mocean energy

Road to COP28, Offshore Renewables And New Energies MENA perspective

Wave technology

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SUT
Society for Underwater Technology

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Who are Mocean Energy?

- Founded in 2015, second generation wave energy company, building on past commercial & technical experience
- £13m 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 23 industry leaders; from 8 nationalities
- Scottish heritage

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

A Short History of Wave Energy

Wave energy R&D started in the 1970's as exemplified by Stephen Salter's "Duck" device.

In the 2000's it gained industrial focus with the wave and tidal test centre, EMEC, and companies like Pelamis, Aquamarine, WaveBob, Ocean Power Technologies etc.

Pelamis exemplifies the "utility-scale" ambitions of the time – built 6 big machines (1000 tonnes +!), spent £50m+

Lessons learned:

- Started too big / R&D too expensive;
- Concept didn't evolve / innovate enough;
- Focused on cost-competitive market (utility electricity) – couldn't get cost of energy low enough.

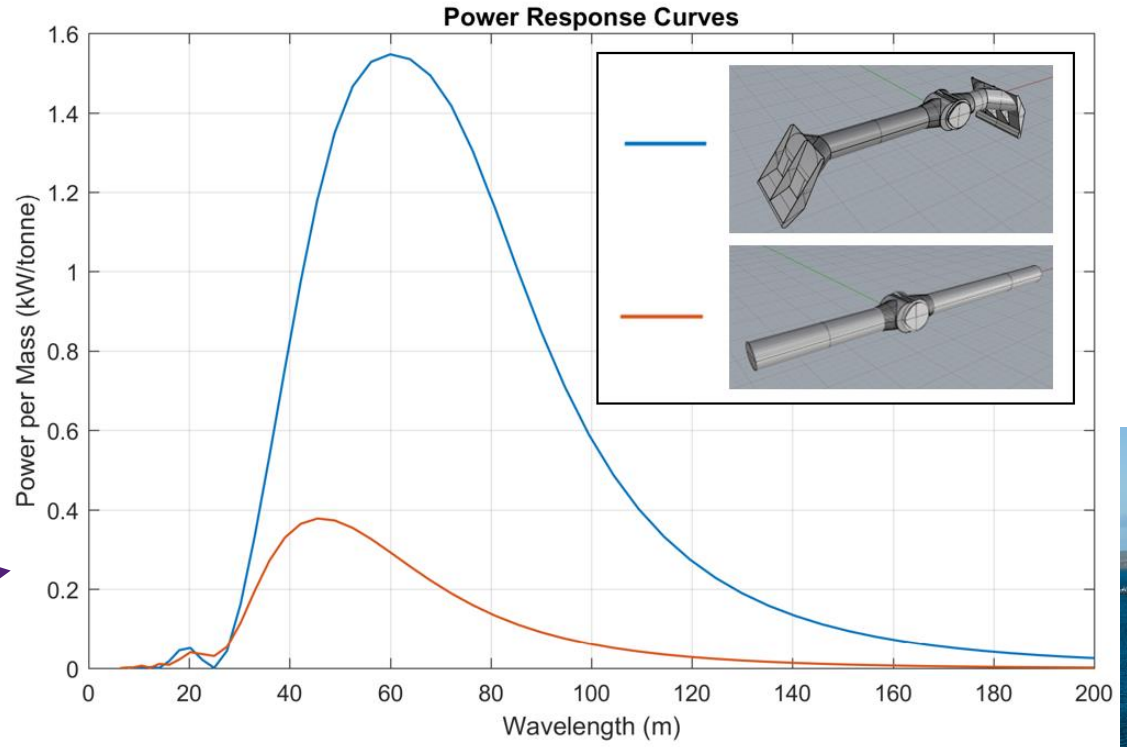
Mocean are part of a second generation of wave energy companies who have made significant technical and commercial innovations, based on past technical & commercial experience.

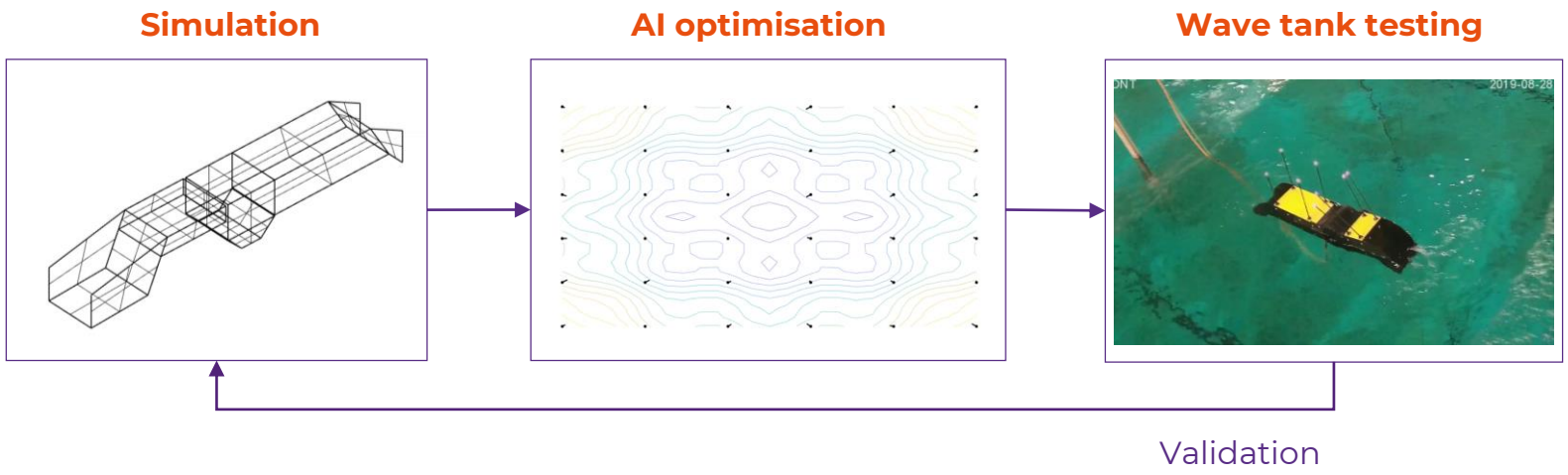
Render of Salter Duck wave farm from the 1970's.

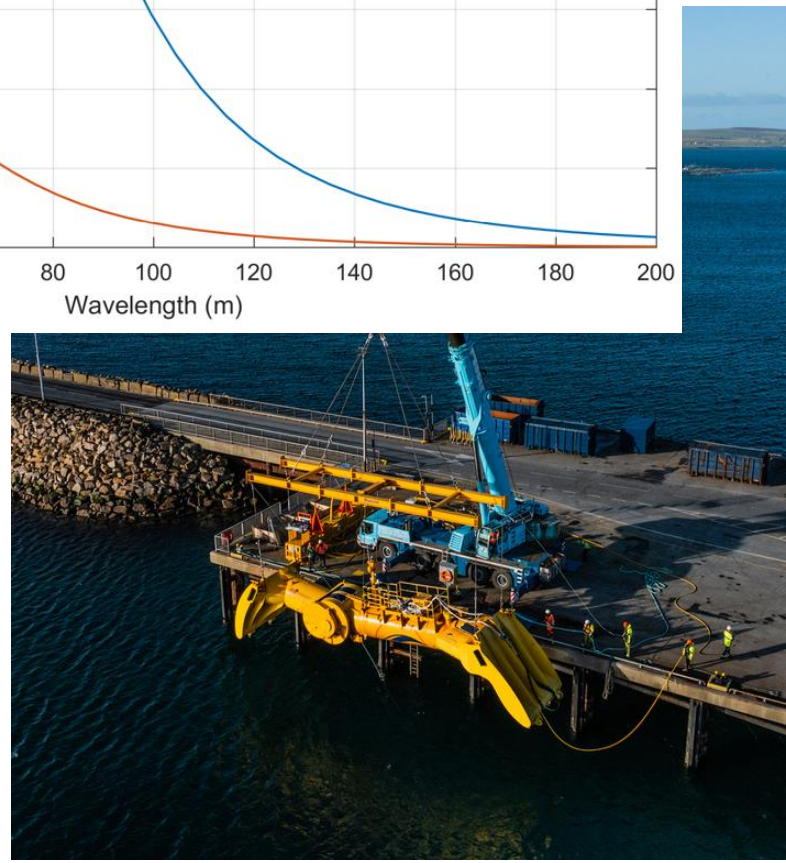
Pelamis's P2 wave energy converter being tested at EMEC – 2010-2014.

Mocean's approach

- Mocean: optimise, model, validate, test, deploy
- **We do things differently to wave energy companies of the past:**
  - AI-based optimisation
  - Learn by doing
    - enabling markets (off-grid) & at sea experience
- **Optimise** performance based on application parameters – e.g. to maximise power per structural mass
- **Ready to commercialise:** Blue Star (20 kW) released by 2025





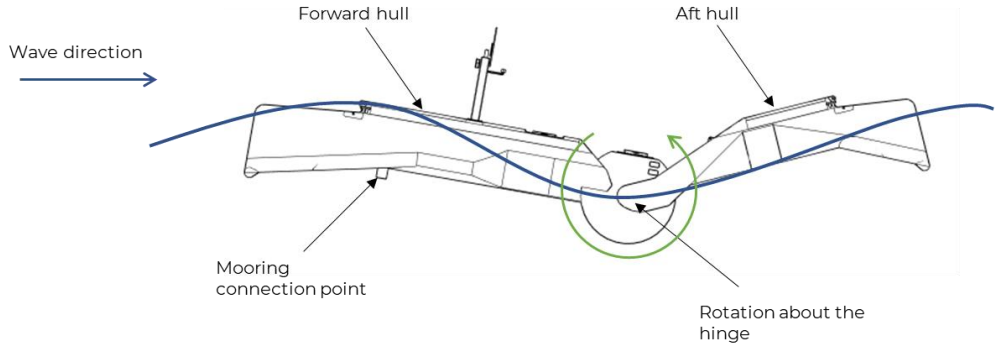


Fundamental principles

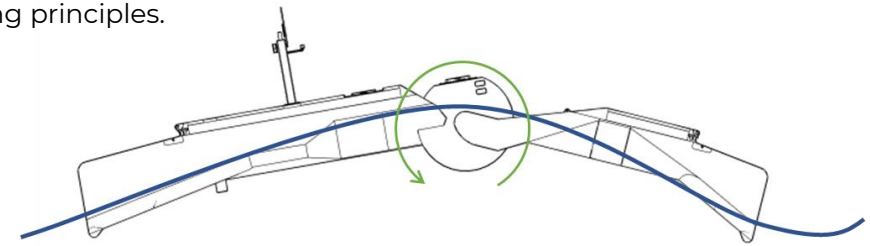
Floating, asymmetric, hinged raft.

Relative pitching of the hulls drives a generator at the hinge.

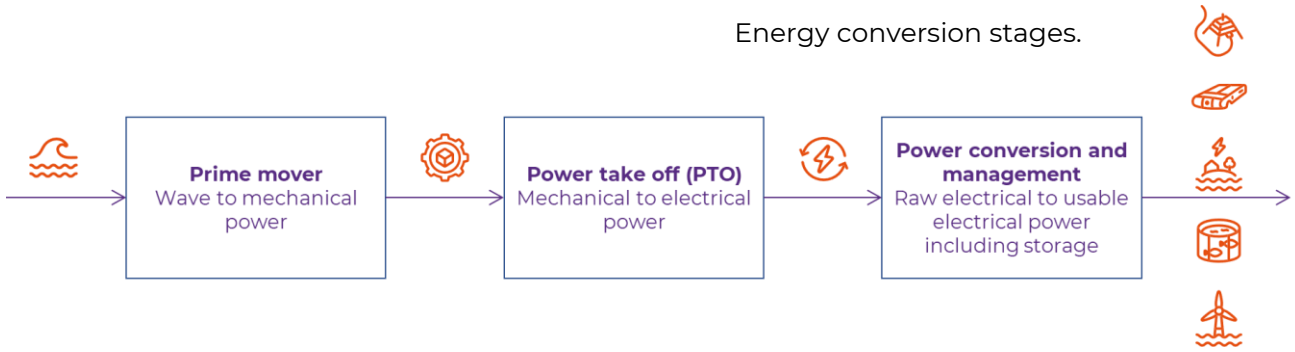
Sloped section ("wave channels") increase the magnitude and bandwidth of the WEC's response.



Operating principles.



Energy conversion stages.



Best in class wave energy technology:

- Fundamental design drivers:
  - Device length, submerged volume, steel plate thickness
- Coupled modes of motion = power from more degrees of freedom
  - Absorbs energy from waves ~3x as long as WEC length
- Self-referencing = depth agnostic
- Functionality at sea: availability, survivability, reliability, operability
  - Load shedding in steeper waves
- **Track-record; system integration; commercial readiness**

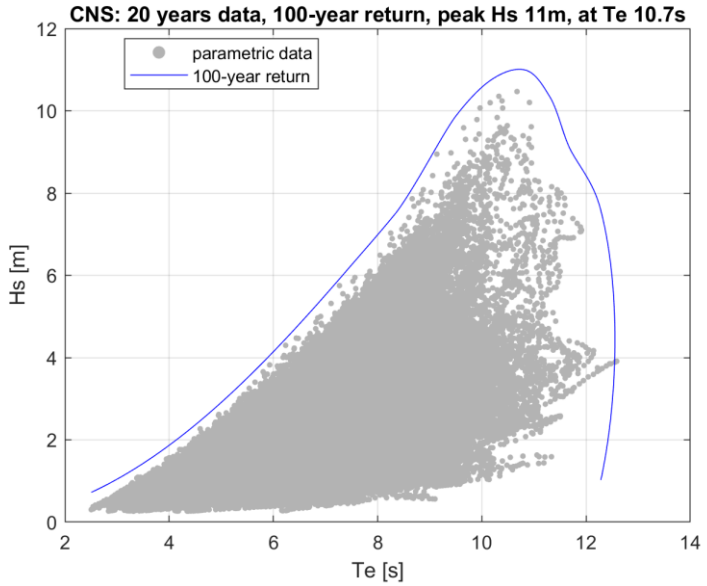
[1] 3 stage-gates in Wave Energy Scotland program; 2 stage gates in EuropeWave;
The programs use IEA-OES International Evaluation and Guidance Framework for Ocean Energy Technology

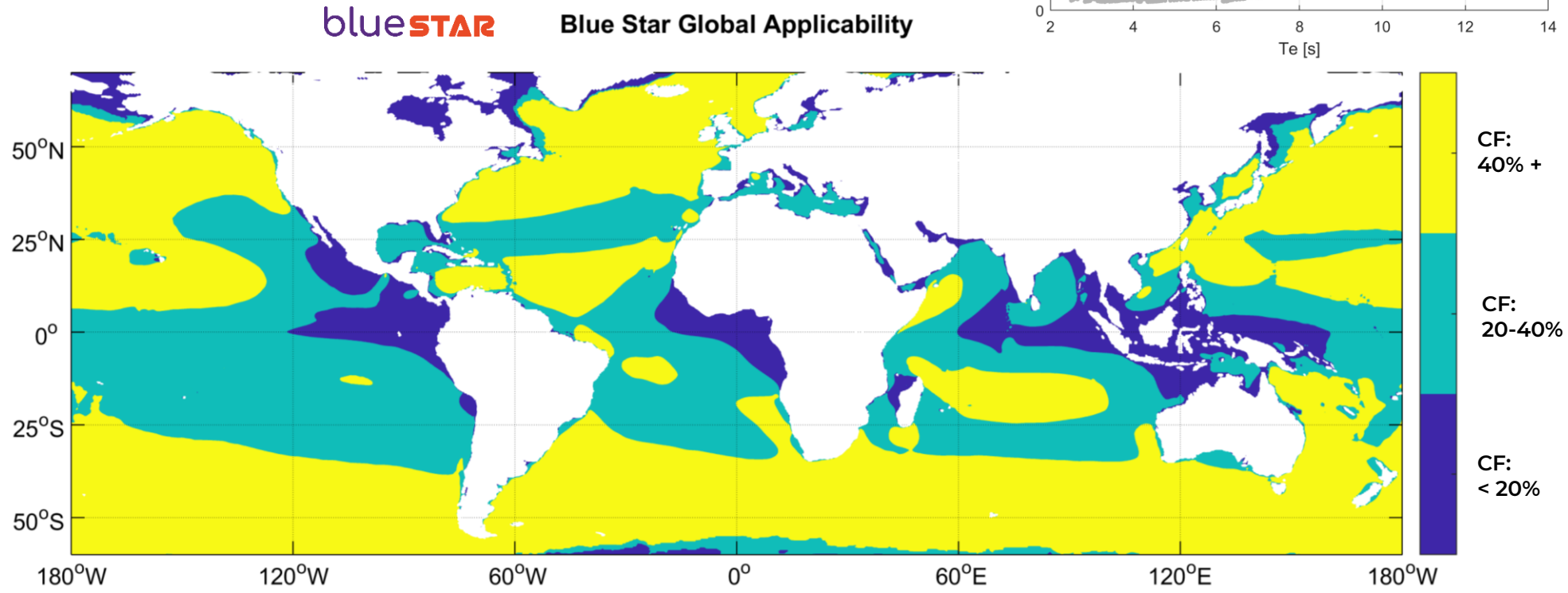
Deployability & potential

Power potential and survivability.

Blue Star WEC has been designed for a 100-year return period in the Central North Sea.

- Hind-cast modelled data from Copernicus ERA5 set.
- 100-year bivariate distribution.
- Safety factors.
- "Cut-in" ~0.5m Hs
- "Cut-off" 5-10m Hs (PTO dependent)





Visual representation of Blue Star global deployability (based on expected capacity factor, CF).

Blue X – learning by doing

In 2021, funded through Wave Energy Scotland's competitive PCP program, we tested our Blue X device (10 kW, 20 m, 40 tonnes) for 5 months at the European Marine Energy Centre, in Orkney.

At-sea testing provided invaluable lessons learned:

- **Power production**: up to 5 kW sustained power and 30 kW instantaneous peak power.
- **Communications**: 99.99% comms system uptime
- **Survivability**: diving through waves to shed loads, equipment autonomously entering survival mode
- **Reliability**: no major equipment failures.
- **Operations & maintenance**: installation, removal, access as sea, battery charging, quick-turn-around removal and return to sea maintenance.

Technology has been proven to TRL 6 (API 0-7 scale):
system prototype in operational environment

Blue X in action at Scapa Flow, EMEC (2021).

Demonstration project: RSP

Renewables for Subsea Power

RSP is a **Net Zero Technology Centre flagship project:**

- "First-of-a-kind" commercial **full-scale system** to provide renewable power & communications offshore
- Combined system deployed, connected & operational as of February 2023

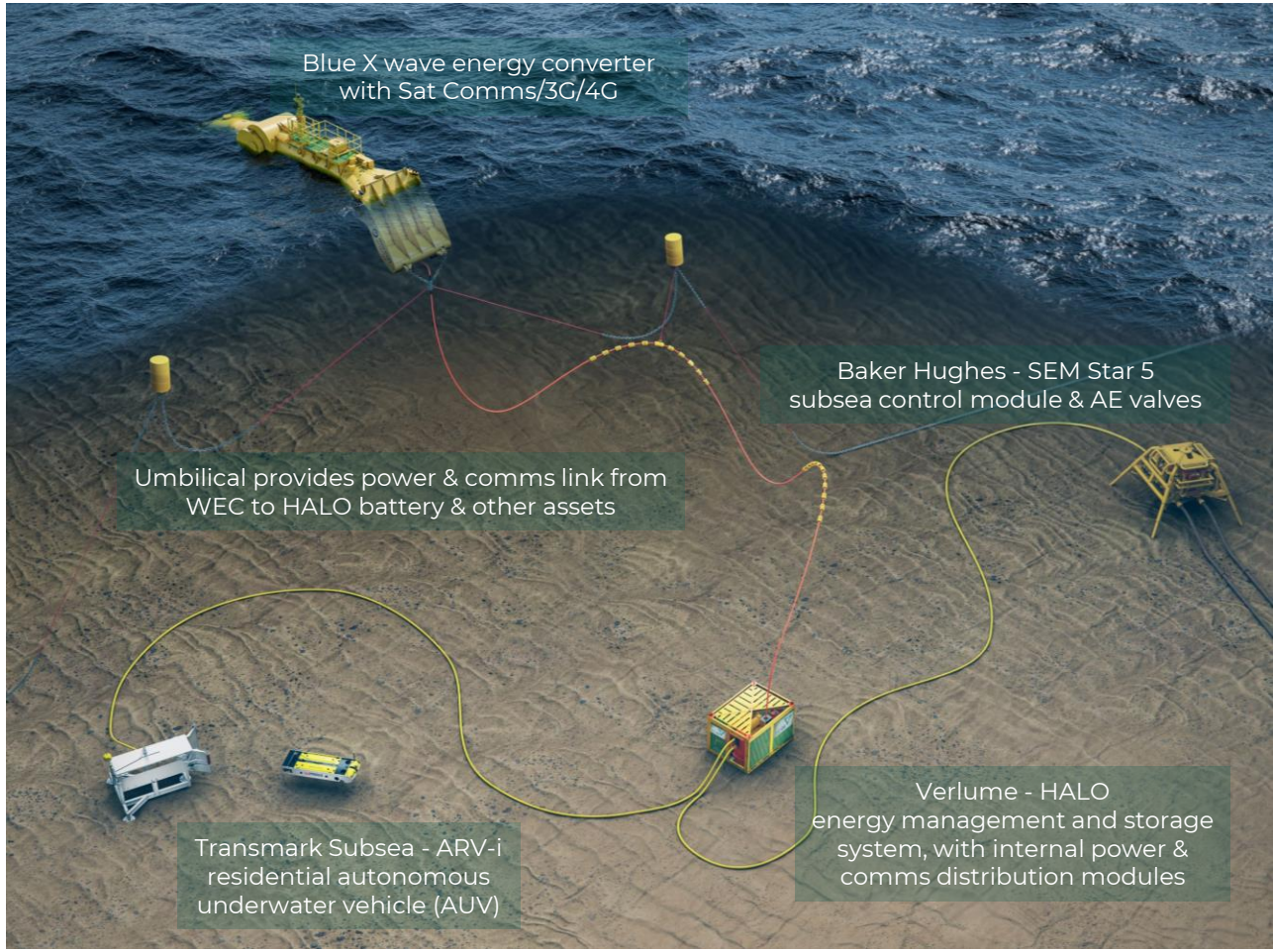
Demonstration via 6 – 12 month minimum deployment:

- 3.5 nautical miles east of Orkney mainland; 50-53m water depth
- Remote comms, control & monitoring

Qualification to a system TRL 6-7 (API):
actual system completed & qualified via test and demo

RSP aims to:

- Boost industry confidence in the proposed solution
- Pave the way to **wider carbon mitigation** via systems scalable in size and number across off-grid subsea power applications

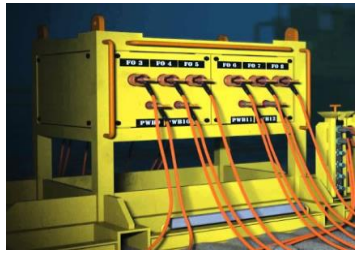


RSP is an **enabler** for wide ranging **electrification & decarbonisation** of subsea solutions …

Umbilical Remediation

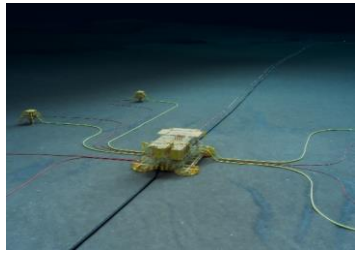
- **Re-enable failed assets with electrical umbilical failures**
- Energy security
- Remote comms
- Works with existing controls architecture

Brownfield Expansion



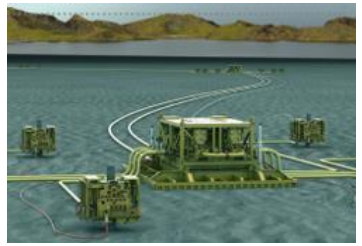
- **Enable in-fill/stranded asset wells**
- Minimal impact on host infrastructure control system
- Simple Transparent link remote SatCom/4G

Long Offsets



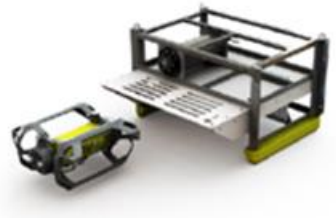
- **Enable Long Offset wells**
- Remove need for Hydraulic umbilical
- Employ remote chem injection subsea
- Minimal impact on host infrastructure
- Simple Transparent link remote SatCom/4G

CCS



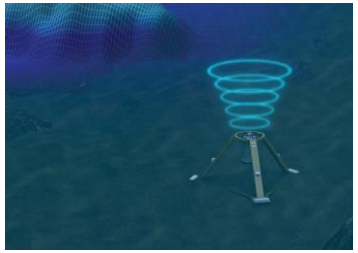
- **Adoption of all-electric subsea systems**
- Green power generation (No GHG)
- Alternative to DCFO from shore
- Remotely powered system (energy security)

Vehicle Residency



- **Short or long term vehicle residency**
- Over-the-horizon comms
- Charge vehicles on the seabed
- Reduce vessel GHG emissions

Metocean & Leak Detection



- **Long duration autonomous data monitoring**
- Data redundancy: remote comms & local data storage
- Power for retrofit leak detection

Decarbonise existing developments & enable electrification via new technology

RSP – Phase 3 Highlights

Some Key outcomes

>3 MWh total generated
(as of Aug)

Monthly Solar yield
46 kWh (July)

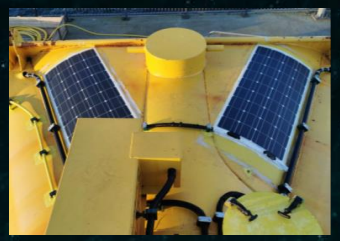
+/- 50deg max hinge angles
(within limits)

Average power:
~2kW (March)
~1 kW (overall)

Solar Contribution
covers 200% Comms demand

Max Hs encountered:
5.32 m

Initial data from first 3 months of operation (Mar-May) suggests robust wave & solar yields, and reliable system integration.



Showing solar panels at hinge & forward wave channel.

Autonomous Underwater Vehicle operations

RSP – Autonomous Resident Vehicle

ARV-i

BOXFISH ROBOTICS

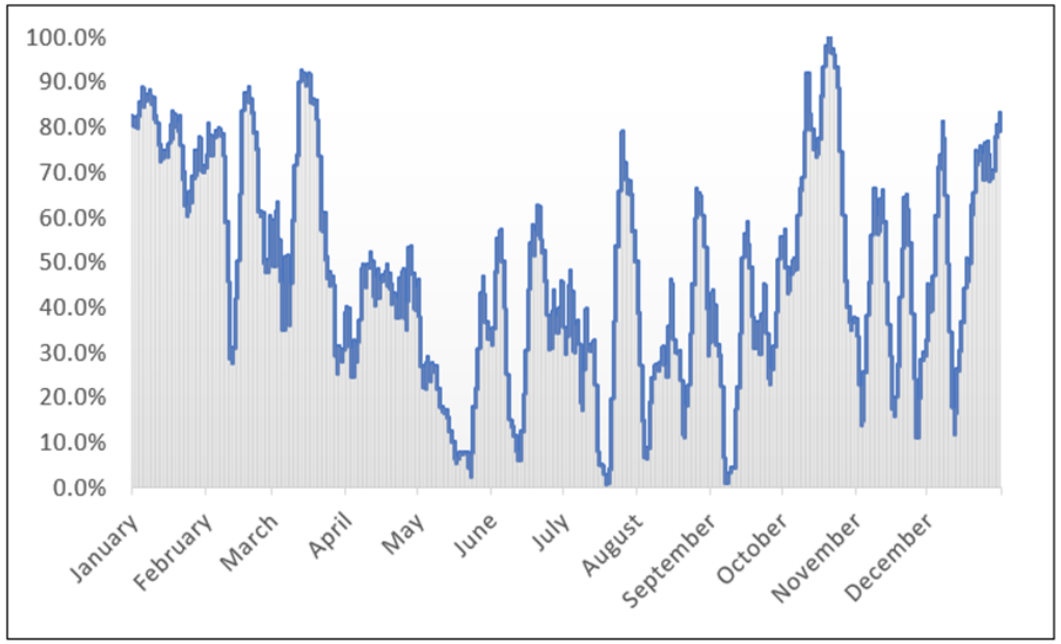
Transmark Subsea
Specialist in Subsea solutions

Completed ARV-i Test Updates:

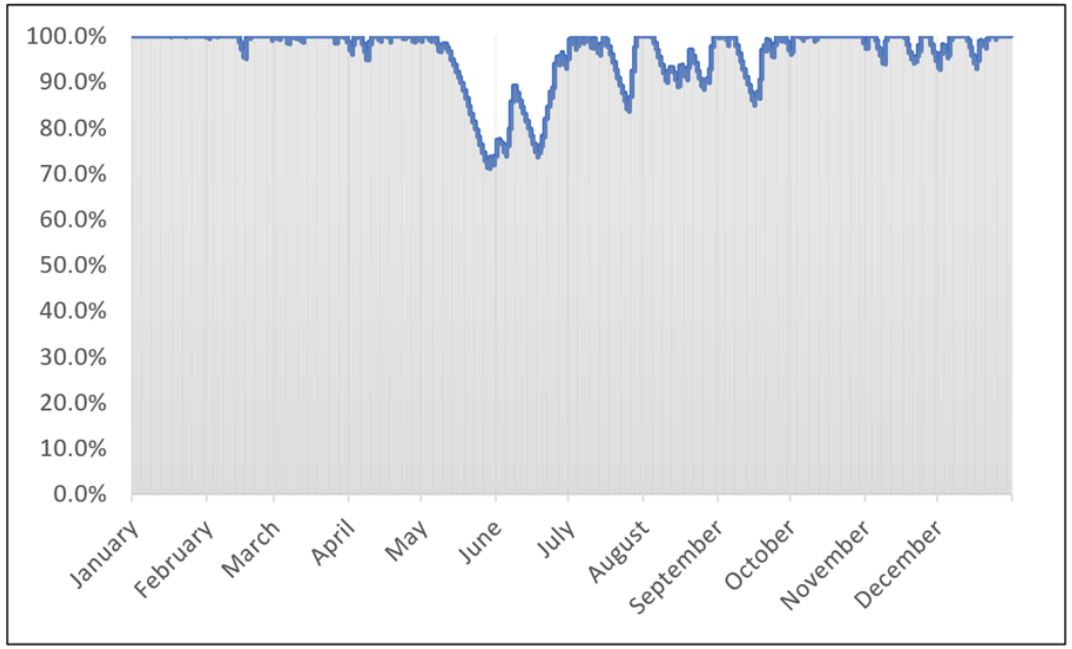
- Initial ARV-i inspection of site
- ARV-i deployment testing
- ARV-i successfully navigated to dock from surface
- ARV-i successfully docked
- 50 autonomous dock and undock manoeuvres completed
- ARV-I Phase 2 & 3 Testing

Power stabilisation

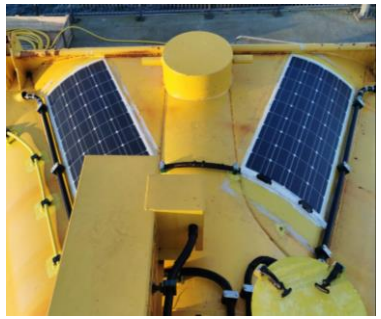
Power Generated



Power Available



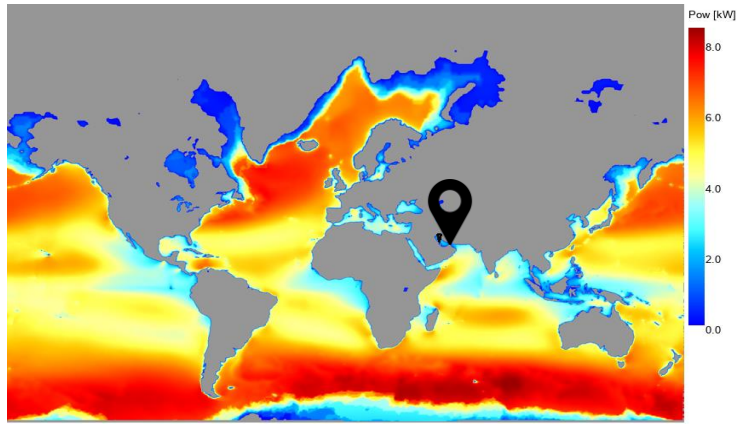
Power hybridisation



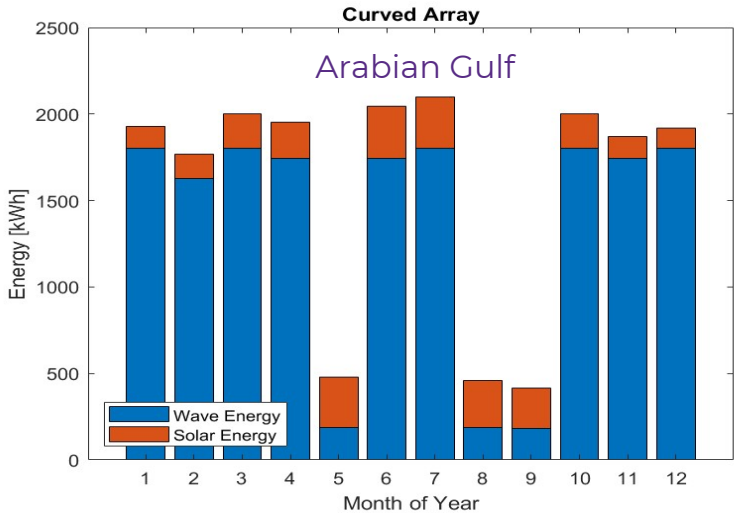
RSP learnings

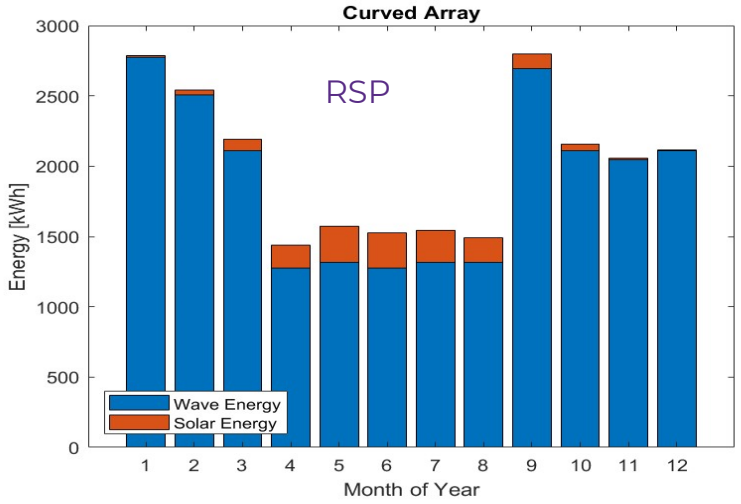
- Balancing the intermittency output
- Combined Wave and Solar reducing the intermittency of period of low wave power generation
- Scalability of increasing the quantity of solar panels on the surface deck of the hulls
- Reduce uncertainties and need for contingency for subsea storage

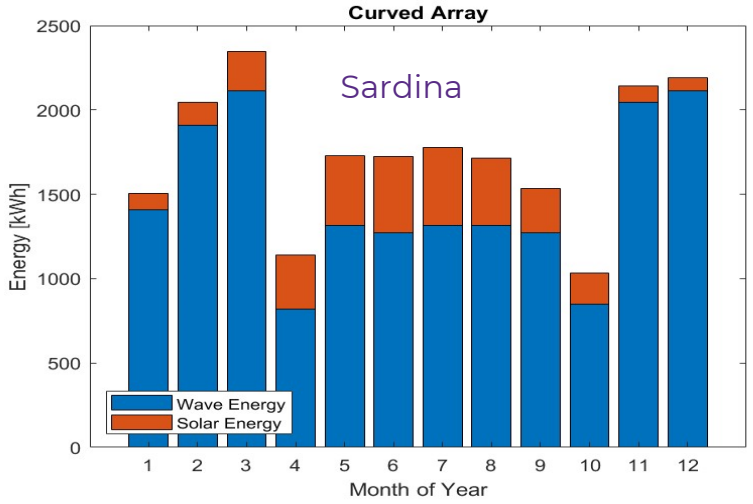
bluestar



CurvedYield – is the combined monthly yields of a curved array onboard BlueX (panels follow the curvature of the hull)

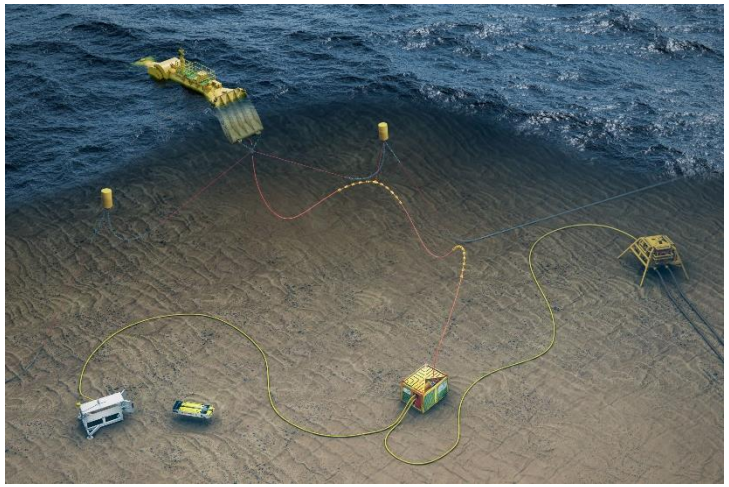






Start small – go big: Roadmap to scale

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.



bluestar

***Small-scale**:* 10's kW

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

Saving 10,000+ TCO2 / project

blueHORIZON

***Mid-scale**:* 100's kW

Islands, small platforms, offshore aquaculture, vessel charging.

Saving 200,000 TCO2 / year [1]

[1] in 10 years

blueHORIZON

***Grid-scale**:* MW's

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

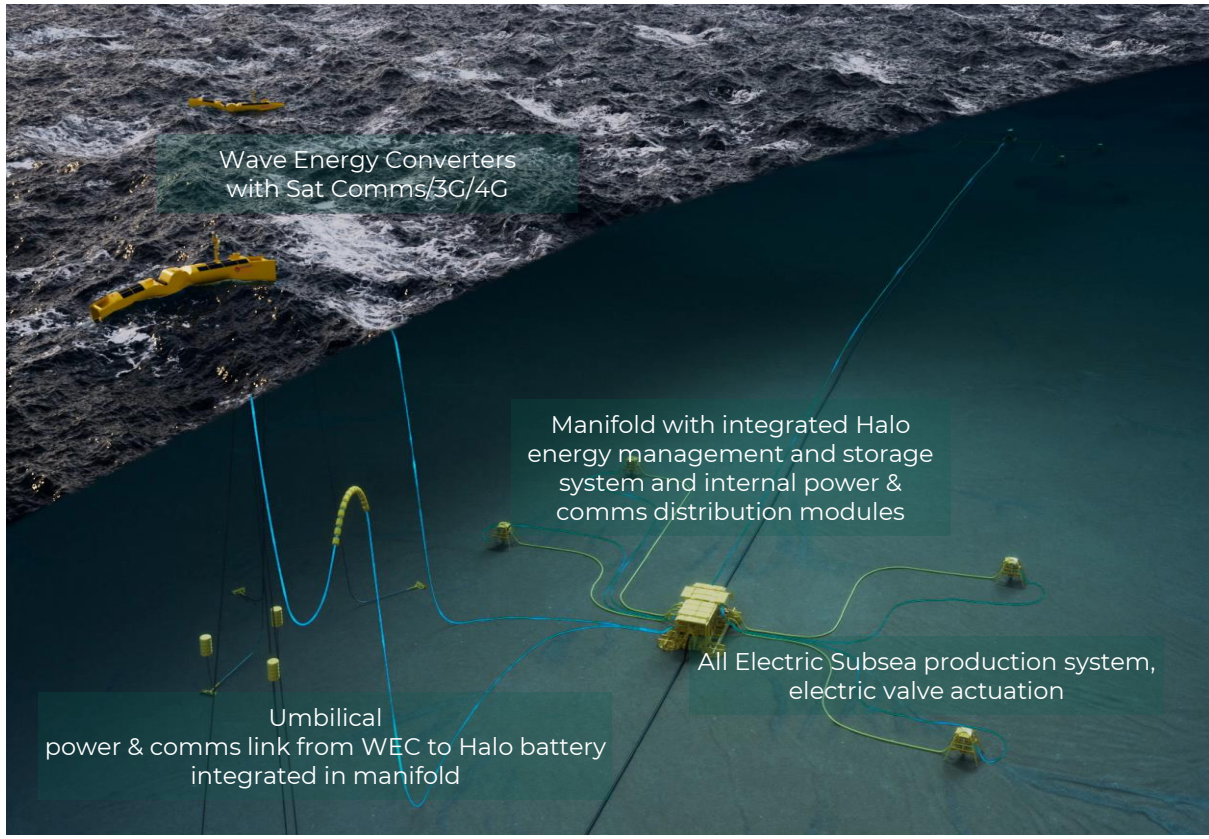
Saving 100,000,000 TCO2 / year [2]

[2] by 2050

Concluding remarks

Wave energy has a significant role to play in the North Sea, across Europe, and globally.

- Ready, reliable, renewable, source of local energy at sea
- **Cross-industry collaboration is key:**
  - RSP brings industry together developers, operators, integrators – all building towards Net Zero targets
- Larger scale decarbonisation opportunities await:
  - Islanded systems and larger scale off-grid (e.g. CCS, hydrogen)
  - **£3.2 Grant** awarded to deliver next size machine 2025
  - Seeking partners to complement EuropeWave funding for Blue Horizon 250 development
  - EuropeWave final phase will lead to TRL6 (API scale); pre-commercial projects in 2027 and beyond
- **Gaining momentum and seeing growing industry traction**
  - Attracting international investment and energy super majors into Mocean projects



"How does wave energy fit with your projects, and how can it play a part in your strategy towards decarbonisation?"

Thank you for listening

10 years

- 200 ocean technology projects enabled
- 20 communities empowered by ocean energy
- Flagship co located wind wave farms
- Mitigate 200,000 TCO2 per year

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