Renewables for Subsea Power (RSP) Phase 1 desktop design-FEED

2020



Blue X testing EMEC THE EUROPEAN MARINE ENERGY CENTRE LTD

2021



Phase 2 – Onshore procure, manufacture and test



2022



2023

Phase 3 – Offshore Demonstration



So, how do we leverage commercial acceleration to larger scale devices ?



Key take aways



Cross-industry collaboration is fundamental

- RSP brings cross industries together with developers, operators, integrators – all building towards Net Zero targets. Start small – go big!



Set a course for action

- Govt to create a sense of urgency and act on it
- Strategic roadmap to align the needs and pathway to consenting from mid to grid MW



Capital intensity

- Renewed understanding between Govt, investors, technology and field developers
- Bankable technology through deployment



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Simon Grey

Chief Executive

AWS Ocean Energy



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AWS Ocean Energy

Simon Grey - CEO



Introduction



- AWS Ocean Energy was founded in 2004 to develop and commercialise the Archimedes Waveswing wave energy converter
- We are a technology development company with a passion for finding a practicable and affordable way to generate power from ocean waves
- We are one of the few companies who has experience of equipment in the water and recognises the challenges of maintenance and scale
- We have a range of technology offerings covering a variety of different markets from defence, through offshore de-carbonisation to utility power
- We have a clear development plan that will lead to utility-scale wave power within 10 years



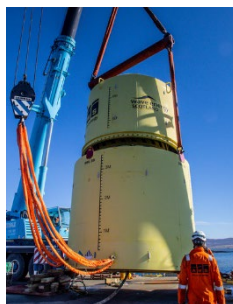
Micro Waveswing

- 50 to 100W
- Remote oceanographic sensing and other applications
- Small form-factor (0.5m x 2m)
- Single use or recover for maintenance



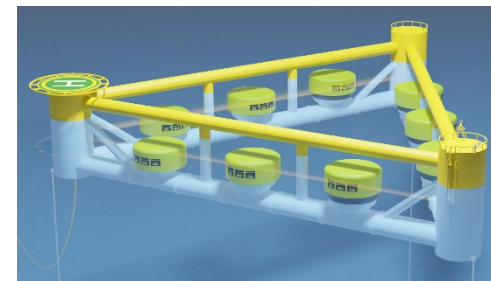
Single Waveswing

- 20 to 400kW
- Remote off-grid power
- Rapid deployment
- Recovery for maintenance



Multi-Waveswing

- 3 to 10MW
- Utility scale power
- Safe maintenance in-situ
- Many features and supply chain common to FOW





Next step or step change?



- In 2013 AWS had a team of 36 people and was majority owned by Alstom, one of the largest power system OEMs in the world
- In 2023 AWS has a team of 3 and is owned by its directors

What happened in between?

(and what lessons can we learn?)

- Market failure 
- Wave Energy Scotland 

But re-creation of our 2013 position requires re-establishment of the conditions that got us there!

Entrepreneurship 1.01



“The single necessary and sufficient condition for a business is a paying customer.”

Bill Aulet – MIT Sloan School of Entrepreneurship



- Without a business, how do we raise investment?
- So where are the customers for marine energy, and what do we need to do to attract them?

What do marine energy project developers need?



- Projects that can make money at an acceptable level of risk:
 - Ability to secure site rights and consents in a reasonable time-frame and within known parameters
 - Sufficient revenue to repay the capital invested, and to compensate for the risk (particularly early stage)
 - Access to finance and grants which help to mitigate down-side risk in early projects
- A pipeline of projects to make early risk worthwhile

This all calls for a joined-up strategy backed by policy actions!

Strategy and actions

- Set a clear ambition for marine energy development with targets for both wave and tidal – 100MW each by 2035
 - Together with a commitment to implement the policy actions to enable the private sector to deliver on the ambition
- Recognise and fix the road-blocks
 - Crown Estate – leasing round (per PFOW)
 - Marine Scotland – light touch, rapid consenting esp. for early schemes
 - UK Government – long-term commitment on CfDs with clear strike-price / pots out to 2030+
 - SG / SNIB – commitment to capital grant and soft loans for early projects to mitigate risk and top-up finances



The Scottish Government



marine.scotland



A big idea – give wave power the BOOT!



- Scottish Government commit to a 10MW BOOT wave power project, to be completed by 2030
- Using this mechanism, government takes the early-stage construction risk, and then sells the operational project to the private sector to exit
 - Doesn't compete with project developers or energy companies
 - Allows public procurement at 100% of cost
- This provides a customer to wave technology developers and project EPC contractors, thus enabling private investment into the tech companies

Build
↓
Own
↓
Operate
↓
Transfer

This move could be catalytic for delivering Scotland's marine energy ambitions!

Let's do it!



Practical affordable wave energy

www.awsoccean.com

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Director of Policy, Scottish Renewables

Andrew Scott

Chief Executive Officer, Orbital Marine Power

Gavin McPherson

Associate Director of Policy & Research, Nova Innovation

David Taaffe

Chief Operating Officer, SAE Renewables

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Commercial Director, Mocean Energy

Simon Grey

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Director of Policy

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