LiftWEC

DEVELOPMENT OF A NEW CLASS OF WAVE ENERGY CONVERTER BASED ON HYDRODYNAMIC LIFT FORCES

Deliverable D2.2

Identification of evaluation criteria

Deliverable Lead	Queen's University Belfast
Delivery Date	1st May 2020
Dissemination Level	Public
Status	Final
Version	1.0

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Document Information

Project Acronym	LiftWEC
Project Title	Development of a new class of wave energy converter based on hydrodynamic lift forces
Grant Agreement Number	851885
Work Package	WP2
Related Task(s)	T2.2
Deliverable Number	D2.2
Deliverable Name	Identification of evaluation criteria
Due Date	1st May 2020
Date Delivered	8th May 2020
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Document Number	LW-D02-02-1x0

Version Control

Revision	Date	Description	Prepared By	Checked By
0.5	30/04/2020	Internal release for comment	RPA	MF
0.7	07/05/2020	Internal release for comment	RPA	MF
1.0	08/05/2020	released	RPA	MF

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EXECUTIVE SUMMARY

The objective of this report is to review the existing literature relevant to the early stage evaluation of WECs and propose a set of relevant evaluation criteria for the LiftWEC project.

These criteria will be used throughout the LiftWEC project to evaluate the potential of the different concept candidates and will be adapted to the level of maturity of the proposed concepts. Importantly, the criteria should not be used to evaluate the current stage of development of each concept but its potential to become a successfully commercialised WEC.

This report describes the identification of the selection criteria. The methodology to benchmark and to score each concept against these criteria will be developed and documented in following deliverables related to Task 2.5.

A review of the WEC selection criteria within different ongoing projects has been carried out. The criteria used in such projects are broadly consistent and can be used as a basis of the LiftWEC selection criteria, but they are generally defined from the point of view of an external evaluator of technologies. The criteria are therefore focused on providing an absolute evaluation of a technology, and do not consider the difficulty of developing the concepts up to commercial maturity level (the "developability" of the concept). The interest in conducting a Technology Performance Level (TPL) evaluation of the selected concepts at the end of the LiftWEC project is identified.

Based on this literature review, a specification of the LiftWEC criteria was drawn, emphasising the need to provide relative evaluation between concepts which will be grouped into a tighter design space that the one considered by the reviewed project.

A structured list of selection criteria is provided, with 5 principals thematic: Energy Production, Affordability, Survivability, Developability, Acceptability Each thematic is then divided into criteria. Notes are provided for each criterion to provide some clarification about the criteria selection and its future scoring methodology.

COVID 19 Deviation:

Due to the current circumstances related to the outbreak of the COVID 19, the content of this deliverable had to be amended, and the summary of the findings from a delayed workshop are pushed back to the deliverable 2.3. There is no change of content proposed in the descriptions of the projects deliverables when taken together, but the changes simply reflects the required change in schedule. This change is not anticipated to have any significant impact on the delivery of the LiftWEC project.

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1 INTRODUCTION

1.1 OBJECTIVES

The LiftWEC project aims to explore and define a Wave Energy Converter (WEC) based on lift forces. The LiftWEC project will generate a significant number of candidate concepts, developed them from TRL 1 and select the most promising ones for further development both within and after the project lifetime. At the end of the project, at least one concept developed to Technology Readiness Level (TRL) 3 is expected to be selected to be carried forward.

The objective of this report is to review the existing literature relevant to the early stage evaluation of WECs and propose a set of relevant evaluation criteria for the LiftWEC project.

Contrary to the focus of most existing work on the subject on targets for stage gate metrics ([1]–[4], the set of evaluation criteria required for the LiftWEC project must allow the differentiation between concepts fitting within a narrower range of cases as all the WECs considered will fit within the LiftWEC scope. Existing work, therefore, cannot be adopted without prior examination and modification.

These criteria will be used throughout the LiftWEC project to evaluate the potential of the different concept candidates and will be adapted to the level of maturity of the proposed concepts. Importantly, the criteria should not be used to evaluate the current stage of development of each concept but its potential to become a successfully commercialised WEC.

1.2 SCOPE AND LIMITATIONS

This report describes the identification of the selection criteria. The methodology to benchmark and to score each concept against these criteria will be developed and documented in following deliverables related to Task 2.5.

1.3 DEVIATION

Unfortunately, due to circumstances, including the outbreak of COVID-19, a knowledge gathering workshop will not have been held prior to the proposed delivery date of the 30th April 2020. However, much of the work of identifying appropriate evaluation criteria can be completed without holding a knowledge gathering workshop. Thus, it is proposed that Deliverable D2.2 is submitted prior to holding a knowledge-gathering workshop. However, these evaluation criteria will be reviewed at a subsequent workshop and this review reported in Deliverable 2.3 (Review of current Lift-based WEC concepts and specification of preliminary baseline configuration), which is due on the 31st May 2020. Thus, the revised deliverables now read

> ***Deliverable D2.2***
>
> *This is part of Task 2.2. This report will describe the evaluation criteria that will be used to guide the selection of the baseline configurations and assess their performance and provide clear guidelines for their use by an external party.*

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Deliverable D2.3

This is part of Task 2.3. This will consist of a report that reviews the current lift based WEC concepts and describe the configuration specifications that will be used in the preliminary numerical and physical models, as well as for the design development. The specification will be provided in sufficient detail to ensure that the configurations are unambiguously defined. This report will also include details of the workshop to review the evaluation criteria.

It can be seen that there is no change of content proposed in the descriptions of the project deliverables when taken together, but the revised deliverables simply reflect the required change in schedule. This change is not anticipated to have any significant impact on the delivery of the LiftWEC project.

2 BIBLIOGRAPHY REVIEW

2.1 DTOCEANPLUS

The DTOceanPlus project[1] is a Horizon 2020 project supported by the European Union aimed at providing design tools for the development of ocean energy systems. Part of these tools involve a "Structured Innovation Tool" and a "Stage Gate Tool", as described in [5]:

- "The Structured Innovation design tool generates new concepts; including novel concepts for wave and tidal energy devices, or an improvement of a sub-system, device, or array at higher maturity level. The tool also provides the ability to assess technologies at the early concept stages when there is minimal data available and will inform part of the inputs for the Stage Gate design tool."
- "The Stage Gate design tool supports the objective assessment of technologies in the development process, ensuring a fair assessment of sub-systems, devices and arrays from early stage concepts up to commercial deployment."

The specific deliverable defining the Stage Gate Tools is not published at the time of writing this report, and therefore the selected criteria used to inform the Stage Gates are not available. The specific deliverable describing the criteria should be available in May and its findings and conclusion will be included in the following LiftWEC deliverable (D2.4). However, [5] provides a description of the requirements of the software tools for the assessment of the technologies. The assessment methodology varies with the maturation of the concept devices and associated farm design. For the levels of technological maturity corresponding to the LiftWEC project, Technology Readiness Levels (TRLs) 1 -3, [5] states:

[1] https://www.dtoceanplus.eu/

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Table 2-1: extract of Table 1-2 of [5]

Stage and approximate TRL	Data availability	Assessment method
1-3	Little quantitative data available; overview of capabilities and operation modes	Assessment through the Structured Innovation and Stage Gate design tools by utilising the earliest level assessments of technologies; these may use: • Fundamental physics, engineering and economic relationships. • High-level quantitative assessments from the Assessment and Deployment design tools. • Scoring of a technology by qualitative assessment from an expert assessor

The rest of the document focuses on the structured innovation process, giving example of how the process has been successfully implemented in other industries and listing the current projects in Marine Renewables that make use of it. Unfortunately, the criteria used during the stage gate evaluation process are not presented. However, it is very clear that the objective of the assessment process of DTOceanPlus is to provide quantitative and absolute metrics to evaluate the technologies and farm design. Relative evaluation between different options would be provided based on the absolute evaluation of the options.

2.2 DoE TRL/TPL levels

The Technology Performance Level (TPL) scale was devised for the Wave Energy prize of the US Department of Energy (DoE). It is presented in [2]. The objective of the TPL scale is to provide a score that relates to the potential performance of the WEC technology at every stage of the technological development. By providing a measure of the potential of the technology at an early stage of development, it encourages developers to invest in the performance of the concept early on, before increasing the Technology Readiness Level (TRL). The logic is that developments at later stages of the maturity are more costly than at early stage. That is, the development path should be to first increase the TPL of a wave energy converter concept before attempting to increase the TRL.

The TPL scale provides a score from 1-9. Technologies with scores between 7 and 9 are deemed viable and competitive.

The key criteria used in the scoring are listed below:

- Acceptability
- Power absorption, conversion, and delivery
- System availability
- Capital Expenditure
- Operational Expenditure

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The last four are grouped to provide a TPL economic level, reflecting the nature of the relation between them, and are later combined with the TPL acceptability level to provide the TPL of the whole system.

Each of these criteria is separated into factors that contribute to the criteria. An example is provided with the scoring for a fictitious wave energy converter in Figure 1. This provides a starting point for the factors that can be used as the basis of the LiftWEC evaluation system.

The TPL assessment is focused toward the assessment of the concept potential once developed, and therefore the technical difficulty and resources required to reach the developed stage are not considered. In this sense, the TPL is a tool defined for an external entity wanting to evaluate a technology, but it is not specifically a tool for the technology developer itself.

Completing a TPL assessment of a device requires producing a narrative of the full life cycle of the technology. In doing so it forces the developer to consider all aspect of the technology. In addition, early stage TPL scoring is not only useful for evaluation of particular solution but can also provide valuable insight into which aspects of the technology require further development and highlights the technological risk associated with a technology.

A TPL assessment of the selected LiftWEC concept configuration at the end of the project might be a relevant exercise as a method of judging its performance relative to other wave energy converters and to help build the case for further development.

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Category	Criterion	$TPL_{i,j}$	TPL_i
Acceptability:			7.3
	Lifecycle Environmental Acceptability	7	
	Social Acceptability and Socio-Economic Impact or Benefit	8	
	Legal, Regulatory and Certification Acceptability	8	
	Safety	7	
	Risks and Risk Mitigation	6	
	Insurability	6	
	Market Acceptability by Investor, Financier, Operator, Utility	7	
Power:			4.4
	Hydrodynamic Wave Power Absorption	3	
	Internal Power Conversion	5	
	Power Output and Delivery	6	
	Controllability - Fast - Wave to Wave	3	
	Controllability and Adaptability - Slow - Sea State to Sea State	4	
	Short-Term Energy Storage Capability	5	
Availability:			5.1
	Survivability	5	
	Reliability	6	
	Durability	7	
	Redundancy	2	
	Force, Power and Information Flow	4	
	System Adaptability Supporting Availability	3	
	Forced Shutdown	4	
Capital Expenditure (CapEx):			6.0
	Supply Chain	9	
	Material Types	7	
	Mass and Required Material Quantity	4	
	Manufacturability	5	
	Transportability	3	
	Wave Farm Infrastructure (non-WEC Device)	8	
	Device Deployment, Installation and Commissioning	5	
	Maintainability - CapEx Requirements	6	
	Modularity - CapEx Requirements	9	
	Redundancy - CapEx Requirements	9	
	Loading and Load Bearing - CapEx Requirements	4	
	Acceptability - CapEx Requirements	7	
Operational Expenditure (OpEx):			4.9
	Ability and Ease of Monitoring	5	
	Accessibility	5	
	Maintainability	4	
	Modularity and Ease of Subsystem and Component Exchange	3	
	Ease of Partial Operation and Graceful Degradation	4	
	Insurability Cost	5	
	Planned Maintenance Effort	7	
	Unplanned Maintenance Effort	5	
	Acceptability - OpEx Requirements	8	
TPL_Eco = TPL_Pow x TPL_Ava x (0.7 TPL_CapEx + 0.3_TPL_OpEx)			2.4
TPL_System = 0.2 TPL_Acc + 0.8 TPL_Eco			3.4

Figure 1: example of TPL scoring. From [2]

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2.3 WES/USA DoE WORKSHOPS

Wave Energy Scotland (WES) has been running a structured development program for wave energy converters (WEC) since 2015, and in this process has joined with the US Department of Energy (DoE) to run a series of workshops ([1], [4], [3]) focused on the development of metrics for WECs. As funding agencies, the DoE and WES are interested in developing an objective evaluation of the future commercial potential of the technologies within their various programs. It is therefore necessary for WES/DoE to be able to select the most promising candidate within a pool (relative selection) but also to evaluate the potential of these candidates within a wider competitive field against other energy sources (absolute evaluation).

The first of these workshops focused on establishing the match between required functions and capabilities of the potential WEC technologies. The list was drawn up with the perspective of a full commercial WEC farm, but no clear distinction between farm and individual WEC characteristics was defined. The following thematic areas were identified:

- Energy capture
- Energy conversion
- Survivability
- Affordability
- Controllability
- Maintainability
- Reliability
- Instalability
- Manufacturability
- Acceptability

The second workshop reused the identified thematic areas and worked toward defining metrics related to each thematic. Importantly, the participants to the second workshop identified that rating a device independently of the **wave resource** and **commercial project** is meaningless, and a recommendation of up to five reference wave climates was introduced as not all commercial projects have the same target wave resource.

In addition to the tentative metrics defined, success thresholds were introduced for each metric. This is relevant in the context of funding agencies, which need to identify early if the funded technologies have commercial potential. For example, if none of the competitors for a particular funding stream is identified as having a high enough potential, then the funds should be retained and redirected to another area.

The report of the third workshop held in 2017 [4] expands on the previous report and provides defined metrics in relation to each of the identified topic. For each metric, a method of estimation is provided depending on the stage of development of the technology. For technologies in the early stages of development, the methods are mainly based on qualitative assessment of several parameters for each thematic area, and therefore the specified metrics themselves cannot be quantified directly.

As for the TPL assessment, the required resources and technical difficulties likely to be encountered along the development path of the technology are not considered. The level of support provided by a funding agency in a structured innovation program with Stage gates is normally not dependent on the technology selected. It might therefore be assumed that the return on investment for the funding agency is not dependent on the *developability* of the concept as long as it progresses in accordance with the metrics and thresholds defined by the agency.

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3 SELECTION CRITERIA

3.1 SPECIFICATION

The principle objective of the LiftWEC project is to develop and bring to TRL 3/4 a wave energy converter based on lift forces. The LiftWEC concept is broadly defined as using one or multiple rotor(s) with an undetermined number of blades and the axis of each rotor horizontal and perpendicular to the main direction of wave propagation.

This general definition accommodates a large design space for concepts to fit within, but it is still much more limited that the range of concept that funding agencies such as WES or the USA DoE must consider in their WEC development programmes. The selection of evaluation criteria for the LiftWEC configurations and especially the methods to quantify the associated indicators should reflect this reduced design space. By tailoring the evaluation criteria for the LiftWEC project it is possible to increase the specificity of the technological evaluation, which may result in more target evaluations and a more efficient identification of the more promising configurations.

The identification of promising LiftWEC configurations is supported by the generation of multiple concepts within the design space. Those concepts will then be trimmed down through a series of steps within the project (starting with preliminary configurations in moving to baseline configurations, and then ultimately the final configurations) where the more promising concepts are carried forward to the next step based on their evaluation. The evaluation criteria presented in this deliverable will support this process.

Based on these previous observations, the evaluation criteria for the LiftWEC:

- Should allow the differentiation between the potential of several concept fitting within the LiftWEC design space in order to effectively select the “best” one for further development;
- Should therefore not focus on the specific solution at the time of the evaluation but should contemplate the potential of the concept to accommodate different solutions (at TRL3, specific choices regarding materials, type of generators and other elements might not be set in stone);
- Does not need to provide an absolute quantification of the potential of the concepts with regards to their performance relative to other wave energy converters.

Regarding the last point, an “absolute” evaluation of the potential of the final LiftWEC concept would be better defined by applying a recognised process such as the TPL assessment common to other types of WECs. However, this route has not been taken so that the evaluation can be more effective in identifying the more promising LiftWEC concepts, which is the primary objective of the LiftWEC project. This objective would not be as well fulfilled if a more “absolute” evaluation was used.

Additionally, to the previous considerations, the set of evaluation criteria deployed within LiftWEC must be defined from the technology developer point of view. The “developability” of the concept, i.e. the amount of resources required to develop the concept (the affordability of the test for example) and the technical difficulty should be considered. Between two concepts with an identified potential

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nearly identical, the one with the lowest expected cost of development (and shorter development times maybe) should be favoured.

Finally, it is important that the evaluation criteria cover the entire route towards commercialisation of the concept, anticipating the requirements regarding the concept development, the performance and cost potential of the mature concepts, the operational safety, and the future decommissioning of the devices. It is however possible that, as the design space is limited, some of these requirements will not provide substantial differentiation between LiftWEC concepts. In such cases, the evaluation criteria related to these requirements within the LiftWEC project may be discarded, not because they become irrelevant, but because they no longer serve the purpose of helping the selection of promising concepts.

3.2 SELECTED LIFTWEC EVALUATION CRITERIA

The selected LiftWEC evaluation criteria are classed within thematic categories and presented in Table 3-1. The main thematic categories are largely inspired from the thematic areas presented in the WES/DoE workshops (see section 2.3). As the design space investigated in the project is smaller than the design space considered for such funding program as the Wave Energy Prize (US DoE) and that the objective is to rank the concept (and not to obtain an absolute evaluation of their potential), the application of the TPL scale to each concept is not justified.

Contrary to the evaluation methodologies presented in section 2, the developability of the concepts is also considered. A concept's developability conditions the efforts and resources required to carry the concept all the way to commercialization, and as such it is considered a critical characteristic to include. The LiftWEC evaluation criteria are organised using five thematic categories, these are:

- Energy production: a group of criteria linked to the energy production of the concept
- Survivability: a group of criteria ranks the concepts regarding their ability to survive extreme conditions
- Affordability: a group of criteria linked to the affordability of the concept when deployed in a commercial farm setting. The criteria cover the elements influencing the CAPEX and the OPEX of the WEC farm/concept.
- Acceptability: a group of criteria linked to the general acceptability of the concept and the associated farm by the wider society.
- Developability: ensemble of criteria that defines the capability of the design team to develop the concept, and the associated financial cost. A concept which working principles are inherently difficult to model and test will be difficult to optimize and mature. The possibility of the technology to provide sources of revenues from secondary market is also considered, as it would reduce the resources required to develop the technology up to the large scale electricity market level.

The list of criterion within each thematic category is presented in Table 3-1.

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Table 3-1: list of selected criteria

Criteria Level 1	Criteria Level 2	Note
Energy production		
Energy capture	energy absorption potential	This is independent of the potential of control of the device. It should mainly represent the ability to absorb power based on the rotor area, number of foils, and working principle. This criterion should be largely independent of the "scale" of each concept, focusing on the underlying efficiency of the concept with regard to the rotor/structure size and volumes.
	control potential	The criterion ranks the potential of the concept to be controlled. It valorises having a large number of parameters to adjust and the expected sensitivity of the absorbing principle to these parameters. Control on a sea state per sea states (long term) and wave by wave (short term) cycle are considered.
	Load shedding abilities	This should reflect the concept ability to limit loads during heavy sea states, in order to reduce the variability of the energy production. This is a valuable characteristic to ease the dimensioning of the PTO and the structure. The ability to continue producing in survival mode is also valorised and should be assessed.
	Versatility	The capacity of the concept to be adaptable to a variety of resources. While the LiftWEC concept will be developed for a given site, the possibility to deploy it in the future to other sites is valorised.
energy conversion	storage	Internal energy storage is an important characteristic of WECs, due to the variability of the incident power. While the LiftWEC concept should fare better than most WECs on the variability of the primary power capture, it is still an important characteristic.
	efficiency	Rating linked to the expected efficiency of the selected PTO chain of a given concept. It will be based on the description of the envisaged PTO chain. PTO chain description includes: - gearbox efficiency (if present) - presence of intermediate storage between rotor and generator - fully electric or hydraulic/other transmission
Survivability		
Load shedding abilities	Rotor shedding abilities	The ability of the rotor, through active or passive control, to limit the hydrodynamic loads during extreme event is valorised

Criteria Level 1	Criteria Level 2	Note
	Structural support abilities	The ability through control to limit the loads on the support structure is valorised.
Loads in extreme event	extreme loads	A scoring of the concept based on the expected extreme loads occurring during extreme event,
	snaps loads/ end stops risks	An evaluation of the concept based on the risk of snap loads and or end stops issues during extreme events
Affordability		
Structural requirement	rotor structural requirement	A high score is given to a concept with low expected requirements for the rotor structure. This would be linked to low expected Fatigue Limit States (FLS) or Ultimate Limit States (ULS) loads for example.
	Support structure structural requirement	A high score is given to a concept with low support structure requirement. This would be linked to low expected FLS or ULS loads for example.
	Structural versatility	Some concept might accommodate several types of materials, and or construction methods. This should be valorised even if all options are not explored at TRL 2/3.
Station keeping requirement	Station keeping requirement will vary largely for different concept. Therefore, concepts can be scored based on the function of the station keeping system. Concept for which the station keeping system is only used to keep the system broadly in position will score higher than concept for which the station keeping system is an integral part of the energy capture chain.	
Instalability	safety	Criterion linked to the safety of the installation procedure, from launch to commissioning. Ranking concepts along this criterion will be possible when conceptual installation procedures will be defined for each concept. A minimum level should be defined for this criterion, and WEC concepts scoring below this level will be eliminated.
	transport to site requirement	Criterion related to the possible ways to transport a concept from launch to deployment sites and associated requirement
	boats/asset requirement	Criterion ranking the asset requirements for the installation of a farm of the selected concept. The requirements linked to the number of WEC to be installed to reach the expected installed capacity should be considered. The needs to have divers and/or certain classes of ROVs for the operation is integral to the scoring of this criterion

Criteria Level 1	Criteria Level 2	Note
	WEC installation time	A criterion related to the time required to install one WEC, as the sum of the actions needed. Weather window reliance do not apply here and are accounted for in the Farm installation time criterion
	Farm installation time	This criterion relates to the relative duration required to install the target wave farm, taking into account the reliance on weather window of the operations.
Manufacturability Note: for each main subassembly, this should reflect ease of manufacture, the scalability of the process taking into account the number of WECs required, the time required for manufacture, the availability of parts	rotor	Criterion related to the complexity of mass production of the rotor. Longer blades, blades with materials more complicated will be harder to industrialize. This might be a criterion that does not provide much differentiation at the early stages of LiftWEC
	support structure	Criterion related to the complexity of manufacturing the support structure of the concept. Water tightness requirements with high static pressure (submerged concept for example) will increase the requirements for the mass production of the support structure
	PTO	Criterion related to the complexity of manufacturing the PTO of the concept.
Maintainability	Connection/disconnection requirement	A criterion related to the requirement to conenct and disconnect one WEC fro maintenance purposes. Weather window reliance should be considered.
	modular O&M	Criterion scoring the concepts based on the ability to have O&M procedures based on independent modules, therefore not bringing the concept availability to 0 during O&M operations.
	boats/asset requirement	Criterion ranking the asset requirement for the O&M of a farm of the selected concept. The requirements linked to the number of WECs to be installed should be considered. The needs to have divers and/or certain classes of ROVs for the operation is integral to the scoring of this criterion
	Safety	Criterion linked to the safety of the O&M procedures. Ranking concepts along this criterion will be possible when conceptual installation procedures will be defined for each concept. A minimum level should be defined for this criterion, and WEC concepts scoring below this level will be eliminated.

Criteria Level 1	Criteria Level 2	Note
	critical elements	The concepts should be examined regarding the presence of critical elements in the design, i.e. elements that threaten the device survival if they are not functioning as intended.
Reliability	Prime mover/structural	Concepts are scored based on the perceived reliability potential of the rotor/ support structure/ station keeping system
	PTO	Concepts are scored based on the perceived reliability potential of the PTO
Acceptability		
Regulatory & environmental	This criterion might differentiate the concepts based on their likelihood to be acceptable from a regulatory point of view. Environmental aspect of the WECs and its material will be considered. Hydraulic PTOs, fully submerged WECs, WECs with small footprint might yield different scores.	
Societal impact	As for the regulatory and environmental criterion, the societal impact criterion relates the acceptability of the concept from a societal point of view. This criterion might be merged with the Regulatory & environmental criterion if not enough differences can be found between concepts on this specific aspect.	
Developability		
Physical tests requirements	Evaluate the technical possibility and difficulty to conduct all the required experimental testing required to develop the concept. This includestank tests, PTO banch tests and the first sea going prototypes. This criterion should also reflect to expected cost and resource requirement of these experimental activities..	
Numerical modelling complexity	Rate the expected complexity required to provide numerical solution that the design team can use for design inputs and optimization.	
Scalability	WECs have different ability to be scaled, both from a hydrodynamic performance point of view, and from a cost perspective (see [6], [7]). As in other industry, scalability appears to be an important factor to reduce the future LCoE, and therefore should be valued. Based on the way each concept satisfies the main function of the WEC, it will be possible to assess the "scalability" of the concepts, and score them accordingly.	
Secondary markets	The suitability of the concept to serve secondary markets, such as powering oceanographic instruments or oil and gas isolated offshore facilities, island communities	

4 FUTURE WORK: SCORING GRID AND PONDERATION

Future work within the LiftWEC project on the selection criteria will be conducted and disseminated through the Deliverable D2.4, *Specification of design and evaluation support software tools*. In this subsequent deliverable, the scoring methodology for each criterion presented in this document will be explained. As the LiftWEC project is only considering early stage development, the scoring will be based on a combination of quantitative calculations and a qualitative narrative for each concept with regards to each criterion. The methodology will be designed to explicitly take into account the views of the LiftWEC research consortium. In particular, the members of the work packages related to each group of criteria will be directly involved in the calculation/assignment of the evaluation criteria.

Finally, the ponderation of the criteria is critical to obtain a balanced evaluation of the concept. As specified, some criteria such as safety should be treated differently, with minimum threshold achieved. A pairwise comparison methodology (see note below) to balance the scoring will be considered. The specification of the evaluation support software tool (D2.4) will also include recommendations about a possible sensitivity study of the results to the ponderation of the criteria.

Note: Pairwise comparison consists in establishing a qualitative balance between 2 criteria (Much Stronger, Stronger, Neutral, Weaker, Much Weaker), for all combinations of paired criteria. This way, each criterion is weighted considering its importance relatively to all the other criteria individually.

5 CONCLUSIONS

A review of the WEC selection criteria within different ongoing projects has been carried out. The criteria used in such projects are broadly consistent and can be used as a basis for the LiftWEC selection criteria, but they are generally defined from the point of view of an external evaluator of technologies. The criteria are therefore focused on providing an absolute evaluation of a technology, and do not consider the difficulty of developing the concepts up to commercial maturity level (the “developability” of the concept). The interest in conducting a TPL evaluation of the selected concepts at the end of the LiftWEC project is identified.

Based on this literature review, a specification of the LiftWEC criteria was drawn, emphasising the need to provide relative evaluation between concepts which will be grouped into a tighter design space than the ones considered by the reviewed projects.

A structured list of selection criteria is provided, with 5 principal thematic categories: Energy Production, Affordability, Survivability, Developability, Acceptability Each thematic is then divided in criteria. Notes are provided for each criterion to provide some clarification about the criteria selection and its future scoring methodology.

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.

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