Technology Collaboration Programme
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WAVE ENERGY DEVELOPMENTS HIGHLIGHTS

OCEAN ENERGY SYSTEMS

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Advances in Wave Energy

The wave energy sector is experiencing significant progress and growth, with multiple devices either in fabrication or preparing for deployment. This trend demonstrates the sector's continued expansion and potential. Breakthroughs in wave energy technology have led to the integration of innovative features into new prototypes.

Developers are gaining a better understanding of how their technologies operate at sea and are progressing towards larger prototypes designed for utility-scale power arrays. Ongoing efforts are focused on enhancing their performance, cost efectiveness and reliability.

Alongside the progress in larger systems, the wave energy sector is also witnessing the development of kilowatt-scale power solutions to meet the needs of underwater vehicles, subsea operating equipment, and offshore data communications networks. Wave energy developers are unlocking innovation in critical offshore industries such as defense, aquaculture, science and research, and communications. These advancements have the potential to bring profound changes in the maritime industry, fostering sustainable and efficient offshore operations.

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CalWave's wave energy pilot tested off the California coast © CalWave

1.
CalWave successfully concludes 10-month open-ocean testing off the coast of San Diego, California

CalWave Power Technologies deployed its xWave technology at the Scripps Institution of Oceanography research pier off the coast of San Diego, California in September 2021. After 10 months of continuous operations, the system was decommissioned in July 2022. The project was supported by a US Department of Energy (DOE) award as a follow on to the winners of the US Wave Energy Prize with the goal to advance innovative technologies capable of generating reliable and cost-effective electricity from US marine energy resources.

The device survived two extreme storms enabled by the xWave's innovative shutdown features and operated for 90% fully autonomous and achieve an availability of 99.8%. The insights derived from this pilot are guiding the development of the company's 100-kW system, which will be deployed at the grid-connected, pre-permitted PacWave South test site offshore Oregon.

2.
C-Power set to reach significant milestone with its SeaRAY Autonomous Offshore Power System test at US Navy's Wave Energy Test Site

The US developer Columbia Power Technologies (C-Power) completed fabrication and conducted onshore testing of SeaRAY autonomous offshore power system. The device was then shipped to be tested at the US Navy's Wave Energy Test Site (WETS), off the coast of Hawaii. where it will undergo extensive testing. Prior to its deployment at WETS, the device underwent in-harbor operational trials.

SeaRay is designed to support unmanned offshore activities and equipment, including subsea vehicles, sensor packages, and operating equipment.

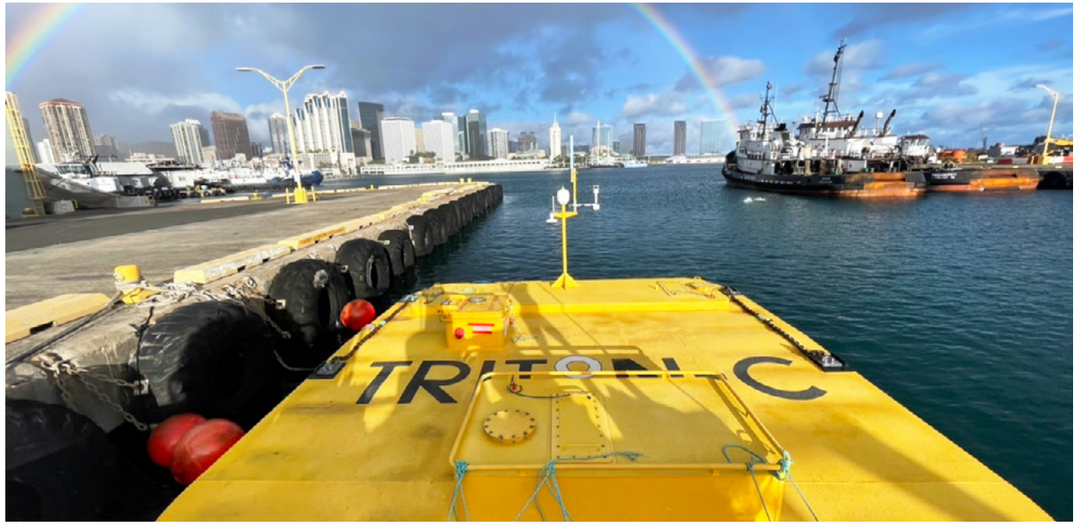
SeaRAY prepared to be tested at the US Navy's Wave Energy Test Site © C-power

3.

Oscilla Power is ready to launch its new device Triton-C at US Navy's wave energy test site

The US developer Oscilla Power has completed the fabrication and onshore testing of Triton-C and is now preparing for installation and testing at the US Navy's WETS site, off the coast of O'ahu, Hawaii.

Oscilla Power is producing two wave energy systems with the same geometry: the Triton and the Triton-C. The Triton-C is a 100 kW rated power system designed for power-at-sea applications or isolated coastal communities, while the Triton is a 1 MW rated power system that is designed to be installed in large arrays to provide utility-scale power.



Triton-C prepared to be tested at the US Navy's Wave Energy Test Site © Oscilla Power

Sea trials of C4 wave energy converter in Portugal © Corpower Ocean

4.

CorPower is preparing the deployment of their first full-scale prototype in Portugal

CorPower Ocean has been developing the HiWave-5 project, which involves a 1.2 MW grid-connected array of four full-scale devices located at the Aguçadoura site in Northern Portugal. The first phase of the project focuses on a single device, the full-scale C4 wave energy converter, and the next phase will involve a pilot array with three additional C5 devices.

The C4 power take-off (PTO) underwent successful dry testing in Stockholm before being transported to Portugal. For the composite hull development, CorPower Ocean partnered with composite experts in Viana do Castelo, Portugal. After completing the C4 WEC system integration, the device was towed to the Aguçadoura site, where a rigorous Pre-Deployment Check program was initiated as a final step to ensure the system met all key requirements and functions before being deployed in the ocean.

5.
MOcean successfully tested their first prototype “Blue X” at EMEC in Orkney, UK

Mocean Energy is actively engaged in the development of wave energy converters across a wide range of applications, including small-scale off-grid usage as well as large-scale utility projects. Recently, the company conducted a sea trial of a ½ scale prototype of their M100 device. This project received funding from the Wave Energy Scotland’s Novel Wave Energy Converter (NWEC) programme and served as a valuable learning experience for Mocean’s ambitious “Blue Horizon” technology, aimed at generating large-scale power, as well as their “Blue Star” device designed for subsea power applications.

Mocean Energy is now advancing towards their next phase known as the Blue X project. The Blue X prototype underwent rigorous testing for a period of five months at the European Marine Energy Centre (EMEC) in Orkney, UK. This stage involves the deployment of the Blue X along with subsea equipment to showcase its ability to provide reliable power and facilitate communications in a real-world setting. Concurrently, Mocean Energy intends to further enhance the Blue Horizon technology through their participation in the EuropeWave programme. They also have plans to commercialize their small-scale product lines, with an anticipated launch scheduled for 2024-25.

Mocean Energy Blue X device at EMEC © Mocean Energy

6.
AWS Ocean Energy completed a successfully testing programme at EMEC in Orkney, UK

AWS Ocean Energy has successfully conducted tests of its 16 kW Archimedes Waveswing wave energy prototype at the EMEC test site in Orkney, UK. The project received funding from Wave Energy Scotland (WES) as part of the Novel Wave Energy Converter development programme.

The positive results of the prototype tests have demonstrated the essential technological subsystems needed for the concept to operate effectively on a real-world scale. AWS is currently carrying out a feasibility study to validate the practicality of large-scale multi-absorber wave energy platforms utilizing Waveswing technology.

Looking ahead, the company has set its sights on developing and showcasing a 2 MW multi-absorber pre-commercial prototype while also exploring additional possibilities for remote power applications.

Sea tests of the AWS Ocean Energy prototype © AWS Ocean Energy

Mutriku Wave Power Plant © Bimep

7.
Mutriku Wave Power Plant connected to the grid since 2011, has generated nearly 2.8 GWh of energy

Mutriku, a coastal village in the Spanish Basque Country, is home to the Mutriku Wave Power Plant which has been connected to the grid since July 2011. The plant comprises 16 oscillating water column (OWC) units, each with an 18.5 kW Wells turbine and electrical generator, totaling 296 kW installed capacity. This facility is used as a testing site, offering a unique opportunity for developers to test new air turbines, generators, control strategies, and auxiliary equipment.

Mutriku's wave energy plant has made the town a global reference for wave energy and attracted regional and international tourism. It has been integrated into BiMEP infrastructure, making it the second testing facility of BiMEP. Since its inception, the plant has generated nearly 2.8 GWh of energy.

8.
DiKWE scale prototype started sea trials in Brittany, France

The ¼ scale prototype of DIKWE, a wave energy converter designed to be inserted in port infrastructures, has been installed in April 2022 off the local dyke of Sainte Anne du Portzic, in Brittany, France. The device consists of an Oscillating Surge Wave Energy Converter with a top horizontal axis included in a chamber.

The DIKWE project is being developed by a consortium of French entities including Legendre Group, GEPS Techno, and Ifremer.

Phase 3 is underway with the technical studies for the construction and the installation of an 800 kW demonstrator, in the western part of Britany. The target time for the installation is Q3 2024.

DIKWE device at Sainte Anne du Portzic test-site © Ifremer, Olivier Dugornay

9.
Exowave deploys a scale model at the Blue Accelerator Test Platform in Belgium

Exowave, a Danish start-up, achieved a significant milestone with the testing campaign at the Blue Accelerator, a test platform for blue energy innovation off the coast in Ostend, Belgium.

Having successfully demonstrated the viability of its wave energy converter at the Blue Accelerator test platform, Exowave is now focused on the next upscaling project to be deployed in the Danish North Sea.

Exowave project to be tested at Blue Accelerator © Exowave

Deployment of full scale unit at PLOCAN © Wavepiston

10.
Danish company Wavepiston continue progress at PLOCAN's Test Site in the Canary Islands

Wavepiston continue progress in the Canary Islands, aiming to get their full-scale installation operational in Gran Canaria in operation during the second quarter of 2023.

The system consists of a series of wave energy collectors connected by a chain and anchored between two buoys. The initial phase involved assembling a short test string with two energy collectors at the Port of Las Palmas in Gran Canaria and then it has been successfully installed at the Plataforma Oceánica de Canarias (PLOCAN) test site. Preliminary testing took place at the PLOCAN test site between 2020 and 2021.

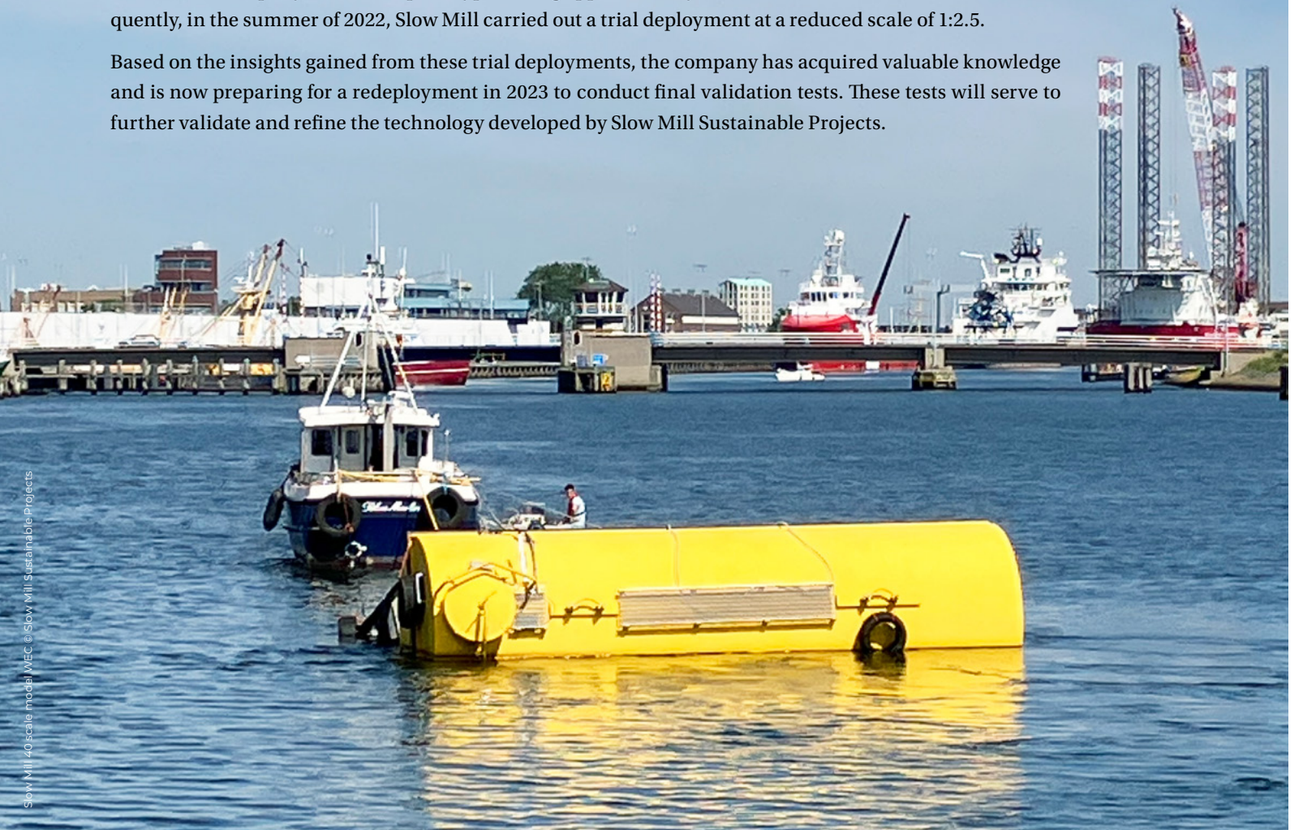
Wavepiston has progressed to the installation of the full-scale system at PLOCAN. Once operational by Q2-2023, the energy collectors will harness wave power and pump seawater to the PLOCAN platform for both power generation and desalination purposes.

11.
Slow Mill Sustainable Projects is making trial deployments in the North Sea

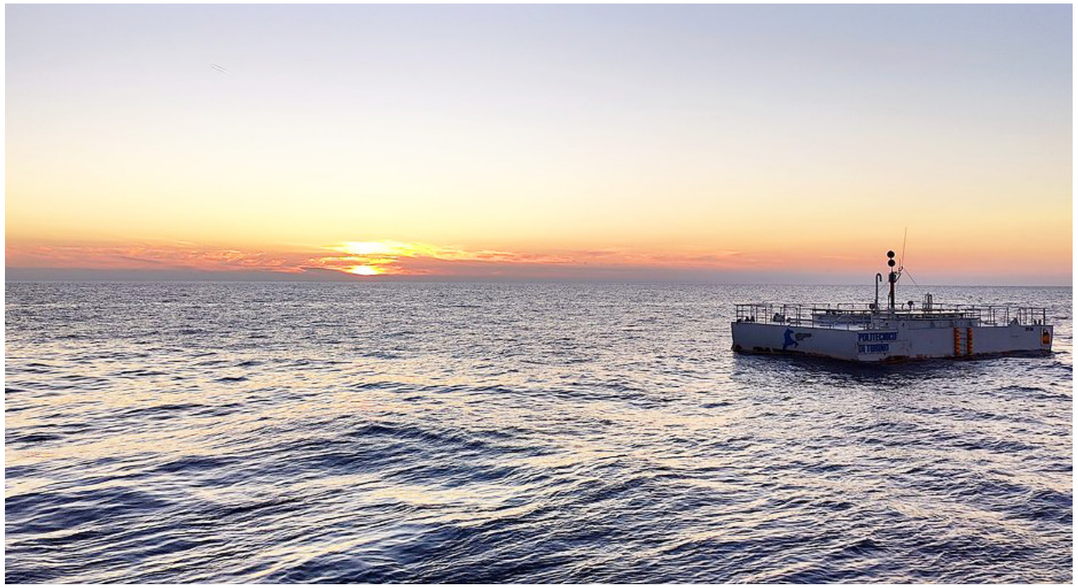
Slow Mill Sustainable Projects, a Dutch company, has developed an innovative wave energy device specifically designed for the moderate wave conditions found in the North Sea.

In 2020, the company conducted prototype testing approximately 4 km off the coast of Texel Island. Subsequently, in the summer of 2022, Slow Mill carried out a trial deployment at a reduced scale of 1:2.5.

Based on the insights gained from these trial deployments, the company has acquired valuable knowledge and is now preparing for a redeployment in 2023 to conduct final validation tests. These tests will serve to further validate and refine the technology developed by Slow Mill Sustainable Projects.



Slow Mill Project model WEC © Slow Mill Sustainable Projects



ISWEC off the coast of Pantelleria © Eni

12.
ISWEC was successfully deployed of the island of Pantelleria, in the Mediterranean sea

The ISWEC (Inertial Sea Wave Energy Converter) is a point-absorber wave energy converter based on the gyroscopic technology, specifically designed for mild climate seas, such as the Mediterranean.

A 250 kW unit of the ISWEC device was successfully deployed about 800 m off the coast of the Pantelleria Island, located in the strait of Messina within the Mediterranean Sea.

The Italian company Eni collaborated with Politecnico di Torino and Wave for Energy s.r.l. (a university spinoff) to develop the ISWEC technology.

13.
Wanshan project has now two 500kW wave energy devices in sea trials

The Guangzhou Institute of Energy Conversion (GIEC), along with the China Southern Power Grid, China Merchants Heavy Industry Company, and other units, are jointly conducting the Wanshan 1 MW Wave Energy Demonstration Project.

This project is centered around the “Sharp Eagle” technology, a wave energy converter that uses a hinged double floating body and semi-submersible barge, which has been under development by GIEC since 2011.

The project includes two devices, each with a capacity of 500 kW, which have been constructed and deployed in the open sea near Wanshan Island in Zhuhai, Guangdong Province, and have successfully endured multiple typhoons. The project is set to enter its demonstration operation phase in 2023.

500 kW WEC “Zhoushan” © GIEC

500 kW WEC “Changshan” © GIEC

Penghu deep-water aquaculture platform with wave energy © GIEC

14.
Wave-powered Penghu aquaculture platform completes 47 months of successful demonstration

The Guangzhou Institute of Energy Conversion (GIEC) has developed a unique platform that integrates aquaculture with wave energy. This innovative platform combines the sharp eagle-type wave energy converter (WEC) technology with aquaculture in a single design that also has the potential to serve as an offshore tourism site.

The Penghu platform, which has a capacity of 60 kW, was deployed near Wanshan Island in 2019 and has completed 47 months of successful demonstration operation in the aquaculture base of Zhuhai city.

Using the semi-submersible aquaculture platform technology, GIEC has designed and constructed several types of deep-water aquaculture platforms to meet the diverse needs of users in different sea areas, resulting in the acquisition of numerous commercial orders.

15.
Yongsoo OWC Pilot Plant at the KRISO-Wave Energy Test Site in Korea is being prepared to produce green hydrogen

KRISO-Wave Energy Test Site (WETS), located in the western part of Jeju Island, has been in operation since 2019. The test site has five berths, with a total capacity of 5 MW. The water depth ranges from 15 meters to 60 meters and is constructed to test different types of devices.

The Yongsoo power plant installed at berth 1 is a 500 kW fixed OWC type wave energy converter. It has two impulse turbine-generator units with a diameter of 1.8 meters. It was operated to evaluate the performance of the wave power generation system, demonstrate the optimal operation control logic, and verify the digital twin technology. At the same time, the plant is preparing to produce green hydrogen from next year. By this year, the generator type of two units will be changed from synchronous generators to permanent magnet synchronous generators and the test operation will be completed. From next year, green hydrogen will be produced at offshore using marine energy power. The basic design of the hydrogen production system has been completed, and we plan to complete manufacturing and onshore performance testing this year.

View of the Yongsoo Wave Power Plant © KRISO

Green hydrogen production concept

16.
The King Island UniWave200 project running for more than 12 months, was successfully completed

UniWave200 experiencing a large storm during deployment
© Wave Swell Energy

Wave Swell Energy has achieved a major milestone with the successful completion of its King Island wave energy demonstration project in Tasmania, Australia. The UniWave200, a 200 kW wave energy plant based on the oscillating water column principle, operated and delivered electricity into the local Hydro Tasmania hybrid electrical grid for over 12 months. Currently, the device is undergoing decommissioning, which is a final milestone condition outlined in the funding agreement with the Australian Renewable Energy Agency.

During its deployment period, the UniWave200 exhibited an impressive availability rate of over 80%, showcasing during two years its ability to survive in Southern Ocean conditions. The success of the King Island project earned the UniWave200 Wave Energy Converter the prestigious Sir William Hudson Award at the 2022 Engineers Australia Excellence Awards.

The data collected during the demonstration project will be utilized to validating its power performance and to optimize and enhance the technology.

Other Upcoming Developments

Other developers are currently preparing to advance their wave energy projects in different parts of the world:

Bombora Wave Power

The Australian wave energy developer Bombora Wave Power has established its key operations in Pembrokeshire, Wales and is progressing wth the 1.5 MW mWave™ Pembrokeshire Demonstration Project.

Carnegie Clean Energy

The Australian Carnegie Clean Energy is progressing with wave energy technologies, including CETO and MoorPower. A scaled demonstrator of the MoorPower with application for the aquaculture sector is planned to be deployed in Western Australia. Also, Carnegie's subsidiary CETO Wave Energy Ireland is working towards a CETO deployment in Europe.

Crestwing

Danish company Crestwing has during 2022 worked on further development of their technology based on the results achieved with the half-scale testing at Kattegat sea, Denmark.

Marine Energy Research Australia (MERA)

The Australian organisation, MERA, is planning the deployment of the M4 (Moored MultiModal Multibody) wave energy device in King George Sound, Albany, with application to the aquaculture industry.

Novige

The Swedish wave energy developer Novige is planning to install their NO2 prototype at a small island close to Stockholm.

NWEI Azura

The Australian and New Zealand based EHL Group aims to commercialise the Azura wave energy converter. Prototypes have been tested off the coast of New Zealand, at the Northwest National Marine Renewable Energy Centre's (NNMREC) and at the US Navy's Wave Energy Test Site (WETS) in Hawaii.

OceanEnergy

OceanEnergy's OEBuoy, a 500 kW demonstration unit, is set to undergo testing in 2023. The project has been co-funded by the Sustainable Energy Authority of Ireland (SEAI) and the U.S. Department of Energy (DOE). A new project called WEDUSEA co-funded by the European Commission aims to scale up the technology to a 1 MW device to be deployed at EMEC.

Ocean Harvesting Technologies

The Swedish wave energy developer Ocean Harvesting has started preparations for sea trials off the west coast of Sweden with their InfinityWEC scale device.

Oneka Technologies

Canadian company Oneka Technologies successfully tested its demonstrator project for desalinating water using wave energy on the coast of Algarrobo, a seaside town in the central coast of Chile.

WaveRoller

The SURGE2 prototype, deployed nearshore Peniche, Portugal, has confirmed the design of the technology. Waveroller is currently leveraging insights gained from previous projects to enhance the device's design in key aspects such as logistics, manufacturability, and project financing. These efforts aim to facilitate the successful deployment and performance of their upcoming unit.

www.ocean-energy-systems.org