The LiftWEC Newsletter

A HORIZON 2020 PROJECT DEVELOPING A NOVEL LIFT-BASED WAVE ENERGY CONVERTER

Welcome to LiftWEC!

LiftWEC is a Horizon 2020 Research Project focused on the development of a lift-based Wave Energy Converter. This is the third LiftWEC Project Newsletter. Here you will find an introduction to the LiftWEC project and consortium, as well as some highlights of the ongoing project research activities.

Find Out More Online!

If you would like to find out more about the LiftWEC project or our research, check out our website at:

https://www.liftwec.com/

Here you will find details about the project and consortium as well as regular news updates, downloads, project data and other interesting things.

LiftWEC

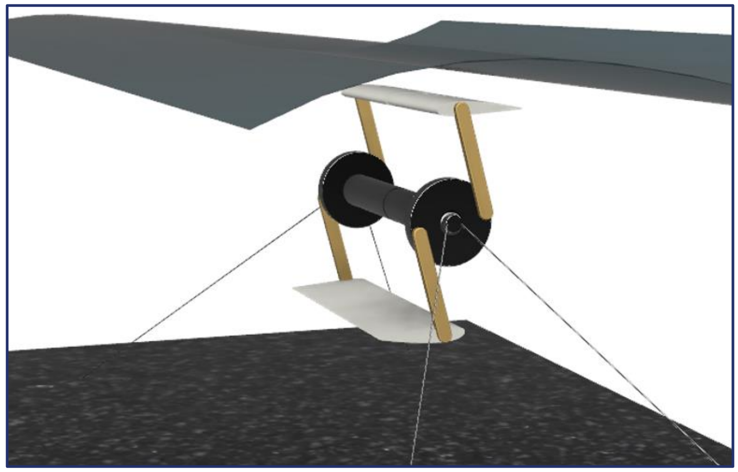
Contact Us!

If you are interested in the work of LiftWEC, or if you would like to get involved, get in touch! We would love to hear from you! Email us at:

General@LiftWEC.com

Or click below to find us on social media:

Project Update



The aim of the LiftWEC project is to develop a novel wave energy converter that extracts energy from incident waves through the generation of hydrodynamic lift. This lift is generated by a number of rotating hydrofoils orientated orthogonal to the direction of wave propagation.

The LiftWEC project takes a co-design approach to the development of this new device, ensuring that a wide variety of perspectives are involved in the design from the beginning. This ensures that critically important elements including; hydrodynamics, structures, foundations, control, operations & maintenance, cost of energy, environmental interactions and social acceptance are considered at a stage where their input can be used to improve device design, and allows design decisions to be made on a holistically informed basis.

During project year one, the consortium collaboratively developed 17 potential device designs that were referred to as *Preliminary LiftWEC Configurations*. During year two, the design knowledge required to undertake quantitative comparative assessments of the preliminary configurations was developed. Using this learning, the 17 Preliminary Configurations were comparatively refined and iterated upon until only 4 configurations remained. The remaining 4 designs are termed the *Baseline LiftWEC Configurations*, and form the foundation of work being completed during the third year of the project. Within each configuration, the rotor element of the device is identical and so each configuration is defined according to its installation and station-keeping system. Each of the four Baseline Configurations is detailed on the next page.

Project Consortium

If you are reading the digital edition of the newsletter, click on any project partner logo to head directly to their home page.

Queen's University Belfast | TUHH Hamburg University of Technology | Maynooth University National University of Ireland Maynooth | INNOSEA An ABL Group Company | Aalborg University Denmark

UCC Coláiste na hOllscoile Corcaigh, Éire University College Cork, Ireland | LHEEA Centrale Nantes | CNRS | Julia F. Chozas Consulting Engineer | WavEC Offshore Renewables | University of Strathclyde

Project Work Streams

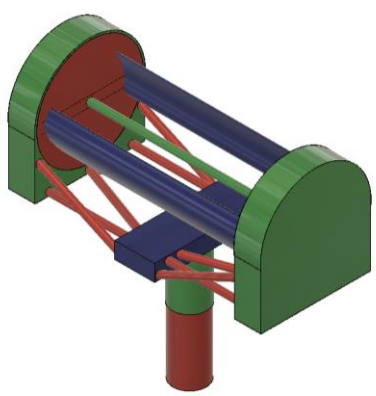
The following sections give a short update on each of the main work streams within the LiftWEC project. For more information see the LiftWEC website or get in touch!

CONCEPTUAL DESIGN

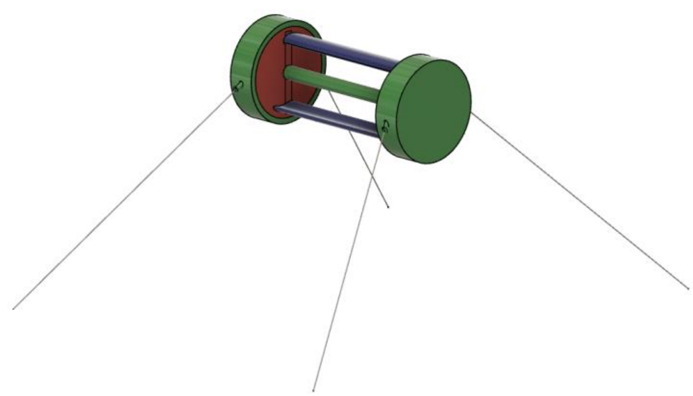
LED BY: QUEEN'S UNIVERSITY BELFAST

The Concept Design work stream is responsible for developing the final outline design of the LiftWEC device using a co-design approach that ensures knowledge and learning generated within all project work streams is incorporated into the ultimate design. Previously, this work stream developed 17 potential device designs referred to as the *Preliminary LiftWEC Configurations*.

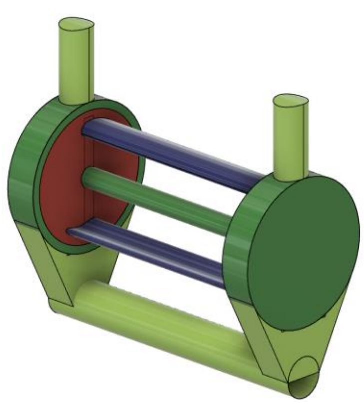
Since that time, the Conceptual Design work stream identified the key design knowledge required to determine the most desirable characteristics of a lift-based wave energy converter. Once this knowledge had been generated by the various work streams, the information was used to conduct a comparative analysis of the 17 Preliminary Configurations. The outcomes from this study were used along with a list of desirable features and characteristics to filter and refine the Preliminary Configurations, resulting in the generation of 4 *Baseline LiftWEC Configurations* which were put forward for further investigation. The rotor of each configuration is mechanically and functionally identical, thus the four configurations are distinguished through their anchor and station-keeping systems. Each of the remaining four Baseline LiftWEC configurations are shown below.



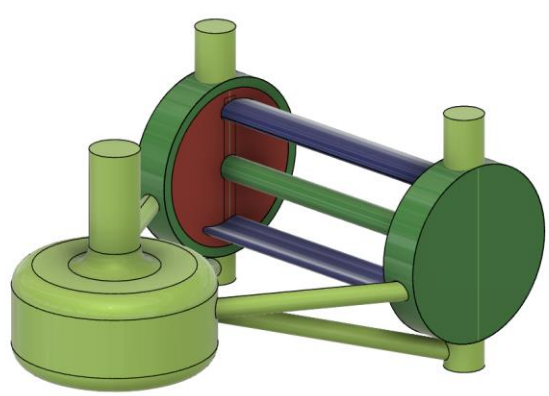
Tower LiftWEC Configuration



Tension Leg LiftWEC Configuration



Spar-Buoy LiftWEC Configuration



Semi-Submersible LiftWEC Configuration

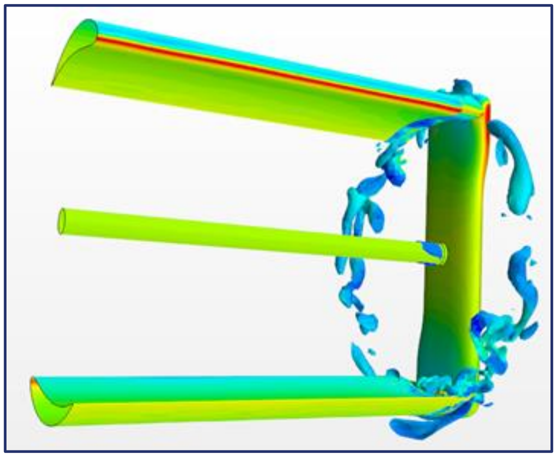
HYDRODYNAMIC MODELLING

LED BY: HAMBURG UNIVERSITY OF TECHNOLOGY

During the past twelve months the global and high-fidelity numerical models have been further extended and used in various investigations. Both models were successfully validated against results of the 2D physical testing campaign conducted during summer 2021 (detailed in Deliverable D3.3).

Deliverable D3.3

The point-vortex approach of the global model has been improved through calibration using physical test data. The newly calibrated model has been used to simulate device operation in irregular sea states using different control approaches to provide a first estimate of the annual power production the LiftWEC device may deliver.



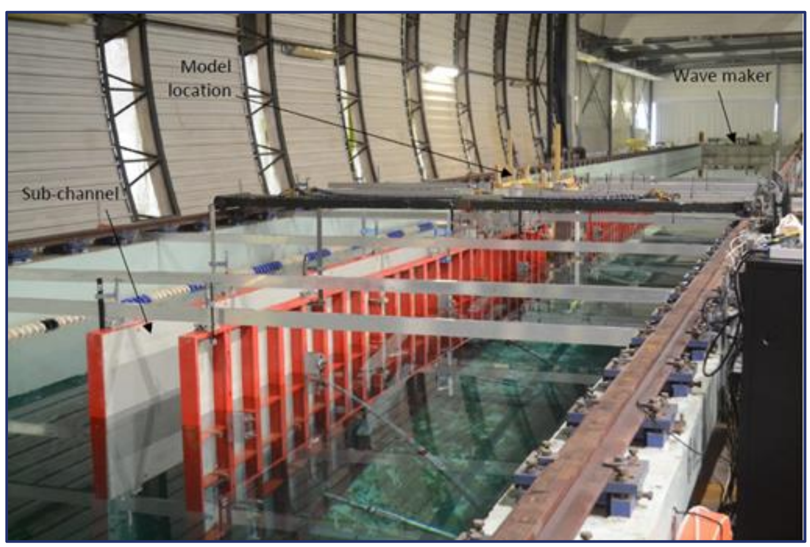
The high-fidelity model has been shown to deliver good predictions of mean loads and load fluctuations during normal operation. Using the CFD simulations, complex flow phenomena such as separation induced force fluctuations have been identified and quantified. Currently the CFD model is being used to provide additional tuning for the various potential-flow models being developed within the project. In addition, the CFD simulations have recently been extended into the 3D domain to investigate the influence of a finite span on hydrofoil performance.

LED BY: LHEEA CENTRALE NANTES

PHYSICAL MODELLING

The focus of the Physical Modelling work stream throughout 2021 was the design, manufacture and testing of a small-scale 2D LiftWEC model at Ecole Central de Nantes. This testing resulted in the generation of a 2D physical testing dataset which has been made available for public download and use by the wave energy community. The dataset is hosted on the Zenodo Repository and can be accessed at: https://zenodo.org/record/5596066. Two public deliverables (D4.1 & D4.2) have been published that detail the design and manufacture of the model, as well as two further deliverables (D4.3 & D4.4) detailing the physical testing itself. All deliverables are available for download on the LiftWEC Website and Zenodo Repository. Readers who wish to make use of the 2D data are advised to download D4.4: Report on Physical Modelling of 2D LiftWEC Concepts.

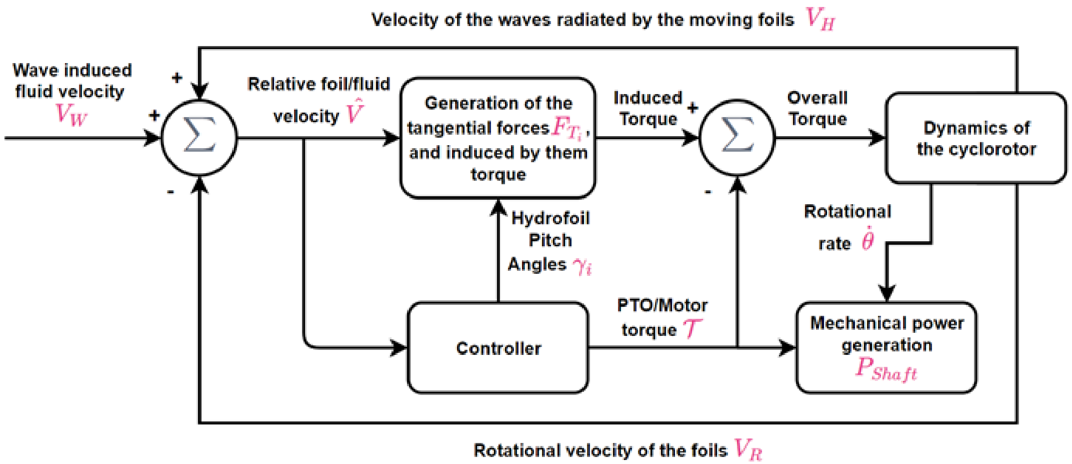
Deliverable D4.4



CONTROL SYSTEM DESIGN

LED BY: NUI MAYNOOTH

Recent work on control system design has involved developing control strategies for the LiftWEC device that use real-time rotational speed and/or hydrofoil pitch angle control to increase energy absorption. The approach is inspired by pseudo-spectral and moment-based methods originally developed for more traditional WECs. The optimisation of the rotation rate and pitch angle has been conducted in terms of mechanical power capture. Inclusion of generator and other PTO characteristics may require further refinement to the control algorithm.



Publications:

Ermakov, A. & Ringwood, J.V., "A control-orientated analytical model for a cyclorotor wave energy device with N hydrofoils". *J. Ocean Eng. Mar. Energy* 7, 201-210 (2021).

LED BY: UNIVERSITY OF STRATHCLYDE

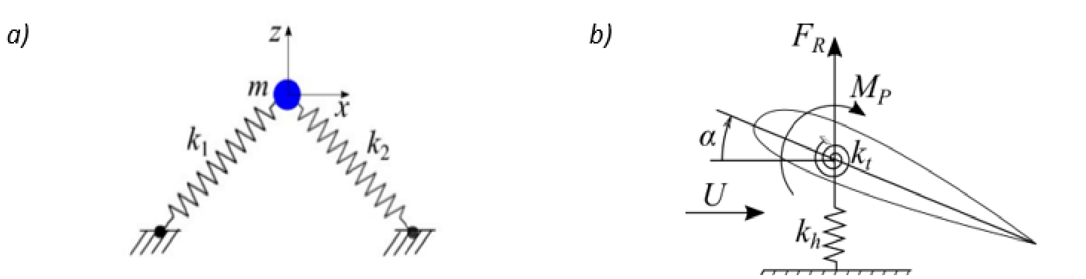
STRUCTURAL DESIGN

A structural dynamic model was developed to identify scenarios that may excite natural frequencies and undesired motions of the LiftWEC structure. A compliant v-frame structure and passive radial heaving of the foils were assessed by modelling support structures as compression springs. It was found that resonant excitation due to wave interaction is unlikely. Using the structural model, a probabilistic damage method is being developed to carry out fatigue assessments and identify points of stress concentration for further improvement of concept designs.

Deliverable D4.4

In parallel with these activities, INNOSEA is dimensioning the rotor's support structure for the remaining LiftWEC concepts. The loads are obtained through the global model previously described in the Numerical Modelling work stream. This first estimation aims at providing an estimated bill of material for each of the four Baseline Configurations to assist with LCoE calculations and support the next iteration of design refinements and improvements.

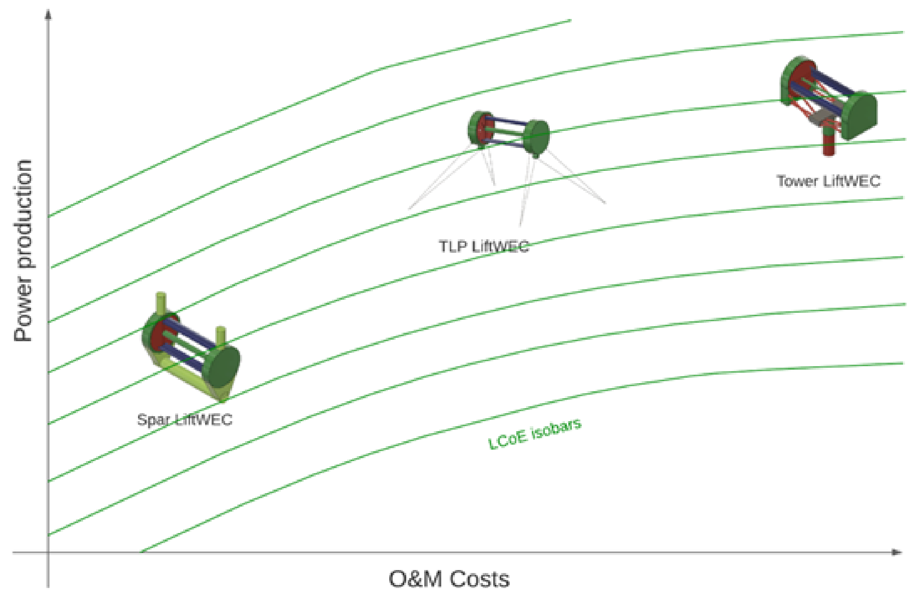
Figure 1: Structural model of LiftWEC, a) compliant v-frame structure and b) passive radial ar pitching support structure for single foil



OPERATIONS & MAINTENANCE

LED BY: UNIVERSITY COLLEGE CORK

When comparing the four *Baseline LiftWEC Configurations* presented above (see: Conceptual Design work stream) one could expect a greater power yield from the Tower & Tension Leg Configurations as the Spar and Semi-sub concepts may incur losses due to device motion. However, these concepts would also be expected to have increased installation and operations costs. The potential benefits of the increased power capture must be balanced by the operational cost of installing and maintaining them. The adjoining figure provides a qualitative illustration of the expected Power production vs the O&M costs for three of the Baseline Configurations. The aim of the next O&M deliverable (D7.4) is to put quantitative values to this assessment and assist with further concept refinement.



LED BY: AALBORG UNIVERSITY

LEVELIZED COST OF ENERGY

Work Package 8 focuses on developing methods and tools to accurately estimate the LCoE of the different LiftWEC configurations developed within the LiftWEC project. Initially, the LCoE tool adopted by the project was extended to include a parametric cost model that represents all relevant cost centres of the LiftWEC configurations. As part of CAPEX the following cost centres were identified: *Development and Consenting; WEC structure and Prime Mover*, *Balance of Plant*, *Control*, *Installation and Commissioning;* and *Decommissioning*. As part of OPEX, *Minor repair and Inspection*, *Major maintenance/repair: tow back or lifting*, and *Fixed OPEX: Annual Site lease, Insurance and Management* were identified. This work was presented in Deliverable D8.2.

Over the last half year the LCoE Calculation Tool has been further updated and refined for a single LiftWEC device, and more recently extended to allow for calculating the LCoE of a complete array of LiftWEC devices. The unit costs that provide the default values in the parametric cost model have been updated and reviewed. In this way the LCoE tool can now provide a representative cost estimate for every cost centre. The Tool can, in a simple manner, capture the key economic aspects of the different LiftWEC configurations – which can be helpful when comparing one solution against another. The Tool is based on Excel software and is free to download as part of Deliverable 8.3: LiftWEC LCoE Calculation Tool.

Deliverable D8.2

ENVIRONMENTAL & SOCIAL ACCEPTANCE

LED BY: WAVEC

Work has continued on the environmental and social acceptance of LiftWEC.

Deliverable 9.2: "Scoping report of the Environmental Impact Assessment" presents a scoping report of the LiftWEC technology accounting for all sections usually addressed in EIA scoping reports, including the description of the project, operations undertaken at sea and potential environmental & socioeconomic effects mitigation & monitoring.

Deliverable D9.2

Deliverable 9.3: "Scoping report of the social acceptance of LiftWEC" provides learning lessons, based on literature review and interviews to MRE actors, to guide the manner in which the LiftWEC project should engage with the planning process, investors and local communities for its future implementation. The aim is to maximise its potential socio-political, market and community acceptance.

Deliverable D9.3

The upcoming Deliverable 9.4: "Life Cycle Assessment of the LiftWEC design" will conduct Life Cycle Assessment (LCA) of the LiftWEC technology in terms of greenhouse gas (GHG) emissions (g CO2eq/kWh). Comparisons will be made with other ocean energy installations and provide recommendations on the most environmentally appropriate design decisions considering alternative materials, manufacturing processes etc. which represent lesser environmental impacts.

Get Involved!

Do you have an idea for a lift-based Wave Energy Converter that you would like to explore? Do you have any thoughts on the potential viability of a lift-based system? Do you have experience that you think would help the development of this type of device? If so, get in touch – we would love to hear from you!

Email us at:

General@LiftWEC.com

Alternatively, you can follow us on social media by clicking on the icons to the right.

If you would like to learn more about the LiftWEC project, visit our project website at:

https://www.liftwec.com/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 851885. This output reflects the views only of the author(s), and the European Union cannot be held responsible for any use which may be made of the information contained therein.