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Statement of originality

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.



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Glossary

EC	European Commission
EU	European Union
GW	Gigawatt
IP	Intellectual Property
IPR	Intellectual Property Rights
LCOE	Levelized Cost of Energy
MW	Megawatt
O&M	Operation and Maintenance
R&D	Research and Development
TRL	Technology Readiness Level
TWh	Terawatt-hours
WP	Work Package(s)
PTO	Power Take-Off
AMSRM	Azimuthal Multitranslator Switched Reluctance Machine
HLC	High Level Control
LLC	Low Level Control
FAT	Factory Acceptance Tests



Executive summary

The SEA-TITAN project aims at making a step change in the wave energy sector by designing, building, testing and validating a crosscutting and innovative Direct Drive Power Take-Off (PTO) solution to be used with multiple types of wave energy converter.

This document is part of the report done to the European Commission under the H2020 funding program and contains the integrated plan of the exploitation activities of the project consortium and the future impact that each partner expects from the knowledge acquired throughout this project.

After a high-level introduction in Section 1, an overview of the planned strategy for the management and protection of the innovative and IP assets of the technology that supports the SEA-TITAN is provided in section 2 of this deliverable.

Section 3 defines the main guidelines of results exploitation for the consortium, as well as a set of well-defined measures foreseen to maximise impact of the project in the consortium in the short, medium and long term.

Section 4 details the impacts that each partner expects to retrieve from the project and how these results will affect their respective business plans. An overview of the areas for these impacts is also defined, proving the wide range of applications that result from a solid and well-balanced project consortium.

Finally, section 5 sets a timeline for exploitation activities that are expected to be developed throughout the project and further on. The timeline for these activities is divided in three different periods, according to the focus of each of the periods.



1. Introduction

1.1 SEA-TITAN Exploitation

The overall objective of the SEA-TITAN project is to make a step change in the wave energy sector by designing, building, testing and validating an innovative second generation Direct Drive Linear Electric Generator Power Take-Off solution: an Azimuthal Multitranslator Linear Switched Reluctance Machine (AMSRM). This development is based on a new configuration and geometry of a first generation Multitranslator Linear Switched Reluctance Machine developed by some of the proponents some years ago. The development aims at achieving high continuous and peak force densities and also high efficiencies with application to multiple wave energy conversion technologies through collaboration with different wave energy developers and industrial partners with strong track record on technology.

These improvements will contribute to an increased energy production, reduced system mass, increased reliability and increased availability. Together these innovations will reduce significantly the Levelized Cost-of-Energy (LCOE) delivered by the SEA-TITAN crosscutting PTO system.

As a research and development project, co-funded by the European's Community's H2020 Programme, any technical and operational breakthroughs to the existing wave energy chain will be disseminated to progressively wider audiences. The project's results will be used by the partners (through innovative products, services or future consultancy activities), by the wider R&D community (via scientific papers in selected conferences) and by the wider utility and finance industry in the wave energy sector.

Thus, the exploitation of the results of the SEA-TITAN project is an important part of the whole project, as it fosters the identification of market opportunities and contributes to the assessment of future strategies to commercialize the technology.

1.2 Purpose and Scope of the Deliverable

The scope of the Exploitation Plan is to define an overall strategy to adopt regarding the knowledge acquired while performing the project or any commercial end result of the project. The main targets of this Exploitation Plan are identified in Figure 1 and together with "D7.2 – Exploitation Plan" it will promote the exchange of experiences and further development of new products and services that enable cost reduction while mitigating risk.

The Exploitation Plan will be divided mainly in three different areas: Innovation and Intellectual Property Management, Consortium Activities and Partners Activities. Additionally, it will also define the methodology to evaluate the Exploitation Plan throughout the entire project. In order to achieve the intended goals, this Exploitation Plan will be regularly revised during the lifetime of the project and properly corrected, if necessary.

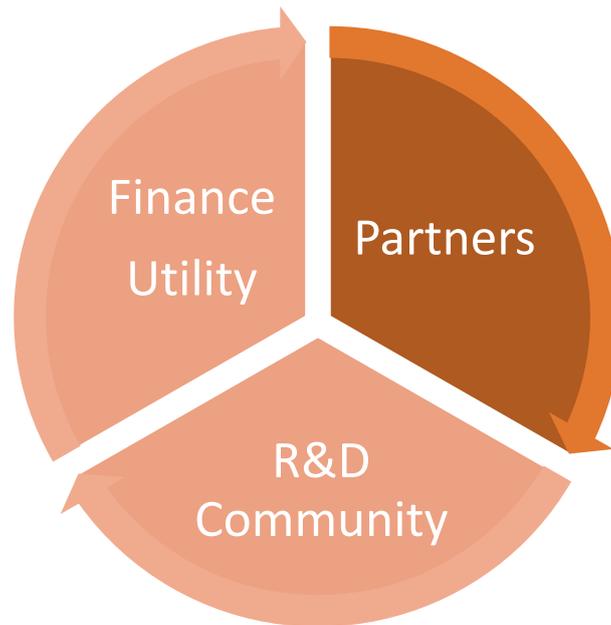


Figure 1 - Main targets of the Exploitation Plan

1.3 References

“Fact Sheet – The Plan for the Exploitation and Dissemination of Results in Horizon 2020” – available online (https://www.iprhelpdesk.eu/sites/default/files/newsdocuments/FS-Plan-for-the-exploitation-and-dissemination-of-results_1.pdf)

2. Innovation and Intellectual Property Management

One of the most relevant aspects to consider in exploitation of the results of SEA-TITAN project is how to manage and protect the innovative aspects of the SEA-TITAN technology.

2.1 Relevance in SEA-TITAN

For any company, having the IP assets in place enables it to provide unique services or products to its clients. This constitutes, in fact, a market leverage that has to be acquired and maintained, audited and accounted for, valued, monitored closely, and managed in order to extract its full potential. Intellectual Property Rights (IPR) maximise the protection of valuable specific knowledge by legally binding the IP to a certain company in a delimited market.

In SEA-TITAN procedures for protection of the intellectual property rights (IPR) will be envisaged in the Consortium Agreement conditions. Freedom to operate for the industrial partners should be guaranteed. Nevertheless, each partner will be obliged to give reasonable free non-exclusive access to the background information to the other partners for the purpose of using it to develop the project tasks.

The IPR issues will agree the conditions established by the Open Business Model scheme, described later in this document.



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The Parties will identify and agree on the Background for the Project. Access Rights General Principles as follows:

- Results and Background shall be used only for the purposes for which Access Rights to it have been granted;
- All requests for Access Rights shall be made in writing;
- The granting of Access Rights may be made conditional on the acceptance of specific conditions aimed at ensuring that these rights will be used only for the intended purpose and that appropriate confidentiality obligations are in place;
- The requesting Party must show that the Access Rights are needed;
- Access Rights to Results and Background needed for the performance of the own work of a Party under the Project shall be granted on a royalty-free basis;
- Access Rights for Exploitation. Access Rights to Results if Needed for Exploitation of a Party's own Results shall be granted on Fair and Reasonable conditions. Access rights to Results for internal research activities shall be granted on a royalty-free basis;
- Access Rights to Background if Needed for Exploitation of a Party's own Results, including for research on behalf of a third party, shall be granted on Fair and Responsible conditions;
- Additional Access Rights. The Parties agree to negotiate in good faith any additional Access Rights to Results as might be asked for by any Party, upon adequate financial conditions to be agreed;
- For the avoidance of doubt, the general provisions for Access Rights provided are applicable also to Software.

Having in mind the EC guidelines for IPR and the expectations of the SEA-TITAN consortium to develop commercially valuable know-how throughout the project, both IP and IPR ownership and usage are clearly stated in the Consortium Agreement signed by all partners.

2.2 Innovative concepts of SEA-TITAN

The SEA-TITAN project aims at making a step change in the wave energy sector by designing, building, testing and validating a crosscutting and innovative Direct Drive Power Take-Off (PTO) solution to be used with multiple types of wave energy converter. Between others, SEA-TITAN will implement the main innovations:

- Increased force and force density levels in PTOs, in order to maximize the wave energy capture and conversion into utility-standard electricity;
- Increased velocity range, in order to boost the energy capture;
- Double IPCR by the PTO jointly with float to wire efficiency improvement will increase annual energy production;
- Reduced capex per kW by reducing the size of: linear generator spar end stop and brakes, and the assembly and installation costs;
- Novel topology for a Switched Reluctance Machine based on the existing Multi-translator concept, aimed at increasing the airgap surface with reduced impact on the volume of the full machine. This will allow the development of a more compact and



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efficient set of generators able to increase significantly the amount of energy that can be extracted from the sea waves;

- Consider superconductivity as a way for increasing the electrical load in the machine, practically eliminating the losses while improving the shear stress significantly.

Another innovation comes from the open source platform concept that SEA-TITAN presents, which will be discussed on later sections.

2.3 SEA-TITAN Patents

Patent details not ready for public submission because the patent application is in the preparation process and has not been filed yet.



3. Consortium Exploitation

One of the main goals of SEA-TITAN project is to foster the development of a technology that are capable of reducing the cost of renewable energy. To achieve that, exploitation activities have a central role in the project scope.

In order to accelerate internal innovation and technology deployment SEA-TITAN will explore a new business concept to the wave energy industry, following an open source approach. Technology developers have felt compelled to create patents out of concern that the big energy companies would copy their technology and then use their massive manufacturing, sales and marketing power to overwhelm these technology developers. They couldn't have been more wrong. The unfortunate reality is the opposite: wave energy programs at the major utilities or independent power producers are small to non-existent, constituting an average of far less than 0,1% of their total R&D resources. In the software industry, the success of open innovation strategies through open sourcing is widely known and acknowledged. The open source approach to create software innovations has become a vital alternative to inhouse developments for many firms. In fact, in Open-source software (OSS) projects, the major innovations come from the users, the open source community.

SEA-TITAN will advance in business models based on "open hardware models" (new concept to be developed and implemented within SEA-TITAN Project) where methods and work environments from OSS are translated into hardware environments. By opening the innovation process to the open source community, SEA-TITAN can profit on the technology side through comments, ideas, and further developments. Through this, firms can improve quality and applicability of their technologies. Moreover, the open source concept allows the developers to base their developments and contributions on an already existent basis of technology. Also benefiting the community through the dissemination of an innovative platform with relevant disruptive characteristics.

Complementary products and services such as monitoring, training, maintenance, consultancy, and certifications will play a major role to achieve competitive advantage and will be included in the model through the implementation of the "Smart-sensors" package. These sensors will be provided by Wedge and installed in each manufactured PTO to monitor the system while providing added value to the final user.

Figure 2 is an example where SEA-TITAN Open Platform (centered black box) interacts with the key business players to accelerate wave energy deployment. This is an innovative concept because:

1. Free use of patents, generated by Wedge Global, by other competitors (Wave Energy Technology Developers). Procedures for protection of the intellectual property rights (IPR) of other Consortium members and others will be envisaged in the Consortium Agreement conditions;
2. Added value through PTO lifetime monitoring to optimize performance, propose upgrades and preventive maintenance plans. Unique access to global operational data gives WEDGE an exceptional position in the market;



3. SEA-TITAN network. Final users will take advantage of a standard and crosscutting technology.

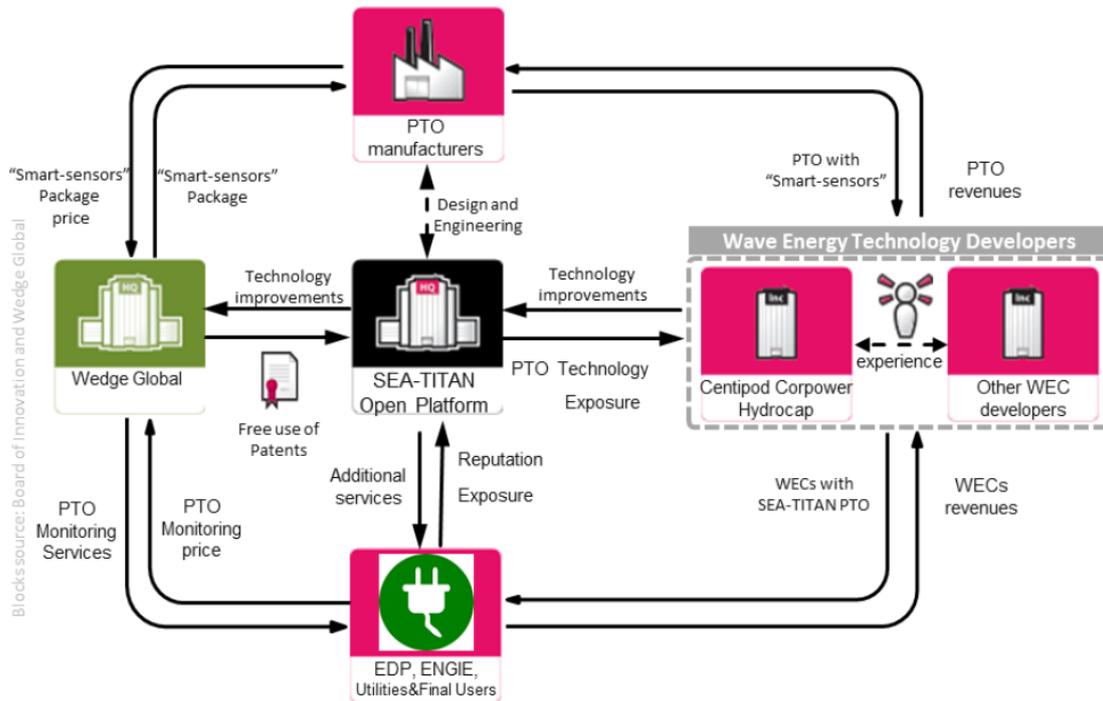


Figure 2 - SEA-TITAN business plan

Open source and crosscutting are the characteristics that will define SEA-TITAN business model. We believe that SEA-TITAN consortium members, other companies making wave energy technology, and the European Union would all benefit from a common, rapidly-evolving technology platform.

Exploitation of results:

After SEA-TITAN finalization, the partners in the Consortium are committed to follow-up the further development and demonstration stages. The following points summarize how the partners plan to exploit the project results:

1. Pursue commercial demonstration and first arrays with project developers. Widen the commercial scope to a substantially larger range of users. Preparing commercial pipeline with wave energy technology ready-to-compete on RE market;
2. Provide the laboratory as testing area for PTO validation in national and other international research projects;
3. Use the developed POM analysis tool to model other types of WECs, fostering these unique;
4. Capacities to participate in further research international projects;
5. Jointly with other technology developers, get access to SEA-TITAN Platform to enhanced;
6. Technology development and accelerate market deployment. Evaluate economically the possibility to integrate SEA-TITAN solutions in their WECs;



7. Access to a new and emerging market, ocean energy, to diversify products, customers and project pipeline. Moreover, access to the industrial market of the switched reluctance machines;
8. Develop of a cutting-edge technology to advance TRLs and utilize results in research activities related to superconducting electric machines;
9. Access to a new and emerging market, ocean energy, to diversify products, customers and project pipeline;
10. Promote the integration of the WEC technology developers participating in SEA-TITAN as electricity producer in the electric market;
11. Use the benefits of standardization to increase the exploitation possibilities of the rest of the partners or other entities interested in standardization.

4. Partner’s Exploitation

The consortium is composed by a multidisciplinary set of companies, including manufacturers, promoters, engineering companies and public institutes. This provides the project with complementary sets of skills that increase the joint competence of the consortium.

The following provides insight on how each of the consortium partners envisages their role in the future exploitation of the results of project SEA-TITAN. Depending on each company’s core areas and expertise, each partner foresees clear future benefits for their business as a result of the successful completion of the SEA-TITAN project.

WEDGE GLOBAL S.L.

WEDGE is Wedge Global S.L. is a mid-stage stat-up technology based company in the new offshore renewal industry, whose objective is to become a global leader in the provision of integrated turnkey solutions for the generation of electricity from ocean waves.

Table 1 – WEDGE exploitation plan

Deliverable	Possible Impact					Comments
	Service	Product	Publications	Patent	Consulting	
MS4	x		x	x		A detail design of the PTO, including AMSRM, power electronics and control platform could provide WEDGE with a new product ready to install in many WEC topologies, widening the market share, also, the novelty contained within of this kind of technology let us think in patentability and publications of scientific interest.
MS5		x				Fabrication and FAT of the AMSRM complete prototype. A new device will be built, as so, this could be potentially used in future projects for additional verification process, also, it can be provided to potential



						final users for internal testing so they gain trust in the technology.
MS7		x	x			Development of the experimental tests and update of the PTO model. As a continuation of the MS5, MS7 will provide us with scientific results of the prototype, potentially these data can be used for publications, which at the same time, will give the technology trustworthiness
MS8			x	x		Conceptual design of a complete PTO based on a superconducting linear generator. While MS8 will potentially provide us with a new product/service for the final user we don't expect the TRL to be high enough to consider that application. Instead, we consider MS8 as a starting point to create a detailed SLG design in future projects, also, the results obtained in this process could be enough to think about patentability and/or scientific publications
D3.3		x				Power electronics design. As part of the MS4 we will have this new product which is good to have on its own. Power electronics is a key component in any WEC device, as so, this design could have potential market applications or transversal applications in future R&D projects with the W1 technology.
D3.5		x				Control platform design. As part of the MS4 we will have this new product which is good to have on its own. Control is a key part regarding energy absorption, a good control design is the difference between the success or the failure of a WEC technology. As so, we expect to obtain a good enough control system from this deliverable to be applied to any WEC and be easily adaptable, being a new product ready to deliver.

CIEMAT

The *Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT)* is a public research body assigned to the Spanish Ministry of Economy, Industry and Competitiveness under the Secretariat of State for Research, Development and Innovation, focusing on energy and environment and the technologies related to them. It has offices in



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several different regions of Spain, and its activity is structured around projects which form a bridge between R&D&I and social interest goals.

Table 2 - CIEMAT exploitation plan

Task	Possible Impact					Comments
	Service	Product	Publications	Patent	Consulting	
WP3/3.1	x					Increase the capability for complete designing of electric machines.
WP3/3.5		x				Development of a n industrial digital control platform to be adapted to advanced power electronic converters
WP5	x					Increase of its scientific capabilities by improving the PTO testing facility, providing the laboratory as testing area for PTO validation in national and international research projects.
WP7/7.1			x			Development of scientific publications. Journal papers in Energy, Applied Energy and IEEE Transactions on Magnetics. Also participation in international conferences: International Conference on Ocean Energy (ICOE), European Wave and Tidal Energy Conference (EWTEC) and European Power Electronics and Applications (EPE).
WP7/7.2				x		Development of a patent based on the new concept of PTO

WavEC Offshore Renewables (WAVEC)

WavEC Offshore Renewables is a private non-profit association created in 2003 and is one of the leading R&D centres in wave energy technologies. WavEC is devoted to the development and promotion of offshore energy utilization thorough technical and strategic support to companies and public bodies. Use the developed POM analysis tool to model other types of WECs, fostering

these unique capacities to participate in further research international projects.

Table 3 – WaVEC exploitation plan



CORPOWER/CENTIPOD/HYDROCAP AND ALSO WEDGE (WEC developers)

CorPower Ocean is a leading wave energy developer with broad backing across Europe. The

Task	Possible Impact					Comments
	Service	Product	Publications	Patent	Consulting	
T2.1		x	x		x	After the validation of the analytic tool (POM) it will be used to extend the services portfolio of WavEC. The use/application of this numerical tool along with the acquire knowledge will be crucial to the development of other future projects and thus it will contribute significantly to increase the consultancy capacity of WavEC. In this context the POM tool can be seen as a new product. A paper on the POM implementation and validation process will be published and presented in a relevant conference.
T2.2	x				x	The POM parametrization to specific requirements of WEC technologies will be a new WavEC service (in the framework of the development of other point absorbers WEC). Therefore, this new service will contribute to extend the consulting capacity of WavEC.
T2.3	x		x		x	The computation of the average energy capture (by using the POM tool), the optimization procedure that maximize kWh/kN and the definition of PTO rated force and PTO efficiency will be, eventually, new services in the WavEC services portfolio. The results related to the evaluation of the PTO force capability in the annual energy capture will be published and presented in a relevant conference in the wave energy field.
T2.4			x		x	The acquire knowledge from the analysis and evaluation of the PTO improvements will be the foundation of new services on the adequacy of the SRLG to other point absorber concepts. The lessons learned in this optimization process will be published in a scientific paper to be presented in a relevant conference in the field of wave energy.

company brings a new class of high efficiency Wave Energy Converters, representing a breakthrough in electricity harvesting from ocean waves.

Table 4 - WEC developers exploitation plan (Corpower/Centipod/Hydrocap & Wedge)

WP	Possible Impact					Comments
	Service	Product	Publications	Patent	Consulting	
WP2					x	Develop processes and acquire knowledge for future projects. Task:



						Providing the geometry and the force characteristics of the Corpower WEC. Defining the economic, dimensional and operational restrictions.
WP5					x	<u>Develop processes and acquire knowledge for future projects.</u> Task: Providing the Corpower WEC control strategy in the appropriate format.
WP7					x	<u>Consult on risk assessment in another project.</u> Task: Contribute to dissemination and communication plan definition and their activities

CENTIPOD Ltd

Centipod Ltd. is a Wave Energy Converter (WEC) technology developer advancing a design for unique WEC with a topology that amortizes the costs of infrastructure and moorings while employing an industry-pioneering advanced control system. The principals of the company have a 30-year record of technology development execution, commercialization and manufacturing in the renewable energy sector.

Table 5 - Centipod exploitation plan

WP	Possible Impact					Comments
	Service	Product	Publications	Patent	Consulting	
WP2		x				Jointly with other technology developers, get access to SEA-TITAN Platform to enhance technology development and accelerate market deployment of our WEC.

OCEM

OCEM Energy Technology is an Italian company founded in 1943. During the years OCEM has focused its activities on power electronics for scientific research, with a flexible customer-oriented approach. The main commitment is in the field of Plasma physics, Particle accelerators, industrial applications, Medical particle therapy, Superconductivity, Radio Frequency Systems, Transportation and Food processing.

Table 6 – OCEM exploitation plan

Deliverable	Possible Impact					Comments
	Service	Product	Publications	Patent	Consulting	
D3.3		X	x			Power electronics design. (confidential)The design of the power converter could allow OCEM to gain experience on generator/motor drives and to



						complete its range of products also with solutions for energy exploitation from motional prime source.
D3.4	x	x	x		x	PTO complete model (confidential)Experience on integration of electrical simulation model with the power electronic part and control part is a key asset of OCEM design workflow which is compliant with the Model Based Design (MDB) process. The set-up and validation of PTO complete model, considered under the MBD process perspective, is an occasion for OCEM to gain experience also with the integration on electromechanical systems with moving parts and therefore with mechanical quantities and variables.MDB is also a powerful tool for troubleshooting on-field products, thus also the customer service capability of OCEM will be improved when and if products with electromechanical parts will be delivered to the market.
D4.3		x	x			AMSRM power electronic. (Public)Construction and validation of AMSRM power converter enables OCEM to exploit its power electronics experience and skills in a potential new application area.
D5.3	x		x		x	PTO prototype testing results - OCEM contribution (Public)Testing result will be compared with the simulation to verify how accurate and predictive is the model of the system. Testing results validation with the model is one of the key procedure of the MDB process. Experience in this process can be exploited with the publications of results and with service or consulting activities to customers.
D6.3		x	x	x	x	Conceptual design o the SSRM Power Electronic Converter. (confidential)Design of a power converter suitable for



						superconducting machine is not a trivial exercise. The results can be exploited also in similar applications where fast and precise dynamic control of intense magnetic fields is required.
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COLUMBUS

Columbus Superconductors S.p.A. was founded in Genoa in 2003. This company focused on the R&D and commercialization of new superconducting materials like MgB₂. Columbus was born as a joint venture between ASG Superconductors S.p.A., a renowned superconducting magnet manufacturing company, and CNR/INFM, a leading Italian public research institute on materials science with know-how and IPR on superconducting wire development.

Develop of a cutting edge technology to advance TRLs and utilize results in research activities related to superconducting electric machines.

Deliverable	Possible Impact					Comments (mandatory)
	Service	Product	Publications	Patent	Consulting	
D6.1		x	x	x	x	Develop a new design of a superconducting machine, acquire knowledge for future projects. Reinforce our own patent process and produce new ones.
D6.2	x	x	x		x	Develop processes and new products, acquire knowledge for future projects.

ENGIE FABRICOM

ENGIE Fabricom is the benchmark in the field of innovative multi-technical installations and services for the infrastructure, buildings, industry, as well as the Energy and Oil & Gas markets.

Fabricom is the biggest electromechanical contractor in Belgium, having a total personnel resource base of +- 5500 people spread along 17 different office and warehouse sites.

Access to a new and emerging market, ocean energy, to diversify products, customers and project pipeline.

Table 7 - ENGIE Fabricom exploitation plan

WP	Possible Impact					Comments
	Service	Product	Publications	Patent	Consulting	
WP2 - Detailed model	x				x	Assessment & scaling of a AMSRM PTO technology for use in a new wave energy convertor (generic approach, to be used as tool for an electromechanical contractor (Engie Fabricom) towards a main



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						external developer or as overall project developer (Engie).
WP3 - Detailed design	x				x	Recuperation of the used design methodologies & tools towards other wave energy, renewable energy or overall drive train projects (as electromechanical contractor).
WP4 - Fabrication & set to work	x	x				Reference as PTO constructor with added value for dry commissioning of complex PTO installations.
WP7 - dissemination	x				x	Use of the consolidated results and conclusions towards future overall performance / AEP / LCOE / O&M assessment(s). Future consultancy services to be set up through Engie Laborelec (as Engie's central competence center).

EDP Centre for New Energy Technologies (EDPCNET)

EDP Centre for New Energy Technologies (EDP CNET) is a subsidiary of the EDP Group and has the mission of creating value through collaborative R&D in the energy sector. It is fully committed to research and development with a strong focus in technology demonstration projects. EDP CNET was the result of an internal reorganization process, centralizing the Group's R&D activities in a newly created center, established within EDP Group's laboratorial facilities and creating EDP's technical excellence center of R&D in the EDP Group.

Table 8 - EDP CNET exploitation plan

Task	Possible Impact					Comments
	Service	Product	Publications	Patent	Consulting	
T7.2					x	Encompassing benchmark, with the analysis of the potential competitors for the technology and assessment of the competitiveness of the proposed solution, which will be internally divulged in the EDP Group;



T7.2					x	Creation of a business case for the PTO, identifying market opportunities, quantified value proposition, possible business models and up-scaling strategies;
T5.5					x	Analysis of the laboratory results, evaluating the technology benefits and advantages.

UNE

The Spanish Association for Standardization (UNE) is a non-profit-making, private, independent and multisectoral organization, recognized at National, European and International level. Through the development of technical standards helps improve the quality and competitiveness of companies, products and services.

As standardization body, UNE is the national representative and member of the European (CEN/CENELEC), International (ISO/IEC) and Pan-American (COPANT) Standards Organizations, and member of the European Telecommunications Standards Institute (ETSI).

UNE wants to use the benefits of standardization to increase the exploitation possibilities of the rest of the partners or other entities interested in standardization.

5. Technology Roadmap

The exploitation of the project’s results is a continuous task that starts along with the project but surpasses the end of it until the partners involved agree that no further action can be taken with the data or experiences gathered in the project scope. Nevertheless, the scope of the exploitation changes across the project as it starts as gathering of knowledge that can act as corrective measures for the project itself and evolves towards future utilizations of the created value and its communication to the broader R&D Community and Investors.

To objectively comply with these differences, three different phases of exploitation will be created, as depicted in Figure 3.

M01

M18

M36

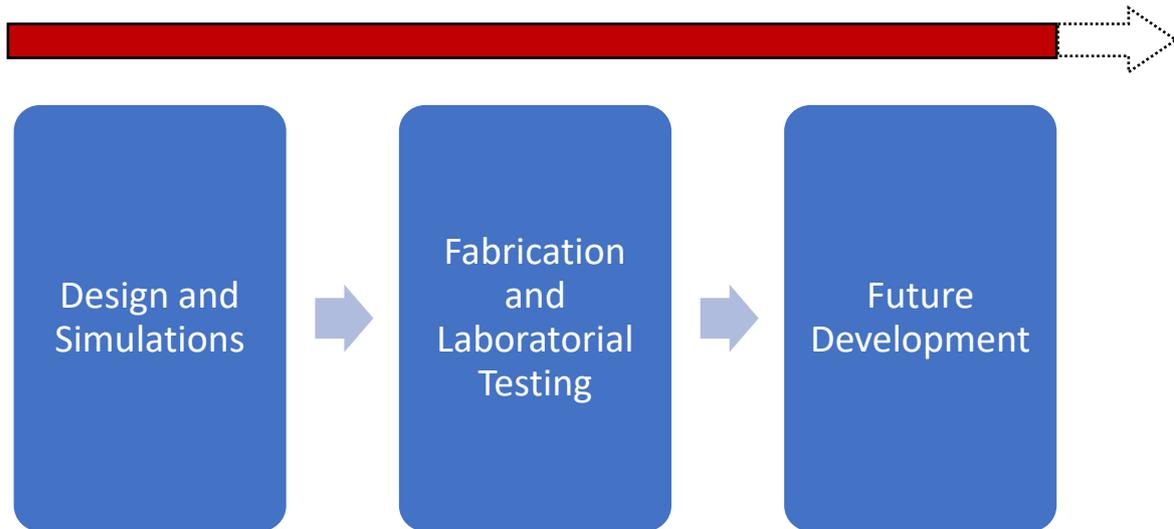


Figure 3 – Phases of the SEA-TITAN Exploitation Activities

5.1 Design and Simulations Phase

The first period of the project is mainly devoted to simulation studies performed mainly by WEDGE on WP2, where the goal is to specify a PTO modular unit that could be used in different WEC technologies. For that purpose, in the simulation scenarios will be considered 4 different WEC technologies and two sea locations, per technology. The results will help finding the needed PTO characteristics for each WEC technology and defining a PTO basic modular unit. The results will be discussed internally and they will serve as a valuable input for the designing phase, which is defined on WP3.

The simulations will be followed by the design of the new PTO, a complete Azimuthal Multitranslator Switched Reluctance Machine (AMSRM), its associated power electronic converter (PEC) and control platform. The power electronic converter requirements need to be defined to permit the AMSRM developing the peak force requirements from the WP2. The exchange of experience and requirements from the WEC developers is essential to design SEA-TITAN as modular as possible, according to the open source business model.

Given that the direct result of this first phase of the project will not have a significant amount of tangible results, the exploitation activities of this phase will be mainly internal. Nevertheless, it is the consortium intent to start issuing information to the broader community by publishing scientific publications related to the methodologies and studies executed. The results encountered in the studies can also be used in the future to develop more tangible specifications, standards and policies related to the innovative aspects of the project, namely the design and construction of modular PTOs adaptable to different WEC technologies, that could boost the development of the wave energy industry.

5.2 Fabrication and Laboratorial Testing Phase

The second phase of the Exploitation Plan will be the one yielding the majority of the results that can later be presented to investors and R&D community in the Future Development phase. The



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activities to be developed during this phase will focus on two main objectives: Fabrication of a prototype and its Laboratorial testing.

The fabrication process (WP 4) will involve the following activities: fabrication and Factory Acceptance Tests (FAT of the AMSRM and the associated PEC); development, fabrication, validation and test of a Low Level Control (LLC) platform adequate to the PTO (AMSRM + PEC) and implementation of the programming codes in this control platform.

The fabrication process will be followed by the laboratory testing of the novel PTO prototype in CIEMAT facilities. The test will lead to characterize and validate the performance and feasibility of the PTO solution proposed as well as getting real information about: force limits, efficiency map, thermal behaviour and mechanical vibrations, in order to complete the WEC model, including the PTO. By using an external hydraulic actuator and connecting the PTO prototype to the electric grid, a set of tests will be carried out to firstly characterize the PTO properly and to secondly test the system in relevant environment, under the sea conditions defined in WP2 and using the control strategies from each WEC technology.

The investors and the wave industry need to perceive SEA-TITAN technology as feasible in order to scale up its use to a higher than TRL 5. Consequently, an analysis on the performance of the prototype in the terms of performance and peak force is essential to demonstrate the real potential of the technology. The consortium's intent is that this evaluation provides three main results:

- Evolution of TRL of SEA-TITAN from 3 to 5 as result of proof of concept in a laboratory environment;
- Validation of the requirements Evaluation of the real energy harvesting increase as a function of PTO force and efficiency, giving the impact of the PTO improvements on the global Levelised Cost of Energy (LCOE) for each WEC technology;
- Identification of development areas of SEA-TITAN and future actions to maximise the technology potential.

Since the exploitation of results is a continuous task, this validation will feedback on the procedures, standards and policies thought on the design phase in order to improve, and optimize the SEA-TITAN technology. At the end of this phase, there will be events that will also be a first contact point with the wider industry opinion on the methodology of the project and its first findings.

The general objective of the workshops will be to promote open discussions on experiences, data and tools, as well as policy and other framework conditions in order to obtain relevant information of the adequate conditions and pathways needed for the research development and implementation of the considered technology. The workshops will be aimed not only at dissemination purposes (related to the results of the project) but also at communication purpose for the project itself.

Networking activities will be organized involving researchers working on projects related to the same topic of wave energy conversion. The collaboration will be aimed at **maximizing the distribution of the advantageous results of the proposed solution developed in SEA-TITAN**. Moreover, the feedback from other projects will be beneficial for the identification of PTO



necessities from different wave energy converters as well as detecting restrictions in the PTO performance. Market conditions will be also assessed in order to adapt the developed product accordingly, increasing the expected impacts and taking advantage of SEA-TITAN project results.

Similarly, feedback will be obtained from the members of the **External Industrial Exploitation Board (EIEB)**, during the two meetings programmed in M15 and M33. They will have a **multiplicative effect in the dissemination** since the selected institutions for this Board have important connections with industrial manufacturers, technology developers and electric utilities.

5.3 Future Development Phase

This phase will include the work done on WP6 where SEA-TITAN will explore, as long-term strategy, a complementary solution of a superconducting PTO, as a continuation of the AMSRM development and at a conceptual design level. This alternative will allow to increase considerably the current capacity of the generator coils (no Joule losses) and therefore the force capacity, achieving an important increase of the annual energy capture.

In addition to the above mentioned and with all the results from WP2 and WP5, the consortium will start to look to the future of SEA-TITAN. The project was thought through from the beginning looking at its future implementation, as it can be perceived by the joint collaboration between all the partners, in which are included 4 WEC developers. The previous phases of the Exploitation Plan will get together in this final one to collectively provide a solid case for SEA-TITAN future development, having in account the main keys that are present throughout the following phases:

- Evaluation of the real energy harvesting increase as a function of PTO force and efficiency, giving the impact of the PTO improvements on the global Levelised Cost of Energy (LCOE) for each WEC technology
- Complete WEC modelling, including: force limits, efficiency map, thermal behavior and mechanical vibrations.
- Optimization of the machine topology and parameters such as the number of phases and poles, the coil aspect ratio, pole depth, etc
- Superconducting wire optimization (AC losses) and comparison with refrigeration power.

In order to comply with the key drivers presented above, there will be a strong consortium effort on this last phase to prove not only the technology feasibility (which is already proven by the demonstrator) but its reliability for a large-scale prototype.

After all technical data is gathered and processed, the exploitation of the results will move to a more strategic communication with the wider public, targeting as well future investors that might see SEA-TITAN project as a first step to the future of commercial wave technology. Having in mind the important aspect of communicating directly to future investors, there will be at least 3 direct points of contact with them:

- B2B events (Workshops)



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There are 3 workshops already programmed with B2B events for SEA-TITAN project at months 15 (Portugal), 25 (Rome), and 33 (Madrid), these workshops will show the most relevant results of the project at that given moment while also bringing the opportunity to the main stakeholders and partners in this sector (namely investors, finance, industry and academia) to share comments and ideas about what SEA-TITAN is developing.

- SEA-TITAN website

As part of the communication plan a new website is about to be created at the time of writing this document. This new webpage will serve 2 main purposes: information and interaction. In this webpage will be allocated one of the document repositories of all the public information about SEA-TITAN, but will also feature a way of direct contact from relevant stakeholders to the consortium.

- Exhibition report

Final event of the project in which the main findings will be presented to both stakeholders and the EC in order to define future actions regarding the future development of the technology.

6. Conclusions

This Exploitation Plan provides insight as how the results of the project SEA-TITAN are to be used, by which partner, under what context and at what moment throughout the duration of the project and from then on. The scope of the exploitation covers not only technological aspects but has considerable part of its scope on aspects of possible future industrialization & commercialization.