Review of Public and Private Sector Investments in Offshore Renewable Energy

North Sea Solutions for Innovation in Corrosion for Energy

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The NeSSIE project (2017-2019) seeks to deliver new business and investment opportunities in corrosion solutions and new materials for offshore energy installations. The project aims to draw on North Sea regional expertise in traditional offshore sectors (i.e. oil and gas, shipbuilding) in order to develop solutions for emerging opportunities in offshore renewable energy sources (wave, tidal and offshore wind energy).

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1 Abbreviations and Acronyms

ADMA:	Advanced Manufacturing for Energy Related Applications in Harsh Environments
CAPEX	Capital expenditure
DP	Demonstration Project
LCoE	Levelized Cost of Energy
O&G	Oil and Gas
O&M	Operations and Maintenance
OE	Ocean Energies (wave and tidal energy)
OEM	Original equipment manufacturers
OPEX	Operational expenditure
ORE	Offshore renewable Energies
OWE	Offshore Wind Energy
OWF	Offshore wind farm
OWT	Offshore Wind Turbine
R&D	Research and Development
R&D&I	Research and Development and Innovation
SME	Small to Medium Enterprise
TE	Tidal energy
TRL	Technology readiness levels
VC	Value Chains
WE	Wave energy
WP	Work Package

2 Executive Summary

The value of investments in Renewable Energy (RE) technologies has increased rapidly over the last decade as a result of political pressure to reduce carbon dioxide emissions and the policy incentives to increase the share of RE in the energy mix. Demonstration Projects (DPs) are a phase of the innovation process in which several actors jointly test a given technology for many purposes such as to accelerate its introduction into a (new) market, to illustrate that the technology is up scalable or to test how it works in field conditions. Hence, DPs are a crucial tool for companies to facilitate learning and reduce risk associated with innovation. DPs are too a tangible way of demonstrating the utility of a technology to potential users, investors and a vital instrument for policy makers to direct and encourage the sustainable development.

The aim of this report is to support the optimal design of the NeSSIE DPs through showing and discussing some best-practices in the design process of DPs. Such an aim is reached combining a state of the art with an experienced-based study on DPs exploiting the NeSSIE partnership experience in this field. This document (deliverable D2.4) starts with a state-of-art study of the scientific literature on DPs within the renewable energy sector. This is followed by the description of the main funding opportunities for DPs. This document will then present some examples of DPs within offshore energies in the partners regions already ongoing or in development and will try to give some advices for the NeSSIE DPs design.

3 Introduction

This report is aimed at supporting the NeSSIE DPs design phase. To do so, it will highlight the importance of demonstration projects (DPs) in the renewable energy innovation process through analysing the scientific literature and some examples of DPs within the renewable energy sector and describing the main funding opportunities for DPs.

The NeSSIE project is aimed at promoting and supporting the development of collaborative demonstration projects (DPs), through the establishment of strategic cross-sectoral public-private partnerships in the North Sea basin.

NeSSIE will:

1) Promote collaborative projects and establish strategic cross-sectoral public-private partnerships in the North Sea basin, starting from previous work undertaken within the Vanguard Initiative Pilot in Advanced Manufacturing for Energy Related Applications in Harsh Environments (ADMA Energy). Such partnerships will be aimed at increasing the know-how on the reliability of the offshore structures; a key engineering challenge in the offshore sectors, as well as delivering new business and investment opportunities in the Offshore renewable energy sector.
2) Develop a roadmap and three investment plans for the delivery of three bankable, investment-ready demonstration projects in the North Sea. These projects will test corrosion solutions and new materials for use in the wave, tidal and offshore wind energy sectors.

To support the optimal “strategic” design of the NeSSIE demonstration Projects this report:

a) Analyses the previous experiences of demonstration projects within the discovery and development of new technologies in the renewable energy sector through a state-of-art study of the scientific literature.
b) Analyses the different funding opportunities for demonstration projects (a detailed study on this issue will be performed in NeSSIE Report 3.1).
c) Analyses examples of demonstration projects within offshore energies in the partners regions

already ongoing or in development.

d) Discusses the fundraising process adopted in DPs development.

As illustrated in Figure 1, Deliverable 2.4 fits into the overall NeSSIE WP2/WP3 scheme; providing the different criteria which are to be adopted when designing offshore demonstration activity to be developed during NeSSIE. This knowledge will be useful in supporting the NeSSIE demonstration project definition process and further actions to finance the resulting projects.

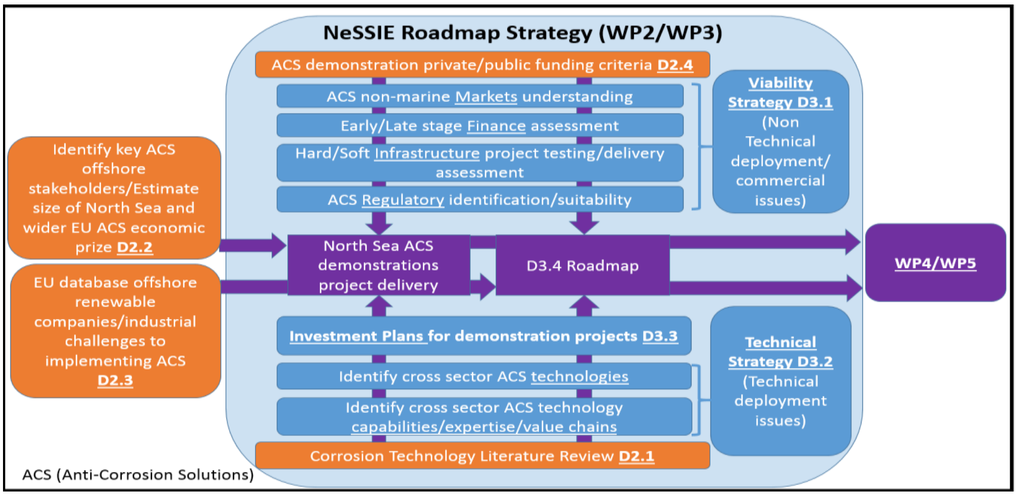


Figure 1 – D2.4 position in the wider WP2/WP3 NeSSIE project (UEDIN, Laurie 2017)

3.1 Definitions

The technical concepts discussed in this report are defined as follows:

Demonstration Project (DP): Many definitions of a Demonstration Project (DP) exist, but a common feature is that a DP is a phase of the innovation process in which several actors jointly-test a given technology to accelerate its application to a (new) market; providing practical proof of its technical, economic, social and environmental feasibility [1].

Hence, a DP is a tangible way of demonstrating the utility of a technology to potential users, investors, regulators and others, not all of whom are fully knowledgeable in the field, but whose support is essential to the adoption process of the technology. DPs have an "experimental" and a "diffusion" aim and can be categorised by:

- Experimental projects for "testing the workability of an innovation under operational conditions": the term may be used to describe a test undertaken by technology owners primarily to demonstrate whether a development, which may have been proven under laboratory conditions, is workable at adequate scale in the operational environment. To the technology owner, a failure which leads to improved design is a positive result. To the extent that its outcome is known to be uncertain, and its primary purpose is to resolve or confirm a result, such a demonstration is an experiment.
- Exemplary projects to demonstrate the utility of innovation to potential adopters: the term is linked with the communication of the innovation also to citizens and policy makers [2]. In fact, DPs can force the political/social process to remove institutional/social barriers standing in the way of an innovation and promote/align the discussion/development of policies aimed at enhancing the innovation path to the market [3].

Funding / Fundraising / Financing: The financial development process by which organisations gather funds from private (e.g. individuals, corporations, foundations, various finance focussed organizations, etc..) and government sources for their operation, projects and services [4].

3.2 Literature study on Demonstration Projects for Sustainable Energy

Innovation is the complex process which brings an idea to the market [5]. Innovation is a complex, non-linear process made up of many steps [6] involving feedback and feed-forward loops [7] and depends upon a multitude of internal and external aspects [8]. A clear demarcation into further innovation phases is therefore not always feasible, although during the innovation process the minimum following "proving" criteria need to be satisfied:

i) Technical: To see how well the technology works in a realistic but controlled environment, such as in a laboratory, test centre or field site (most probably without user involvement).
ii) Economic: To understand the costs of installing and operating a complete technology system in the field, (including experimenting with different designs, components or technologies).
iii) Commercial: To test market acceptability in a specific setting through an end-user or operator running one or more installations for some time, normally with significant public exposure [9].

Such "proving" criteria are also studied during the DP phase. DPs play important roles in the innovation process, representing the bridges between basic knowledge generation and technological breakthroughs on the one hand, and industrial application and commercial adoption on the other [10]. In fact, in DPs, users and support systems interact with prototypes or emergent products to test the performance of the technology in different operational environments and refine commercial offering, because technologies cannot become cost-efficient through laboratory R&D alone [11]. DPs have multiple objectives, from evaluating the functionality of innovation under field operating conditions to reduce the risks (not only technical riskss, but also uncertainties regarding market demand, public attitudes, and legal rules) before promoting it to potential adopters in exemplary demonstrations. However, the final objective of DPs is the learning process necessary to bring a technology closer to market.

It is possible to distinguish the learning process during the DP phase in: learning-by-searching (e.g. basic R&D resulting in formalised knowledge), learning-by-doing (e.g. tacit knowledge acquired during manufacturing), learning-by-using (e.g. know-how acquired in the use of technology), and learning-by-interacting (e.g. know-how acquired in interaction between users and producers) [10].
DPs should be purposefully used to create alliances among actors along future value chains which have the capacity to develop new technology as well as different organisational solutions which influence the political landscape of the technology. Although successful actor networks are key to developing new technological regimes, the challenges involved in governing these networks must equally be recognised. The policy network literature suggests that actor diversity is key. Networks composed of a heterogeneous set of actors may often be more successful in securing necessary resources (e.g., competence and public support) and sustaining the network's innovative capacity [11].
Government intervention in the energy sector has in the past been driven by economic, welfare and security issues. However, the need to manage climate change has changed the emphasis to environmental issues. Therefore, designing effective policies to promote innovation and diffusion of the next generation of energy technologies is nowadays extremely pressing.

DPs in sustainable energy can often be the setting in which authorities cooperate with academia and commercial firms to further test, understand and improve new sustainable energy technologies before they grow large and can be commercially exploited [12].

As participants in sustainable energy demonstration projects, producers, suppliers and end-users develop crucial knowledge and experience. By putting what they have learnt into practice, they serve as role models for others to follow [13]. DPs, in tandem with other activities, should aim at supporting a new energy technology to the point where it is self-sustaining and market forces take over.

Clearly, this means evaluating DPs in their wider historical context, especially considering accompanying market creation measures (such as incentives and subsidies), which are likely to predominate in the 'take off' phase of market formation [14, 15]. Governments have funded projects to demonstrate important innovations ever since the US Congress appropriated $30,000 in 1834 to demonstrate Samuel Morse's telegraph system [16]. The first examples of the demonstration concept within publicly-funded energy systems have their origins in the USA's social programs of the mid-1950s, where they were initially employed for technology demonstration by the Department of Defense (DOD) in the early 1960s. In that period DOD started sponsoring engineering prototype power plants called "demonstrator engines".

The objective of such demonstrators was to remove technical, economic, and social uncertainties – thereby accelerating the practical application of R&D results. After the first DPs in the USA, in the past decades many studies on DPs in sustainable energy have been conducted and published [10,17]. The increasing attention of the academic researchers towards DPs in sustainable energy development is confirmed by the fact that since the first paper was published in 1976 [9], more than 200 papers have been published on DPs (of which more than 50 are from the last two years) and data from the IEA/OECD database collection on R&D indicators shows increased governmental expenditures on the DP phase [11]. These studies mainly focused on DP definitions, practical (e.g. market) as well theoretical characteristics, and classified DPs as per their basic organisational characteristics and learning effects [17]. As is possible to observe in Table 1, DPs can be categorised based on their main characteristics (aim, organizational form, learning effect and location).

Means of categorization	Types	Source
Specific aim	a) Prototyping demonstration projects: To develop new prototypes and turn/improve prototypes into viable product version. b) Organizing demonstration projects: To develop a production organisation capable of producing large(r) quantities or larger-scale of the prototypes-turned-into-products. c) Market demonstration projects: To find and explore (a) market(s) for the new prototype-based products.	[17]
Organizational form	a) Cooperating private organisations: This organisational form is absent in the DP literature. This might be due to those private firms' fully-funding DP ambition to retain the results without publication. DPs may generate knowledge spillovers which benefit other firms at the expense of those involved in the projects. Even though this may be beneficial to society at large, it may delimit the incentives for firms to contribute to the development of the projects [18]. b) Cooperating public organisations: Mostly in case of fundamental research. c) Cooperating public and private organisations: This organisational form develops thanks to public grants and has three principal types of participant: a) Public universities and RTOs which develop knowledge, competence and prototypes in sustainable energy, b) Private firms which turn prototypes into products in (protected) market settings, c) Public organisations which provide funding to cover (some of) the costs and efforts made by public and private organisations.	[17]

Learning effects	a) Technical: Enable scientists and technicians to learn how to technically develop sustainable energy prototypes. b) Organisational: Enable actors to cooperatively-organise the sequential improvement and commercialisation process of new prototypes in sustainable energy (e.g. deciding which organisations and investors to involve, how to lower costs and balance cost/reward ratios for all participants, which technical standards to apply). The sequential improvement is a reason why DPs frequently last several years and should have an international, global character to accelerate p the technical as well as social learning processes, and large-scale diffusion and adoption of sustainable energy technologies. c) Policy: Teach policy officers how to develop public energy policy (regulation and legislation) which stimulates the development, production and commercial exploitation of prototypes-turned-into-products in sustainable energy. d) Market: Provide experience to commercial professionals to bring sustainable energy prototype-based products to the market. DPs are "protected" spaces in business and society where niche markets can be created and build socio-technical innovation scenarios for sustainable energy exploitation on the market (create a positive public opinion about the new sustainable energy technologies).	[10]
Locations	Laboratory: With public universities and public research centres as the leading organizations. Real world site: With private firm leading supported by public researchers because firms want to improve/test and then commercialize the product. Market place: In case of a market DP this is located where the marketing dept. of the firm decide that it is the best location to show it to the market.	

Table 1 – Demonstration Projects classification (adapted from [17])

After reviewing the studies performed on DPs in sustainable energy, we summarise that:
1) The main role of DPs in sustainable energy is to provide learning opportunities. By means of participating in prototyping, organisation and market demonstration, participants learn to improve their technical, organisational, and market insight on the technological development and commercialisation aspects of sustainable energy prototypes, products and accompanying services. At the same time, they gain an understanding of the public policy content needed in support of these prototypes, products and services. It is important to categorise DPs in terms of whether they are primarily aimed at generating technical, economic, social or commercial information. Depending upon the main DP aims, necessary timing and funding are different. When considering the timing of certain types of DPs, Karlström and Sandén distinguish between DPs in different phases of the formative period of a technology's life-cycle. In the experimental phase, DPs should "be designed to maximise learning and novelty" and a variety of projects should be selected. In the take-off phase, where market growth is the aim, consumer awareness and network formation become important, and therefore DPs should support the proof of technological and financial feasibility, outreach activities and institutional embedding [18].
2) When designing the DP phase, as various commentators have argued, it is essential to involve an effective industrial system to fully-realise the benefits of DPs [9, 14]. This translates to not only fully-involving the DP industrial value chain (manufacturers, component suppliers, installers and support services providers), but also to the value chain's ability and interest in being part of the emerging industry. Besides, it is necessary to network with committed customers in the electricity utilities and with politicians willing to commit to renewable energy goals [19-21]. Therefore, the DP design phase requires a strong attention to defining the DPs:

a) Mission and vision (value proposition).

b) Team involved in the design, implementation, O&M phase.
c) Business plan (fundraising, financial sustainability, etc…).
d) Mostly important to implement a co-design and an open innovation approach during the DP overall life cycle.

In conclusion, many authors highlight the following reasons for success or failure of DPs:

a) User involvement is crucial at all stages of DPs to facilitate information and learning.
b) Government support is important because it can "influence the diffusion of innovations indirectly by indicating to potential adopters the direction of public policies and priorities" [19].
c) Project design should not be rigid to allow user input and modifications to improve effectiveness.
d) Careful planning to take account of market readiness and user participation.
e) Dissemination of results and evaluation information should be included in the project design.

3.3 Funding options for technological innovation within Offshore renewable energies

The following chapter is a summary of the main funding options for DPs development. For more information, a detailed study on the available Finance Mechanisms for funding offshore renewable energies (ORE) technology can be found within the Chapter 5 of the NeSSIE Report entitled "Non-Technological Challenges and Innovation Strategy" (http://www.nessieproject.com/library/reports-and-researches/nessie-report-non-technical-challenges-in-developing-offshore-renewable-energy-projects).

3.3.1 Funding for renewable energy technology development

The roll-out of green power has been closely associated with subsidies. The International Energy Agency (IEA) has estimated that total global fossil fuel subsidies were $325 billion in 2015, down from nearly $500 billion in 2014, but still more than double the $150 billion spent on subsidies to renewable energy [22].
As it can be seen from Figure 2 the different technological innovation/market uptake phases within the energy sector are funded through different private/government finance mechanisms.

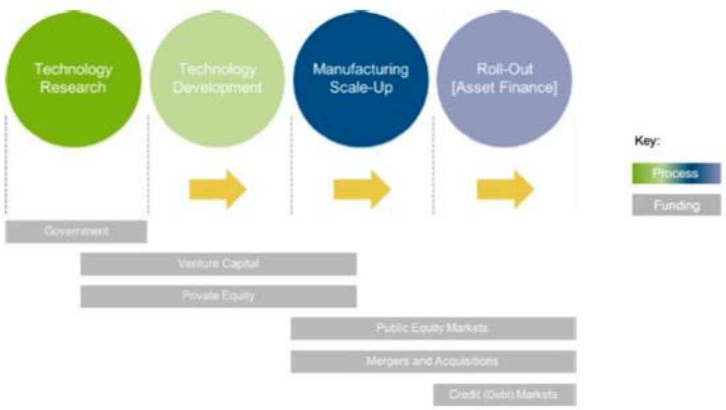


Figure 2 - Different funding mechanism for a market-uptake of a Technology [23]

Availability of finance does not appear to be a bottleneck to investment in renewables power plants in most countries. Indeed, investor hunger for what many regard as mature technologies helped to fuel record acquisition activity in the clean power sector worldwide last year, totalling $110.3 billion, up 17% [23].
However, prospects for R&D investment in renewable energy could hardly have looked better due to:

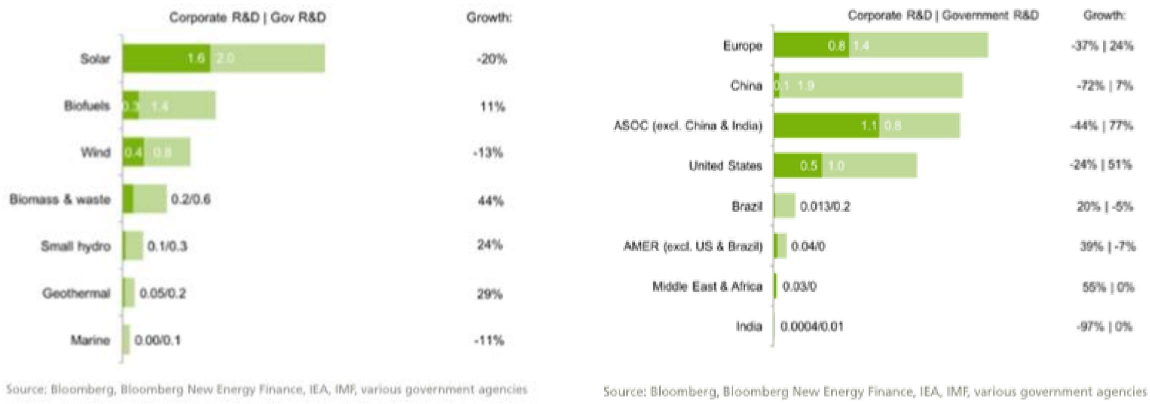
i) Almost 200 countries signed the Paris climate accord [24].
ii) The 20 of the world's richest countries committed to double their investment in clean energy R&D

within five years [25].

iii) Ample evidence that R&D works (e.g. LCOE prices for solar and wind were so low in the last years that renewable energy started not only to compete with fossil fuels, but to undercut them without subsidy in much of the world).

In 2016 the total investment in renewable energy R&D fell 7% (see Figure 3). As it can be seen from Figure 4 the main cause of this drop is the 40% fall in corporate R&D spending, while estimated government spending on renewables research increased by 25% and Europe remained the biggest regional investor in R&D (see Figure 4).

Figure 3 - R&D Investment in Renewable Energy from 2004 to 2016



a) b)

Figure 4 - Corporate and Government R&D funding in renewable energy in 2016 and growth on 2015 divided by: a) technology and b) Region

The rationale behind such increasing government R&D funding lies in the fact that in sustainable energy technology the main driver is the public good of mitigating carbon emissions from fossil fuels to avert catastrophic climate change. In the early stages of the innovation process of such technologies, capital requirements are high, protracted periods of experimentation are necessary and frequently market demand has yet to emerge. Therefore, corporate or private stakeholders find it difficult to fully engage in such experimentation due to uncertain financial/competitive returns. This government R&D funding is linked to supporting not only the technological innovation process, but also to promoting/discussing the "new" energy technology society acceptance [26,27].

3.3.2 *Funding mechanisms for Ocean Energy early stage development*

Many stakeholders fund technology development along the innovation chain, including various finance-focussed organisations (private equity, venture capital etc.), governments and corporates active in renewable energy technologies (primarily technology developers and utilities). In the past, some utilities invested in Ocean Energy (OE) R&D projects, but due to the longer-than-expected return on investment they stopped funding these projects. The industry mainly lacks the scale of capital needed to finance DPs in OE. This is mainly due to the combination of risk of failure, high costs involved in early-stage development and a long timeframe to deployment. Figure 5 shows that most finance for the OE sector currently comes from government R&D funding.

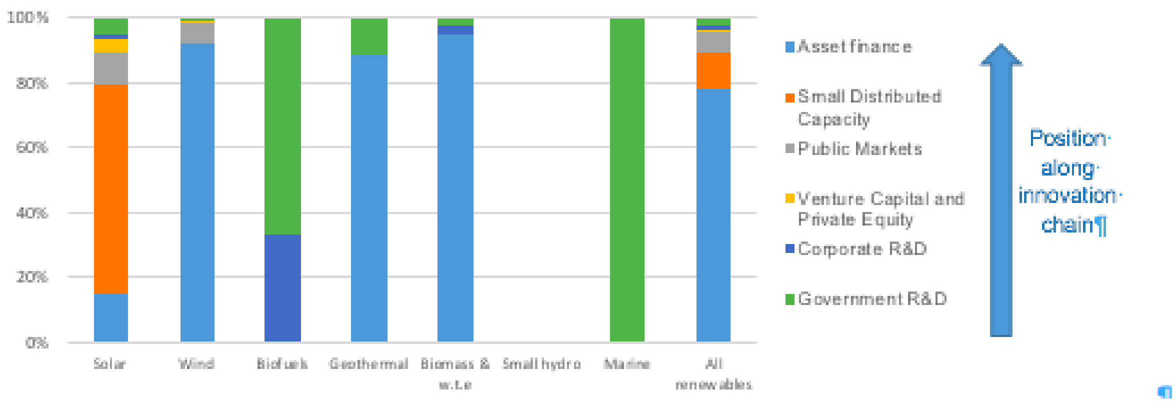


Figure 5 - Average Investment distribution breakdown for each renewable technology in 2016 [23]

Regarding government OE DP funding, many mechanisms exist at European, national and regional levels.

At the EU level the main funding mechanisms are:

i. European Structural and Investment funds (ESIF) [29]: ESIF consist of five funds, including the European Regional Development Fund (ERDF) and European Social Fund (ESF), which can provide financial products such as loans, guarantees, equity and other risk-bearing mechanisms to support economically-viable projects which promote EU policy objectives. The EU countries administer the funds on a decentralised basis through shared management and can fund many phases of the innovation process. Contained within ESIF are also the ERDF-funded European Territorial Cooperation programmes (INTERREG), which fund collaborative projects on a cross-border, regional or pan-European basis along thematic axes. An ESIF fund, the European Maritime and Fisheries Fund (EMFF) is also in the process of supporting early-stage DP activity such as in the case of the NeSSIE project. In addition to more typical ESIF funding sources, the prioritisation of regional research and innovation smart specialisation strategies (RIS3), as an *ex ante* conditionality for the implementation of 2014-2020 ESIF, has led to a Vanguard Initiative partnership on Marine Renewable Energy (MRE) being established under the European Commission's Thematic Smart Specialisation Platform on Energy, which the Commission is supporting through ERDF. More in details, the MRE thematic platform within the framework of the European Smart Specialisation Platform on Energy (S3PEnergy) is aimed at pooling regional resources and expertise in order to create new business opportunities and increased growth for the MRE sector [34]. Besides, Funding Ocean Renewable Energy through Strategic European Action (FORESEA) [30] is an 11M euro project, funded through Interreg North

West Europe, which helps to bring offshore renewable energy technologies to market by offering free access to a world-leading network of test centres.

ii. European Investment Bank (EIB) [31]: The only bank owned by and representing the interests of the European Union Member States. EIB has a wide range of products to support public and private investment in innovation such as: projects/intermediate loans, project bonds, InnovFin [32] (a platform of financing tools covering a wide range of loans, guarantees and equity-type funding, which can be tailored to innovators' needs and is either provided directly or via a financial intermediary, most usually a bank or a fund).

iii. NER 300 Initiative [33]: the world's largest funding programme for carbon capture and storage demonstration projects and innovative renewable energy technologies.

iv. Horizon 2020 programme (H2020), [28]: The largest EU Research and Innovation framework programme financing the whole innovation process. H2020 has financed approximately ten projects on OE, with an overall budget of €30M. The projects' main goals ranged from reducing the costs of technologies up to upscaling technologies from lab to DPs.
Within H2020 but at a regional level, we can cite:
I) OCEANERA-NET COFUND: an initiative of eight national and regional government agencies from six European countries. The participating countries / regions are: the Basque Country, Brittany, Ireland, Pays de la Loire, Portugal, Scotland, Spain and Sweden. The aim is to coordinate support for R&D in OE, to encourage collaborative projects that tackle some of the key challenges identified for the sector as it progresses towards commercialisation [35].
II) MANU-NET: is a specific support action to move towards a European regionally-based Research Area on manufacturing. It supports innovation-driven, close-to-market research and development projects in manufacturing. It aims at encouraging cross-border value chains that emerge from advancing technologies [36].

At a National level France, Ireland, Portugal, the North Sea basin countries (Belgium, Denmark, Germany, Netherland, Norway, Sweden and United Kingdom) have a great variety and implementation of these financial support mechanisms providing upfront capital for pilot projects deployment.

It follows a list of the regional funding sources existing in some of the NeSSIE partners regions:

<u>FUNDING SOURCES AVAILABLE FOR POTENCIAL DEMOSTRATION PROJECTS in ASTURIAS</u>

Aid/Subsidy	Object	Management Entity
Support for companies and research centers of the Principality of Asturias for the technology transfer (TT)	- Transnational TT: enhances the activities of the Galactea-Plus, Asturias Enterprise Europe Network (EEN) node, aimed at promoting the transnational TT. - Valorization of technology: finances DPs developed in a precompetitive phase that will ensure the commercial viability of the technology, as well as actions of a scientific and technological nature linked to activities implementing marketing strategies and transfer results. - International cooperation: organizes international missions to promote technological cooperation between Asturian and foreign entities.	FICYT (Fundación para el Fomento en Asturias de la Investigación Científica Aplicada y la Tecnología) [**www.ficyt.es**]
Subsidies aimed at companies developing R&D&I projects within the framework of the Innova-IDEPA (RIS3-Business Program)	The Innova-IDEPA call is an instrument to help regional industrial companies to orientate themselves to new and demanding markets thanks to technology. To this end, the program supports experimental development/innovation projects in the priority areas of the Asturias S3 subprograms.	IDEPA (Agencia de Desarrollo Económico del Principado de Asturias) [**www.idepa.es**]

Subsidies for the implementation of R&D projects	IDEAP manages competitive grants for companies carrying on regional R&D&I projects on themes of the Asturias RIS3. Projects can be individual or collaborative and can start at different TRL Level.	IDEPA
"Jovellanos" program	"Jovellanos" Program finances Asturian companies hiring university graduates or implementing temporary mobility of human resources from the private sector in other companies or in public institutions for the implementation of R&D&I projects.	FICYT
Support to Asturian companies and research centers for participation in international R&D+I programs	The purpose of the competitive grants is to encourage Asturian companies or research centers to attract external resources that complement those available in the Autonomous Community.	FICYT

FUNDING SOURCES AVAILABLE FOR POTENCIAL DEMOSTRATION PROJECTS in BASQUE COUNTRY

Aid/Subsidy	Object	Management Entity
Non-repayable grant for tests of DPs for wave energy, floating wind, offshore wind and auxiliary devices	This call is available for every legal entity that carries out its activity in the territory of the Basque Country. The actions subject to subsidy are tests in demonstration and validation phase of wave energy, floating wind, offshore wind and auxiliary devices. The economic endowment allocated to this Program amounts to € 2.5M (€ 0.5M for 2017; € 1M for 2018 and € 1M for 2019). Both individual and collective proposals can be presented. The maximum grant per project is worth €1.25M [http://www.eve.eus/CMSPages/GetFile.aspx?guid=273c7d33-6a6b-420b-8b23-d657372ea2da].	Ente Vasco de la Energía (Basque Energy Agency) [**www.eve.eus**]
HAZITEK Programme: Non-repayable grant for industrial research nd experimental development	This call is available for every legal entity that carries out its activity in the territory of the Basque Country. The eligible actions are industrial research and experimental development activities. Costs for the design phase of demonstration projects are eligible, but costs for the construction not. Budget allocation for 2017 was 68 mln€. Both individual and collective (min. 3 entities) proposals can be presented. For a project to be eligible it must have a minimum total budget of € 4M and a maximum duration of 3 years [http://www.euskadi.eus/gobierno-vasco/-/ayuda_subvencion/2017/hazitek-2017/].	SPRI Business Development Agency of the Basque Government) [**www.spri.eus**]

FUNDING SOURCES AVAILABLE FOR POTENCIAL DEMOSTRATION PROJECTS in FLANDERS

Almost all public funding sources in the Flanders region are governed by either the Research Foundation Flanders (FWO) or the agency Flanders Innovation & Entrepreneurship (VLAIO). The FWO has been appointed as a National Contact Point (NCP) within H2020. Management of the Flemish European Regional Development Fund (ERDF) is in hands of VLAIO. The following is a non-exhaustive list of the most relevant project-based funds, for projects in cooperation with industry.

Agency	Type	Description/Goal
FWO	SBO (Strategic Basic Research)	Focuses on innovative research which, if successful, will create prospects for economic applications.
VLAIO	O&O (Research&Development)	Individual R&D project by one or a group of companies. Priority goes to projects with a high risk and large potential economic impact for Flanders.
	VIS (Flemish Innovative Cooperations)	Solving specific and demand-driven challenges of a collective of companies, based on innovation. During the project, clear economic added value has to be realized for a broad target group.
	ERDF - INTERREG	Focus on a number of core theme from EU2020, of which the most relevant one is 'transition to a low carbon economy', for which international cooperation is required.

These project types must include companies in consortia. Funding levels are typically around 50%. The rest of the budget comes from company involvement (this can be 'in kind', for example with infrastructure or man hours).

3.3.3 Funding mechanisms for Offshore Wind early stage development

As wind energy technology evolves towards larger wind turbines (longer blades, taller towers and more powerful generators) cutting-edge technology developments and deployments continue to emerge. In the wind sector, the majority of project finance comes from asset finance. Among the sources of finance available between R&D and technology deployment, the most relevant ones are major corporates, governments and venture capitals. H2020 currently allocates more than 140M euros to 60 wind energy-related projects and covers, in most cases, between 70-100% of their total costs. Spain has the strongest presence, participating in more than 40 % of projects, while United Kingdom ranks in second position, accounting for 32%. Germany, the Netherlands and Denmark have a high presence in joint projects accounting for 22%, 20% and 18%, respectively [37].

3.3.4 Offshore Renewable Energies recommendations for Government DPs financing

As far as government intervention in renewable energies policies goes, the study of the literature has demonstrated two different approaches – between which the difference's being the rate of government intervention in the commercialisation phase.

The former approach states that government support is permissible only if the inhibiting market defect or "contingency hedges" can be corrected by a temporary government intervention, such as supporting early-stage innovation phases [38**]**. Through funding, governments can ensure early stage technological development and promote societal acceptance of technology, but they cannot force market acceptance.

In the second approach, governments create niche markets and must not only provide adequate incentives, but also certainty and longevity to be effective in bringing technologies through commercialisation. In this approach governments can also guard against technology lock-in through flexible regulation, as the technologies needed to manage climate change will not be widely commercialised without government policies.

Mazzuccato [39] states that government must play an aggressive role in the initiation of such DPs, but in doing so must involve private sector stakeholders from the beginning of the R&D process adopting the open innovation approach, because value is created through the interaction and mutual collaboration between people, organisations and technologies. Private stakeholders must be involved from the early stage of R&D, as they can make important market and technical inputs to the planning and management of projects.
Key to note is that early stage technical performance is not a sufficient condition for commercialisation. There are many other important factors/steps that determine the market acceptance of a new energy technology because the innovation process is complex, and the alignment of private stakeholders to Government is crucial for the overall innovation process.

4 Examples of funded demonstration projects in offshore renewable energy

4.1 Asturias

Demonstration Project Information:
Title (Acronym) / Lead Company: Hybrid steel structural laminates / composite material for application in marine renewable energies (ACERCOM) / Arcelor Mittal **Project Location:** Asturias (Spain) **Project Timing:** 24 months from 2013 to 2015 **Project Objectives / TRL / Partners:** ACERCOM aims at developing a new generation of hybrid structural materials for application in the construction of offshore wind generation and ship building to overcome the drawbacks of the use of steel. The project started at TRL 2 and finished at TRL4. The partners of the project were: Arcelor Mittal (Leader)**,** Polytechnic University of Madrid and Instituto IMDEA Materials (Partners).
Technology Challenges / Market Opportunity
What was the specific technical challenge that has been identified within the sector that will reduce costs? The development of new materials constitutes a fundamental pillar since they will allow obtaining lighter structures with more efficient designs than those currently used. **Why was it an issue? What is the impact on current technology projects?** Structural steel has traditionally been the material used for the construction of the support towers of wind turbines, both marine and terrestrial. Steel is a structural material par excellence, relatively cheap, with good mechanical performance and dominated construction techniques. However, it presents a series of drawbacks, particularly those derived from its weight, resistance to fatigue or to aggressive environments. **What impact is it expected to have on cost reduction?** The reduction of costs associated with offshore wind energy with respect to onshore wind energy was the project driving force, but due to the low TRL of the project the cost reduction was not evaluated. **What is the overall Market opportunity that has been identified?** Wind turbines are one of the most important renewable energy technology and the possibility to decrease the tower weight would have an enormous impact on the wind power plants CAPEX influencing not only the manufacturing, but also the logistics costs. Contemporary, also in the naval sector the development of a lighter material would represent a huge market opportunity.
Finance
What did the finance package for the project look like? The project cost was 637.771,66€. The project was financed through the RETOS Program by the Spanish Ministry of Economy and Competitiveness that awarded a grant of 423.717,16€.

Demonstration Project Information:
Title (Acronym) / Lead Company: Innovative Non-Destructive Corrosion Under Paint Integrated Detection System (CUPID) / Inspection Technologies Ltd **Project Location:** Asturias (Spain) **Project Timing:** 24 months from 2013 to 2015 **Project Objectives and Work Packages (WPs):** The objective of the CUPID project was the development of three integrated inspection technologies to detect corrosion under paint, at distances of up to 10 meters. The project was implemented through the following 5 WPs: WP1 Operational and system requirements, WP2 Production - version prototypes of individual detection modules, WP3 Combined control system and defect detection software development, WP4 Exploitation and Dissemination, WP5 Consortium

Management. The project partners were: SOLID OFFSHORE TECHNOLOGY AS (Norway), TECNOLOGIA Y ANALISIS DE MATERIALES SL (Spain), INRAY SOLUTIONS LTD (Bulgaria), INTERVISION GLOBAL LTD (United Kingdom), PRA TRADING LTD (United Kingdom).
Technology Challenges / Market Opportunity
What was the technical challenge? The technical challenge was Corrosion detection. As well known, Corrosion is a universal and global challenge that has an average cost to societies globally of 3-4% of GDP. **Why was it an issue? What is the impact on current technology projects?** A recent US study (2012) revealed an annual cost of $1 Trillion for corrosion damages in USA. **What is the overall Market opportunity that was been identified** Naval and Offshore energy sector.
Finance
What did the finance package for the project look like? The project cost was 1.391.752,20€. The project was financed under the Seventh Framework Programme (FP7), FP7-SME-2013 with an EU contribution of 1.074.922,20€. **What was the IP strategy?** The CUPID Consortium secured foreground IP protection in the form of the UK patent application GB 1413566.9 which established a priority protection date for later international patents based on the Project results.

4.2 Basque Country

Demonstration Project Information:
Title (Acronym) / Lead Company: Platform for testing and validating products for offshore energy installations (HarshLab) / Fundación Tecnalia Research & Innovation **Project Location:** At bimep, a unique test site located in the Basque Country designed for testing and demonstrating prototype devices for harnessing ocean energy in terms of their safety, economic and technical viability prior to their full-scale commercial development. bimep is sited near the village of Armintza-Lemoiz (Bizkaia), in one of the areas of highest energy potential on the Basque coast (21 kW/m) [www.bimep.com]. **Project Timing:** The development of the offshore laboratory has a time horizon of 2 years (2017-2019) with an intense previous work of identification of problems and needs. The development will be addressed in two phases. First, during 2017-2018 a first prototype will be built and anchored from a commercial buoy plus a lightened final anchoring solution in order to carry out the first tests and extract lessons for the final design. After that, the final infrastructure is expected to be fully operative for 2019. **Project Objectives:** Tecnalia, together with other stakeholders, has the objective of designing, constructing and launching HarshLab, an offshore laboratory for experimentation and validation of materials, components and subsystems in real marine environment. The main characteristic of the HarshLab is that even though there are some laboratories in the marine environment to carry out specific validations, there is no worldwide offshore laboratory that integrates the versatility and huge range of testing that is proposed in this project. HarshLab seeks to become: • a floating laboratory in the marine environment for the validation of components of the equipment and subsystems that are going to operate in a hostile environment and which integrates a wide variety of testing in the offshore environment. • A floating laboratory where teams working in offshore environments can be trained, as well as a lab which offers specific training courses for tasks in the marine environment. • An authorised centre to obtain high value training qualifications for integration in tasks in the offshore market. /

TRL: HarshLab will mainly be directed to test projects with high TRLs. Interested actors should start testing their solutions in HarshLab at TRL7 and finish tests achieving TRL8.
Workpackages (WPs): The development of the HarshLab infrastructure is an internal project to Tecnalia. The phases in which it is going to be developed are the following: Phase 1: Design, Phase 2: Construction, Integration and Launching, Phase 3: Installation, Operation and Maintenance, Phase 4: Exploitation.
Key components: The key component of the project that was addressed by the wider supply chain is that the laboratory will enable the following actions:

- evaluation of materials, components and independent systems in a real offshore environment: atmospheric, splash, immersion, confined and seabed zones.
- Testing of solutions aim at protecting components and systems against corrosion, fouling and corrosion-fatigue.
- Testing of solutions for corrosion monitoring.
- Study of the performance of umbilicals, risers, handling and anchoring systems.
- Training of personnel in offshore operations.

Project Partners: HarshLab design is a collaborative action that involves Basque suppliers of the value chain of offshore wind, marine energy and offshore Oil&Gas, RVCTI agents, specialised training centres, the Basque Energy Cluster and Basque Maritime Forum, as well as also connecting directly with the Advanced Manufacturing, area within the framework of remote sensing and monitoring. The main actor for the development of the project is Tecnalia, one of the leading applied research and technology organisations in Europe. Tecnalia is in charge and owner of the design of the offshore laboratory. It should also be noted that the conceptual design and the basic engineering of HarshLab are being developed with the direct involvement of 11 organisations in the offshore field, in a project called HARSH within the Basque HAZITEK regional programme (funded by the Basque Government). In addition, several entities have shown an explicit interest in using the infrastructure once it is operative. The 11 companies directly involved are: Matz-Erreka (coordinator of the Harsh project), Blug, Ditrel, Glual, Hine, Navacel, NEM Solutions, Sasyma, Tubacex, Vicinay Cadenas, Vicinay Sestao.

Technology Challenges / Market Opportunity

What was the specific technical challenge that has been identified within the sector that will reduce costs?
HarshLab will be a platform to test solutions to protect offshore devices and materials against corrosion, fouling and corrosion-fatigue. Therefore, the technical challenge will be for the solution developers that will perform the tests at the offshore laboratory trying to demonstrate the viability of their solution at lower costs.
What is the overall Market opportunity that was been identified
The targeted market segments are the offshore wind, oil and gas, and the marine markets. The first two segments are growing/will grow immensely in the coming years, which opens the door to a great market opportunity for any activity related to both. In addition, as the offshore sector is emerging, there is and will be the necessity to test new solutions in real marine environments, which suggests that HarshLab will be in great demand. Concerning the local market, more than 150 companies have been identified in the Basque Country with activity in the three value chains involved, with a joint turnover of €11,000M. While not all of these entities are working in the offshore field, offshore equipment and services are the segments with the greatest growth potential in both wind and Oil&Gas sectors, as well as being inherent to all activity in the field of wave energy, an emergent market where the Basque Country has an international positioning. The same logic could be applied for the rest of the world, where the number of enterprises and entities working on this fields and therefore possibly interested on testing in HarshLab multiplies. On the other hand, several calls have already been identified for the next H2020 work program (2018-2020) that fit in with the activities that will be developed around HarshLab.

Finance
What did the finance package for the project look like? As the project is in an initial phase, it is not yet known what the final investment needed will be. Nonetheless, it has been initially estimated to be an amount of €1.4M for the period 2017-2019. There is an important commitment on the part of companies, and Tecnalia, to assume 50% of this figure. The rest will be financed with public funds. Tentatively, the financing will be structured as: • Contribution from the 11 enterprises 15%, • Tecnalia's own private resources 35%, • Public funding (mainly from the Basque Government) 50%. The installation of HarshLab in bimep has also been a strategic financing decision (among other advantages), as it has a base infrastructure which will reduce the necessary investment and have the services associated with the platform required, also completing a greater offer of technological services of bimep. **What was the commercialization strategy?** The case of HarshLab is a unique case among Demonstration Projects because it is a validation infrastructure, not a solution or project to be tested. What it has been identified is the need of the market for an infrastructure where to test solutions for harsh environments. Under this framework, Tecnalia which is an entity used to offer testing solutions, will commercialize the activity in HarshLab with its usual commercialization structure. For the commercialization, the global market will be addressed, although demand is mainly expected from European organizations, given the location of the infrastructure. On the other hand, it should be borne in mind that the direct exploitation of HarshLab is expected to be deficient (as it usually is for most test-sites). However, the offshore laboratory will also attract business and R&D to the territory, which will make it a beneficial asset for the Basque Country. That is the trigger, for example, for public funding. **What was the IP strategy?** It does not apply since the IP is property of the platform users, not of the infrastructure owner.

Impact
Which is the forecasted economic impact The expected economic impact for the next 10 years is: - mobilisation of 30 Basque enterprises that will perform testing activities, - attraction of 15 non-Basque enterprises that will perform testing activities, - mobilisation of global R&D sources worth 20 mln€, - attraction of European funds worth 9 mln€ through 3 projects, - more than 200 products/materials tested and validated, - demonstration of 10 new products, - participation in the development of the offshore wind market contributing to the goal of 30% reduction of the LCOE, - incorporation of 6 new companies into the value chains of offshore energy applications, - improvement of competitive position and development of new value-added product by 10 companies.
Which is the Forecasted social impact HarshLab will enable the attraction of business and R&D&I activity to the Basque Country with commensurate economic and social benefits for the local population. It is expected that HarshLab will increase the job creation of 5% in the Basque Country by the participating companies.
Which is the Forecasted environmental impact HarshLab will be installed at bimep which is located in an area with no impact on surrounding beaches or environmentally protected areas. In addition, it will not be tested any material with critical environmental

impact and the laboratory does not demand high amounts of energy. As it is a floating platform the impact caused to the marine fauna is much lower than it could be in an installation nearshore. What needs to be taken into account is the environmental impact caused by the transport of devices and people from the coast to the platform and vice versa.	
Delivery Against Strategy	HarshLab is directly aligned with the objectives of the Advanced Manufacturing Energy pilot of the Vanguard Initiative, co-led by Scotland and the Basque Country. In the same way, it is aligned with the European Blue Growth strategy supporting smart, sustainable and inclusive growth.
Risk/ Lessons Learned	
What are the lessons learned from the delivery of the project? For the moment, it has been concluded that although an infrastructure with the characteristics of HashLab it is in great demand by the sector, to carry out its development public financing and a strong commitment on the part of the public administration are required. In turn, there is a need of an involved manager in charge of offering services and attracting business.	
Are there any risks that Demonstration projects need to be aware of? No significant risks have currently been identified.	

Demonstration Project Information:

Title (Acronym) / Lead Company: Open Sea Operating Experience to Reduce Wave Energy Cost (OPERA) / Fundación Tecnalia Research & Innovation

Project Location: In this Demonstration Project there are three test facilities involved:

- a Laboratory test located in the Instituto Superior Técnico of Lisbon, Portugal.
- Mutriku OWC Plant – the first commercial plant in Europe to use wave energy to generate electricity. It is sited in Mutriku, a Basque village (Basque Country, Spain).
- bimep, an infrastructure for testing and demonstrating marine energy converters, located off the coast at Armintza, Basque Country, Spain.

Project Timing: 42 months, from February 2016 to July 2019.

Project Objectives:

To collect, stream and publish two years of open-sea operating data of both a floating WEC and a shoreline wave power plant.

- To de-risk innovations that lower mooring cost over 50% and enhance survivability.
- To increase OWC power production 50% and improve reliability.
- To advance predictive and latching control to enable 30% increase in power production.
- To advance standards to reduce business risk and give access to lower cost capital.
- To reduce uncertainty, frequency, risk and cost of offshore operations.
- To improve risk management and cost estimation with real data.
- To maximise impact on the entire value chain and society for wave energy.

TRL: OPERA will collect, analyse and share open-sea operating data and experience to validate and de-risk several industrial innovations for wave energy, taking them from a laboratory environment (TRL 3) to a marine environment (TRL 5), opening the way to long term cost-reduction of over 50%.

Workpackages (WPs): WP1: Data Collection, WP2: Moorings, WP3: Power take-off, WP4: Control algorithms, WP5: Standards, WP6: Offshore logistics, WP7: Risk, cost and assessment, WP8: Exploitation, dissemination and communication, WP9: Management and coordination.

Key components: Before launching the project, certain key components were identified by a wider supply chain whose improvement could help achieve the goal of reducing the cost of wave energy by 50% in the long term. These key components are the following:

- novel biradial air turbine,

- advanced control strategies,
- elastomeric mooring strategies,
- shared mooring configuration.

Project Partners:

- Researchers (Advanced control algorithms): FUNDACIÓN TECNALIA RESEARCH & INNOVATION (project coordinator), UNIVERSITY OF EDINBURGH, UNIVERSITY OF EXETER, UNIVERSITY COLLEGE CORK and INSTITUTO SUPERIOR TÉCNICO LISBOA.
- Field Test facilities (Open-sea test data): EVE and BiMEP.
- Suppliers (Components & sub-systems): Kymaner.
- WEC & farm designers (Floating WEC & shared mooring): Iberdrola Engineering and Construction and OCEANTEC.
- Certification bodies (Contribution to standards & de-risking): DNV GL.
- Service companies (Validated operational procedures): Iberdrola Engineering and Construction and Global Maritime.
- Promotors (Validated cost models): EVE.

Technology Challenges / Market Opportunity

What was the specific technical challenge that has been identified within the sector that will reduce costs?

Europe is currently the world leader in wave energy, but costs remain high compared to conventional forms of energy. There has been very limited open-sea experience to fully understand the challenges in device performance, survivability and reliability. The limited operating data and experience that currently exists are rarely shared, since it is often partly private-sponsored. OPERA will remove this roadblock by delivering, for the first time, open access, high-quality open-sea operating data to the wave energy development community. In addition, the specific technical challenge addressed in OPERA is to validate and de-risk 4 industrial innovations for wave energy in relation to bringing costs down in the sector.

Innovation	Target	LCOE impact
Novel biradial air turbine	50% higher annual efficiency compared to Wells turbine	33%.
Advanced control strategies	30% increase in energy production	23%.
Elastomeric mooring tether	Reduce peak loads by 70%	7-10%
Shared mooring configuration	50% reduction in overall mooring costs in arrays	5-8%

What is the overall Market opportunity that was been identified

The targeted segment is the wave energy market. Nowadays it is a limited market since wave energy converters are not in a commercialization phase yet. As it has been stated, the overall objective of the project is to reduce 50% the cost of LCOE to improve wave energy industry competitiveness and get access to the global market of renewable energy generation systems. Focusing on the market opportunity identified, it could be stated that wave energy sector will continuously grow over the next years. The main challenge that is currently being faced is the achievement of the commercialization stage for wave energy converters. To this end it is compulsory to gather more data, to validate new technologies and to reduce costs. This is exactly what OPERA focuses on.

Finance

What did the finance package for the project look like?

The project is completely financed (100%) by H2020 under grant agreement No 654.444 with 8 million €.

What was the commercialization strategy?

As is known, the wave energy industry is in a pre-commercialisation phase. The main actors in the marine sector seek cost reduction and technology validation in order to achieve competitiveness against other cheaper and proven renewable technologies. For this reason, OPERA does not pursue a commercialization strategy. The project is focused in lower TRLs with the aim of collecting, analysing and sharing for the first time high-quality open-sea operating data and experience.

What was the IP strategy?

As usual in H2020 projects, IP developed throughout OPERA will belong to the consortium partners (following the guidelines defined in the consortium agreement). In this sense, each partner will capitalize on its own IP.

Impact

Which is the forecasted economic impact

Long term cost-reduction up to 50% for wave energy.

Which is the Forecasted social impact

The EU is currently the world leader in wave energy and thus there are significant opportunities for green jobs associated with its development and deployment. No job creation estimates have been carried out in the OPERA project since it is difficult to calculate exact figures in projects with low levels of TRL. In any case, the project ensures the activity in the test sites with the corresponding benefits for the territory where the facilities are located.

Which is the Forecasted environmental impact

As bimep and Mutriku OWC are already in place, most of the environmental issues are already considered, evaluated and approved. Tests on those locations are pre-consented and all the consultation with locals were performed before becoming operational. Besides, devices are deployed there with a limited duration. There is no permanent installation for 20 years that could cause significant impacts.

Delivery Against Strategy	OPERA is funded by H2020 which means it is directly aligned with their objectives of cost reduction of renewable energy generation systems to achieve emission reduction targets. In the same way, the project is aligned with the European Blue Growth strategy supporting smart, sustainable and inclusive growth.

Risk/ Lessons Learned

What are the lessons learned from the delivery of the project?

Lessons learned during different phases of marine operations:

- it is very important to influence the design phase considering the limited but available equipment and resources in the area. Divers and tugboats should be involved in designing the installation. They provide valuable information, such as local knowledge to define actual constraints (e.g. weather conditions that enable safe operations).
- In the planning phase it is extremely important to engage with all people involved in the different operations and to listen to their feedback. Another advantage of involving them early in the project is that they will be committed to the project and help solve problems that may arise during the execution phase. It is also important to work with experienced people.
- In early stages, it is very important to have sufficient resources to deal with problems when they happen. Of most importance is to ensure sufficient resources (always difficult for small companies) to deal with problems.
- It is very important to consider marine operations and O&M in the design of an ocean energy

device. Offshore operations introduce some requirements into the device design:

- o Take into account available equipment and resources in the area.
- o Design for availability, installability and maintenance; not just for efficiency and cost.
- o Fouling in mooring lines is not normally taken into account when calculating mooring forces on the device. Besides, marine fouling is very difficult to predict.
- o Scaling up the device can make impossible to use the same solution either technically (high loads) or economically (O&G technologies or vessels).
- o Plan for WEC accessibility due to resonance in some sea states.

Are there any risks that Demonstration projects need to be aware of?

OPERA consortium states that detailed planning of operations is paramount for avoiding any risks and uncertainties at sea. They therefore strongly recommend:

- Do extensive testing and simulations prior performing the operations.
- Perform a risk analysis using standard tools and procedures (HAZIP, HAZOP, etc.).
- Account for delays in the schedule.
- Have a Plan B if the operation cannot be finished in time.
- Engage with all people involved in the different operations. Listen to their feedback, they provide valuable information to solve problems that may arise during the execution phase.
- Onshore meetings save valuable time offshore.
- Visual aids such as work cards, use of different colors and graphical diagrams to prevent any misunderstanding at sea.
- Other more general recommendations have also been gathered:
  - o Perform a staged testing programme.
  - o Document everything. Changes to the prototype should be logged very carefully using any kind of media such as videos and photos.
  - o If no regulation exists, do not take O&G regulations as baseline, since they are based on very different requirements.
  - o Allow for mistakes since mistakes most certainly will happen and have sufficient resources to deal with problems.

4.3 Flanders

Examples of ongoing projects and funding derivatives

Title	Type	Description
Factory of the Future: Blue Energy	Funding by the Provincial Dev. Corp. (POM) West-Flanders	Funding of R&D projects of SMEs and institutes in the framework of developing the potential of oceans and seas, including renewable energy. Facilitate innovation by the strategic development of infrastructure and logistical services.
GreenBridge Blue Growth	Incubation and Innovation Centre	Support for regional tech companies active in sustainable development. Support consists in office space, service packages and technological support both in terms of infrastructure and knowledge.
Inn2POWER	INTERREG	Support SMEs from the North Sea Region to initiate innovative cooperation in the maintenance and monitoring of Offshore Wind Parks to decrease LCoE.
MET-CERTIFIED	INTERREG	Increase the adoption of insurable and bankable marine energy projects through the development of internationally recognized standards and certification schemes.
MaDurOS	SBO	Material Durability for offshore structures. Focus on

		Renewable Energy Devices. Objectives: 1. Gain deeper insight into material behavior under combined loading (corrosion, abrasion and fatigue). 2. Develop, build and offer combined loading test facilities. 3. Develop new and improved alloys and monitoring techniques.
Innovative Business Network – Offshore Energy	IBN	Develop a network spanning the complete offshore renewable energy value-chain. Facilitate innovation by providing a framework in which companies can share knowledge and experience. Incubate new projects.

Public/Private funded test platforms: Anchor sites for NeSSIE demonstrators

The construction of two test sites has been approved and has received significant government funding. One is the ‘Coastal & Ocean Basin’, the other the ‘Blue Accelerator’ offshore test platform. Both projects are aimed at facilitating innovations in the offshore sector by providing the relevant infrastructure. Both test sites will be finished by 2019, at which point the potential of the test sites will have to be fulfilled with projects of the type of the ones that will be prepared in NeSSIE.

Coastal & Ocean Basin (COB): COB is a wave tank made of a large concrete construction filled with water (30 m x 30 m x 1,4 m deep) in which controlled waves, currents and wind can be generated. Its construction has been funded by: i) Ministry of Public Works, ii) Hercules funding (Funding for Academic Infrastructure), iii) Academic partners (UGent, KUL). To avoid the appearance of government funding for certain companies, companies are not involved in operational management. Instead, 50% of the COB’s capacity is reserved for companies, which will pay a correct market price for use of the COB. This constitutes the private part of the funding foreseen in the Business Plan.

Blue Accelerator: This is an offshore test platform located on a monopile, 1 km from the coast where the sea depth is 5-6m with an area of 500x500 of seabed around the monopile for installation of test infrastructure. It has been funded through ERDF funds with an additional funding from the Provincial Development Corporation West-Flanders. The academic partners are UGent, Vives and VITO. It received private funding according to the same scheme as the COB. Offshore corrosion is one of the core themes considered in the project description. Research projects using the platform as a base can be funded through the sources described above. It is foreseen that, as completion of the platform approaches, strong projects anchored on the platform will have a good chance of success. Coating of the monopile itself with an innovative coating will not be allowed, in order not to risk the structural integrity of the platform. However, a ring or sleeve could be placed around the monopile as a ‘dummy’, which could be coated and serve as a large-scale demonstrator. There will be access to all corrosion zones: submerged, tidal, splash and atmospheric.

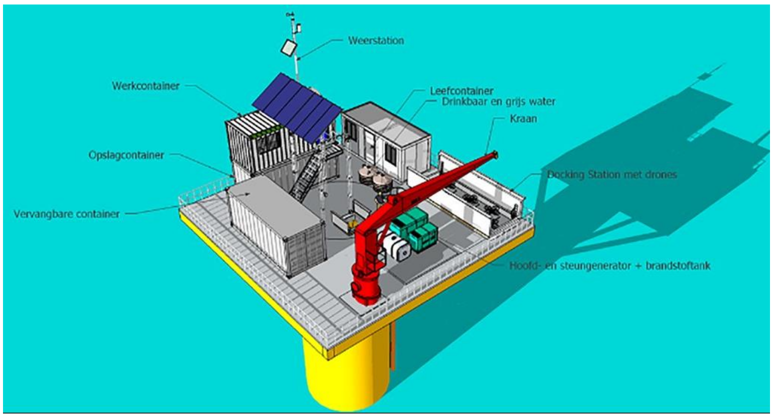


Figure 6 - Drawing of the Blue Accelerator

Demonstration Project Information:

Title (Acronym) / Lead Company: Offshore Wind Infrastructure Application Lab (OWI-Lab) / Sirris, the collective center of the Belgian technological industry
Project Location: Antwerp (Belgium)

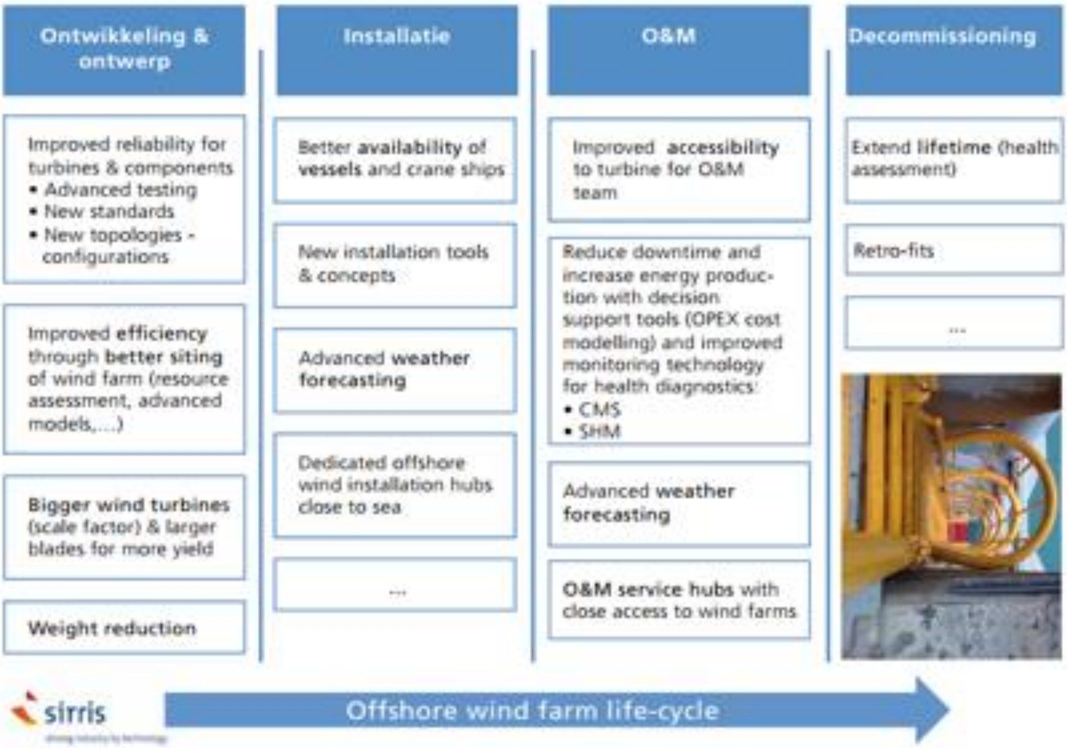
Picture of the Climatic Test Chamber in OWI Lab

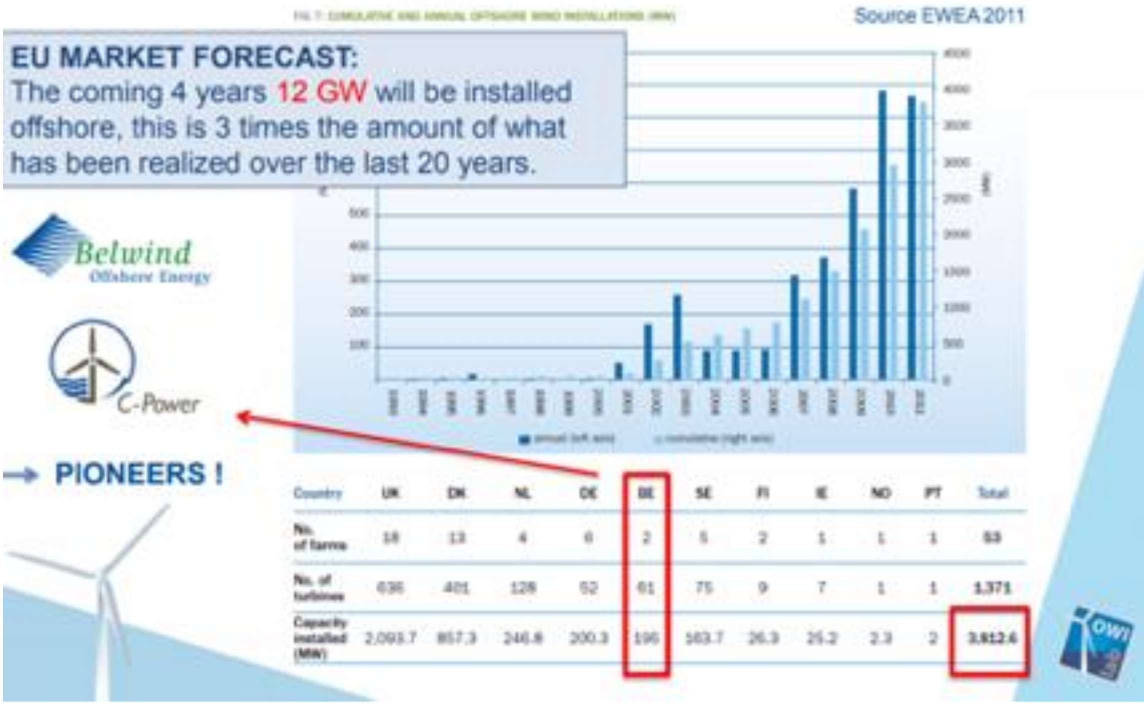

Picture of a large scale equipment in the OWI Lab

Project Timing: The idea was proposed to the Flemish government in 2008, and the OWI-Lab has been inaugurated in September 2012.
Project Objectives:
The OWI-Lab is a Research Development and Innovation platform which aims at initiating and supporting R&D and innovation projects concerning wind energy in extreme environments as offshore, cold and hot climate conditions. The project itself aims at increasing the reliability and efficiency of wind farms by investing in test and monitoring equipment that can help the industry in reaching these goals. As part of the project the following specific infrastructure was acquired:

- Large scale climate chamber,
- Installation of sensors on offshore wind turbines.

OWI has as main objectives to bring added value in setting up new projects, finding the right partners, look for funding and act as a platform to initiate local and European research projects together with industry and universities (SBO, O&O, H2020).
Partners:
The coordination is in hands of Sirris. More than 30 Companies and 2 universities are participating in the user group as it is possible to observe from the following scheme:

Technology Challenges / Market Opportunity
What was the specific technical challenge that has been identified within the sector that will reduce costs? The industrial challenge is to find appropriate test infrastructure and datasets for reducing O&M cost of wind turbine components.  **Example 1: Wind Turbine Component Test Lab** Standard on- and offshore wind turbines are designed to operate in a temperature range from -10°C to +40°C, but in some (remote) locations this specification is not enough to ensure reliable operations (example: Finland: turbine operate at -40°C). These inhospitable locations form a huge challenge for the machine and for the maintenance and repair teams. High operations and maintenance (O&M) costs should be avoided for remotely located wind turbines (arctic wind turbines, turbines installed in high mountains, etc…). This can be achieved by testing their components up to their limits and ensure reliability in all operational conditions, using the OWI-lab climate chamber, which permits full-scale testing of large equipment. **Example 2: OptiWind - Remote measurement and monitoring system** OptiWind is a Strategic Basic Research (SBO) project, which builds further on the activities within the Offshore Wind platform. This project is a logical further step that uses the data gathered from sensors installed on offshore turbines, to deliver models and tools that support the development of smart O&M strategies. Through the development of robust and effective Structural Health and Condition Monitoring techniques, the serviceability of the next generation of offshore wind turbines is optimized. These research themes are clearly articulated around the development of new design methodologies on one hand, and advanced monitoring techniques on the other hand. **What is the overall Market opportunity that was been identified** Only a cost optimized and reliable wind turbine is bankable.

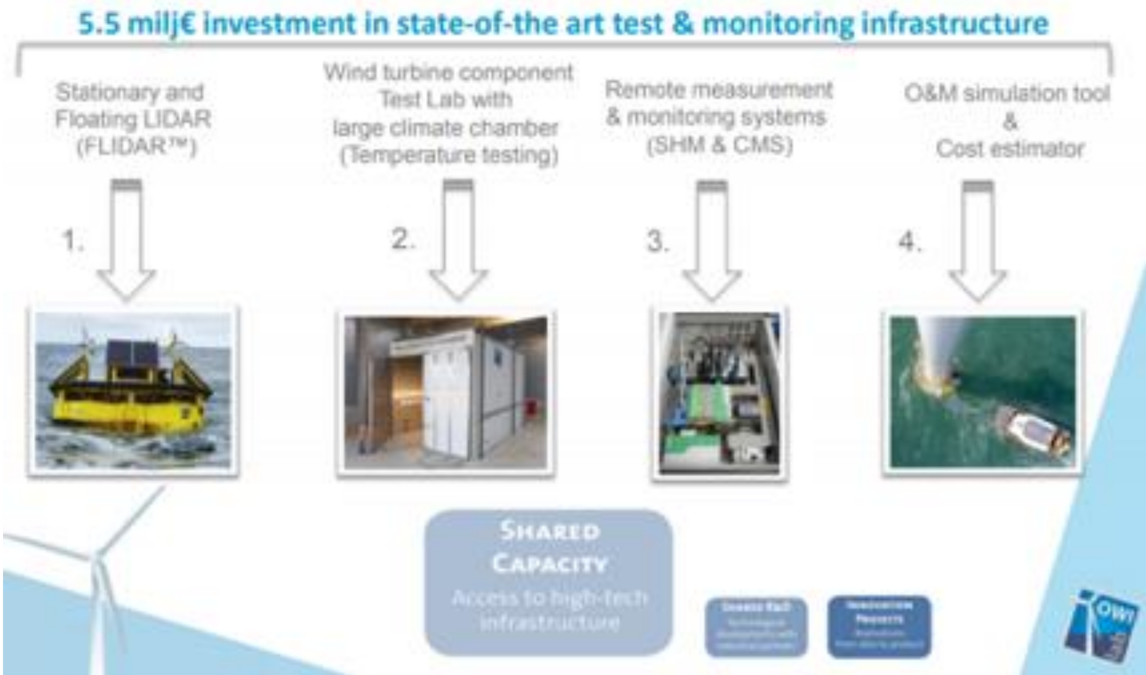


- Expected 30 GW (Europe) by 2020 equals 10.000 jobs in O&M (1FTE per 3MW)
- The forecast 2020 for Belgium: 2.2 GW and 1000 jobs in total, with biggest impact in offshore wind energy.
- Large international component suppliers active in Belgium (export): Smulders, CGPower, ZF, etc.
- Pioneering experience in installing and operating offshore, as well as exporting O&M knowledge and experience.

Finance

What did the finance package for the project look like?

A total of 5.5M euro was invested in the OWI-lab infrastructure. The largest part of the funding came from the Flemish government.



R&D projects making use of the test infrastructure can receive additional funding on a project basis. As an example, the OptiWind (development of the remote measurement system described above) project consortium consisted of 3 universities, 2 private companies and Sirris with a total project budget of 3.2 Mln Euro (2012-2016). It received funding from the Flemisch Government (VLAIO).

What was the commercialization strategy?

In total, 12 industrial partners have underlined the valorisation potential of OptiWind and have specified that they will implement the project results of the Condition Monitoring System by performing follow-up applied research project (O&O). The project has developed concepts and models/tools/data from which a new generation commercial products/services will be created. Most O&O projects will start close to the project-end, as they require novel concepts and models as well as advanced engineering tools. The industrial partners in OptiWind have been needed for their specific input and expertise for the collective knowledge build-up within this project. Logically, they have also established up follow-up O&O projects to translate the project results to their market. A Valorisation Board was created for this project consisting of a small group of industrial and academic people with experience in valorization of research results. In the project eight open project-workshops were programmed to guarantee a broad dissemination towards industry. Alongside the workshops, project results have also been communicated via scientific channels such as scientific journals, presentations, posters or papers on conferences, etc.

What was the IP strategy?

As a general rule we work with exclusive ownership of project results whereby the results are owned by the partner that created these results. Related to the use of background knowledge (available prior to the start of the project) for valorization it is up to the partner owning the background to decide on the possibility and/or conditions. Related to the use of foreground knowledge (build up during project execution), all partners can set up valorization activities using their own project results extended with foreground knowledge of others. In the latter case, a fair return to the partner bringing the additional foreground knowledge needs to be put in place.

Impact

Which is the forecasted economic impact

Offshore wind energy is a high tech sector. The value chain for offshore wind energy indicates the impact that project results has on different players along the value chain.

Interaction scheme between project research objectives and the Flemish value chain:

	# of primary companies in Flanders	Drivetrain	Blades	Tower - foundation	Electrical connection	Monitoring
wind park development and engineering	15					
Wind park owners and operators	7					O&M
(sub)component suppliers	15	gearbox mft	blade mft	structure mft	electr. mft	design input
Offshore wind turbine integrators	0					
Wind farm installation	5					
Wind farm O&M						

strongly interested	
interested	
moderately interested	
limited interest	

Which is the Forecasted social impact

The forecast 2020 for Belgium: 2.2 GW and 1000 jobs in total, with biggest impact in offshore wind energy.

Which is the Forecasted environmental impact

The project targets several sustainable objectives:

a. Increased life time of products through optimal monitoring techniques,

b. Reduced emissions by increasing uptime and associated energy yield,

c. Use and/or develop renewable energy sources.

If it is estimated that the increase in the offshore wind turbine availability is 1%, each installed MW will hence yield an additional 760MWh over 20 years (impact per installed MW).

Risk/ Lessons Learned
Protection of data and IP limits valorisation among broader group. Companies and park owners are not inclined to share data about their operations. As a result, cooperation between multiple partners, as is often needed, can be difficult and bound by a number of bi-lateral NDA's.
Are there any risks that Demonstration projects need to be aware of • The demonstrator should not be a commercial playground. In order to guard the independency, it would be advisable to avoid that private partners get involved in operational management. • Danger for a feeling of government intervention or 'favoritism' if a government funded demonstrator illustrates a specific company's technology. Unless company provides an adequate share of the resources.

4.4 Scotland

Demonstration Project Information:
Title (Acronym) / Lead Company: Scotrenewables Tidal Power Ltd **Project Location:** European Marine Energy Centre **Project Timing:** Mid 2012 – Last Quarter 2014 **Project Objectives:** The proposed project involved the design, construction and EMEC installation of a commercial demonstrator of a 2MW tidal turbine (SRTT) with full 20-year design life. The objective was to develop a device that can be deployed commercially in an array configuration. **Workpackages (WPs):** Design – 6 months, Construction – 12 months, Initial deployment, commissioning and grid connection –1- 3 months, Ongoing testing – 9-12 months. **Project Partners:** Suppliers and partners included Bifab for construction, ABB for Power take off, Designcraft for the blades, MacArtney Underwater Technology for cabling and connections, Fendercare for anchoring, local marine services providers for deployment support and EMEC for testing.
Technology Challenges / Market Opportunity
What was the specific technical challenge that has been identified within the sector that will reduce costs? The key challenge in the tidal industry is driving down the LCOE of tidal stream. This project has taken the learning's from previous demonstrations of smaller scales of the turbine to test at full scale in real sea conditions. The main challenge was to take the learning's from previous tests and start optimise the performance and the O&M of the device leading to the development of device that can be deployed in an array configuration. **What is the overall Market opportunity that was been identified** The market opportunity for this project is tidal stream. All future energy scenarios show tidal stream as being critical to the delivery of the energy needs of the future. Global markets are opening up in Europe, North America and Asia Pac. The market signals for the next few years are challenging (not least in the UK) but the demand for energy, energy security, the drive for decarbonising the energy system and the focus of regional and national governments to create new high value jobs in coastal communities will result in significant growth opportunities for this emerging technology.

Finance

What did the finance package for the project look like?
The project was financed by the Scottish Enterprise WATERS with a Grant of 1.24 Mln£ and a Private finance of 4.4 Mln£ for a total budget of 5.6 Mln£.

What was the commercialization strategy?
The SR2000 was planned to be the final stage in the commercialisation of the SRTT technology and the first of a number of commercial scale turbines, incorporating cumulative learning from the SR250 and SR2000 projects, installed in a demonstrator array of initial 10MW capacity. Beyond this initial commercial array demonstrator the Company intends to remain focused on the design, construction and maintenance of SRTT machines but may also continue with project development as required by market uptake. The initial market focus for offshore application of the SRTT will be the UK and Europe. The UK has an excellent tidal resource, an established offshore industry and steadfast political support for marine renewable energy. Therefore the Company will remain focused on the UK market in the near term for tidal application of the concept. However, subsequent changes to the UK Government policy of support for Renewable Energy have negatively affected the Tidal sector with consequent reduction in the Investor appetite to support less developed Renewables technologies. SRTT remain active in considering options for future development.

What was the IP strategy?
IP was predominantly in the turbine technology with SRTT looking to work with project developers for the deployment of the technology. The know how that is being developed on the project in terms of deployment and operation is crucial to the wider supply chain as it develops within the sector but not protectable.

Impact

Which is the forecasted economic impact
The project was forecast to increase the business from 14 to 23 FTEs at project completion with further growth as the product was commercialised.

Which is the Forecasted social impact
Whilst the specifics of this have not been calculated the project is situated in a remote location in the North of Scotland and will have a significant impact on the island community of Orkney. The company has in the last few years doubled in size in terms of FTEs. Wider benefits will be delivered in the EU, UK and Scottish Supply chain.

Which is the Forecasted environmental impact
The development of this project will result in a reduction in carbon emissions associated with energy generation, but these have not been calculated specifically. This demonstration project continues to evaluate the wider impact on the marine environment.

Delivery Against Strategy
The project is in line with regional, national and EU strategy on a number of levels. Delivering high value jobs in coastal communities, decarbonizing the energy mix, energy security, blue growth, diversification opportunities for the marine/oil and gas supply chain, tapping into the subsea expertise that exists in Scotland and the wider North Sea Basin, creating high value manufacturing opportunities and ultimately creating a world class industry that can be exported around the world.

Risk/ Lessons Learned

Principle lessons learned were that the project took longer to deliver and was more expensive than anticipated. The project also led to another successful EU application to further develop the turbine. Overall it is clear that incremental development of technology as it moves up the TRL scale is required and that to operate in the marine environment is a costly exercise.

4.5 Sweden

Demonstration Project Information:
Title (Acronym) / Lead Company: Waveboost Project / Corpower Ocean **Project Location:** Corpower Stockholm and European Marine Energy Centre (EMEC) **Project Timing:** 2017-2020 / 36 Months **Project Objectives:** This project's main objective is to improve the reliability and performance of Power Take Offs by developing and validating a revolutionary braking module with Cyclic Energy Recovery System (CERS) and advanced control that can be coupled to different types of WECs. **Project Description:** WaveBoost aims at providing a step-change improvement to the reliability and performance of PTOs (Power-Take-Offs). While built and tested on the platform of the existing CorPower technology, the CERS braking module can be integrated in many types of Wave Energy Converters (WECs). Especially for point absorbers - undisputedly the WEC type with best prospects for largescale development - WaveBoost will solve a central reliability challenge, the so-called 'end-stop' problem (excessive, uncontrolled forces when linear movement reaches end of stroke). Further, dedicated reliability assessment methods will be developed and applied. CERS is an energy redistribution system that will allow WECs to absorb more energy from high energy wave cycles, temporarily storing excessive energy in the first step of the PTO chain, then releasing it for conversion through the remaining steps of the PTO in low energy wave cycles. Similar systems are being used in other sectors (e.g. automotive), but have never been applied to ocean energy. The additional damping force required to safely stop the motion of WECs in storm waves may be several times larger than the PTO force used to convert wave motion into electricity. By providing the extra damping needed from the CERS module, system survivability and reliability of critical components are significantly improved. Another consequence is a size reduction of the PTO for the same power rating, and an increase of the Annual Electricity Production (AEP). The technology allows WECS to operate at higher average loading, increasing average conversion efficiency. Further, the grid compliance of electricity produced is significantly improved through this new energy storage concept. The improvements described above are expected to significantly reduce shock loads on WECs, increase in AEP of 25% and reduce LCOE more than 30% compared to the state of art. **TRL:** The project started at TRL4 and aims at reaching TRL5. **Workpackages (WPs):** Project Management, System Design, Manufacturing and reliability testing of the CERS braking module, Integration and Performance Testing of complete CERS PTO, Performance assessment and improvement, Reliability, Risk assessment and certification, LCOE modelling and business case analysis, Communication & Dissemination. **Project Partners:** Corpower – Device Developer European Marine Energy Centre (EMEC) – Test centre, ocean testing University of Edinburgh – lead LCA assessment carried out on the TROPOS project (FP7) WavEC Offshore Renewables - more than ten years of experience modelling wave energy converters with its own wave2wire code PMC Cylinders – Extensive experience in manufacturing of pressure systems EDP Inovação – utility, end-user of the technology, supplying electricity to the consumers. Critical insight on market prices and grid integration of RES, including offshore wind Research Institutes of Sweden (RISE) – Reliability methodologies GS Hydro AB – Industrial pneumatic piping and porting systems
Technology Challenges / Market Opportunity
What was the specific technical challenge that has been identified within the sector that will reduce costs? There are however, a number of technical challenges inherently associated with the nature of ocean waves that explain the relatively slow progress of wave power compared to other renewable energy technologies: 1. Low velocity wave motion requires high machinery force to absorb a large amount of power. 2. Reciprocating motion requires a mechanism able to absorb energy in multiple directions. 3. Wide spectral distribution of the incoming energy requires Wave Energy Converters (WECs) to operate

efficiently over a broad range of wave frequencies.
4. Extreme loads in storms, typically requires large and heavy structures to survive.
5. Waves represent a highly fluctuating power profile, with peak-to-average power of 20:1 being typical over 30min periods.
6. Reducing renewable energy technologies installation time and cost and/or operational costs: this project will significantly de-risk the proposed technology as well as key components for wave energy devices by performing extensive reliability and lifetime testing. WaveBoost aims at achieving an increased component lifetime to 20million cycles (5 years), which will contribute to reducing the operational costs in future projects. Also, the CERS module will allow reducing PTO size and cost by downsizing the drive-train to less than half for the same power output, contributing a WEC having less than 1/5 the weight compared to conventional WECs without CERS and WaveSpring. Therefore, the WECs handling and logistics will be easier allowing the use of smaller vessels in future arrays.
7. New and improved methods, models and reliability and performance data, contributing to creation of new knowledge, services and advancing in international standards. R&D partners will benefit of a leading position to provide services in performance, techno-economic models (LCOE, SCOE and LCA), reliability assessment and a wave-2-wire model with expanded capabilities to other developers. Results are integrated in other research projects specifically targeted to increase the reliability for offshore and renewable technologies and to exploit these results through new technology transfer partnership with industry.

What is the overall Market opportunity that was been identified

This project's main objective is to validate the braking module with Cyclic Energy Recovery System (CERS) and advanced control that can be coupled to different types of WECs. CERS incorporates safety logic and energy redistribution functions beyond that of previous PTOs. The outcome is expected to contribute significantly to solving the sector's challenges 4 and 5 mentioned previously (extreme loads in storms and waves highly fluctuation power profile), making a step change improvement in the reliability of Wave Energy Converters, as well as improving performance and grid integration. The design of CERS braking module is technology-neutral, to be applicable to a wide range of WECs representing potentially over 75% of the current market hence its successful demonstration could provide multiple opportunities for commercialization and impact the entire wave sector.

Finance

What did the finance package for the project look like?

The project was financed through H2020 for a total budget of 4 Mln Euros.

What was the commercialization strategy?

Path to Market:

- Direct Subsystem Commercialisation: a permanent licence of the innovation design could be agreed with a third party engineering and manufacturing firm, for sale to other WEC developers.
- Indirect Subsystem Commercialisation: establish a standalone subsidiary to develop and bring the product to market (similar to Cascade Drives). Subsidiary could license the product exclusively to CorPower or to multiple developer, depending on their own business strategy.
- Commercialisation as a Systems Integrator: Keep the innovation as a core component of the CorPower WEC and further develop and evolve the product as an integrated device.

Exploitation plan for other products, services and knowledge after the project: not only CorPower but all partners will have a role in making wave energy technology and knowledge available. project partners expect to exploit the results of the project to benefit their business areas.

What was the IP strategy?

The consortium has agreed that partners will retain full ownership of any IP generated during the project in relation to the area of technology being commercially exploited by the respective partner and where they bring the main expertise and develop IP. In accordance with the Grant Agreement, all partners will list their included Background in an agreement on Background attached to the Consortium Agreement that has to be approved by all partners before the project start. In the event that arising component IP is generated in partnership by multiple partners, the Steering Committee shall agree on the ownership and in making the decision shall have regard to the following factors:

- the background IP held by each party in the technical subject matter of the component;
- the relative contributions of partners to the creation of the arising component IP in issue;
- the ability and experience of the relevant partner in relation to the filing, prosecution, maintenance, enforcement and management of IP generally;
- any statutory or other limitations on the relevant partner which may jeopardise the ability of such party to properly file, protect, maintain, enforce or licence relevant IP; and the technical subject matter of the arising component IP in question.

In order to avoid any problems related to IP issues within the consortium, special attention will be paid to the specific IP paragraphs in the Consortium Agreement. These paragraphs will deal with (joint) ownership and possible transfer of the IP, and the access rights for project partners and affiliates.

Impact

Which is the forecasted economic and social impact

It is important to note that the majority of the most energetic wave sites are in regions experiencing socio-economic problems (e.g. Northern Scotland, Western Ireland, North-west Spain, France and Portugal) having suffered from the decline in marine industries such as fishery and shipbuilding, resulting in high levels of unemployment and, subsequently, human capital emigration. Creation of economic growth and jobs in these regions is essential in revitalizing the European regions. By developing the proposed innovative system and improved reliability methods, WaveBoost will contribute to the development of the wave energy industry in those regions.

Which is the Forecasted environmental impact

The use of renewable energies avoids the emission of harmful green-house gasses by substituting fossil fuels. However, they do have an environmental impact over their lifetime, and analysis should be performed to evaluate and minimize it. CERS braking module corresponds to a pneumatic system which eliminates the risk of oil leakage in alternative hydraulic systems used in other technologies. By targeting small systems and using a tension-leg mooring system, it minimizes: a) the life-cycle environmental impact, b) the mooring spread and also allows the use of smaller vessels for installation and O&M. This project will conduct a Life Cycle Assessment (LCA) not only to minimize environmental impact and costs during CERS braking module manufacturing, but to assess and minimize the future impacts during installation, operation and decommissioning phases of full integrated systems. This LCA analysis will also give hints about how to reduce the carbon footprint through the development of novel PTO systems.

Delivery Against Strategy

The project is in line with regional, national and EU strategy on a number of levels. Delivering high value jobs in coastal communities, de-carbonizing the energy mix, energy security, blue growth, diversification opportunities for the marine/oil and gas supply chain, tapping into the subsea expertise that exists in Scotland and the wider North Sea Basin, creating high value manufacturing opportunities and ultimately creating a world class industry that can be exported around the world.

LCE-07 Ocean Technology specific challenges:

1) **to increase significantly the performance, reliability and survivability** (15-20 years target) of ocean-energy devices developing solutions based on alternative approaches, sub-systems and materials.

WaveBoost addresses this aspect by:

a) building, testing and validating a novel CERS braking module making direct drive PTOs operate safely and reliably in harsh ocean conditions, improving overall survivability while significantly increasing average

power output.
b) performing exhaustive reliability testing for critical components to identify critical parameters effecting the life time and increase the MTTF (mean-time-to-failure),
c) building a component database benefiting the whole sector. The integrated CERS PTO will increase the energy output while reducing both CAPEX and OPEX.
2) **to adopt an integrated research and development approach** reach maximum impact for the whole sector, and to make ocean energy commercially attractive for investors.
WaveBoost addresses this aspect by developing:
a) a module technology neutral enabling the integration in different WECs, reaching maximum impact for the sector. The project will use a system engineering approach with an ambitious testing & validation program.
b) an improved understanding of component failure and low reliability in current ocean-energy devices, and in the development of ocean energy devices of improved performance, contributing to reduce the cost of ocean-energy.
c) a proper dissemination and exploitation plan.
3) development of **novel and advanced reliable prime mover and the development of novel and advanced PTO and control systems**, converting mechanical energy from prime mover into grid compliant electricity
WaveBoost addresses this challenge by developing a new advanced control technology integrated in a PTO of a formerly proven real-sea device and a state-of-the-art composite prime mover, allowing a fully integrated demonstration of the benefits brought by CERS.

Risk/ Lessons Learned

Ongoing project.

Are there any risks that Demonstration projects need to be aware of

- Safety
- Deployment at open sea
- Logistics in the supply chain and get parts on time
- Technical issues
- Monitoring at sea
- Control system malfunction
- Communication.

5 Conclusions

The aim of this report was to provide suggestions for the optimal design of the NeSSIE Demonstration Projects (DPs) and to highlight the importance of DPs in the innovation process through showing and discussing some best-practices and listing the main funding opportunities for DPs. Such an aim was reached combining a state of the art with an experienced-based study on DPs exploiting the NeSSIE partnership experience in this field.

DP is an important phase of the complex innovation process that can either test the workability of an innovation under operational conditions or force the political/social process to remove institutional/social barriers standing in the way of an innovation. It then promote/align the discussion/development of policies aimed at enhancing the innovation path to the market.

Depending upon the DP's aim, its development has different timing and funding needs. In any case the DP design phase is fundamental for the uptake of the innovation to the market. During the DP design phase, it is necessary to define its value proposition, the team that will be involved, the business plan and how to implement a co-design and an open innovation approach during the DP overall life cycle. Besides, many authors, as well as the NeSSIE partners experience, highlighted that there are main reasons for success or failure of DPs:

a) User involvement: important at all stages of DPs to facilitate learning and to continuously check whether the work being performed in the DPs is indeed representative for 'real conditions'.
b) Government support: crucial because it can influence the diffusion of innovation increasing public acceptance indirectly by indicating to potential adopters the direction of public funding, policies and priorities.
c) Dissemination of results and evaluation information should be included in the project design taking into consideration confidentiality requirements.
d) Careful planning: it is necessary to take account of market readiness, user participation and financial sustainability.

ORE technologies are capital-intensive, require protracted periods of experimentation and market demand has often yet to emerge. Corporate or private stakeholders find it difficult to fully engage in ORE experimentation due to uncertain financial/competitive returns. Hence, government must play a lead role in the initiation of such DPs. In doing so government must involve:

1) The private sector stakeholders from the beginning of the R&D process adopting the open innovation approach because value is created through the interaction and mutual collaboration between people, organisations and technologies.

2) The appropriate team to manage the DP (e.g. business development team).

In conclusion, DPs, being either solution testing or research infrastructures, are beneficial assets for the territory by being a trigger for knowledge/value creation if they are properly designed. Besides, when designing the DP phase, it is crucial to consider an inclusive approach and to set up and further monitor the business plan.

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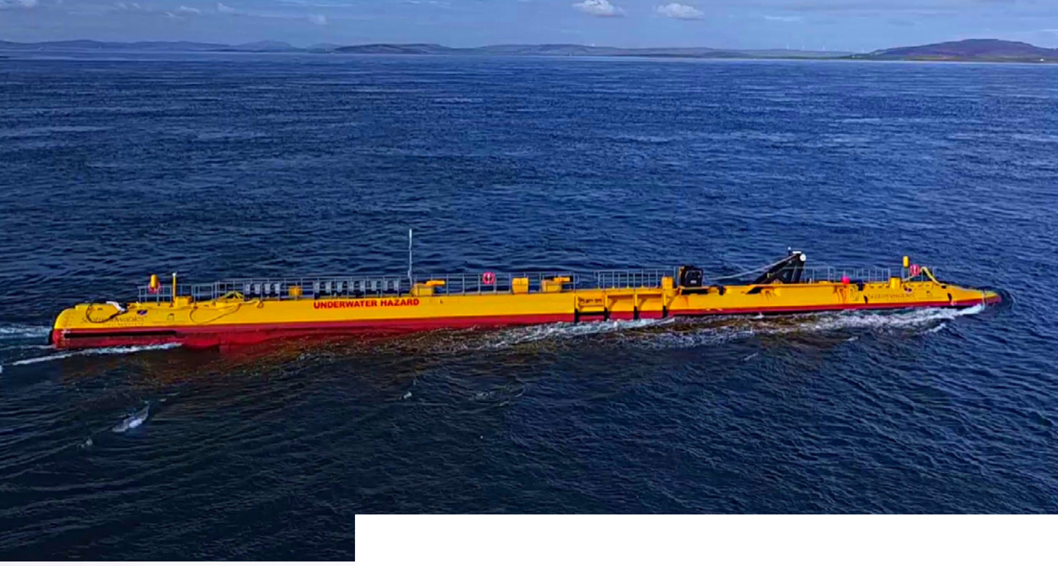

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