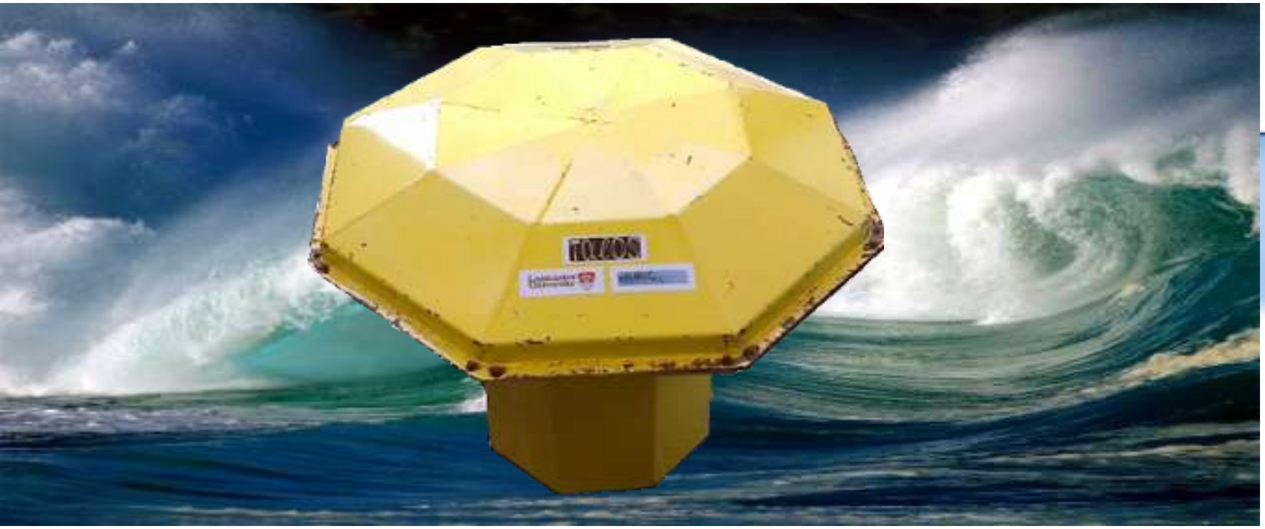
Wave Energy Research & TALOS WEC Developments



Prof George Aggidis

PhD, Eur Ing, CEng, FIMechE

Energy Engineering
Lancaster University

g.aggidis@lancaster.ac.uk

2026 Maynooth Wave Energy Workshop
23rd January 2026
Ireland

Overview

Lancaster University

1. Introduction and Lancaster University
2. Wave Energy Research
3. TALOS WEC Developments

Lancaster University UK

Lancaster University Campus

Lancaster University

The only University Campus in the UK with:

a) Wind Turbine at 2.5 MW

b) Solar Farm at 14.5 MW

ENERGY - LUREG Research

Lancaster University Engineering Building 2 – **EB2**

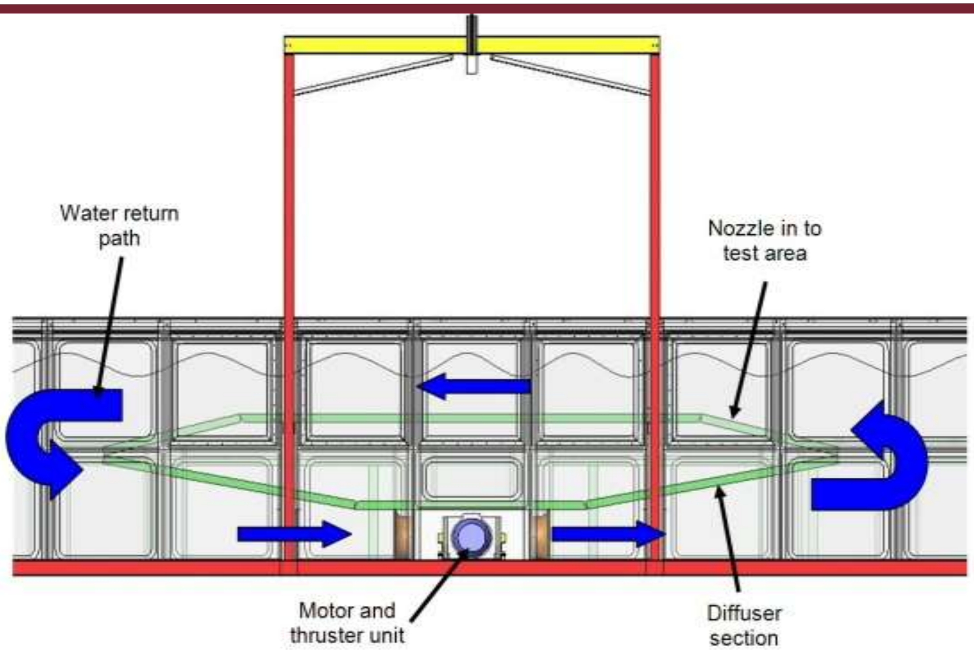
Lancaster University Engineering Building 1 – **EB1**

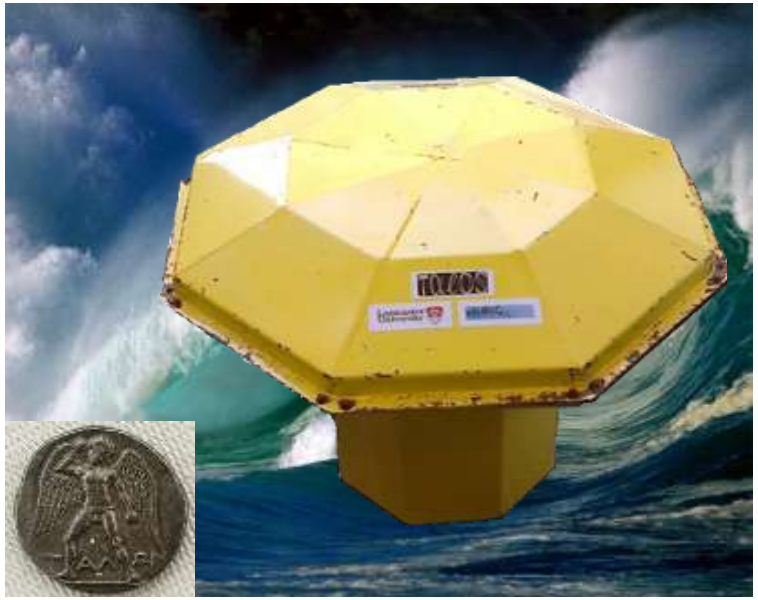
- Research on Renewable Energy & Fluid Machinery
  - Generic & Applied
- Energy & Renewables
  - Computational & Experimental Modelling
  - Device Development & Power take off
  - Computational Fluid Dynamics & Control
  - Economics, Resource & Condition Monitoring
- Novel Topology Fluid Machinery & Turbines
  - Computational Fluid Dynamics, Turbine Design & Analysis
  - Direct Drive & In Line Turbines
  - Siphonic Low Head & Low Cost Turbine Research
  - Novel High Head Impulse Turbines
  - Fluid Machinery reliability & Energy Efficiency
- Funded by EPSRC, Carbon Trust, EU, RDAs, Utilities and Industry

Lancaster University Faculty of Science & Technology Building - **FST**

Waves Tides Hydrokinetics Testing Facility

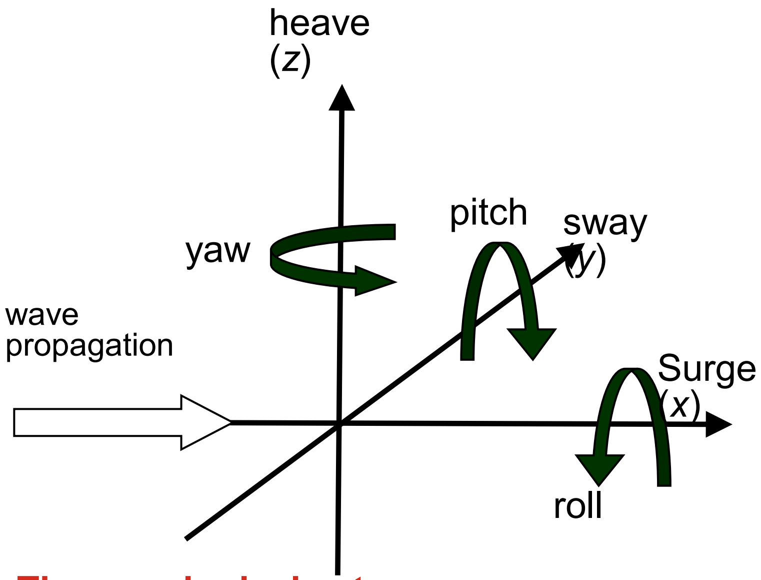
Lancaster University





TALOS Wave Energy Converter
Multi-Axis, Omni-Directional Point Absorber Style WEC completely enclosed with internal inertial mass using Hydraulic Cylinders or Linear Generators PTO

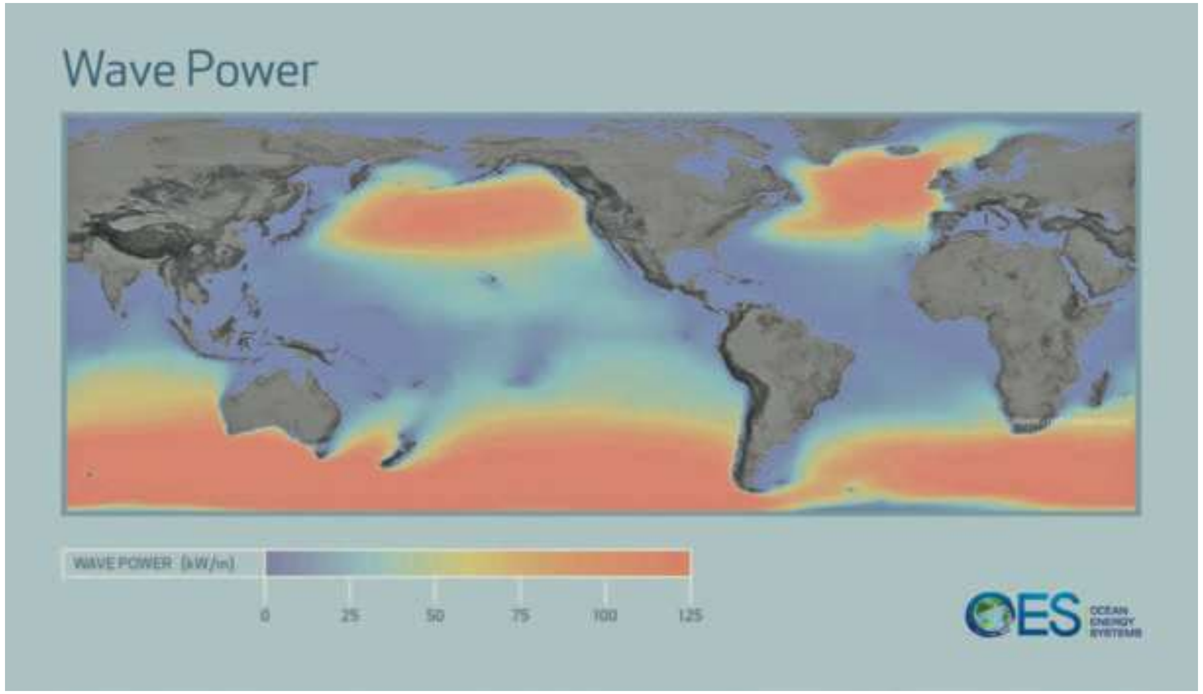
Wave Energy Converter Systems (WECs)



- **Three main device types:**
  - Shoreline
  - Near-Shore
  - Offshore
- **Methods of power extraction**
  - Heave
  - Pitch
  - Surge
  - Overtopping
  - Oscillating Water Column (OWC)

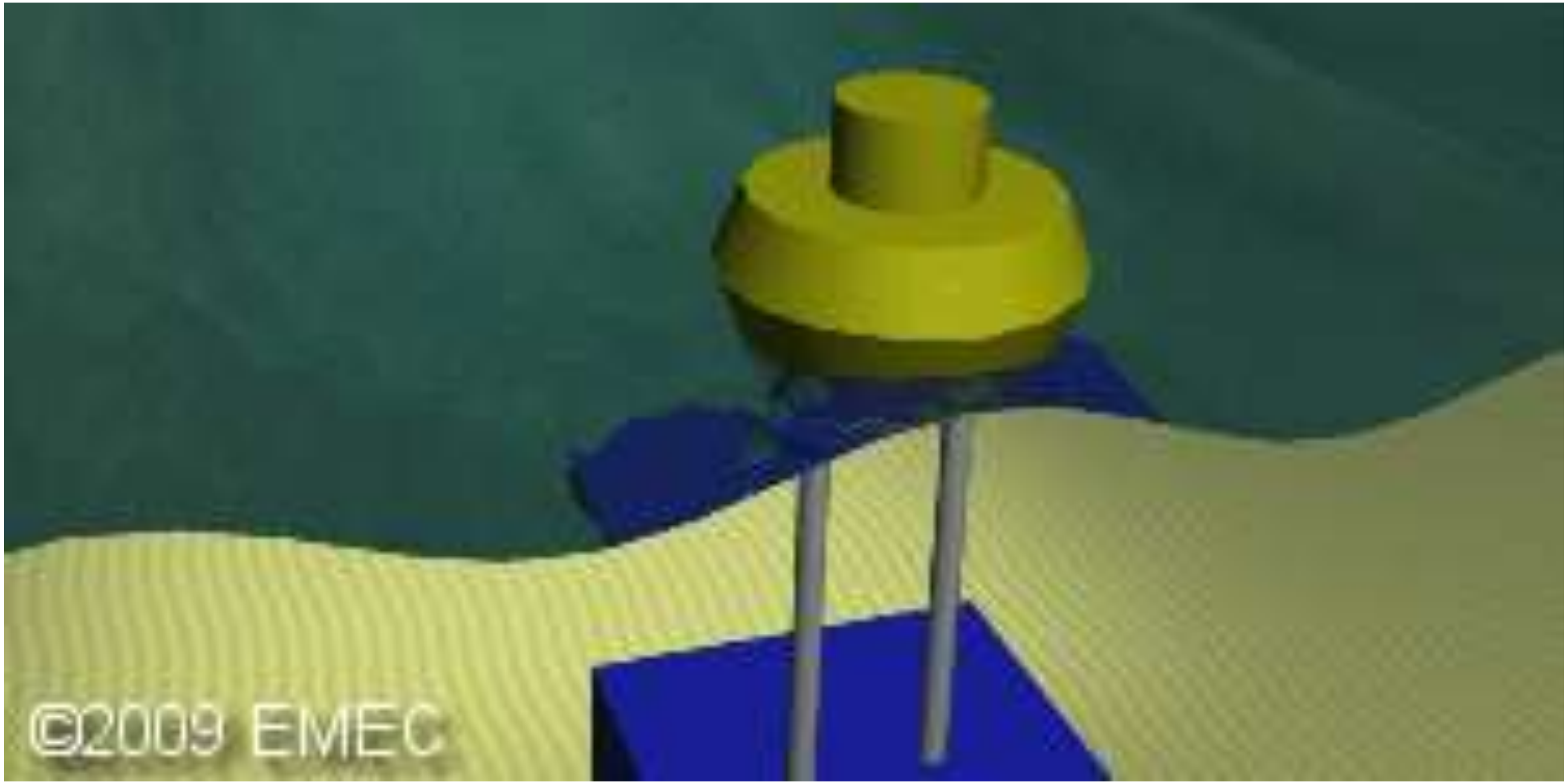
U.S. DEPARTMENT OF ENERGY

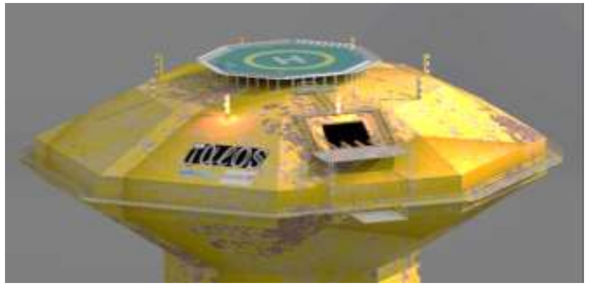
EMEC ORKNEY
A GLOBAL CENTRE OF EXCELLENCE IN MARINE ENERGY TESTING AND RESEARCH



Global annual mean wave power distribution. Source: IEA-OES, 2014

Point absorber





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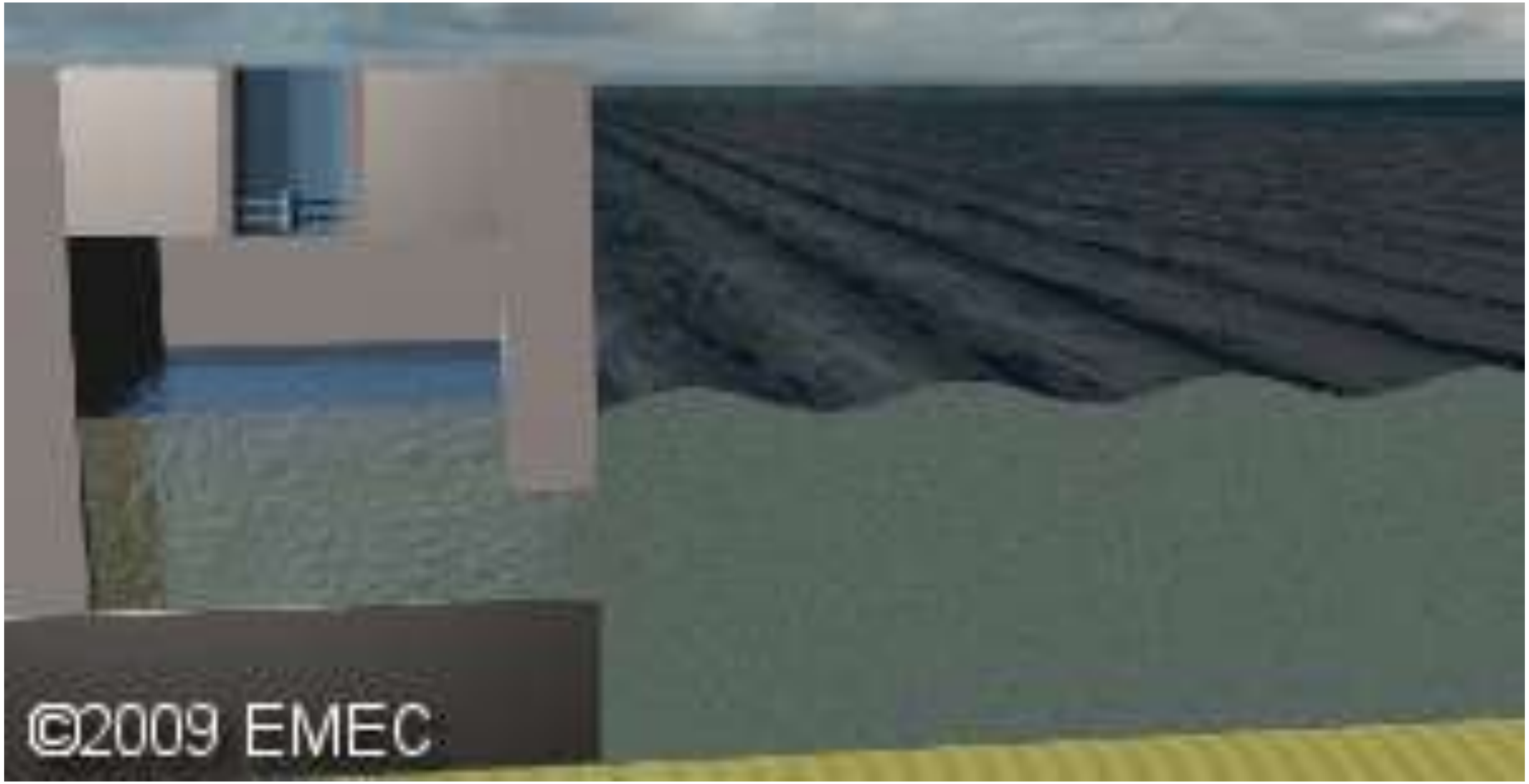
AQUABUOY Finavera – Very High Head Turbines

Development of Ultra High Head Small Size Fast Rotation Pelton Turbines

Oscillating water column

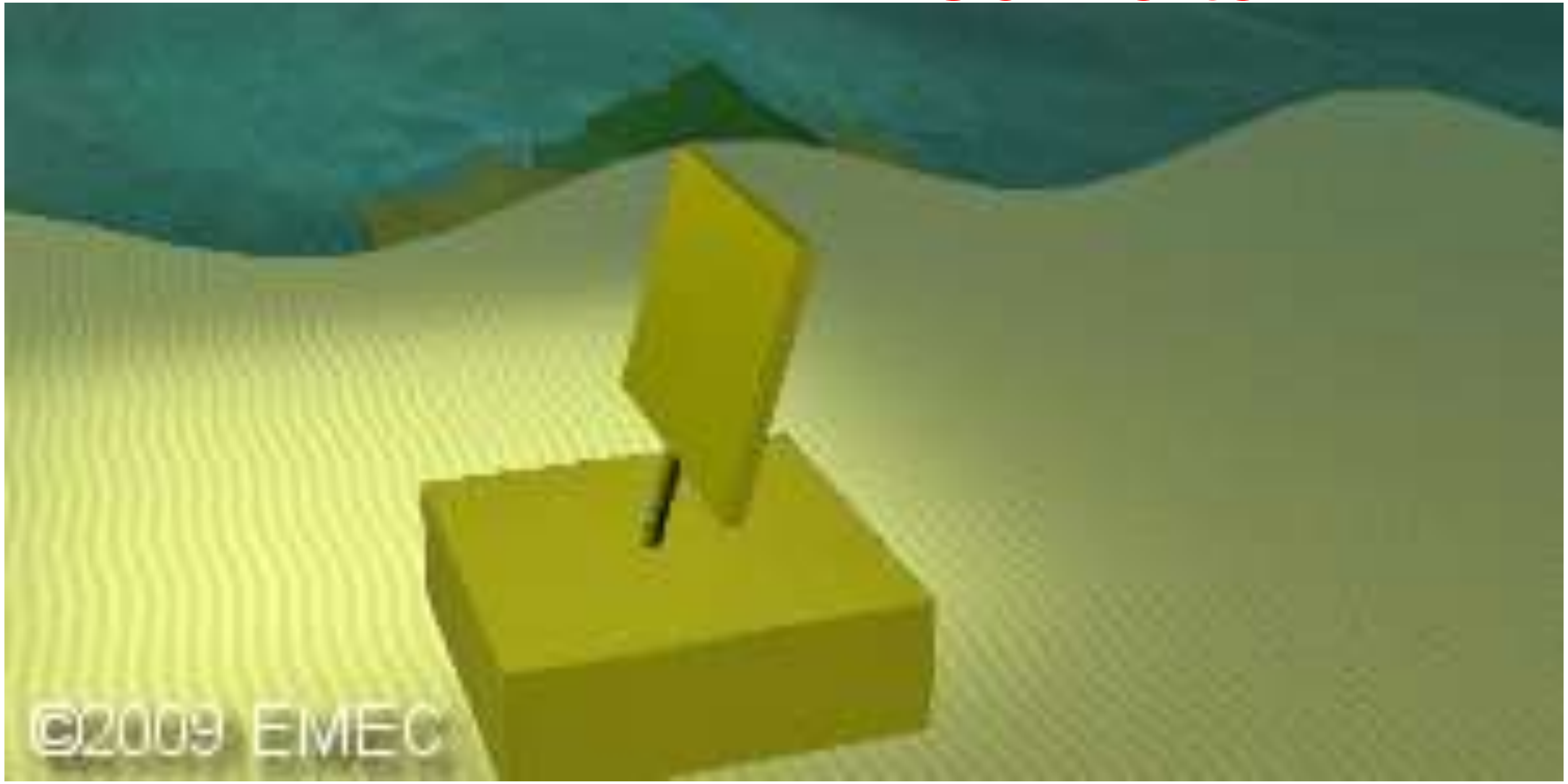
Lancaster University

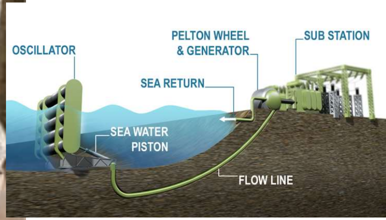


Lancaster University Research on W2W Multi Oscillating Water Column Wave Energy Converter and Floating Breakwater.

Doyle, S. and Aggidis, G.A., 2019. Development of multi-oscillating water columns as wave energy converters. *Renewable and Sustainable Energy Reviews*, *107*, pp.75-86.

Oscillating Wave Surge Converter





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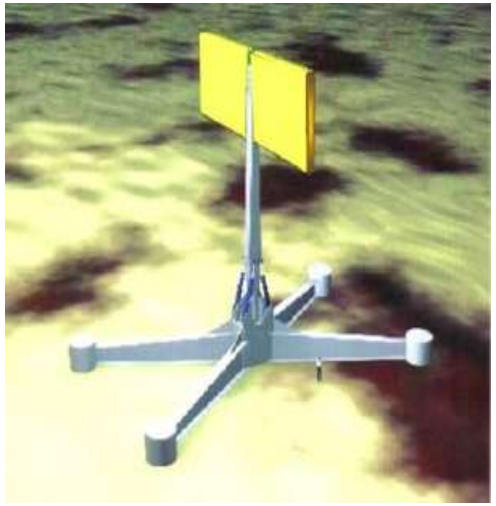
AQUAMARINE OYSTER – High Head Turbines

Aquamarine Oyster Operating at EMEC Orkney Islands

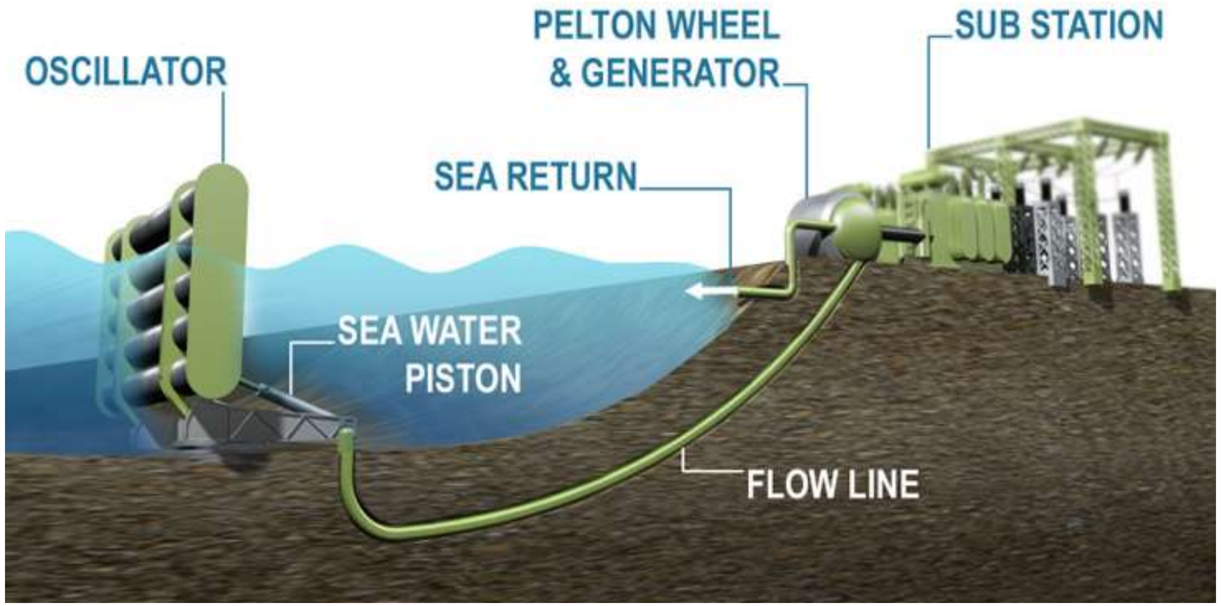


Lancaster University

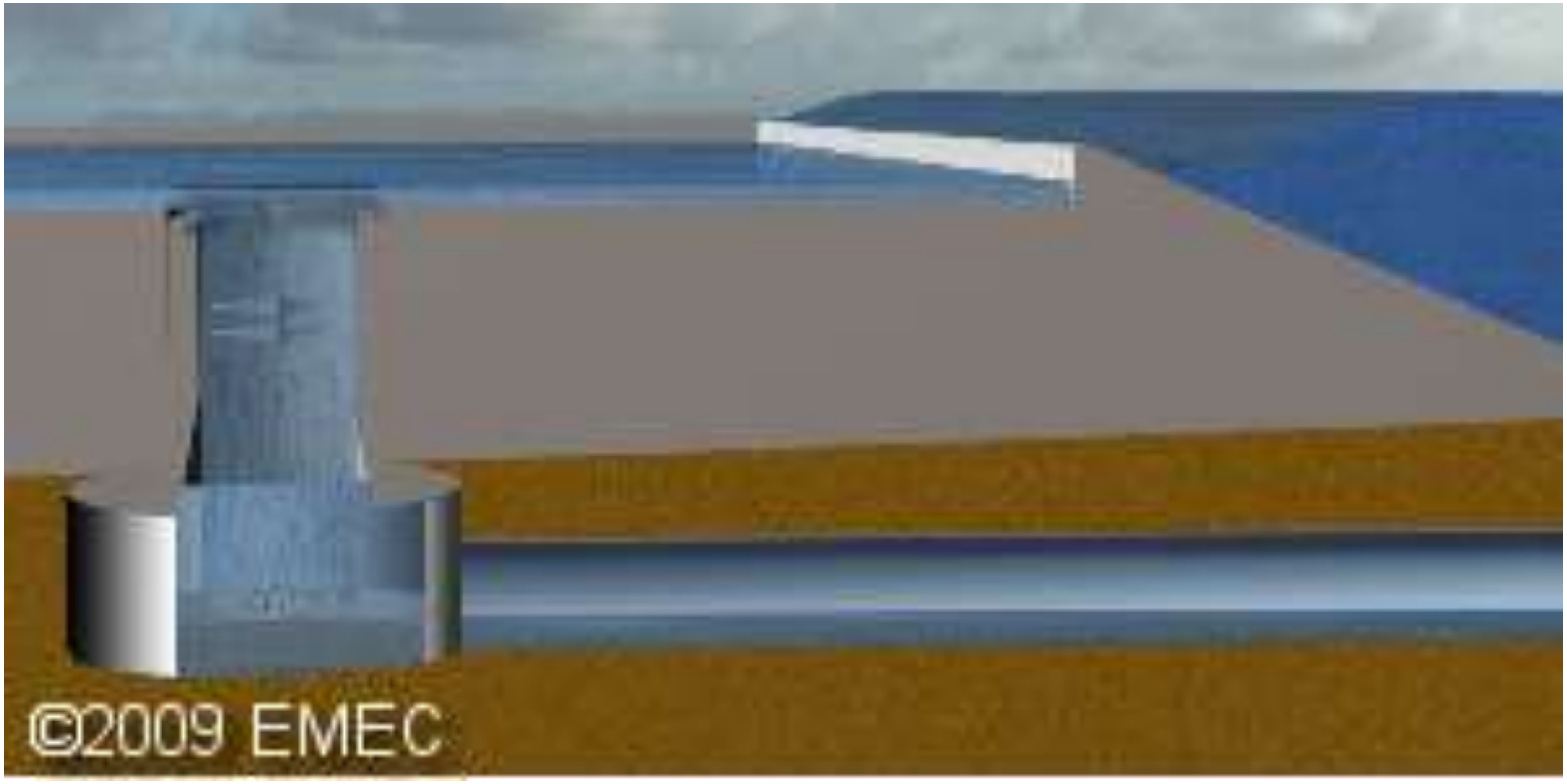
Frond

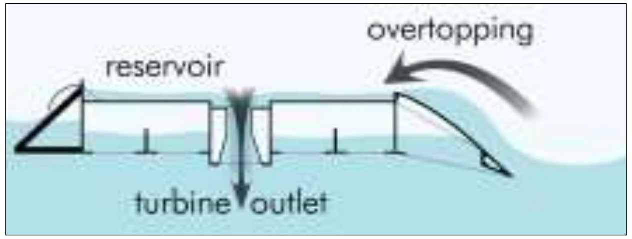
Dr Matt Foley PhD

Engineering Business



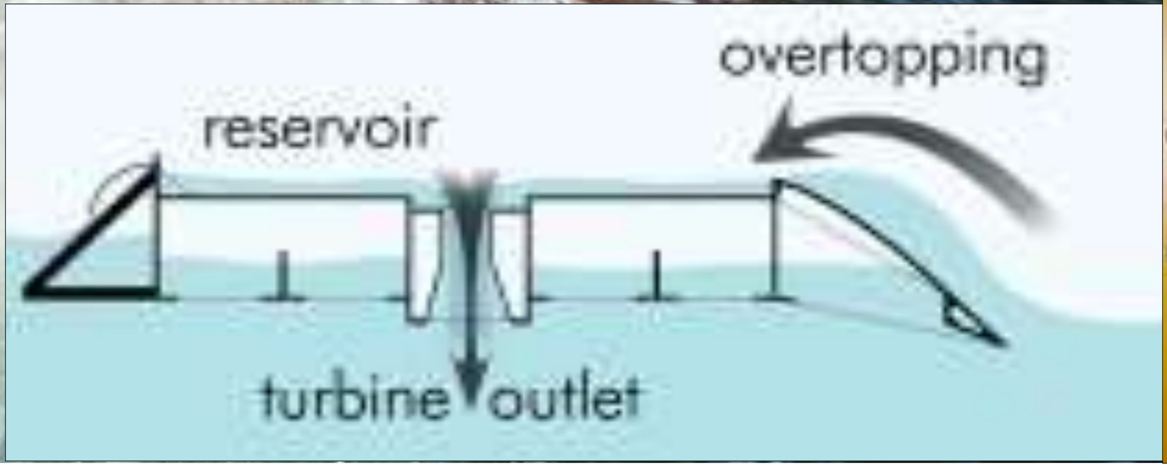
Overtopping device





Ultra Low Head Hydro Turbines

Nine Ultra Low Head Kaplan Turbines
Operating from 2 m down to 0.2 m Head



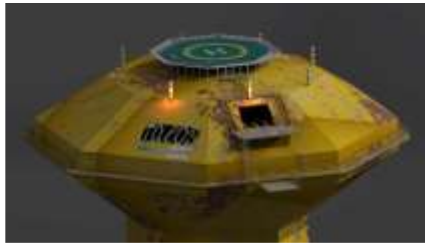
Lancaster WEC Research

Lancaster University

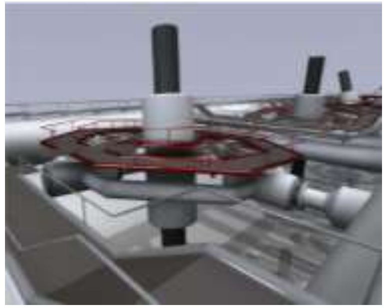
- Flexible Bag
- Flounder Array
- Frog
- PS Frog
- Frond
- Yoyo
- Pushmi
- WRASPA
- Seaweaver
- GAIA
- TALOS

Lancaster Flexible Bag

Yoyo



TALOS



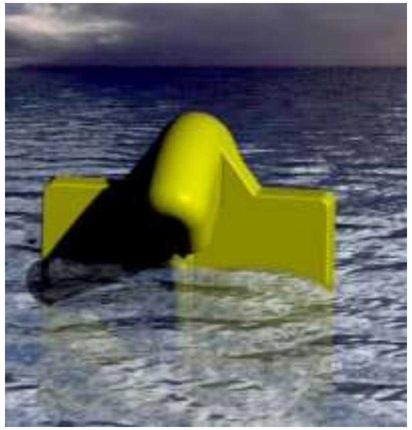
GAIA

Flounder

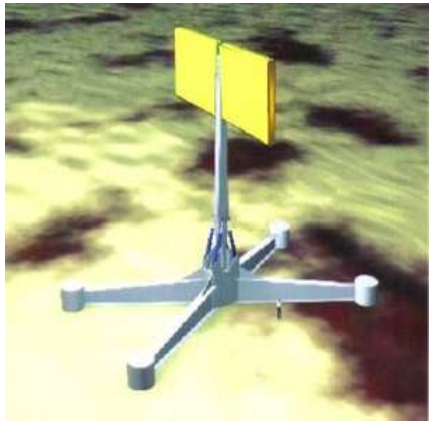
Lancaster Flexible Bag Attenuator

Seaweaver

CRM PS Frog

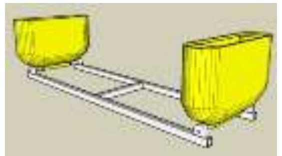


PS Frog 5



Frond

WRASPA



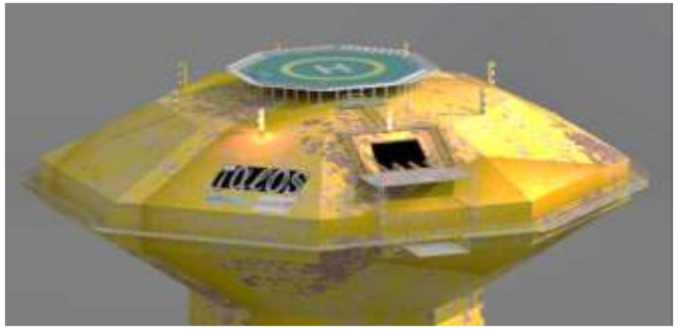
Pushmi

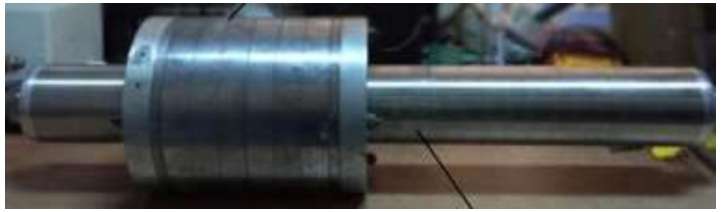
Early PS Frog

Chair of
Advisory
Board

TALOS WEC

TALOS WEC – Multi Axis Omni Directional Point Absorber WEC completely enclosed with internal inertial mass using Hydraulic Cylinders or Linear Generators PTO



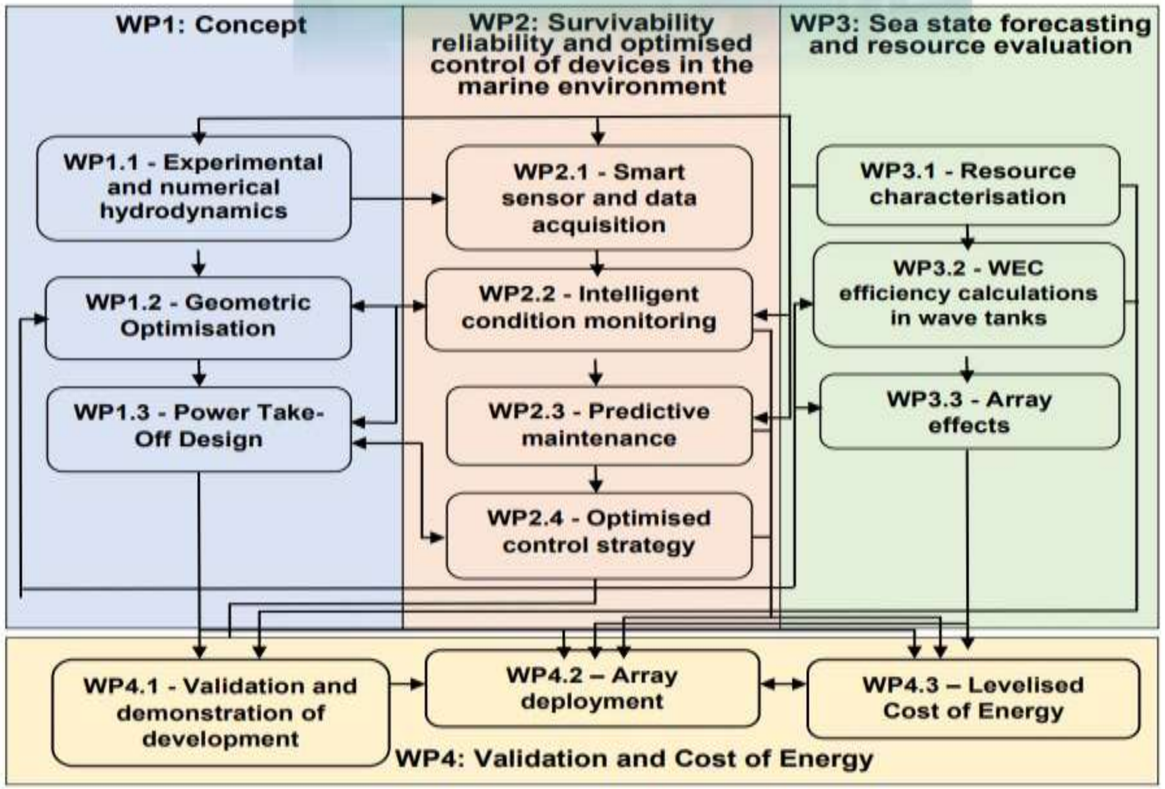


TALOS WEC
Technologically **A**dvanced **L**earning **O**cean **S**ystem
Wave **E**nergy **C**onverter

TALOS Project Aim & Objectives

- The project aim: *Advance WEC technology by developing essential device control and monitoring systems that are integrated with high-fidelity sea state forecasting.*
- Objectives:

1. Concept optimisation – *Parameterize hydrodynamic behaviour due to the WEC geometry and PTO design to refine, optimise and maximise performance.*
2. Operational systems – *Investigate and implement sensors and actuators required to develop a condition monitoring system that will improve reliability and survivability, and control methods for the multi-axis PTO system advancing overall conversion efficiency.*
3. Resource forecasting – *Develop machine-learning based forecasting tools to provide both short-term accurate predictions for the operational systems and long-term energy yield predictions for the device across various deployment sites.*
4. Device deployment potential – *Develop a wave-to-wire model to determine the Levelised Cost of Energy (LCOE) at given sites, for both standalone devices and arrays, quantifying the TRL financial baseline performance essential to stimulate commercialisation.*
5. Marine wave energy development – *Develop industrial input and research impact objective, including dissemination and showcasing of all the outputs, to ensure that not only one technology develops but that the solutions proposed will benefit the wider energy community.*



Lancaster University | University of Hull | SmartWave

TALOS WP1 - International Collaboration

USA - *Time-Domain Modelling of the TALOS WEC using WEC-Sim*

USA - *Numerical Modelling of the TALOS Wave Energy Converter*

NREL Transforming ENERGY | Sandia National Laboratories | TEAMER Testing & Expertise for Marine Energy | U.S. DEPARTMENT OF ENERGY

Greece - *Time-Domain Analysis of the TALOS WEC using different computational tools*

NTUA | INTERNATIONAL HELLENIC UNIVERSITY | ARISTOTLE UNIVERSITY OF THESSALONIKI | DNV - SESAM | DNV

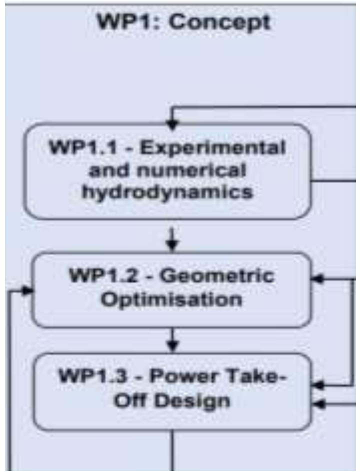
France

CENTRALE NANTES

NEMOH - Boundary Element Methods (BEM) code

China
- *Numerical and experimental study on a scaled TALOS wave energy converter*
- *Wave Energy Converter Shape Optimisation*

ZHEJIANG UNIVERSITY 1897



Turkey - *An initial study on power capture performance analysis of TALOS based on power take-off system parameters*

ÇUKUROVA UNIVERSITESI 1973

Taiwan

國立陽明交通大學
NATIONAL YANG MING CHIAO TUNG UNIVERSITY

TALOS WP1 – Outputs

- **Hydrodynamic studies of floating structures: Comparison of wave-structure interaction modelling.** W Sheng, E Tapoglou, X Ma, CJ Taylor, RM Dorrell, DR Parsons, GA Aggidis. Ocean Engineering 249, 110878 20, 2022.
- **Fundamentals of Wave Energy Conversions: The Dynamics of the Wave-Structure Interactions and Wave Energy Optimisation.** Wanan Sheng and George Aggidis. Eliva Press, 19 Sept 2022, 459 pages, ISBN-10: 9994982761, ISBN-13: 978-9994982769
- **Comparing Numerical Models of the TALOS Wave Energy Converter**. D Ogden, FP Koukouvinis, W Sheng, G Aggidis, J Anagnostopoulos, A Bharath. National Renewable Energy Laboratory (NREL), Golden, CO (United States), 2023. Proceedings of the European Wave and Tidal Energy Conference 15, 2023.
- **A Development and validation of the in-house hydrodynamics code and the DNV software for TALOS wave energy converter**. W Sheng, C Michailides, E Loukogeorgaki, G Aggidis. Proceedings of the European Wave and Tidal Energy Conference 15, 2023.
- **Hydrodynamic Comparisons of TALOS Wave Energy Converter Using Panel Methods.** W Sheng, G Aggidis. ISOPE International Ocean and Polar Engineering Conference, ISOPE-I-23-087. 2023.
- **Python-assisted biological knowledge acquisition method to trigger design inspiration.** ZM Zha, H Zhang, GA Aggidis. Scientific Reports 12 (1), 7864 1, 2022.
- **Time-Domain Analysis of the TALOS Wave Energy Converter Using Different Computational Tools.** C Michailides, E Loukogeorgaki, W Sheng, G Aggidis. ISOPE International Ocean and Polar Engineering Conference, ISOPE-I-23-088, 2023.
- **Time-Domain Implementation and Analyses of Multi-Motion Modes of Floating Structures.** W Sheng, E Tapoglou, X Ma, CJ Taylor, R Dorrell, DR Parsons, G Aggidis. Journal of Marine Science and Engineering 10 (5), 662 6, 2022.

TALOS WP1 – Further Outputs

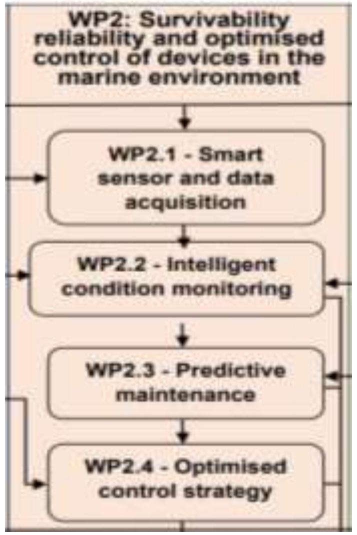
- UK - Lancaster University – “**Shape optimisation of TALOS WEC for improving wave energy conversion**”
- USA - Sandia National Laboratories, USA - “**Design and performance evaluation of a resistive control using a hydraulic PTO system for the TALOS Wave Energy Converter**”
- USA - National Renewable Laboratory, NREL – “**Comparative Analysis of Numerical Models for a Novel Wave Energy Converter: Insights from WEC-Sim, HydroChrono, and a Bespoke MATLAB Implementation**”
- USA – US DoE TEAMER – “**TALOS WEC Optimisation**”
- GREECE - AUTH and IHU – “**Effects of Mooring Lines on the TALOS WEC Performance**” DNV - SESAM
- GREECE – NTUA – “**TALOS WEC and high fidelity CFD modelling**” NTUA
- CHINA - Zhejiang University - “**Development, Optimization and Testing of a multi-axis wave energy converter**”
- NORWAY - SINTEF – “**Performance of a wave energy farm in inhomogeneous wave conditions**”

TALOS WP2 - International & National Collaboration

USA - *Advanced data acquisition and fault diagnosis system for wave energy converter*

USA - *The Impact of Constraints on the Control of a Wave Energy Conversion with a Hydraulic PTO System*

UK - **Medium-Voltage Modular Power Converter for Wave Energy Conversion Systems**



Ireland

Turkey - *An initial study on power capture performance analysis of TALOS based on power take-off system parameters*

TALOS WP2 – Outputs

- **The Impact of Uncertainty on the Control of a Multi-Axis Wave Energy Converter**. C Hall, Y Wu, I Rizaev, W Sheng, R Dorrell, G Aggidis. Proceedings of the European Wave and Tidal Energy Conference, 15, 2023.
- **The Impact of Control Structure and Constraints on the Performance of a Wave Energy Converter with a Hydraulic PTO System.** CM Hall, Y Wu, W Sheng, G Aggidis. ISOPE International Ocean and Polar Engineering Conference, ISOPE-I-23-091, 2023.
- **An Initial Study on Power Capture Performance Analysis of TALOS Based on Power Take-off System Parameters.** H Yavuz, G Aggidis, W Sheng. ISOPE International Ocean and Polar Engineering Conference, ISOPE-I-23-086, 2023.
- **Medium-Voltage Modular Power Converter for Wave Energy Conversion Systems.** A Darwish, X Ma, GA Aggidis. ISOPE International Ocean and Polar Engineering Conference, ISOPE-I-23-092, 2023.
- **Long-Short Term Memory Based TALOS Wave Energy Converter Power Output Prediction with Numerical Modelling.** Y Wu, W Sheng, CJ Taylor, G Aggidis, X Ma. ISOPE International Ocean and Polar Engineering Conference, ISOPE-I-23-095, 2023.
- **A Review of Power Co-Generation Technologies from Hybrid Offshore Wind and Wave Energy.** MW Ayub, A Hamza, GA Aggidis, X Ma. Energies 16 (1), 550 2, 2023.
- **A Review on Power Electronic Topologies and Control for Wave Energy Converters.** A Darwish, GA Aggidis. Energies 15 (23), 9174 5, 2022.

TALOS WP2 – Further Outputs

- UK - Lancaster University – “**Enhancing Long-Term Predictive Accuracy in Wave Energy Converters through a Dual-Model Approach**”
- UK – TURKEY – “**Development of a 3 DOF hydraulic power-take-off system for phase control of TALOS wave energy converter**”
- USA - Illinois Tech Chicago - “**PTO Control Design for a Multi-Axis WEC Device**”

TALOS WP3 - International & National Collaboration

USA - A test bed for the TALOS wave energy converter

NREL Transforming ENERGY · TEAMER Testing & Expertise for Marine Energy · U.S. DEPARTMENT OF ENERGY

Greece - *Time-Domain Analysis of the TALOS WEC using different computational tools*

POSEIDON SYSTEM

EU - *Time-Domain Analysis of the TALOS WEC using different computational tools*

Copernicus Europe's eyes on Earth · Copernicus Marine Service

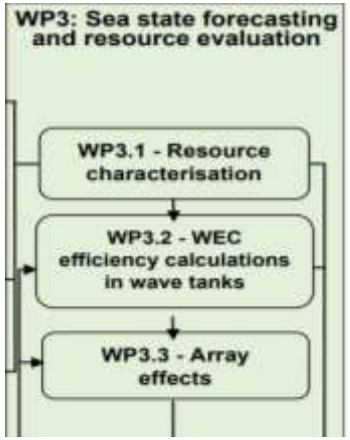
EC

European Commission

Joint Research Centre

Canada

University of Victoria



UNIVERSITY OF HULL

SmartWave

TALOS WP3 – Outputs

- **Operating of TALOS Wave Energy Converter in Different Wave Climates.** CLG Oikonomou, W Sheng, G Korres, G Aggidis. ISOPE International Ocean and Polar Engineering Conference, ISOPE-I-23-094, 2023.
- **Wave Power Resource Dynamics for the Period 1980-2021 in Atlantic Europe's Northwest Seas.** IG Rizaev, RM Dorrell, CLG Oikonomou, E Tapoglou, C Hall, GA Aggidis. ISOPE International Ocean and Polar Engineering Conference, ISOPE-I-23-093, 2023.

TALOS WP3 – Further Outputs

- GREECE – EU – UK – Hellenic Centre for Marine Research Athens – "**Exploring Uncertainties and Challenges in Wave Energy Resource Assessment**"

TALOS WP4 - International & National Collaboration

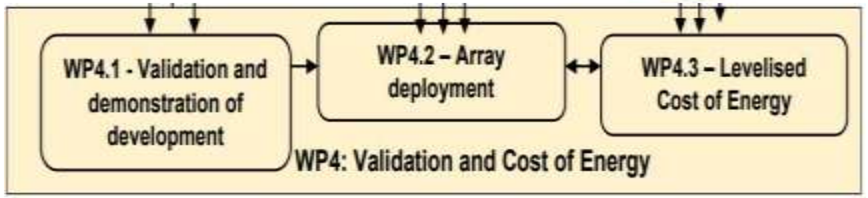
USA

- Characterizing the use of Wireless Communication for Subsea Data Transmission
- Evaluating long-term investments in emerging energy technologies in the United Kingdom with TALOS WEC as a case study
- Bridge the gap between TALOS WEC small-scale modelling and the higher TRL required to provide cost evidence and demonstrate its commercial
- Method of Obtaining Biological Inspiration to Improve the Performance of TALOS WEC

Malibu California USA

China

Canada



Advisory Board Members

TALOS WP4 – Outputs

- **A Method of Obtaining Biological Inspiration to Improve the Performance for TALOS Wave Energy Converter**. H Zhang, WA Sheng, GA Aggidis. ISOPE International Ocean and Polar Engineering Conference, ISOPE-I-23-090, 2023.
- **A review of the levelized cost of wave energy based on a techno-economic model.** C Guo, W Sheng, DG De Silva, G Aggidis. Energies 16 (5), 2144 5, 2023.
- **Python-assisted biological knowledge acquisition method to trigger design inspiration.** ZM Zha, H Zhang, GA Aggidis. Scientific Reports 12 (1), 7864 1, 2022.
- **A preliminary study on identifying biomimetic entities for generating novel wave energy converters.** H Zhang, W Sheng, Z Zha, G Aggidis. Energies 15 (7), 2485 3, 2022.

TALOS WP4 – Further Outputs

- USA - Peperdine Graziadio University – Malibu – California – “**Evaluating the Long-Term Investment Opportunities of Wave Energy Conversion with Real Options**”

PEPPERDINE GRAZIADIO BUSINESS SCHOOL

Malibu
California
USA

- ICELAND - Vestmannaeyjar Municipality – “**Feasibility of the deployment of TALOS wave energy converter in southern Iceland**”

TALOS WEC Review 2025

Journal of Marine Science and Engineering

MDPI

Review

Innovations in Wave Energy: A Case Study of TALOS-WEC's Multi-Axis Technology

Fatemeh Nasr Esfahani [1], Wanan Sheng [1,2], Xiandong Ma [1], Carrie M. Hall [3] and George Aggidis [1,*]

1 School of Engineering, Lancaster University, Lancaster LA1 4YW, UK
2 Department of Aerospace and Mechanical Engineering, South East Technological University, R93 V960 Carlow, Ireland
3 Mechanical, Materials, and Aerospace Engineering Department, Illinois Institute of Technology, Chicago, IL 60616, USA
* Correspondence

Abstract: The technologically advanced learning ocean system—wave energy converter (TALOS-WEC) project addresses the urgent need for sustainable and efficient energy solutions by leveraging the vast potential of wave energy. This project presents a pioneering approach to wave energy capture through its unique multi-axis and omnidirectional point absorber design. Featuring a fully enclosed power take-off (PTO) system, the TALOS-WEC harnesses energy across six degrees of freedom (DoFs) using an innovative internal reaction mass (IRM) mechanism. This configuration enables efficient energy extraction from the relative motion between the IRM and the hull, aiming for energy conversion efficiencies ranging between 75–80% under optimal conditions, while ensuring enhanced durability in harsh marine environments. The system's adaptability is reflected in its versatile geometric configurations, including triangular, octagonal, and circular designs, customised for diverse marine conditions. Developed at Lancaster University, UK, and supported by international collaborations, the TALOS-WEC project emphasises cutting-edge advancements in hydrodynamic modelling, geometric optimisation, and control systems. Computational methodologies leverage hybrid frequency-time domain models and advanced panel codes (WAMIT, HAMS, and NEMOH) to address non-linearities in the PTO system, ensuring precise simulations and optimal performance. Structured work packages (WPs) guide the project, addressing critical aspects such as energy capture optimisation, reliability enhancement, and cost-effectiveness through innovative monitoring and control strategies. This paper provides a comprehensive overview of the TALOS-WEC, detailing its conceptual design, development, and validation. Findings demonstrate TALOS's potential to achieve scalable, efficient, and robust wave energy conversion, contributing to the broader advancement of renewable energy technologies. The results underscore the TALOS-WEC's role as a cutting-edge solution for harnessing oceanic energy resources, offering perspectives into its commercial viability and future scalability.

Keywords: technologically advanced learning ocean system (TALOS); wave energy converter (WEC); power take-off (PTO); multi-axis point absorber; hydraulic cylinders; condition monitoring

check for updates

Received: 3 January 2025
Revised: 29 January 2025
Accepted: 29 January 2025
Published: 31 January 2025

1. Introduction

The global energy demand is projected to rise by 20–30% by 2040, underscoring the urgent need to transition from fossil fuels, which currently account for 78.5% of global

J. Mar. Sci. Eng. 2025, 13, 279

7. Results and Key Findings

Table 14 summarizes the results and key findings of the study, providing information on the performance, design, and optimisation of the TALOS-WEC system in various aspects.

Table 14. Summary of results and key findings

Aspect	Key Findings
Hydrodynamic Modelling	Heave motion plays a dominant role in energy absorption, exhibiting the highest added mass (4.2×10^6 kg) and damping coefficient (7.8×10^4 Ns/m). Coupled surge-pitch dynamics are critical for multi-modal energy transfers, highlighting the importance of addressing transient dynamics in design.
Numerical Tools	WAMIT excels in validating complex configurations, HAMS offers computational efficiency for iterative designs, and NEMOH is suitable for cost-effective preliminary studies.
Numerical Modelling	The hydraulic PTO system ensures stable energy harvesting with synchronised heave oscillations. Asymmetric PTO placements, such as PTO2 and PTO3, highlight the need for optimised spatial design.
Mooring System Effects	Slack mooring (MLC1) enhances energy absorption but increases variability and structural instability. Moderately slack mooring (MLC2) balances energy efficiency and stability.
Geometric optimisation	Shortened and Tailless TALOS configurations excel in energy absorption (8–9 s wave periods). Lowering the centre of gravity and adding overlapping panels enhance stability and performance.
PTO optimisation	Soft springs ($K_{PTO} = 250$ kN/m) and damping coefficients ($B_{PTO} = 150$ kNs/m) maximise energy absorption. Low damping improves efficiency but risks instability.
Condition Monitoring	KPCA-LSTM provides computational efficiency for long-term trends, while ANN-LSTM is effective for real-time monitoring. Combined approaches enhance reliability and reduce downtime.
Control Strategies	Full-state MPC delivers the highest power output (3.7 MW) but requires significant computational resources. Reduced-state MPC balances performance (3 MW) with efficiency.
Wave Energy Resource Dynamics	The highest wave energy potential (>70 kW/m) is west of the UK and Ireland, with peaks in winter (>140 kW/m). Coastal areas offer moderate but stable energy levels (35 kW/m).
Site-Specific Assessments	High-energy sites (Isle of Islay, SW Irish Coast) require minimal optimisation for deployment. Moderate-energy sites (Cantabrian Sea) need customised adjustments, while low-energy sites (West of Sardinia) necessitate significant design modifications.
Uncertainty Mitigation	Bias correction techniques (e.g., BC-QM) improve data reliability, achieving high correlation ($r = 0.96$ for H_s), particularly under extreme conditions.
Validation and Demonstration	Laboratory experiments validated numerical predictions, aligning strongly with real-world performance. Modular, scalable designs ensure efficient array deployment and energy extraction.
LCOE optimisation	Competitive LCOE (0.2–0.35 €/kWh) achieved through modular designs, predictive maintenance, and targeted high-wave-energy deployments. Reactive control improves efficiency and scalability.

TALOS – Computational & Experimental Modelling

TALOS WEC VIDEO taken during Experimental Modelling at the Wave Basin Testing facility of Zhejiang University in China

Experimental Modelling and Validation of the Computational Modelling for TALOS WEC

NREL Transforming ENERGY

Sandia National Laboratories

TEAMER - US DoE - Collaboration

U.S. DEPARTMENT OF ENERGY

TEAMER Testing & Expertise for Marine Energy

- TEAMER – 1
  - "Numerical Modelling of the TALOS Wave Energy Converter”
  - National Renewable Energy Laboratory NREL & Sandia National Laboratories (USA)

- TEAMER – 2
  - “Optimisation and Numerical Modelling of the TALOS Wave Energy Converter”
  - National Renewable Energy Laboratory NREL (USA)

WEC-Sim

Wave Energy Converter SIMulator

ILLINOIS TECH

IHU Wave Tank - Serres near Thessaloniki Greece

Lancaster University

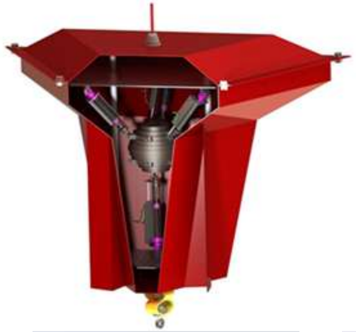
1. **Professor George Aggidis** and Dr **Constantine Michaelides**
2. International Hellenic University Serres near Thessaloniki Greece
3. At the **new Wave Tank Testing Facility** on the **28 August 2025**

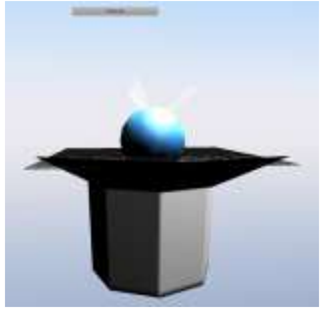
a. **IHU Wave Tank Testing Facility** is ideal for testing **TALOS WEC**
b. Similar to **the Lancaster University UK** Wave Tank Testing Facility
c. Similar to the **US DoE NREL Denver** Wave Tank Testing Facility

16th EWTEC Sept 2025 - Madeira - Portugal

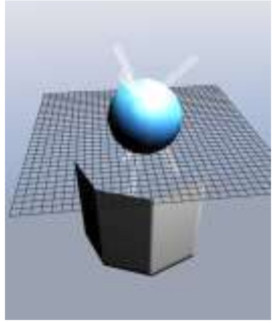
Lancaster University

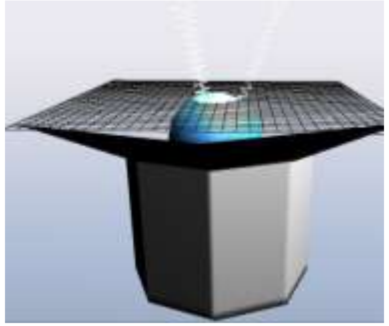
1. **TALOS WEC Paper with US DoE NREL**:
Automated Design Exploration of the TALOS WEC Using the Novel TOP-WEC Software Stack.





2. **US DoE NREL Workshop on SEA-Stack using TALOS WEC models as a case study**. (SEA-Stack: Simulation and engineering analysis code stack for WEC numerical modelling.

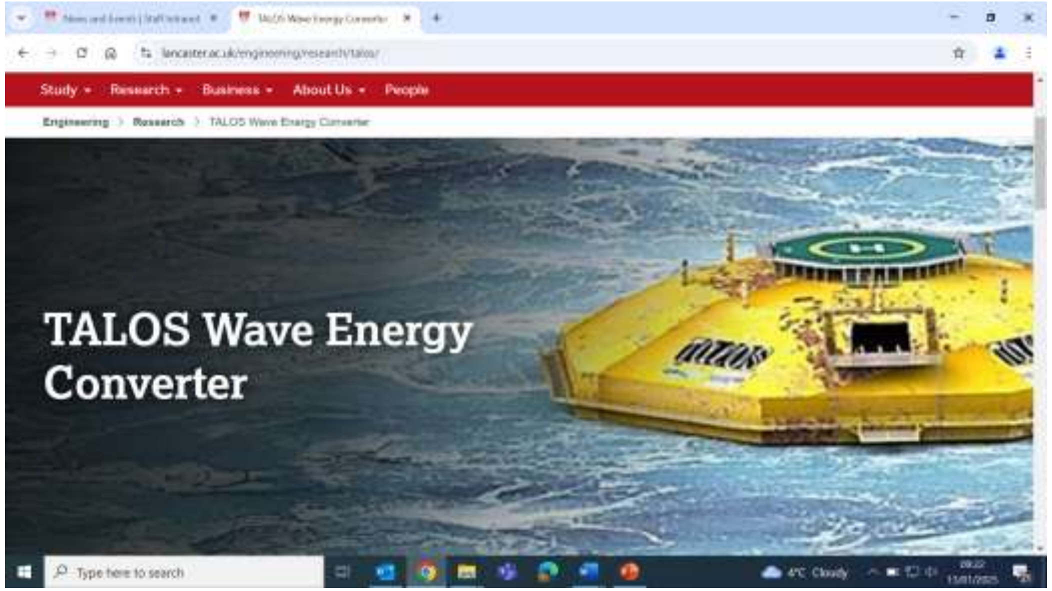


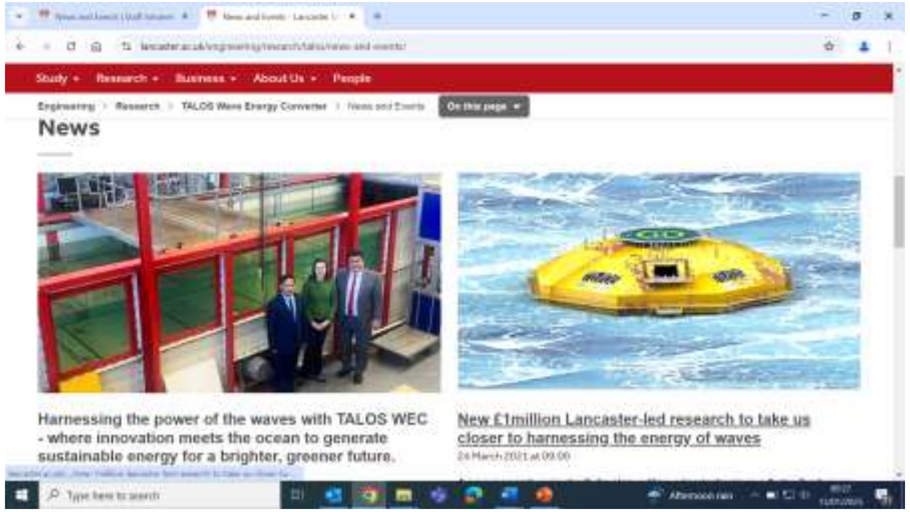


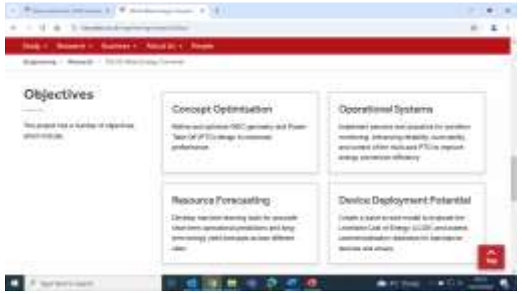
The 16th European Wave and Tidal Energy Conference
EWTEC2025 | 7th – 11th September 2025 in Madeira, Portugal

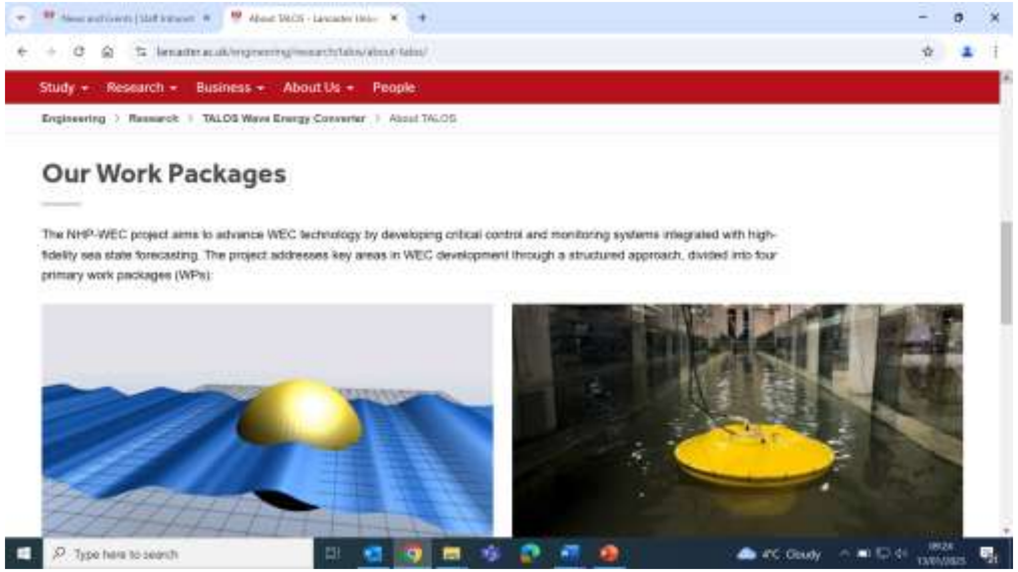
a. NREL SEA-Stack, an open-source numerical modelling framework for WECs.
b. This tool will integrate multiple simulation technologies from low-fidelity to high-fidelity models, enabling a more comprehensive analysis of WEC designs, noted WPTO.
c. SEA-Stack aims to streamline the development process, providing marine energy developers with a more accurate and faster way to test and validate new technologies.

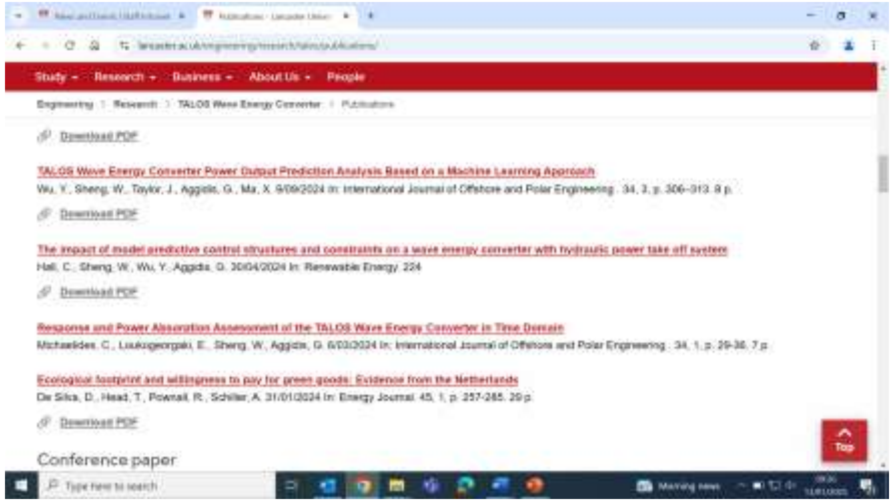
TALOS WEC Website











TALOS WEC - 2026 Research - UK

1. Dr Xiandong Ma, Amani Zaylaee – Hybrid, Wave and Wind
2. Dr Nan Zhao, Renqi Guo – Grid Integration and Linear Generators
3. Dr Ahmed Badawy, Dr Xiandong Ma - WEC Farms Electrical Optimisation
4. Dr Nan Zhao, Xiuping Jiang - PTO and Grid Connection
5. Dr Igor Rizaev - Wave Power Resource Dynamics

TALOS WEC - 2026 Research - USA

Lancaster University

1. Dr Jorge Andres Leon Quiroga, Dr Salman Husain, Dr Jesse Roberts, Dr David Ogden - Modelling and Optimisation and Sea Stack

2. Professor Carrie Hall – Control and Optimisation

3. Professor James DilLellio, Efundem Ashu – Economics and Real Options Theory

Malibu
California
USA

TALOS WEC - 2026 Research - International

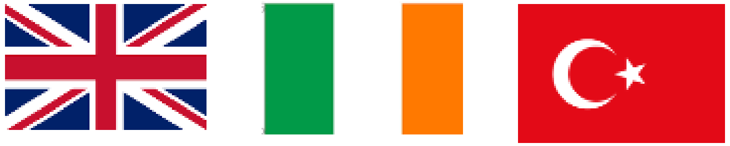
Lancaster University

1. Dr Wanan Sheng – Hydrodynamics and Shape Optimisation - SETU
2. Dr Lily Oikonomou – Wave Resource
3. Professor Hakan Yavuz – Control
4. Dr Constantine Michaelides – Computational & Experimental Modelling DNV SESAM
5. Professor Dahai Zhang, Dr Tan Ming – Computational and Experimental Modelling
6. Dr Hassan Shafei - Predictive coordination and control using Machine Intelligence for the multi axes TALOS WEC
7. Dr Hui Zhang – Biomimetics

DNV - SESAM

TALOS WEC - 2026 Outputs

YAVUZ, H., SHENG, W. and AGGIDIS, G., 2026. Mooring-based frequency-domain and AI-based time-domain optimization for improved power capture performance of the TALOS wave energy converter. *Renewable Energy*, p.125241.



Abstract: Mooring-based frequency-domain analysis combined with AI-based time-domain optimization offers a systematic approach to improving power capture performance in multi-degree-of-freedom wave energy converters. While most existing studies focus on single-degree-of-freedom systems, enhanced energy absorption can be achieved by exploiting the dynamic potential of multi-DoF configurations. This study investigates the TALOS wave energy converter, a six-degree-of-freedom system, with the objective of improving its power capture capability through coordinated mooring and power take-off (PTO) optimization. The optimization framework begins with a frequency-domain analysis to assess the influence of mooring parameters on the system response. Based on this analysis, two refined configurations, denoted as TALOS-L and TALOS-H, are developed using optimized mooring stiffness characteristics. Subsequently, time-domain simulations are conducted using a genetic algorithm to determine optimal PTO damping settings under site-specific sea conditions. The results show that adaptive tuning of both mooring and PTO parameters significantly improves power capture across different sea states. In particular, the TALOS-H configuration, featuring tuned surge mooring stiffness and genetically optimized PTO damping, consistently outperforms the baseline configuration. These findings highlight the importance of site-specific tuning and demonstrate the effectiveness of AI-based optimization for enhancing the adaptability and efficiency of multi-degree-of-freedom wave energy converters.
Keywords: TALOS wave energy converter; multi-DoF system modeling; frequency-domain mooring analysis; time-domain optimization; PTO damping optimization; genetic algorithm


Renewable Energy
Mooring-based frequency-domain and AI-based time-domain optimization for improved power capture performance of the TALOS wave energy converter
Hakan Yavuz, Wanan Sheng, George Aggidis
ARTICLE INFO
ABSTRACT
1. Introduction

Lancaster & Maynooth Universities Collaboration

From Jan 2009 and
SuperGen Marine
To Date - Jan 2026

Prof. John Ringwood

Prof George Aggidis

Wave Energy

Dr Giorgio Bacelli

Carrie Anne Barry

Tidal Energy

Dr Nicolas Faedo

Agustina Skiarski

Thank you

2026 Maynooth Wave Energy Workshop
23rd January 2026
Ireland

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