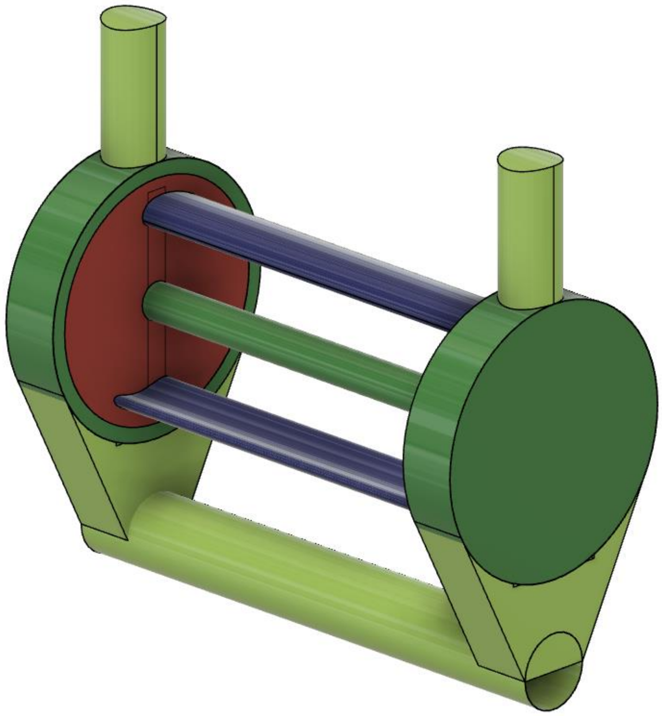
The 4th LiftWEC Newsletter

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



The Final LiftWEC Configuration!

LiftWEC is a Horizon 2020 Research Project focused on the development of a lift-based Wave Energy Converter. This is the fourth 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. In this issue we report on the selection of the Final LiftWEC Configuration – the Spar Buoy.

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

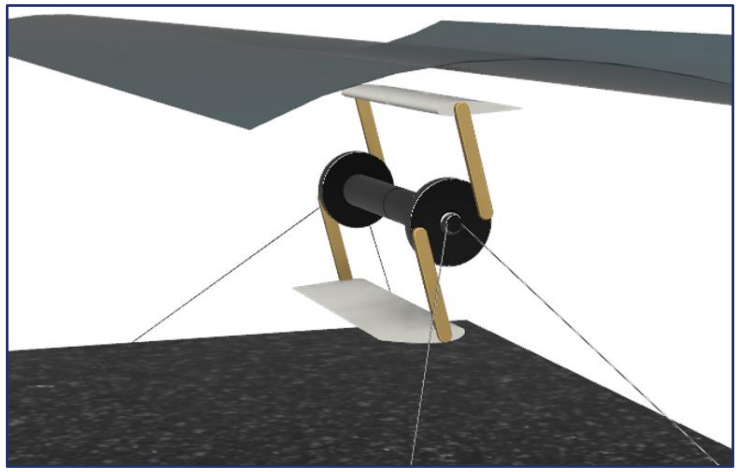
Contact Us!

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 if reading online, 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 inception. 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 comparative assessments of the preliminary configurations was developed. Using this learning, the 17 Preliminary Configurations were assessed, refined and iterated upon until only 4 configurations remained. The remaining 4 designs were termed the *Baseline LiftWEC Configurations*. As previous, further knowledge was generated as required and comparative assessments were made between the Baseline Configurations, resulting in the selection of the *Final LiftWEC Configuration* that is presented and described 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.

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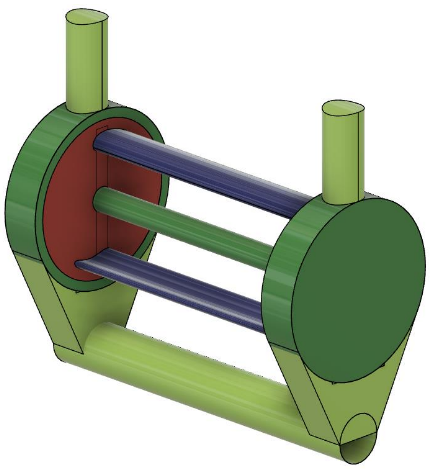
WavEC Offshore Renewables
University of Strathclyde

Project Work Streams

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*. These were subsequently assessed, refined, and the list was narrowed down to the 4 *Baseline LiftWEC Configurations* that were presented in the last LiftWEC Newsletter.

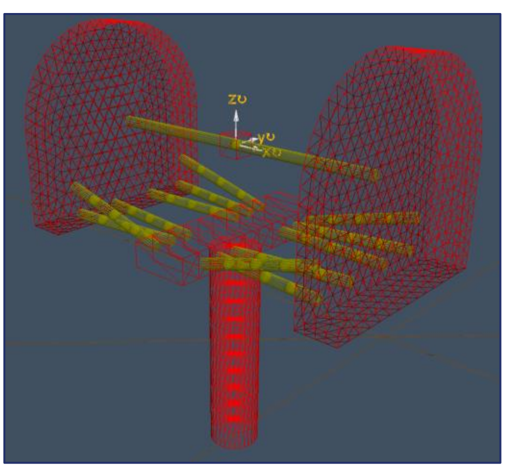


Since that time, the Conceptual Design work stream has generated significant additional knowledge and understanding relating to the design requirements of lift-based WECs. Unfortunately, as with all WECs, many of these design requirements are necessarily in opposition to one another. For example, it is preferable to deploy a device in a high energy wave environment to maximise power production, however this means that weather window availability is typically highly limited. After significant deliberation, the consortium collaboratively selected the Spar-Buoy LiftWEC (left) as the *Final LiftWEC Configuration*. The final phase of the project will now conduct investigations into the commercial viability of the concept.

LED BY: HAMBURG UNIVERSITY OF TECHNOLOGY

HYDRODYNAMIC MODELLING

The latest work using the global model focused on developing the design bases for the Baseline Configurations and a complete loading analysis of the Tower Configuration. The model was constructed in OrcaFlex, a dynamic analysis software for offshore marine systems. The loads on the rotor were computed using potential flow theory, and loading of the braces and monopile were assessed using Morison's equation.

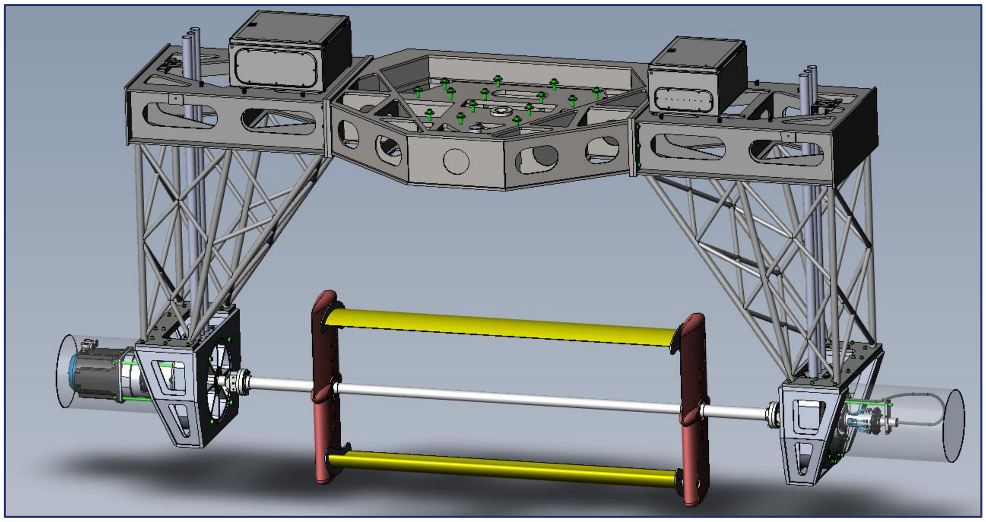


The reference wave climate was taken from the North Atlantic coast of France, close to Quimper at 47.84°N, 4.83°W. To maximize power production, control was applied on a per sea state basis to the rotor submergence, yaw, and speed. During extreme events, a survival mode was employed where the tower was fully retracted and the rotor locked. A variety of Design Load Cases dedicated to the evaluation of extreme loads were defined according to the IEC 62600-10 standards and details of the analysis were presented in *"Deliverable D3.5: Extreme Loads Analysis report"* which will be uploaded to the LiftWEC website in August 2022.

PHYSICAL MODELLING

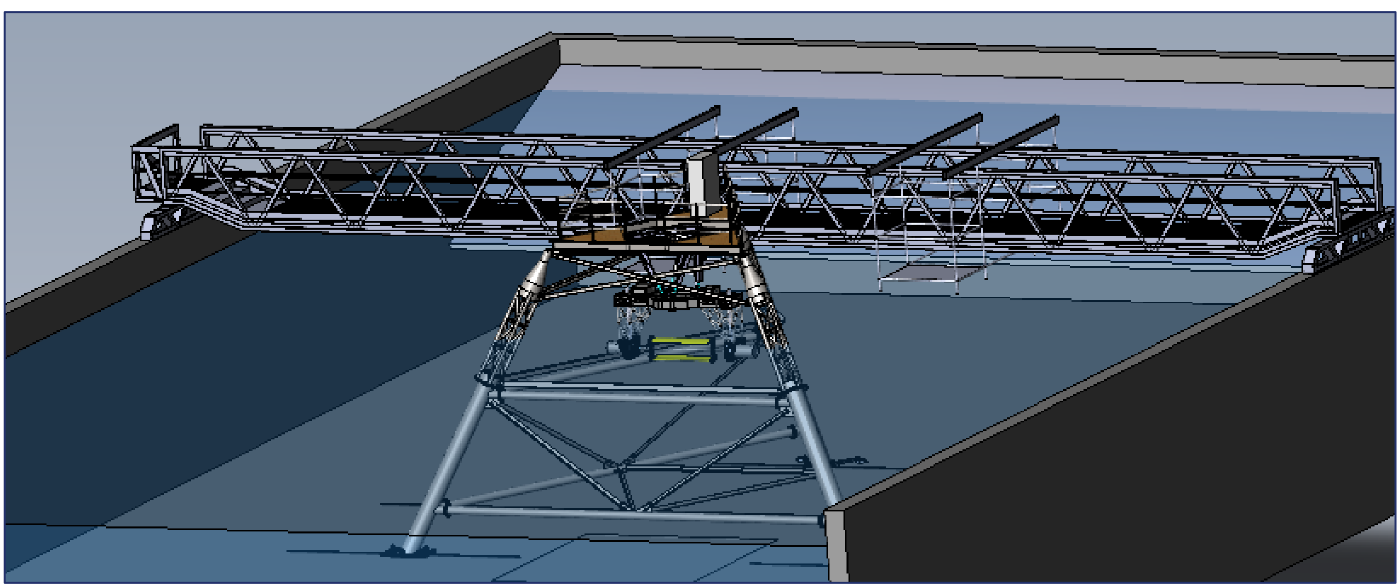
LED BY: LHEEA CENTRALE NANTES

The final phase in the Physical Modelling work stream is the experimental testing of the 3D model of the LiftWEC concept. The 3D model is fully designed and is currently under construction and assembly. It is illustrated in the picture below and is composed of a rigid structure that will be supported under a six-degree motion hexapod.



Beaneath the water surface, the rotor is held horizontal, and in the main configuration, parallel to the wave crest. The motion of the rotor is controlled using a Power Take-Off (PTO) system consisting of an electrical motor which can be operated in position, speed and torque control. The quantities measured include; the PTO torque, radial and tangential loads on the axis of each foil, absolute angular position of the rotor and wave elevation surrounding the model.

There is a dry enclosure on one end of the rotor; it contains the electrical motor and torque meter, a second dry enclosure on the other end contains other sensors and cable connections. Real time motion of the axis is permitted by means of the six degree of freedom hexapod that is used to located the device within the wave basin.



CONTROL SYSTEM DESIGN

LED BY: NUI MAYNOOTH

The work of WP5 was mostly dedicated to the study of the influences of the real time pitch and torque control methods on the adaption of the hydrodynamic gain and the mechanical energy production. The research published in the articles listed below has clearly shown the benefits of the optimal pitch and rotational rate control application, in both monochromatic and panchromatic waves. It was shown that, while rotational rate control looks more compelling than pitch control, in terms of shaft power increase in monochromatic waves, this observation is reversed in the case of panchromatic waves. The implementation of the joint pitch and rotational rate control strategy in panchromatic waves shows a significant increase over the fixed or single input of rotational rate/pitch cases. The main conclusion from the presented results, therefore, is that cyclorotors must be controlled in real time using both actuators, in order to reach their full potential. It has been shown that real time control strategy can potentially increase the energy production in panchromatic waves up to 600%.

Publications:

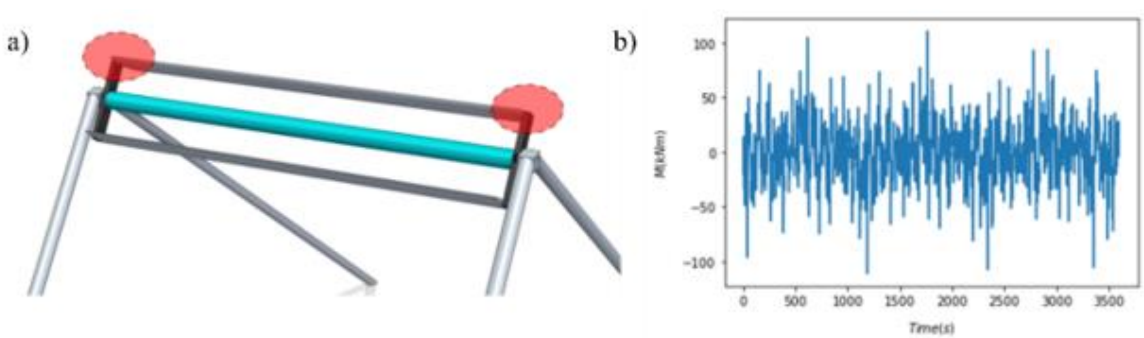
- A. Ermakov, A. Marie & J. V. Ringwood, *"Optimal Control of Pitch and Rotational Velocity for a Cyclorotor Wave Energy Device"*, IEEE Transactions on Sustainable Energy, 13, 3, July 2022.
- A. Ermakov, A. Marie & J. V. Ringwood, *"Some Fundamental Results for Cyclorotor Wave Energy Converters for Optimum Power Capture"*, IEEE Transactions on Sustainable Energy, 13, 3, July 2022.

LED BY: UNIVERSITY OF STRATHCLYDE

STRUCTURAL DESIGN

The Structural Design work stream has focused on developing a fatigue damage assessment methodology for LiftWEC. As an example, we evaluated the annual fatigue damage on a stress hot spot that is located at the fixed end of the foil. Deterministic and probabilistic approaches are currently being compared to assess the validity of both approaches to a wave cycloidal type of rotor. The progress of this work has been submitted in Deliverable D6.4: *"LW-D06-04-1x3 Fatigue Assessment"*. Additionally work package 6 has been following up the planning of the experimental campaign of the LiftWEC rotor to provide input from the structural perspective.

Deliverable D6.4



a) Stress hot spots on the fixed end of the foils where fatigue damage is being analysed, and b) bending moments used to calculate bending stresses on hot spots and on the fatigue model.

OPERATIONS & MAINTENANCE

LED BY: UNIVERSITY COLLEGE CORK

The Operations & Maintenance (O&M) work stream is currently finalizing the detailed O&M assessments of the baseline configurations following earlier preliminary and initial assessments. This includes running installation and O&M scenarios for each specific configuration, following on from initial assessments in LiftWEC Deliverable D7.3. These assessments are conducted assuming the commercial roll-out of a 100MW wave farm as per the project description. Results include the total installation cost per substructure and WEC as well as for inter-array and export cabling. Installation time is also estimated. The O&M tool will determine the total and average annual energy production for each configuration as well as the capacity factor, energy and time-based availabilities, and total and average OPEX. Results will be presented in *Deliverable D7.4: "Assessment of baseline configurations"*.

LED BY: AALBORG UNIVERSITY

LEVELIZED COST OF ENERGY

The Levelized Cost of Energy (LCOE) work stream deals with the Economic Modelling of the LiftWEC Technology. Consulting Engineer Julia F. Chozas, InnoSea and Aalborg University have worked together in the economic assessment of the four Baseline Configurations, where the accumulated costs of construction, installation and operation over the lifetime of the project have been assessed and compared.

Results indicate that the two floating LiftWEC configurations (the semi-sub and the spar) have the lowest LCOE, estimated at about 140 €/MWh. This is about half compared to the LCOE of the Tower LiftWEC. The LCOE for the Tension-Leg Platform (TLP) configuration falls in between.

The high LCOE of the Tower LiftWEC is driven by high installation costs (a heavy lift vessel is needed to embed the monopile into the sea bottom) and higher Operational Expenditure (OPEX), approximately twice or three times more, than in the other configurations.

The TLP configuration has a medium LCOE, mainly driven by OPEX twice as high as that of the floating configurations. The TLP has more complex mechanism under loads (mooring drums), and connection/de-connection operations are expected to be more demanding than those of the single point connection (spar and semi-sub). TLP CAPEX is mainly driven by the high costs of the mooring and installation.

The low LCOE of the Spar LiftWEC is mainly driven by low structural costs, as the support structure only adds 85 tonnes of steel on top of the mass of the prime mover. Installation costs are not high, and are in a similar range as those for the semi-sub, which gives the Spar LiftWEC the lowest CAPEX of the four Baseline Configurations. OPEX for the Spar LiftWEC is also on the lowest level, as the single connection point is expected to allow for a quick and easy connection, and is also possible in larger sea states than for the two non-floating configurations (TLP and Tower). The LCOE of the semi-sub configuration is also low, and in the same order of magnitude as the LCOE of the spar buoy. Further details of the comparisons are presented in *"LiftWEC Deliverable D8.4: LCOE Estimates of Baseline Configurations"*.

Deliverable D8.4

ENVIRONMENTAL & SOCIAL ACCEPTANCE

LED BY: WAVEC

Work has continued on the environmental and social acceptance of LiftWEC to assess relevant environmental and social influences of the LiftWEC device.

The Task on "social acceptance of LiftWEC" was completed with the submission of Deliverable 9.3 which provides learning lessons, based on literature review and interviews with Marine Renewable Energy actors and stakeholders, 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.

The Task on the "Life Cycle Assessment (LCA) of the LiftWEC design" will continue until the end of the project and will culminate in the submission of Deliverable 9.4. This report will include three main sections:

1. Review of LCA studies carried out for MRE projects,
2. The LiftWEC 'cradle to grave' LCA in terms of greenhouse gas (GHG) emissions (g CO2eq/kWh), based on the inputs from other WPs in the LiftWEC project (e.g., life cycle stages, components and sub-components, materials, processes, transport), and
3. comparison of LiftWEC LCA results with those from other ocean energy installations

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/

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