enerOCEAN

2023

KOREA EUREKA Day

Meet with **SPAIN**

Alexander Fairtlough

CCO, EnerOcean

GOBIERNO DE ESPAÑA · MINISTERIO DE CIENCIA E INNOVACIÓN · CDTI INNOVACIÓN

Ministry of Trade, Industry and Energy · Eureka TURKIYE · beyond leading technology KIAT Korea Institute for Advancement of Technology · Keit Korea Evaluation Institute of Industrial Technology · KETEP Korea Institute of Energy Technology Evaluation and Planning

CONTENTS

EnerOcean

EnerOcean

General Description

- General Description
- Our Industrial Shareholders

EnerOcean
General description

2007

First Spanish Marine Energy Engineering company

R&D based company located in:

- Malaga, Southern Spain
- Canary Islands

Active member of National and Regional Marine and Energy Clusters

Business scope:

- Technology developer (W2Power)
- Floating Wind projects developer

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RENEWABLE ENERGIES

PLENITUDE INVESTS IN ENEROCEAN'S FLOATING WIND TECHNOLOGY

22 APRIL 2022 - 11:00 AM CEST

Milan/Malaga, 22 April 2022 – Plenitude (Eni) announces today that it is to invest in EnerOcean S.L., the Spanish developer of the W2Power technology for floating wind power. The deal is structured as a long-term partnership focused on the deployment of the W2Power technology as a lead contender for floating wind power developments worldwide.

EnerOcean S.L.
General description

OUR INDUSTRIAL SHAREHOLDERS

One of the biggest energy companies in the World

69 +32000

Main shareholder of EnerOcean

RENEWABLES PORTFOLIO

- 2200 MW Installed in 2022
- 15 GW in 2030
- 60 GW in 2060

Biggest naval engineering company in Spain

+800

Preferred engineering supplier to NAVANTIA

Experienced in offshore wind

Spanish wind turbines engineering company

+100

Supporting leading OEMs

Norwegian O&G SME company

Belgian energy consulting company

Chapter 02

Marine Energy Solutions

02
Marine Energy Solutions

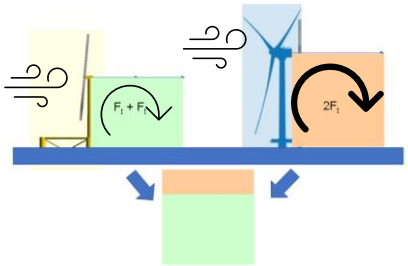
R&D Projects leading to game changing solutions

- W2Power Technology

Some of our R&D Projects

- WIP10+ W2Power Open Sea Testing Project
- LEAF Control, Simulation and Optimization Project
- FIBREGY Fibre Reinforced Plastics Project
- W2P-HERA W2Power Multipurpose Solutions Project
- AQUAWIND W2Power Aquaculture Open Sea Testing Project

Engineering Solutions
W2Power Technology



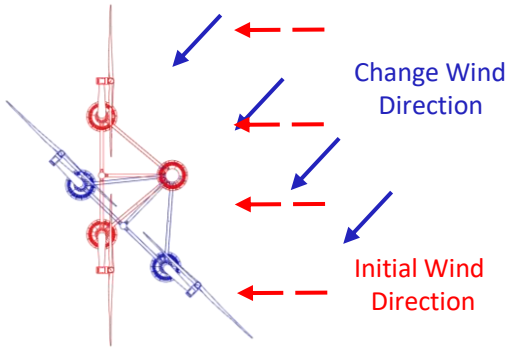
Main design driver for the floater is the reduction of the overturning moment resulting from the thrust on the rotor, and by inertia and gravity forces induced by the rotor nacelle assembly. Lighter turbines at a lower height reduces overturning moment and hence the platform weight needed to stabilize it.

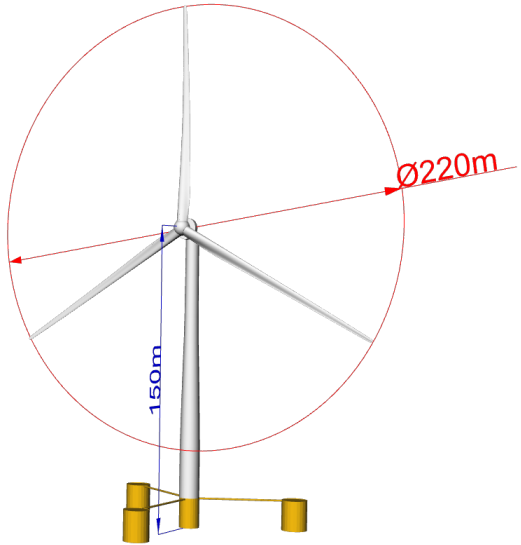
Two wind turbines per platform with a total nominal power comparable to larger platforms with a single wind turbine.

Passive self-orienting system based on wind direction.

Reduced height and low draft enabling easier port assembly and sea installation

Reduced steel weight to power ratio for the floating substructure



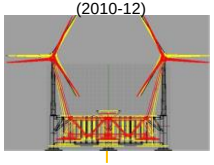


Engineering Solutions

W2Power Step by Step Development

Calculation model (2008-09)

Simple simulations, subsystem models. House tests and MARINA Project. (2010-12)



1:100 complete mooring & Wind test campaigns at UC Cork (2014)

Testing of the 1:6 scale prototype in the open sea of Gran Canaria. (2019).

3 to 5 commercial platforms. “First of a Kind”. (2027)

TRL1 Conceptual definition and technical viability from basic principles. Secure core IP

TRL2 Consolidation of technology: Subsystems precision and integration, costing and road map for technical development. Simulations and studies.

TRL3 Experimental proof of concept: Applied research, lab tests, coupled simulations and techno-economic viability. Simple physical models, scale parameters.

TRL4 Technology validation in lab at controlled sub-system condition. Complex physical models (mooring, impact behaviour). Preliminary LCA. Design related IP.

TRL5 Laboratory validation in relevant conditions. Operation modes. Extreme conditions.

TRL6 Technology demonstration in relevant environment: Prototype testing at sea to prove survival, stability and industrial potential.

TRL7 Large prototype demonstration in fully operational environment. Installation O&M maintenance and grid operation.

TRL8 Commercial full scale technical performance. For FOW, small array normally needed (in exceptional cases single unit). System optimized and managed.

TRL9 Proven operation of commercial Power Plants and available on fully commercial terms.

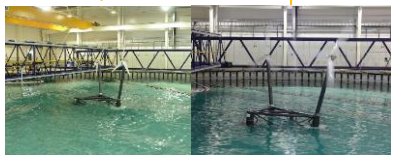
Concept validation

Design and subsystem validation

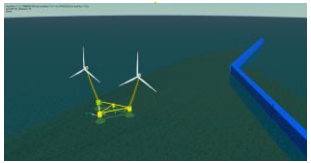
Validation at sea

Commercial

Complex simulation and Physical models. 1:100 Curved tank, U. Edinburgh. (2012-13)



Advanced tests at Flowave, Edinburgh. (2015) 1:40, mooring & wind force, gyroscopic effects.



Pre-commercial 1:1 grid connected demonstrator. (2025)

Commercial floating offshore windfarms. (2028-)

Marine Energy Solutions

WIP10+ W2Power Open Sea Testing Project

- First multi-turbine floating wind platform worldwide
- First floating wind platform to incorporate an aquaculture cage
- 1:6 scale prototype of the W2Power platform
- Stability and Reliability Demonstrated
- Real time collection of meteoceanic and structural data
- Faced 7 Storms with +4m waves
  (24m equivalent height at full scale)
- Capacity to integrate an aquaculture cage

Prototype successfully tested offshore in the Canary Islands

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Marine Energy Solutions

LEAF Control, Simulation and Optimization Project

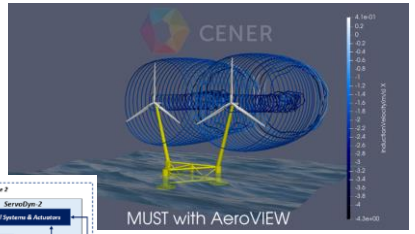
LEAF

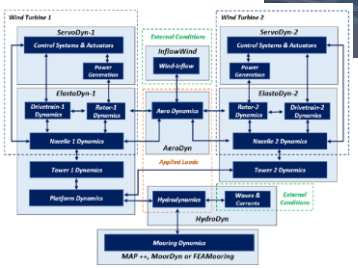
The objective of LEAF project is to respond to a critical need in the offshore wind energy sector through the coordinate effort of the main designers of floating platforms at national level with the goal of improving Spain's strategic position internationally.

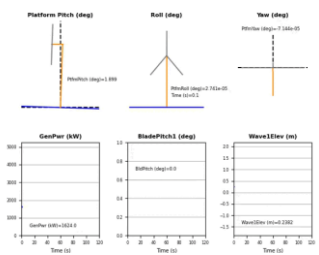
At the same time, we propose commercial solutions for optimization of capacity at each wind farm location. These solutions reduce the cost of floating offshore wind power generation, accelerating its commercialization.

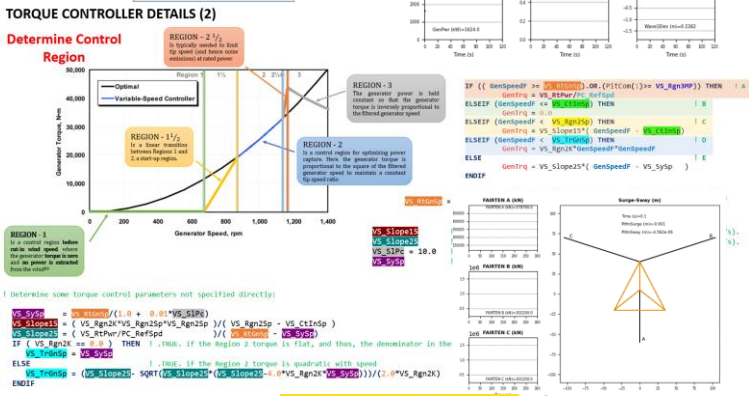
GOALS:

- Design of integrated numerical models to capture complex physical phenomena in floating wind turbines
- Design of hydrodynamic models based on Computational Fluid Dynamics
- Design of control strategies for floating wind turbines.
- Design of different mooring systems for easy installation and adaptable depth









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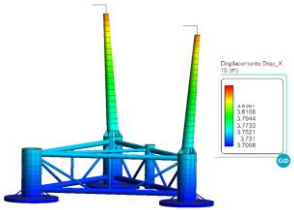
Marine Energy Solutions

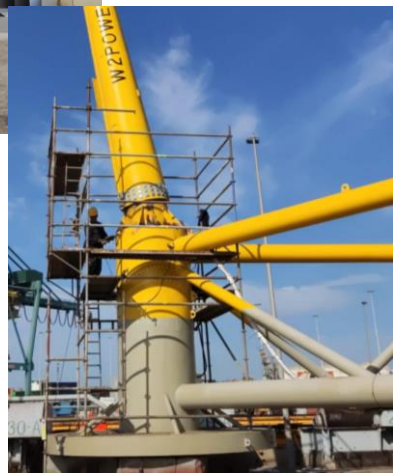
FIBERGY Fiber Reinforced Plastics Project

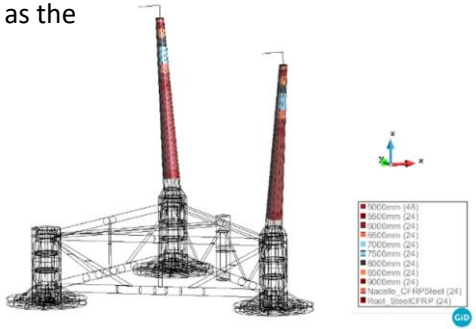
FIBREGY

The overall objective of the FIBREGY project is to enable the extensive use of FRP materials for the next generation of large Offshore Wind and Tidal Power (OWTP) platform structures. Some of the objectives of the project are:

- To develop multi-functional FRP material solutions for the structure and the main components
- To research into advanced manufacturing technologies for large structures and functional components
- To re-engineer two existing OWTP concepts, which have been selected as the most promising solutions from the market uptake point of view.

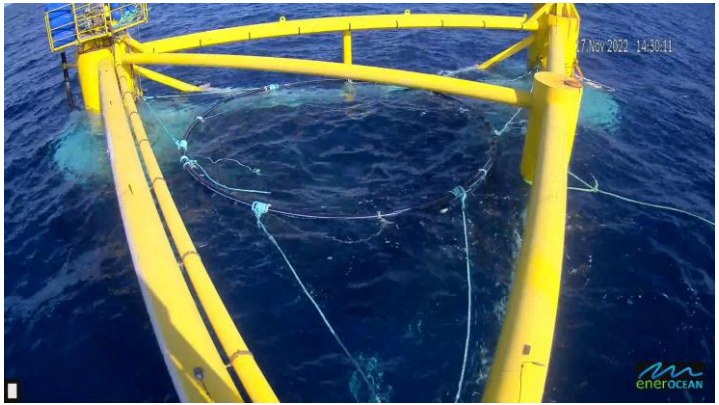






Marine Energy Solutions

W2P-HERA W2Power Multipurpose Solutions Project

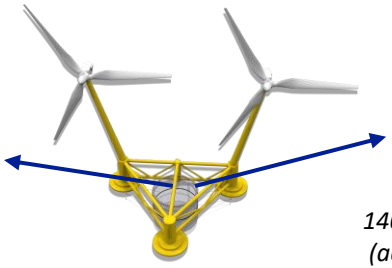


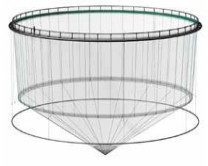
W2P-HERA is a project that applies the knowledge of the partners, from the Spanish industrial sector, to develop the multipurpose solutions of the W2Power technology, in its version with aquaculture and a substation, and obtain a design that allows the manufacture, use and survival of the structure at a scale close to commercial.

First worldwide open sea testing of floating wind platform with integrated fish cage (Orpheo Plus project funded by BLUE-GIFT)

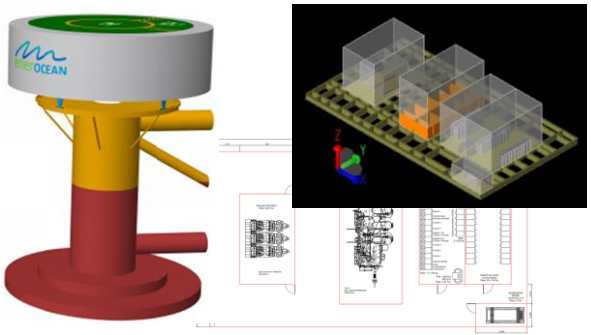
GOALS:

- Development of a version with an integrated substation
- Optimization of key structural elements of the W2Power platform: towers and heave plates
- Integration of an aquaculture cage on the W2Power platform





140m circumferemce cage (adapted for 30 m depth)



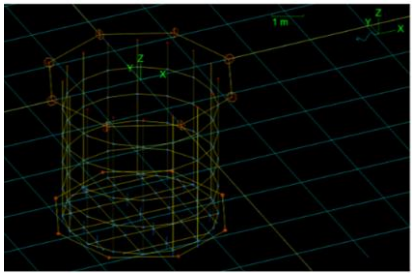
Marine Energy Solutions

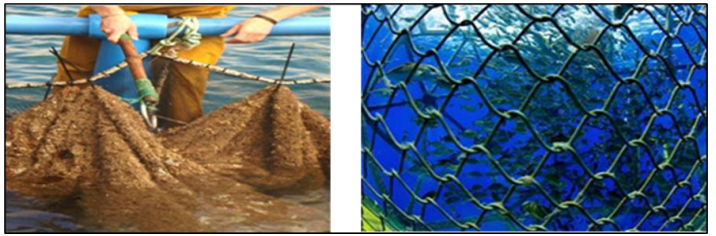
AQUAWIND W2Power Aquaculture Open Sea Testing Project

The aim of AQUAWIND is to perform a demonstration test of a multi-use integrated solution using the W2Power prototype with an innovative aquaculture solution including **live fish behavior testing**

OBJECTIVES

- To provide a route map for regulatory and legal issues for real implementation of multi-use projects.
- To provide a business model case and exploitation plan to evaluate the cost reduction
- To demonstrate at pilot scale the feasibility of the multi-use of an offshore renewable energy prototype
- To demonstrate the neutral or positive environmental and social impacts for the multi-use offshore renewable energy solution





Chapter 03

Ideas for a Korea – Spain collaboration

03

Ideas for a Korea – Spain collaboration

Ideas for a Korea – Spain collaboration

Idea 1

Joint Korean-Spanish R&D projects in floating wind and multiuse applications adapted to typhoon conditions.

Idea 2

Feasibility studies for floating wind projects and multi-use applications in Korea.

Idea 3

Study innovative manufacturing and assembly processes suitable for large series including new materials and joining methods

Ideas for a Korea – Spain collaboration

Idea 4

Engineering support to floating wind projects in Korea.

Idea 5

Partnerships for our 11 MW W2Power demonstrator project in Spain and subsequent 1GW+ pipeline including potential incorporation of innovative cost cutting technologies

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Thank you!

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Eureka TÜRKİYE

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