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MARKET STUDY ON OCEAN ENERGY

FINAL REPORT

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WavEC
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E-mail: MARE-A2@ec.europa.eu
Contact: Xavier GUILLOU

European Commission
B-1049 Brussels

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Stakeholders with experience in the field were invited to provide comments to a number of key points relevant for this study to help understand the needs of the ocean energy sector, thus contributing to improving the near future funding landscape. The study team acknowledges with grateful thanks the input, feedback and expertise provided by the wide range of representatives from the ocean energy sector, who kindly cooperated in the compilation of this study.

Stakeholders

Name	Company/Organisation
Julien Delanoe	ADEME (France)
Roberto Legaz	APPA (Spain)
Manuel Ferrández	Atlantic Insurance & Reinsurance Brokers
Javier Soriano	Atlantic Insurance & Reinsurance Brokers
Marcos Lafoz	CIEMAT (Spain)
Francesco Salvatore	CNR-INSEAN (Italy)
Kim Nielsen	Danish Partnership for Wave Energy (Denmark)
Christian Berhault	Central Nantes SEM-REV (France)
Roland Schulze	EIB - European Investment Bank
Maud Skaringer	EC - Directorate-General for Regional and Urban Policy
Matthijs Soede	EC - Directorate General for Research and Innovation
Davide Magagna	EC - Joint Research Centre
Diána Haase	European Parliament - Directorate-General for Internal Policies of the Union
Peter Fraenkel	Fraenkel-Wright Ltd (UK)
Yann-Hervé De Roeck	France Energies Marines (France)
Jochen Bard	Fraunhofer IEE (Germany)
Indalecio González Fernández	Fundación Asturiana de la Energía (Spain)
Christophe Maisondieu	IFREMER (France)
Raul Guanche Garcia	IH Cantabria (Spain)
Marta Casas Agudo	in2sea (Portugal)
David Jones	Marine Energy Wales (UK)
Jochem Weber	NREL (USA)
Atsuhiko Umeda	Ocean Energy Association (Japan)
Rémi Gruet	Ocean Energy Europe
Simon Cheeseman	ORE Catapult (UK)
Deborah Greaves	Plymouth University (UK)
Freyr Sverrisson	REN21 - global renewable energy policy network
Michael Bullock	Renewable Risk Advisers (UK)
Caroline Bragg	RenewableUK (UK)
Michelle Howell	Scottish Investment Bank (UK)
Maria Olsson	Swedish Energy Agency (Sweden)
José Luis Villate	Tecnalia (Spain)
Diego Vicinanza	University of Campania Luigi Vanvitelli (Italy)
Henry Jeffrey	University of Edinburgh (UK)
Tim Hurst	Wave Energy Scotland (UK)
Stuart Herbert	Wave Hub - Pembroke Demonstration Zone (UK)
Philippe Baclet	WEAMEC - West Atlantic Marine Energy Center (France)

Heather Worley	World Bank Group

Project and Technology Developers

Name
Atlantis Resources - Meygen
AW-Energy
Corpower
DCNS
DP Energy
ENEL
Grey Island Energy
Laminaria
Magallanes Renovables
Marine Power Systems
Nova Innovation
Oceantec
OpenHydro
RESEN WAVES
SABELLA
Schottel
Scotrenewables Tidal Power
Tocardo
Wave Piston
Waves4Power
Wedge

Executive summary

The scope of this study is to:

- estimate the financial needs of the ocean energy sector in the EU;
- identify and analyse potential financing gaps and possible financing solutions;
- analyse recommendations of the ocean energy roadmap in that context.

Three scenarios have been developed: Optimistic, (all projects in the pipeline are deployed and start at the proposed date), Medium (all projects are deployed, but some are delayed), Pessimistic (projects are delayed and some are cancelled).

Main findings:

- In an optimistic scenario, given the current level of political support, about 3.9 GW of cumulative installed capacity are expected globally until 2030. The capacity falls to 2.8 GW in a medium scenario and to just above 1.3 GW in a pessimistic scenario.

- Europe is to keep its global leadership in the ocean energy sector by 2030.

- Tidal stream is expected to take off over the next few years. Even though not modelled in the analysis, the success of a few key projects, such as MeyGen and Cape Sharp Tidal may drive the sector further.

- Most of the financial resources injected in the sector come from private equity.

- Like any other form of renewable energy, ocean energy tends to have relatively higher capital expenditure costs (e.g. installing devices in the water) but lower operational expenditure costs (e.g. maintenance, fuel, etc.). Therefore, if projects prove to be successful, in time the initial investments will be repaid by the capacity generated, which will come at lower operational costs than the carbon sector. The LCOE of fossil energy might remain lower than ocean energy’s for a long time; but the higher CAPEX/OPEX ratio of ocean energy is promising because it reveals that money is being spent to create long-term value. Furthermore, cost reductions in capital expenditures per unit of power are expected with an increase in project capacity and overall cumulative installed capacity, meaning that there is real potential for LCOE reduction for ocean energy technologies. The target of 10c€/kWh could be reached once 10 GW are installed, which could happen by 2030 for tidal stream and 2035 for wave energy, according to Ocean Energy Europe and TP Ocean.

- If we exclude tidal range, in an optimistic scenario, the investments until 2030 amount to 9.4 billion euros in Europe, 7 billion euros in a medium scenario and 2.8 billion euros scenario.

- Over 6 billion euros have been invested worldwide into projects so far, 75% of which from private finance.

- In the EU and between 2007 and 2015 alone, 2.6 billion euros have been invested in the ocean energy sector, 75% coming from private corporate investments. The European Commission has provided support with more than 200 million EUR through its research funding programmes. Another billion EUR has been spent (part of it has been earmarked and will be spent by 2020) by Member States and local governments through EU structural funds as well as own programmes.

- Ocean energy projects can generate revenue by selling power to the grid or to a third party (e.g. a port). The revenue will depend on the price at which the energy produced is sold. The levelised cost of electricity (LCOE) for ocean energy is still relatively high compared with other forms of renewable energy. LCOE could be reduced by reducing capital expenditure, sharing infrastructure, or devising demand pull mechanisms to support revenue.

- "Feed-in tariffs" are the most common pull mechanism. They are government mandated subsidies requiring utilities to purchase energy at a subsidised, higher-than-market rate. This support is fundamental to enable the sector to grow until it reaches a level of maturity to compete on the market.

- The study has confirmed that there are several funding instruments at national and EU level for prototypes and demonstration projects. What is lacking is a critical mass of finance to further develop the sector and scale it up to a fully commercial dimension. Ocean energy projects are usually too capital-intensive for venture capitalists and too risky for private equity. By the same token, borrowing from banks is often too costly. As a result, private investment in the ocean energy sector often involves own financing. While on the one hand this shows a certain dynamicity and optimism in the sector, on the other it seriously limits the overall availability of resources.

- By using public money to leverage private capital, the funds proposed in the Ocean Energy Roadmap might accompany the industry until it reaches the desired level of maturity. However, the funds alone will most likely not be sufficient to reach the tipping point after which the sector can stand on its own feet, without strong and stable public support. The injection of public money via the funds will certainly lower the level of risk for private investors, but these will continue seeking investments based on projected returns. Hence, a form of revenue support is of paramount importance to accompany the funds and maximise their effectiveness. It is thus highly recommended to take action towards the implementation of revenue support mechanisms, as much as possible consistent across Member States, so as to create certainty.

Besides legislative and financial support, forward looking and determination are key. Offshore wind – now considered as a mature sector, albeit still subsidised – took 13 years to reach one GW of capacity installed in Europe; then less than three years to double that, and by 2012 – only 5 years after the first GW – there already were 5 GW installed in Europe. It cannot be taken for granted that ocean energy will follow the same path, but a clear vision and stable support will pay off in the long run.

Introduction

The Commission adopted a Communication on Blue Energy[1] in 2014. With this Communication, it recognised the immense potential of harnessing the power of the seas and oceans. It also acknowledged that blue energy could make a substantial contribution to providing clean, predictable, indigenous and reliable energy in the future.

Further to the Communication, the Commission set up the Ocean Energy Forum. It offered a place where governments, industry, financers and stakeholders were able to meet and work together on a structural basis to discuss a strategic framework for the development of ocean energy sources.

In November 2016, the Ocean Energy Forum delivered an Ocean energy strategic roadmap "building ocean energy for Europe". This roadmap provides a detailed analysis of on-going and potential developments, as well as challenges of the ocean energy sector. It also proposes recommendations for action.

This report is structured in four main chapters. The first chapter reports the findings from a data collection exercise carried out in view of building a set of scenarios that can provide solid estimates on near to medium term financial needs of the ocean energy sector.

The second chapter analyses the investments necessary to install the estimated capacity, based on the same data sources as the first chapter.

The third chapter addresses the financial challenges and barriers to private investment in the ocean energy sector, also drawing comparisons with other renewable energies, most notably offshore wind. The chapter also gives an overview of possible funding sources and prevailing business models.

Finally, the fourth chapter proposes recommendations to address actions 2 and 3 of the Ocean Energy Roadmap:

- Setting up a 250 million EUR Investment Support Fund providing flexible capital and enabling further private capital to be leveraged;
- Setting up a 50-70 million EUR Insurance and Guarantee Fund for ocean energy demonstration and pre-commercial projects, covering risks that are currently not covered by either insurance products or manufacturers guarantees.

Starting from the requirements laid out in the Ocean Energy Roadmap, inputs from the survey and relevant experiences were looked at in view of recommending a possible structure for the two funds.

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[1] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, Blue Energy, Action needed to deliver on the potential of ocean energy in European seas and oceans by 2020 and beyond. COM(2014) 8 final.

1 Ocean Energy Pipeline

1.1 Data collection methodology

The data collection activity was carried out in three stages.

In the first stage, project and technology developers were surveyed, based on a survey developed by Ocean Energy Europe. The questions asked dealt with project pipeline, information on capacity planned, start of operation and project duration, expected costs and financing methods. The survey was sent to 97 technology and project developers, of which 21 responded.

This data had thus to be supplemented with information from WavEC's Ocean Energy Database, and other public databases, such as the OES database[2], renewableUK database[3], openEI database[4] and Tethys database[5].

WavEC's Ocean Energy Database[6] focuses on wave and tidal technologies and projects, with detailed information on all the areas related with technology and project development. Over 300 open water projects are included in the database, from proof-of-concept to pre-commercial deployment. The database is constantly updated and upgraded.

For data related with tidal range and OTEC, the other public databases and news sources were used.

Lastly, as far as wave and tidal streams technologies are concerned, since the data from the surveys and from WavEC's ocean energy database focus on planned projects starting until 2020-2022, further capacity was estimated by simulating new projects each year. For tidal barrage and OTEC technologies no additional capacity was estimated, considering that no further sizable projects are likely to be proposed and built in the medium term.

The number of new projects per year was simulated for 2018-2050, based on TRL, typical duration, average number of project per year and forecast growth. Although this data is generated for the period from 2018 to 2050, the analysis is performed for the medium term (2017-2030).

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[2] IEA-OES, 'OES | GIS Map Page'.

[3] renewableUK, 'UKRED Marine Map'.

[4] US DOE and NREL, 'Marine and Hydrokinetic Technology Database | Open Energy Information'.

[5] PNNL, 'Tethys | Environmental Effects of Wind and Marine Renewable Energy'.

[6] The JRC's Ocean Energy database, focusing on operational and decommissioned projects, was initially developed by WavEC, and was subsequently updated by the JRC. At the time of the writing, a new update by WavEC has been commissioned. The data on both databases can be considered on par in terms of past projects.

1.2 Results from data collection

1.2.1 Surveys

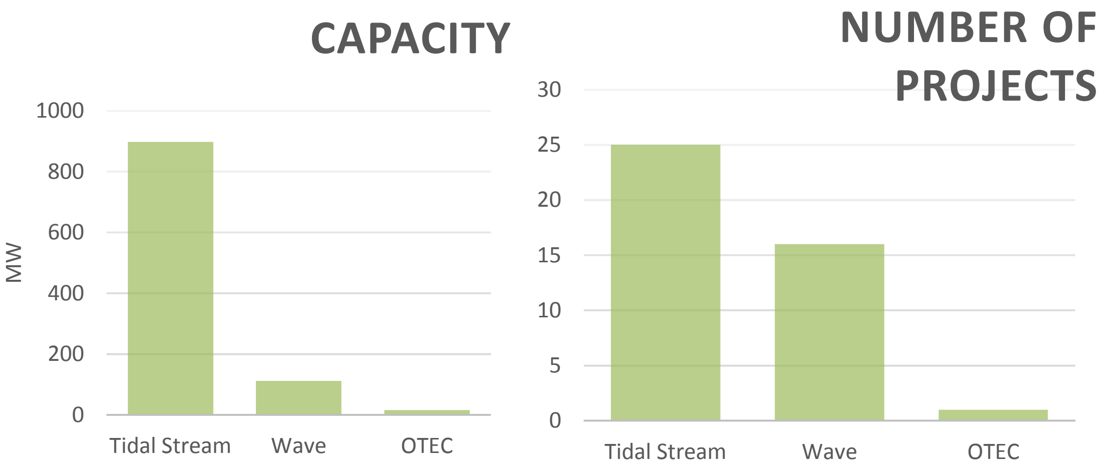
Of the 97 technology and projects developers contacted, 21 responded providing information on future projects. A total of 47 projects of wave, tidal stream and OTEC were reported. Of these, one is already operational.

One project was reported to have further capacity planned/proposed (for which the survey had no separate data), which was thus split in two separate phases. The first, starting 5 years after the initial project, with 1/3 of the capacity, and the second two years after the first phase, with the remainder capacity.

Another project, reported by the developer as a large capacity project, is dependent on grid improvements in the region, which are planned, at the soonest, in 2022. Furthermore, publicly available sources indicate that the project is also likely to be deployed in phases. Therefore, this project was split in four different phases, staggered by 3 years.

The data from the surveys, after the changes detailed in the previous paragraphs, covers projects starting from 2015 to 2021 for wave, 2017 to 2032[7] for tidal stream, and only one OTEC project occurring in 2020. The data from the surveys, after the changes detailed in the previous paragraphs, covers projects starting from 2015 to 2021 for wave, 2017 to 2032[8] for tidal stream, and only one OTEC project occurring in 2020.

Figure 1 - Capacity and number of projects reported in the surveys, according to technology (Europe)



A total 897 MW of tidal stream across 25 projects are reported for the next few years. There is less capacity projected for wave energy, 111 MW in 16 projects. For OTEC only one 16 MW project was reported, for an overseas region of Europe. Additional capacity will be installed outside Europe, although it may be difficult to quantify, due to lack of information. The available data tell us that there will be at least 67 more MW of tidal stream (8 projects) and 10 more MW of wave energy (2 projects) that will be installed outside Europe over the next few years.

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[7] If accounting only for the data reported by developers, without changes into different project phase, tidal stream projects start dates cover the period from 2017 to 2023.

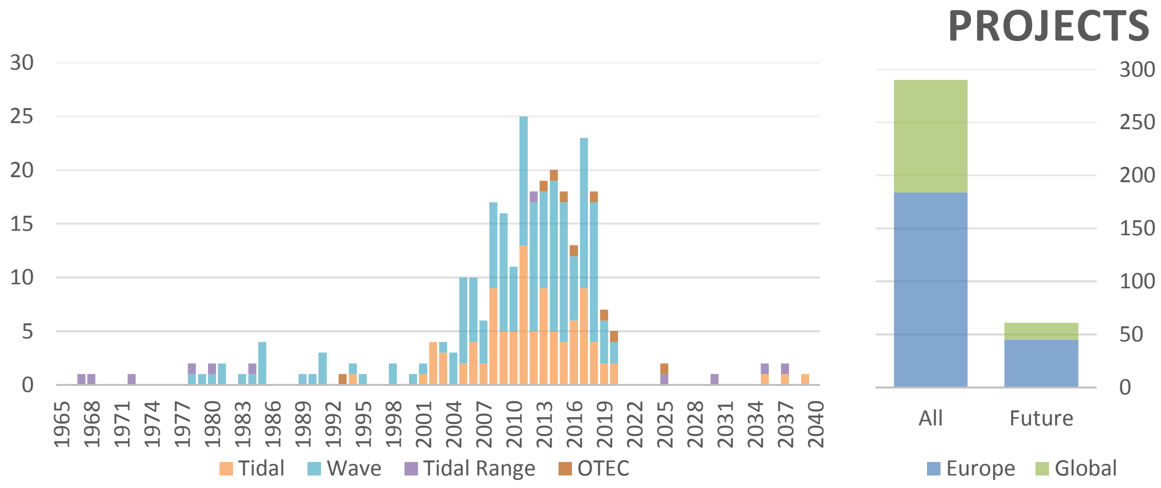
[8] Magagna and Uihlein, *2014 JRC Ocean Energy Status Report*.

1.2.2 WavEC Ocean Energy Database and other public databases

The data from the databases covers projects starting from 1978 to 2020 for wave, 1994 to 2039 for tidal stream, 1967 to 2037 for tidal range, and 1993 to 2019 for OTEC. For wave and tidal, the great majority of projects are between 2001-2017. Tidal stream and tidal range projects are mostly located in Europe, while OTEC projects are mostly located outside of Europe. The OTEC projects that are counted as in Europe, are in overseas territories: La Martinique (FR) and Curaçao (NL).

In the following figures, the number of projects and associated installed capacity is shown for the data from the databases. These figures separate between 'all data', and only 'future data'. Future projects correspond to those starting from 2018. All-data projects include future projects, and past projects either decommissioned or operational, that have been successfully installed and operated at sea or relevant environments (from TRL 4 onwards)

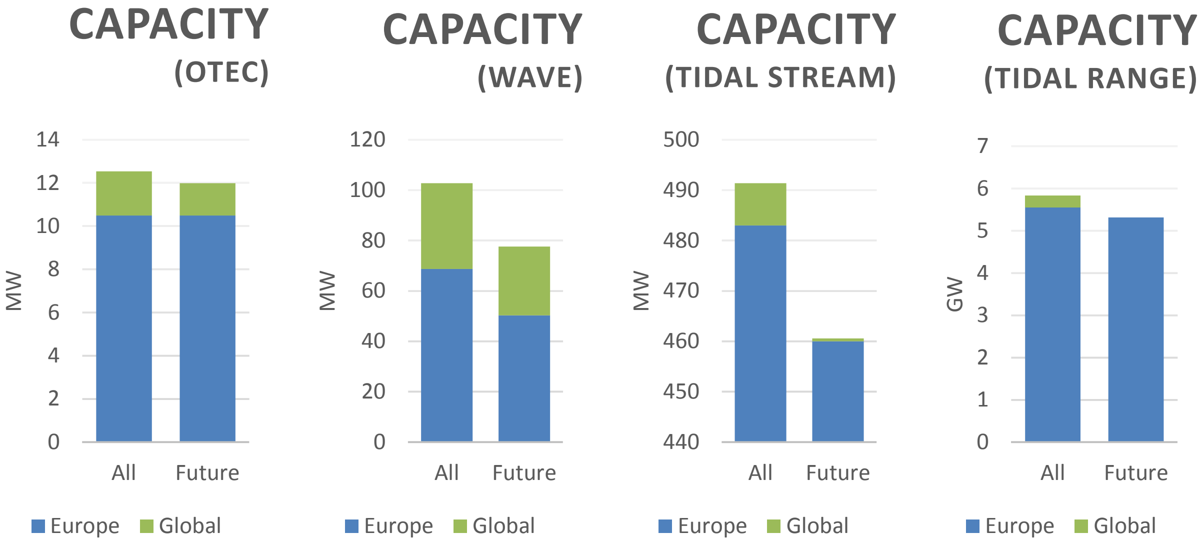
Figure 2 - Number of projects from the database according to time period (1965-2040), and location



Overall, the projects in the database amount to 6.45 GW, 95% located in Europe. Of these, 5.87 GW are future capacity, 99% of which planned for Europe, even though it should be noted that comparatively less information is available for non-EU countries. Most of the capacity planned is in tidal range projects (91%), while OTEC projects contribute only to a very minor extent (0.2%). The graphs should come with a caveat: they are based on the number of projects that have already been announced, therefore they do not include a forecast of how many projects are likely to be developed in the future, which explains why there is so little activity reported in the period post 2019.

In spite of a lower number of projects, tidal stream contributes to a higher percentage of capacity than wave (8% vs. 2%).

Figure 3 - Capacity for Europe and globally according to technology



1.2.3 *Generated data*

For wave and tidal stream technologies, further capacity was estimated to complement the data reported by developers and on the databases. This was done by simulating new projects each year, for TRLs 4 to 9.

For each TRL and type of technology, a typical capacity was assumed, based on the median values from the databases and surveys.

The number of projects each year was calculated based on the average number of projects per year from the period 2013-2017, in order to account for the current trend of new projects. A factor of 1.3 was applied to account for projects that were abandoned/cancelled which are absent from the database used for this report. This factor is based on data from WavEC's database and archival news of projects that have been cancelled in the past.

The evolution of new projects each year, for each TRL, was calculated assuming that a peak level will be achieved, after which the number of projects will decrease. This assumption is also valid for TRL 9, corresponding to pre-commercial projects, as these represent new projects each year, and as technologies/projects are established, fewer sites will be available, and those that are will be less economical.

The peaks for each TRL are offset from each other, in the assumption that as low TRL technologies are tested, some will advance to test at higher TRL, and the sector as a whole will advance towards higher TRLs.

The inputs used for the generated new projects are presented on Table 1 (wave) and Table 2 (tidal stream). The average project capacity and duration was calculated using the median results from the surveys and database data. The average number of projects per year was calculated based on the 5-year average (2013-2017). The average project capacity and duration was calculated using the median results from the surveys and database data.

Table 1 - Inputs for new wave projects

TRL	Avg. Project Capacity (MW)	Avg. Duration (years)	Avg. Projects/year (2017)	Max Value (no of projects)	Years until maximum	Value in 2050 (No of Projects
4	0,04	1	0,3	3	3	1
5	0,1	1	5,5	7	7	1
6	0,2	3	4,7	6	12	1
7	0,8	4	1,3	6	17	2
8	2	10	0,3	5	23	2
9	50	25	0,0	4	27	2

Table 2 - Inputs for new tidal projects

TRL	Avg. Project Capacity (MW)	Avg. Duration (years)	Avg. Projects/year (2017)	Max Value (no of projects)	Years until maximum	Value in 2050 (no of Projects
4	0,01	0	2,3	4	1	1
5	0,1	1	2,6	6	3	1
6	0,5	5	1,6	8	6	1
7	1	15	1,6	7	10	3
8	20	20	0,8	7	15	2
9	124	25	0,0	3	21	1

The evolution of the number of new projects each year is presented in Figure 4, and the evolution of new capacity in Figure 5. While there is a decrease in new installations, especially at low TRLs, the total operational capacity will be increasing, as projects from TRL 8 to 9 will be in operation for 10 to 25 years.

Figure 4 - Number of new projects by year and TRL for wave and tidal stream

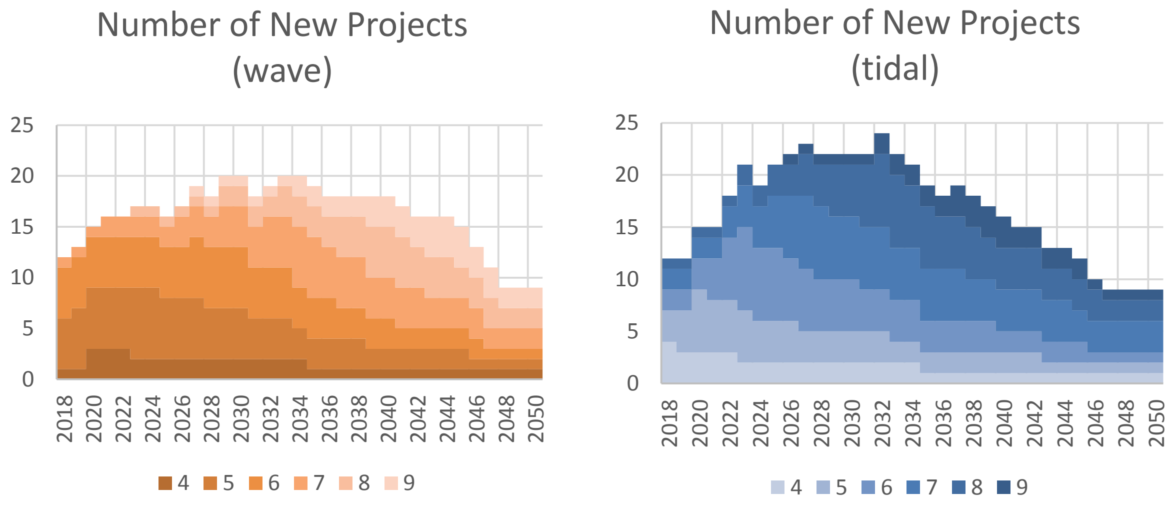
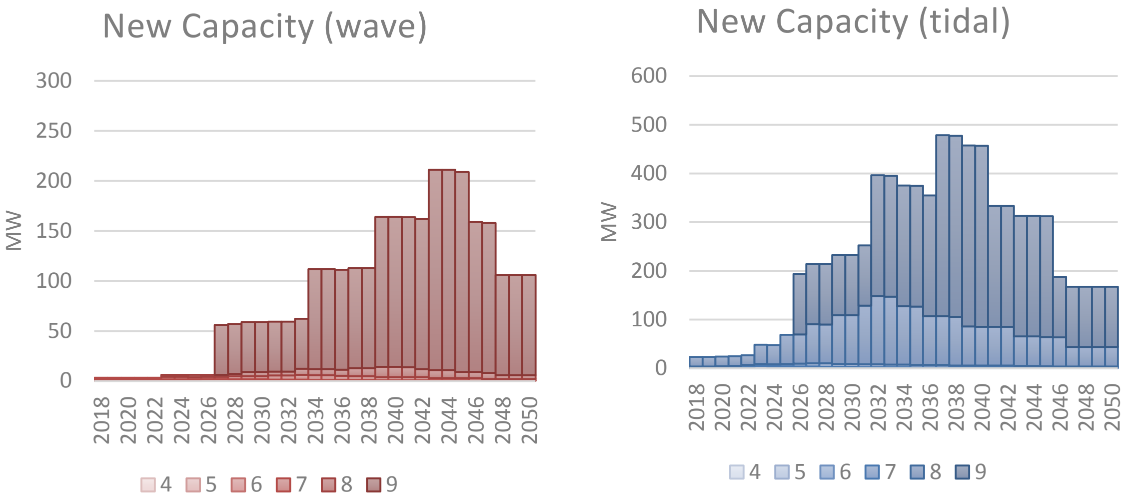


Figure 5 - New capacity by year and TRL for wave and tidal stream



The cumulative capacity was calculated based on the typical project capacity and the simulated number of new projects per year. Combined with the data from developers and from WavEC's ocean energy database, the forecast global capacity for wave and tidal was compared with the figures for maximum potential published by the JRC[9] in the 2014 Status report. The figures were then compared also to the 2016 status report[10], however, this report only publishes figures for 2020.

In the tables below the total capacity values for wave and tidal stream is shown and compared with the maximum potential reported in the JRC's forecasts up to 2050. The percentage of total capacity that relates to projects communicated by developers and publicly announced is also shown.

Table 3 - Comparison of wave energy capacity pipelines used in the analysis and JRC forecast

Year	From Surveys & DB (GW)	Estimated (GW)	Total (GW)	JRC (2014) Maximum potential (GW)	% of JRC	% from Surveys & DB
2020	0.138	0.007	0.146	0.19	77%	95%
2030	0.225	0.266	0.491	1.9	26%	46%
2040	0.225	1.335	1.560	2	78%	14%
2050	0.225	2.927	3.152	3.2	98%	7%

For wave energy, the total pipeline is within 68-91% of the maximum potential values, with the exception of 2030, in which the JRC values foresee a rapid increase compared with 2020, which is not mirrored by the analysis in this report. In the analysis period, the percentage of capacity from generated data varies from 5% (2018) to 54% (2030).

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[9] Magagna and Uihlein, *2014 JRC Ocean Energy Status Report*.

[10] Magagna, Monfardini, and Uihlein, *JRC Ocean Energy Status Report: 2016 Edition.*

Table 4: Comparison of tidal stream energy capacity pipelines used in the analysis and JRC forecast

Year	From Surveys & DB (GW)	Estimated (GW)	Total (GW)	JRC Maximum potential (GW)	% of JRC	% from Surveys & DB
2020	0.545	0.071	0.616	0.4	154%	89%
2030	1.013	1.375	2.388	2.9	82%	42%
2040	1.455	5.395	6.850	3.1	221%	21%
2050	1.455	7.858	9.313	10	93%	16%

As far as tidal energy is concerned, there is less agreement between our estimates and the JRC's. For 2020, the total capacity is over the maximum potential estimated by the JRC in 2014. This figure has been updated in 2016, from 400 MW to 600 MW. Our estimate matched this new forecast, with 89% of the pipeline comes from data supplied by developers and from publicly announced projects. As with the wave case, the maximum potential in 2030 and 2040 is very similar. In the analysis period, the percentage of capacity from generated data varies from 21% (2018) to 58% (2030).

When it comes to the analysis at European level, a percentage of the total capacity is assumed to correspond to projects deployed in European countries, broken down by technology type. The percentages are reported in the table below, based on the data from the surveys and the databases. The values for 2017 are calculated based on the operational and decommissioned projects to date, and the values for 2025 are based on future projects. For 2020, an average value is assumed. For 2030, the value is calculated based on a quadratic decrease towards 2050.

Table 5 - Percentage of capacity in Europe

	2017	2020	2025	2030
Wave	75%	80%	95%	94%
Tidal	73%	79%	81%	80%

1.3 Scenario definition

Using the previously detailed data, three scenarios were defined for analysis. The analysis assumes a pipeline approach, in which a pipeline of future projects is used as the forecasting method. Statistical data was used when available to complement the pipeline information. It should be noted that all the three scenarios assume that the current level of public support to the ocean energy sector is maintained.

The three scenarios are developed:

- OPTIMISTIC

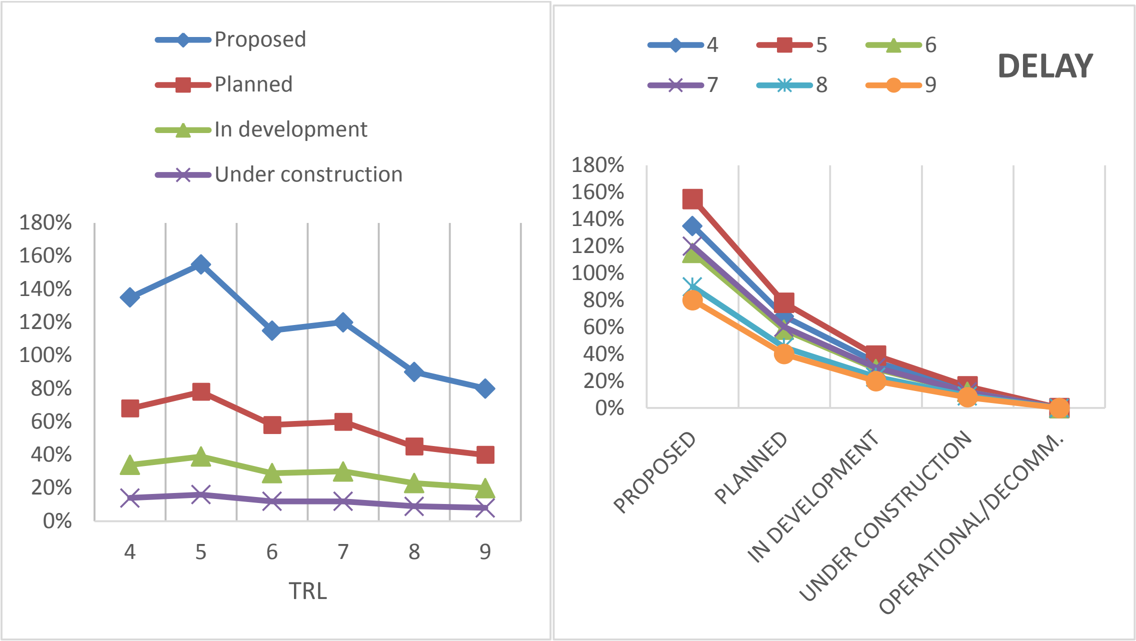
Assumes that all projects (both from the survey and from our estimates) are deployed, starting at the proposed start date.

- MEDIUM

Assumes that all projects are deployed, but some are delayed. The delay is a function of the present status of the project (whether it has started, and/or the permitting and licensing process has been completed) and how far ahead it is planned for, modified by the TRL and the technology. For the survey data, as there is information of the amount already committed to finance the project, this is taken into consideration to calculate the delay rate.

This rate generally decreases along the TRLs. However, for TRL 5 and 7 there is an increasing delay, as there is typically a scale change that triggers the need for higher financing, which may lead to delays – the commonly known valley of death. The rate also decreases as the status of the project approaches the operational phase.

Figure 6 - Delay rate based on TRL and Status, to be used in the medium and pessimistic scenario (not modified by technology)

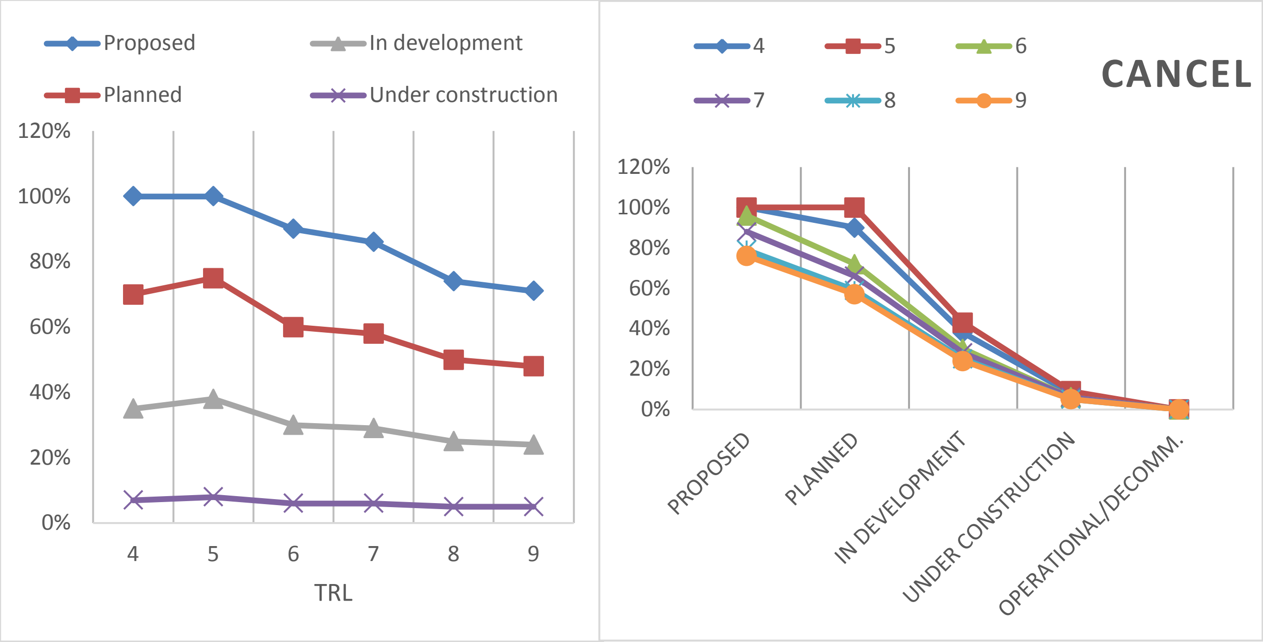


- ❖ PESSIMISTIC

In the pessimistic scenario, it is assumed that projects are delayed, under the same assumptions as the medium scenario, but some of the projects are cancelled. The decision of cancelling a project is randomly generated, and the threshold for cancellation is a function of the status of the project, modified by the TRL and the technology. For the survey data, as there is information of the amount already committed to finance the project, this is taken into consideration to calculate the cancel threshold.

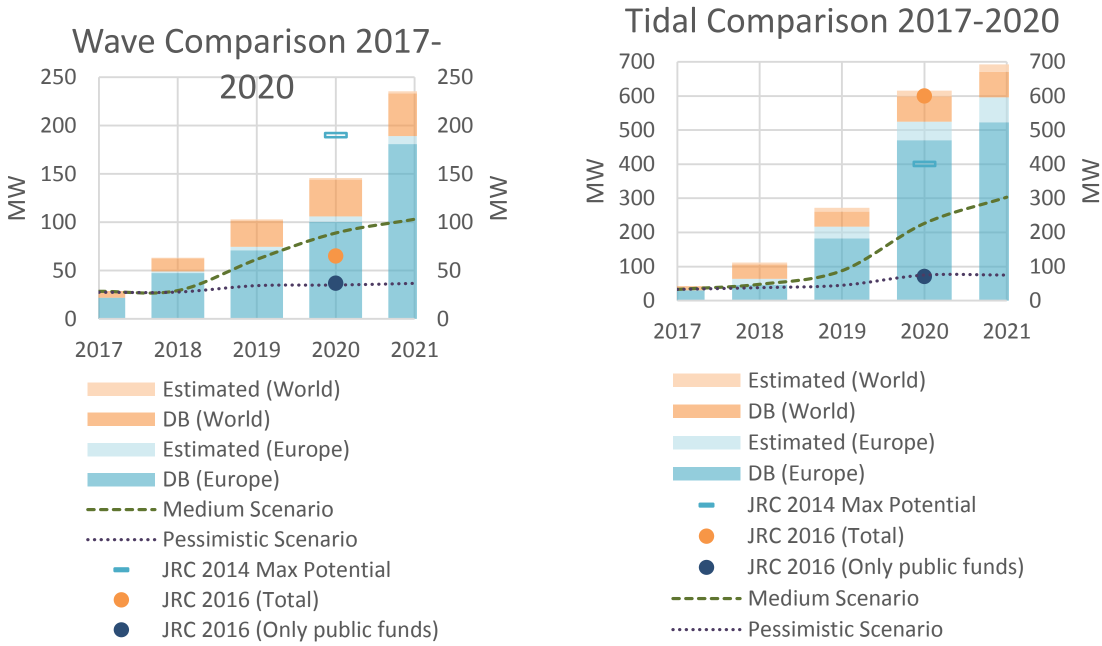
Just like the delay rate, this threshold generally decreases along the TRLs. However, for TRL 5 there is an increase in cancellation of projects, as many projects fail when moving towards testing in open sea. The rate also decreases as the status of the project approaches being operational.

Figure 7 - Cancel threshold based on TRL and Status, to be used in the medium and pessimistic scenario (not modified by technology)



The graphs below compare the scenarios for wave and tidal stream with the published forecast data from the JRC for 2020, from both the 2014[11] and the 2016[12] report.

Figure 8 - Wave and tidal stream scenarios comparison with published forecasts for 2017-2020



Looking at the medium to long term, and comparing with 2014 Status Report[13] forecast, the figures below look at the optimistic scenario for the period of 2013 to 2050.

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[11] Magagna and Uihlein, *2014 JRC Ocean Energy Status Report*.
[12] Magagna, Monfardini, and Uihlein, *JRC Ocean Energy Status Report: 2016 Edition*.
[13] Magagna and Uihlein, *2014 JRC Ocean Energy Status Report*.

Figure 9 - Wave optimistic scenario comparison with published forecasts for 2013-2050

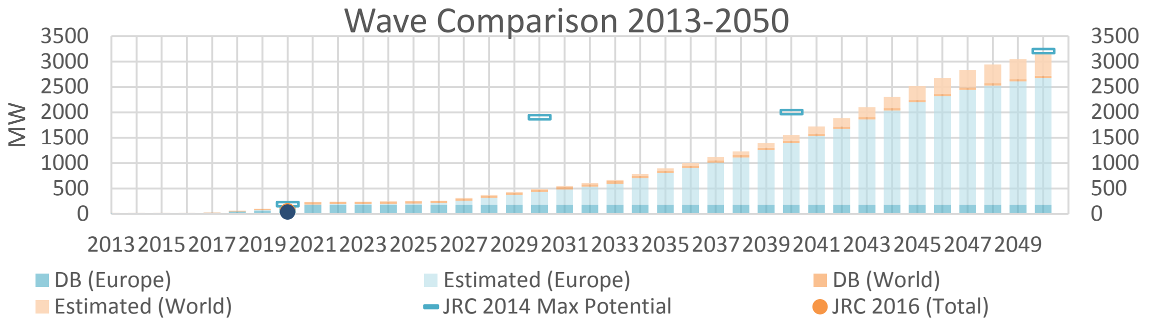
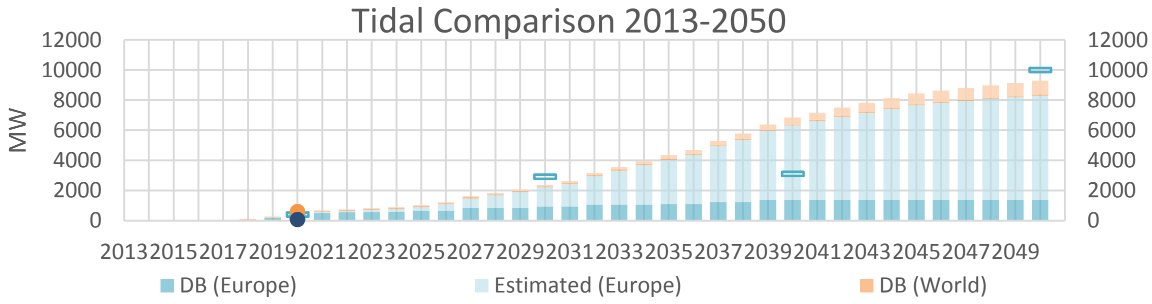


Figure 10 - Tidal stream optimistic scenario comparison with published forecasts for 2013-2050



1.4 Scenario Analysis

As with the previous section, it should be noted that comparatively less information is available for non-EU countries; therefore, the evolution of capacity and number of projects outside the EU might be underestimated.

1.4.1 Optimistic Scenario

Under the optimistic scenario, about 3.9 GW of cumulative installed capacity are expected globally until 2030, given the current level of political support. Of these, 86.7% will be deployed in Europe, and will be tidal stream, tidal range and wave (61%, 26% and 10% respectively). OTEC will contribute to a very minor extent.

The *tidal stream energy* capacity expected in 2030 is just under 2.4 GW, with 93% deployed in Europe.

The biggest growth in new capacity is expected to occur in the short term, between 2018 and 2020, with 400 MW[14] expected to be deployed, and only a few projects slated to be decommissioned. After 2020 and until 2026, with 800 MW of new capacity and only 20 MW decommissioned, the growth rate will be slightly lower than in the previous period. From 2026 until 2030 there will be more activity, with 1.1 GW new capacity installed and only 15 MW are expected to be decommissioned in that period.

Since most of the capacity will be installed in Europe, the trend in Europe follows the global one (Figure 11).

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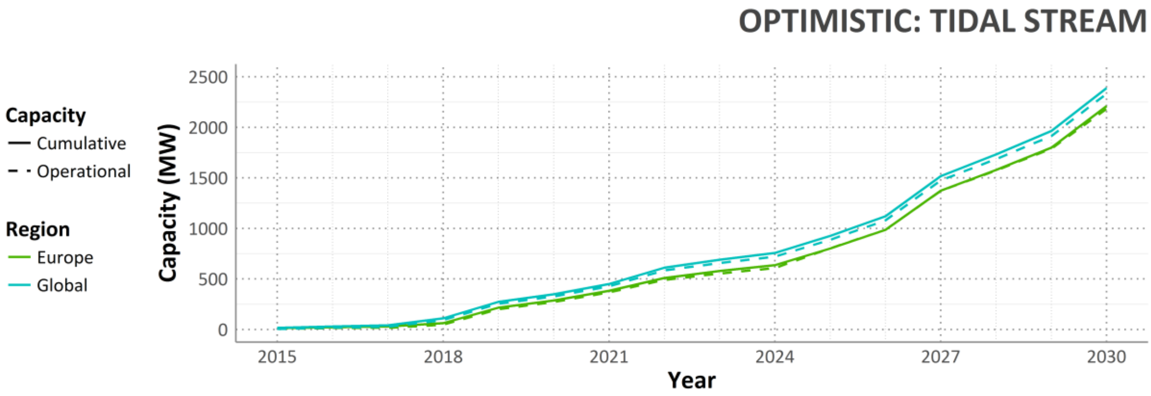
[14] Projects with higher capacities are likely to have a staggered deployment, even when separated into phases, with units becoming online at different times. This analysis does not cover staggered deployment beyond phased deployment (10-30 MW phases). This means that some of this capacity could also be spread over a few years.

In the case of tidal stream capacity, even though not modelled in this analysis, the success of a few key projects, such as MeyGen and Cape Sharp Tidal may drive the sector further, meaning that some projects may happen sooner (especially those slotted to 2025-2030) and there might be a wave of new entrants in the sector.

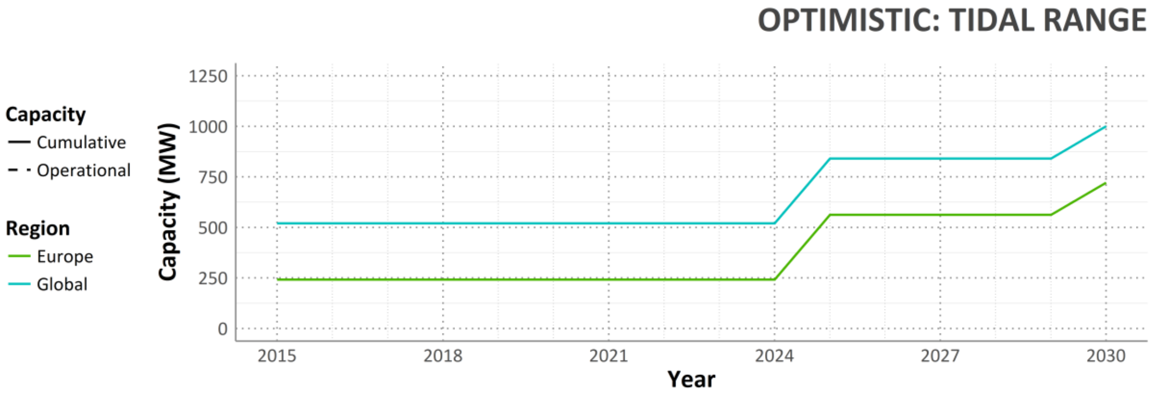
Figure 11 - Pipeline capacity: Optimistic Scenario – tidal stream



The *tidal range energy* capacity expected in 2030 is just over 1 GW, all of which operational, with 72% deployed in Europe. In this period, only 2 projects are expected to be deployed in the optimistic scenario, to 320 MW in 2025 and 160 MW in 2030, both in Europe (Figure 12).

As with tidal stream, the success of a key project (Swansea tidal lagoon) can accelerate the development of the sector, especially in the UK, where there are a few projects lined up, which depend on the approval and success of the Swansea bay one.

Figure 12 - Pipeline capacity: Optimistic Scenario – tidal range

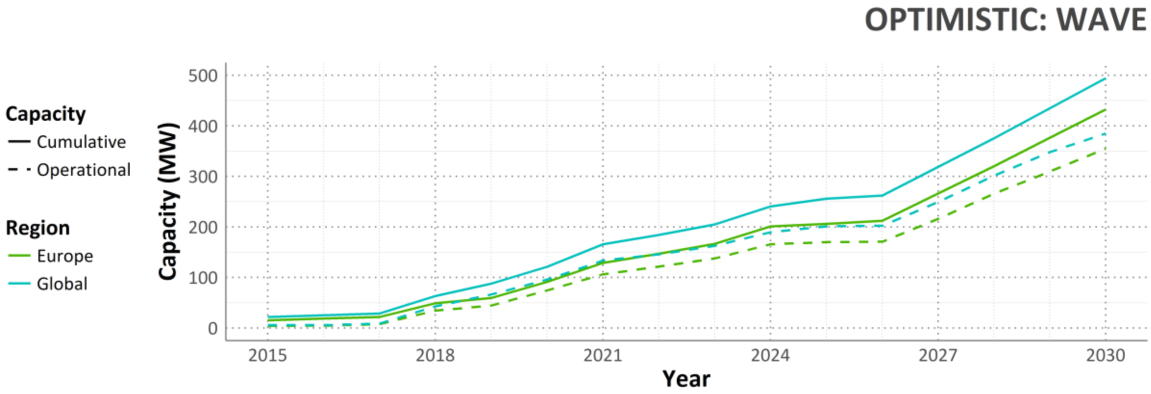


The *wave energy* capacity expected in 2030 is just under 0.5 GW, with 87.5% deployed in Europe. Considering the operational capacity, around 380 MW are expected to be online in 2030.

Between 2017 and 2021, 130 MW are expected to be deployed, with only 15 MW expected to be decommissioned in that period. After 2021, the growth rate slows down until 2026, with only around 100 MW installed, and 24 MW decommissioned in that period. From 2026 to 2030, there will be more activity, with 230 MW new capacity installed. At the same time, up to 50 MW are expected to be decommissioned in that period.

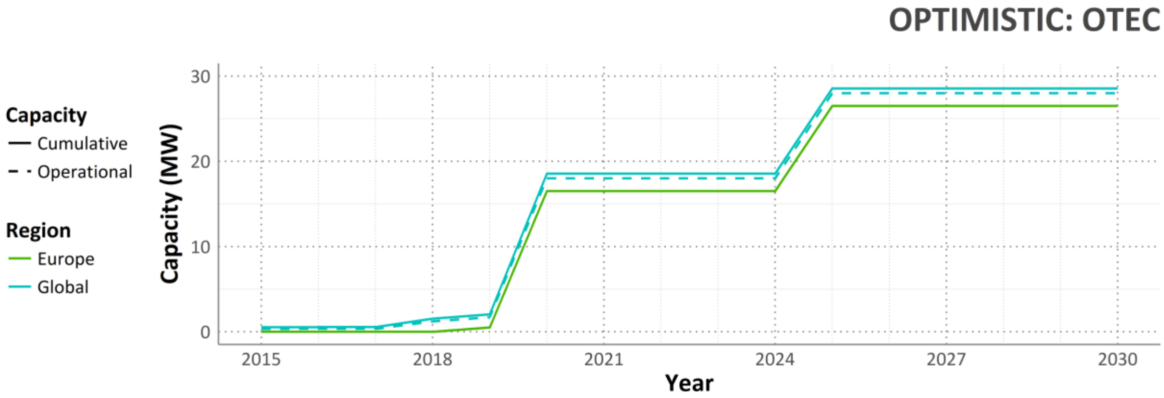
Since most of the capacity will be installed in Europe, the trend in Europe follows the global one (Figure 13).

Figure 13 - Pipeline capacity: Optimistic Scenario – wave



The *OTEC* capacity expected in 2030 is 28.5 MW, most of which operational and deployed in Europe. In this period, a few small projects are expected to be commissioned until 2019, but the medium term is dominated by a 16 MW project that will see the light in 2020 and a 10 MW project in 2025. All the European projects are set in overseas territories (Figure 14).

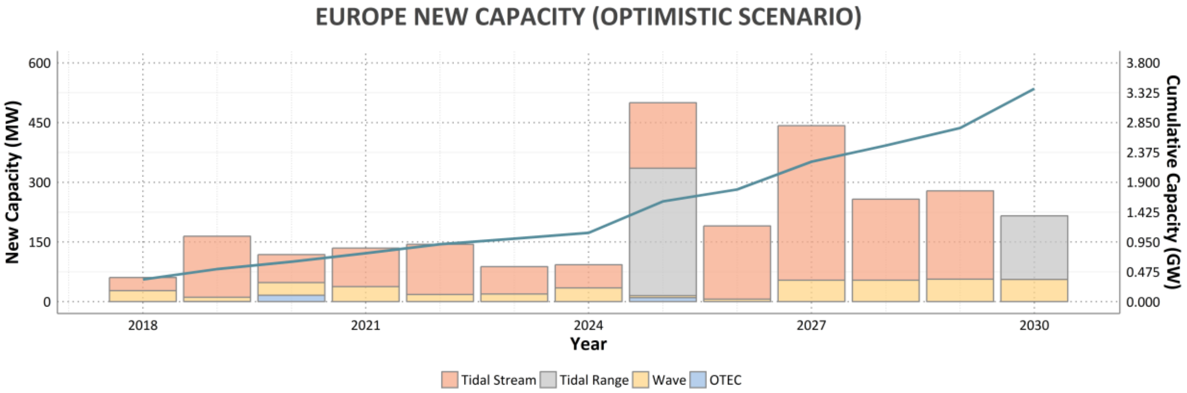
Figure 14 - Pipeline capacity: Optimistic Scenario – OTEC



Overall, the optimistic scenario is driven by tidal generation in the medium term – especially tidal stream, as there are only two projects expected for tidal range. However, these projects have a visible influence on the cumulative capacity. The effects of OTEC are negligible, and the impact of wave energy is also low.

Although there are peaks and throughs in terms of new capacity, there is a consistent rate of new deployments each year (Figure 15).

Figure 15 - New capacity by technology: Optimistic Scenario



1.4.2 Medium Scenario

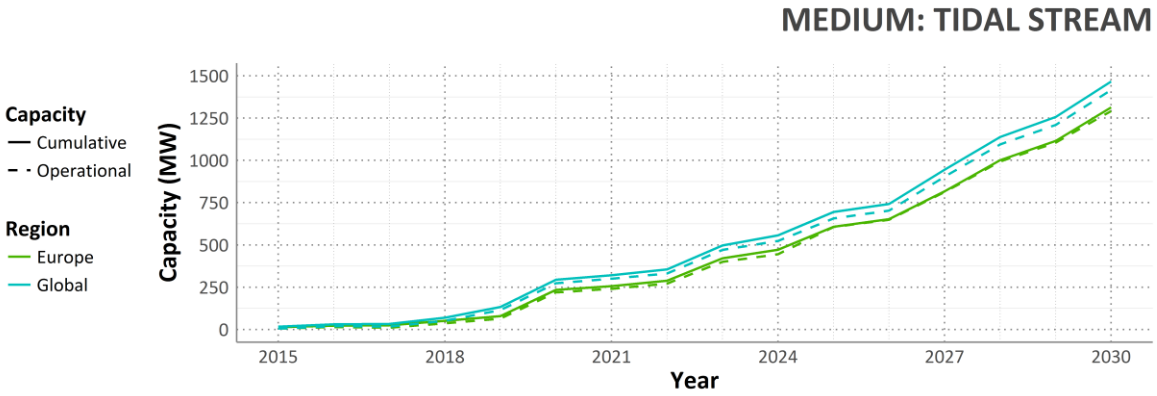
Under the medium scenario, the global cumulative installed capacity in 2030 is 2.8GW, given the current level of political support. It is a decrease of about 1076 MW compared to the optimistic scenario. 83% of this capacity will be deployed in Europe. The tidal range contribution increases (30%), despite one of the projects being outside the scope of the analysis, and thus not considered. Tidal stream is still a big contributor to ocean cumulative installed capacity (57%), followed by wave energy (13%). OTEC contribution remains the same (1%).

The expected *tidal stream energy* capacity in 2030 decreases to just under 1.6 GW (67% of the optimistic scenario), with Europe contributing to 90% of the capacity. Regarding the operational capacity, the decrease from one scenario to the other is equivalent to the cumulative capacity.

For the tidal stream medium scenario there is as steady growth rate from 2018 until 2020, with around 230 MW installed globally. From 2020 to 2022 the rate of growth decreases, with 60 MW of new capacity being installed. From 2022 and until the end of the analysis period there is a steady growth of capacity. Throughout the period of analysis there is very little capacity being decommissioned (around 35 MW), as most of the projects deployed in the very short term are expected to have a duration of about 10 to 15 years, and large capacity projects are expected to have a lifetime of 20-25 years.

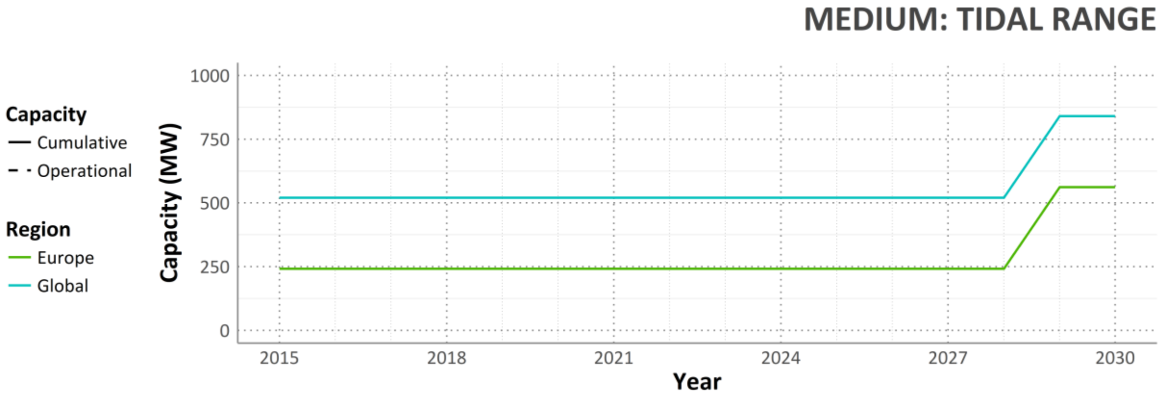
Like in the optimistic scenario, the European trend follows the global one (Figure 16).

Figure 16 - Pipeline capacity: Medium Scenario – tidal stream



The *tidal range energy* capacity expected in 2030 in the medium scenario is 840 MW (84% of the optimistic scenario), as the projects are delayed, and the one slated for 2029 now falls outside the period of analysis. The other project is also delayed, so the increase in capacity happens later in in the period. (Figure 17).

Figure 17 - Pipeline capacity: Medium Scenario – tidal range



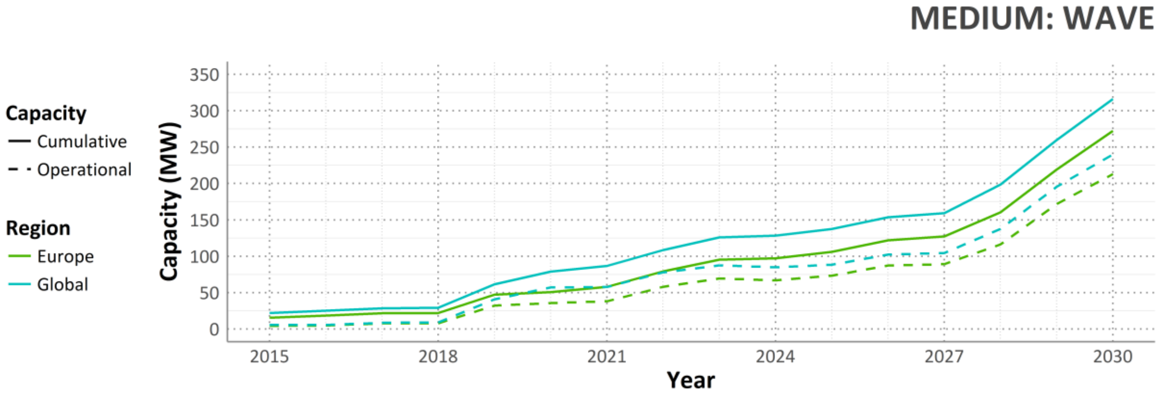
The expected *wave energy* capacity in 2030 is just under 370 MW, with 85% deployed in Europe. This represents roughly 75% of the cumulative and operational capacity of the optimistic scenario.

Regarding the rate of growth of the capacity, this is less accentuated for the period between 2017-2030. The rate of growth increases towards the end of the analysis period.

From 2017 to 2023, almost 115 MW of new capacity are expected, with 22 MW decommissioned in the same period. From 2023 to 2028, 56 MW of new capacity are added, and 19 MW are decommissioned. In the final two years of the analysis, there is a rapid increase of new capacity, with 170 MW of new installation and 15 MW decommissioned.

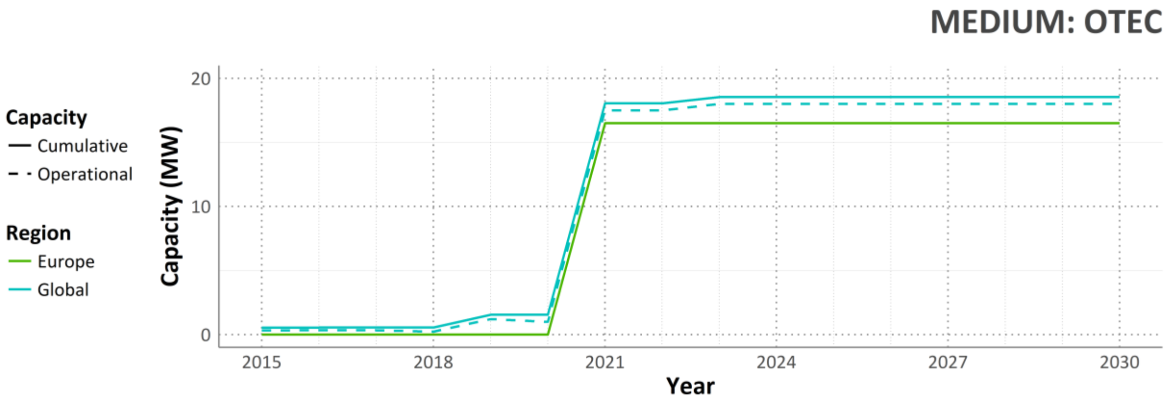
Compared with the optimistic scenario, for the period between 2017 and 2021, only there is less new capacity installed (75 MW vs. 206 MW), but the amount decommissioned is also lower (12 MW vs. 15 MW), as some of the short duration projects that would have happened in this period are delayed. The next period (2021-2026) however, sees a higher increase of capacity in the medium scenario (65 MW vs. 25 MW) as the delayed projects are installed. The final period (2026-2030) has a similar increase in both scenarios (200 MW in the medium scenario, and 230 MW in the optimistic). Like in the optimistic scenario, the European trend follows the global one, although the decrease of operational capacity is more strongly seen at a global scale (Figure 18).

Figure 18 - Pipeline capacity: Medium Scenario – wave



The *OTEC* capacity expected in 2030 in the medium scenario is 18.5 MW, a 10 MW reduction from the optimistic scenario. As with tidal range, the projects are delayed, so the peak in new capacity is delayed by one year, and the decrease of capacity in 2030 is due to projects being delayed beyond the period of analysis (Figure 19).

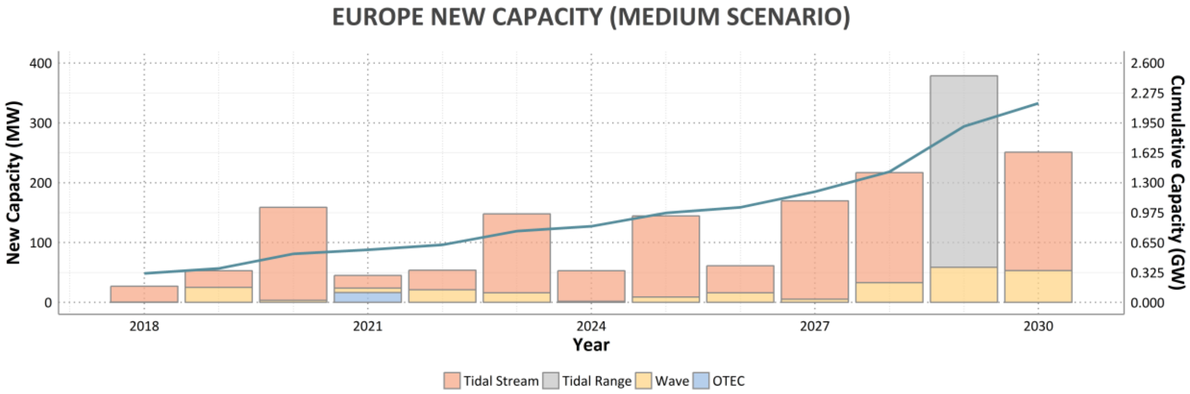
Figure 19 - Pipeline capacity: Optimistic Scenario – OTEC



In the medium scenario, the effects of the only tidal range project are still very visible. However, this happens towards the end of the analysis period. Tidal stream remains the largest contributor to ocean energy deployment.

The new deployments, excluding tidal range, are concentrated in the period from 2019 to 2023, reducing afterwards, before increasing again from 2017 towards the end of the analysis (Figure 20).

Figure 20 - New capacity by technology: Medium Scenario



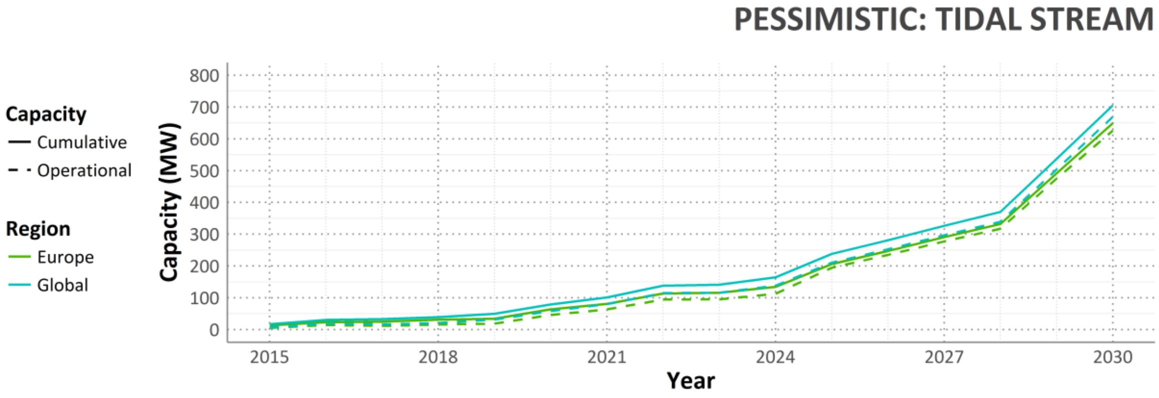
1.4.3 *Pessimistic Scenario*

Under the pessimistic scenario, given the current level of political support, the global cumulative installed capacity in 2030 is just above 1.3 GW, about 34% of the optimistic scenario, and 46% of the medium scenario. Around 73% of the capacity will be deployed in Europe. The tidal range contribution increases in relation to the previous scenarios (40%). Tidal stream contribution remains at the same level (54%), but wave energy contribution decreases to 5%.

In 2030, under the pessimistic scenario, *tidal stream energy* capacity decreases to just over 700 MW, about 44% of the optimistic scenario, with a European contribution of 92%.

Until 2028, the capacity trend is fairly consistent, with a pick-up of new installations between 2025 and 2028. Towards the end of the period of analysis the growth rate increases. The trend in operational capacity is also upward, as the new capacity is an order of magnitude higher than the decommissioned capacity (Figure 21).

Figure 21 - Pipeline capacity: Pessimistic Scenario – tidal stream



When it comes to *tidal range energy*, the pessimistic scenario foresees that no new capacity is installed or decommissioned in 2030. No graph is shown for this case.

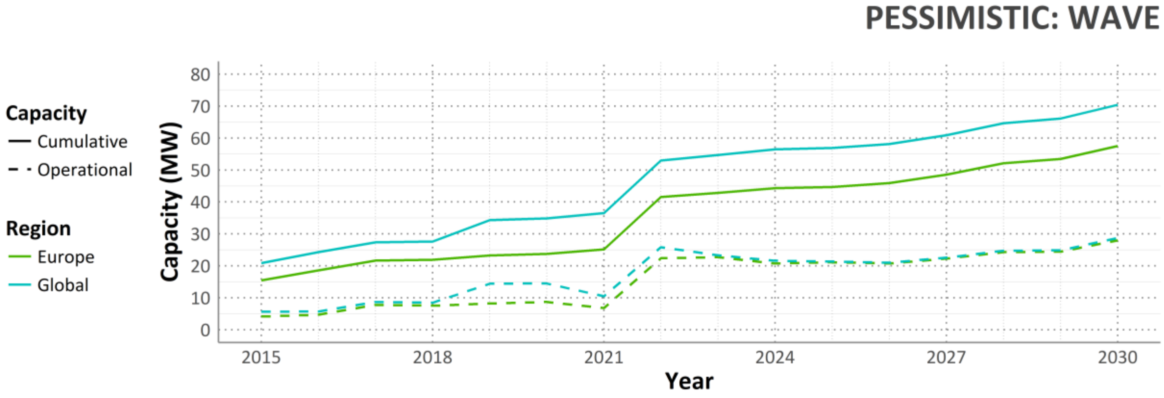
The *wave energy* capacity expected in 2030 is only 70 MW, about 19% of the optimistic scenario. Considering the operational capacity in 2030, the pessimistic scenario amounts to 7% of the optimistic scenario, and 10% of the medium scenario.

The pessimistic scenario sees an increase of installed capacity from 2018 to 2022, especially in 2022, and then a stagnation of the sector. From 2018 to 2022, around 25 MW of newly generated capacity are added globally, but from 2022 to 2030 the total new capacity drops to 17 MW.

While at the end of the period of analysis the operational capacity has risen, in the period between 2018 and 2021 the operational capacity decreases significantly (around 50%). This is due to projects currently operational being decommissioned, and not enough new capacity being installed to offset it.

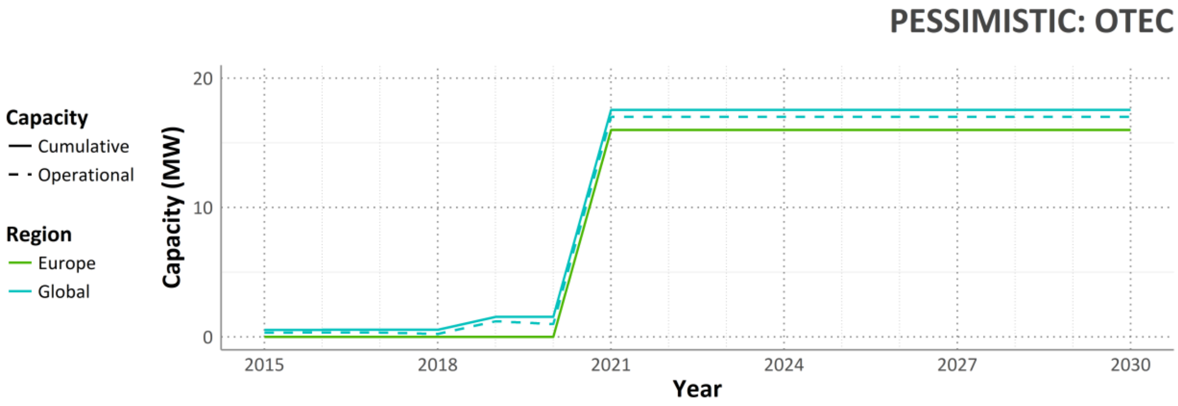
Like in the previous scenarios, the European trend follows the global one, although between 2019 and 2021 there is less new capacity being installed in Europe (Figure 22).

Figure 22 - Pipeline capacity: Pessimistic Scenario – wave



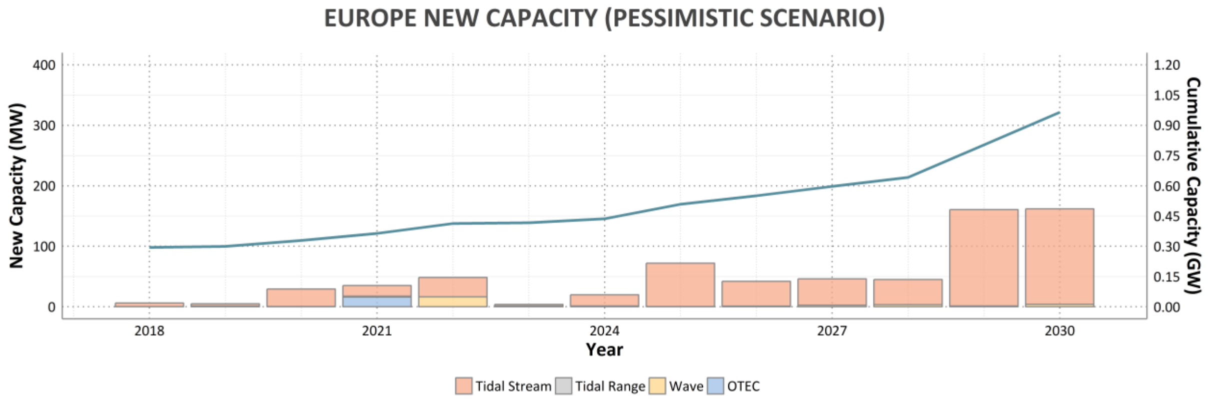
The expected *OTEC* capacity in 2030 under the pessimistic scenario is 17.5 MW. This means that small projects do not go ahead in this scenario, but the 16-MW project that dominates the previous scenarios is still present (Figure 23).

Figure 23 - Pipeline capacity: Pessimistic Scenario – OTEC



In the pessimistic scenario, the increase in ocean energy capacity is driven by tidal stream technology. The new capacity is concentrated in the final period of the analysis (2025-2030), especially in the final 2 years (Figure 24).

Figure 24 - New capacity by technology: Pessimistic Scenario

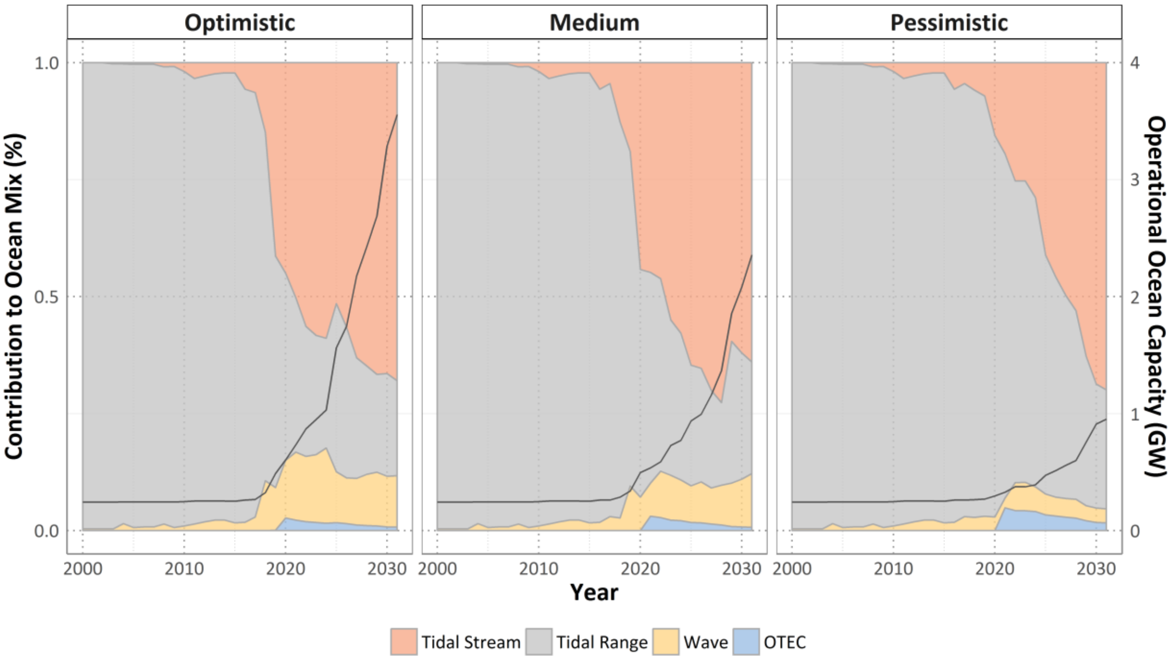


1.5 *Scenario Comparison*

1.5.1 *Operational capacity*

Analysing the operational ocean energy globally for all scenarios (Figure 25) makes a big contribution to the total operational capacity. This is more evident in the medium scenario, as tidal range new deployments are delayed. However, it is important to note that the total operational capacity reduces significantly across scenarios.

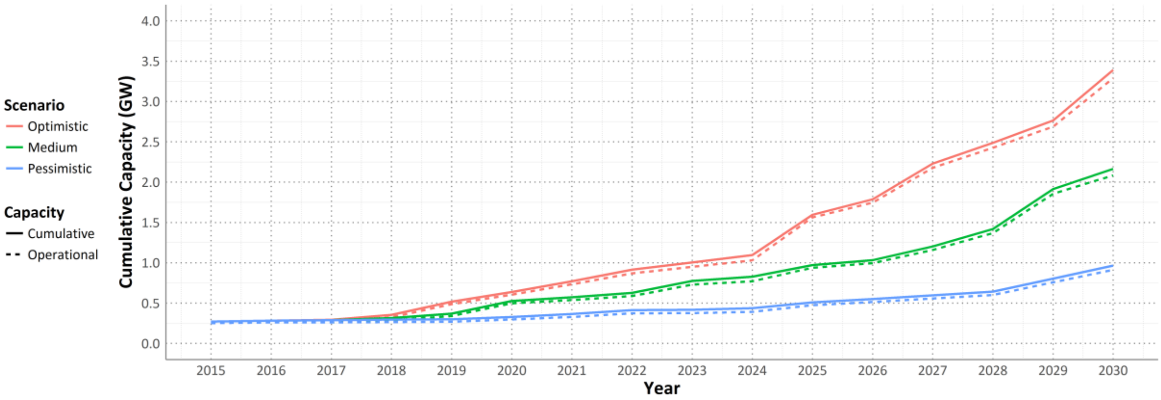
Figure 25 - Operational Ocean Energy (Europe)



1.5.2 *Installed Capacity*

As far as cumulative capacity is concerned (Figure 26), the optimistic scenario shows a steady rate of growth between 2018 and 2020, with a slower growth until 2024, before a more rapid growth until the end of the period of analysis, both globally and in Europe. Under the medium scenario, the growth rate is more consistent throughout the analysis. The pessimistic scenario shows a very slow, but steady rate of growth.

Figure 26 - Scenario comparison – ocean energy

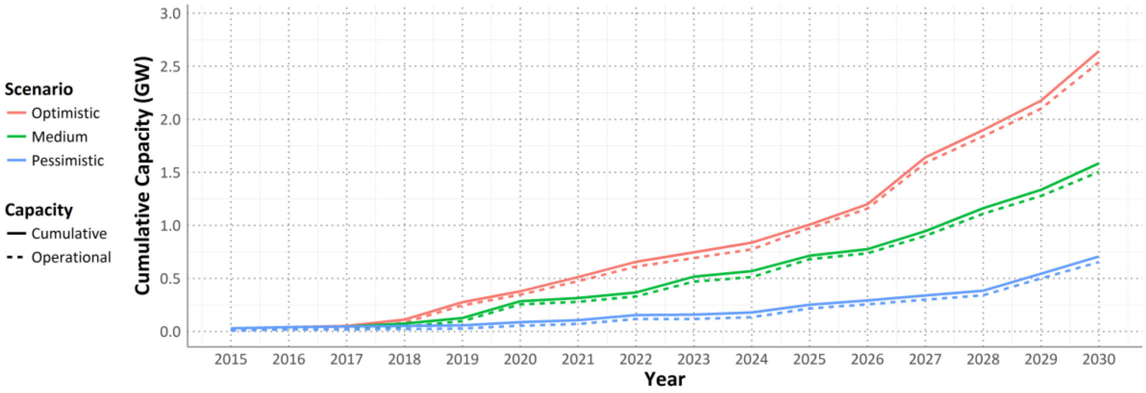


Generally speaking, the capacity installed in Europe and the capacity installed in the rest of the world share the same trend.

As seen in section 1.5.1, tidal range plays a major role in the operational and installed capacity, amounting to 50% of operational capacity. However, this capacity is related to already existing projects, which have a long estimated lifetime (80-120 years), and typical capacity of over 100 MW. New projects expected to be commissioned are few and are characterised by high uncertainty.

Analysing only wave and tidal stream[15], Figure 27 shows the capacity trends under the 3 scenarios. The evolution is smoother than in the previous graph, with global capacity reaching 2.9 GW under the optimistic scenario. There is also a smaller difference between the medium and the optimistic scenario, showing that the latter is mostly driven by tidal range deployments.

Figure 27 - Scenario comparison – wave and tidal stream

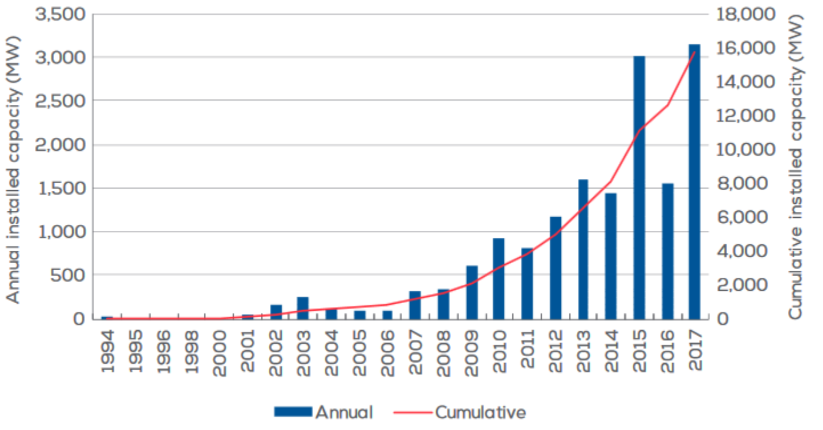


There is also another aspect to factor in when seeking to estimate capacity evolution. The forecasts in this report are based on projects already in the pipeline and data from the survey, according to the methods outlined in the previous paragraphs.

There might be another phenomenon, which – albeit difficult to predict – might influence future capacity. The 1st GW is often referred to as the most difficult to achieve, because initially technologies are not mature enough and financial support might be low. There is nothing inherently special in the 1st GW of energy installed, it is a psychological threshold; but psychological thresholds might influence the behaviour of policy makers and financiers. In other words, it is possible that the forecasts presented in this report – which are based on current and past data – may not take into account that, upon reaching a tipping point, there might be a dramatic increase in the number of projects – hence in the capacity installed – as a result of a change in the perception of the risks associated with ocean energy, and, possibly, a more favourable legislative framework.

It may be useful to draw a comparison with the offshore wind energy sector:

Figure 28 - Cumulative and annual offshore wind installations in Europe (MW)



Source: WindEurope

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[15] OTEC was also not considered as the global capacity is low

WindEurope dataset starts in 1994, when a negligible amount of offshore wind capacity was available in Europe; a situation which resembles the current state of ocean energy in Europe. It took 13 years to reach one GW of capacity installed; then less than three years to double that, and by 2012 – only 5 years after the first GW – there already were 5 GW installed in Europe.

It cannot be taken for granted that ocean energy will follow the same path, especially because offshore wind could benefit from the experience of onshore wind, with which shares the same technology.

Forecasting is a difficult activity. There are far too many unknown variables to take into account that may prove a forecast spectacularly wrong. Therefore, if any lesson is to be learned, it is that reaching a tipping point might trigger a mechanism that might boost expected growth. The same could be said in case of a technological breakthrough.

1.5.3 Summary table

The table below shows the summary of the global capacity evolution for the different technologies, under the different scenarios.

Table 6 - Global capacity evolution by technology and scenario

(MW)	Scenario	2010	2015	2017	2020	2025	2030
Wave	Optimistic	14	22	29	121	256	494
	Medium	14	22	28	79	137	316
	Pessimistic	14	21	27	35	57	70
Tidal Stream	Optimistic	8	17	43	349	926	2388
	Medium	8	17	33	295	695	1467
	Pessimistic	8	17	33	79	238	705
Tidal Range	Optimistic	266	520	520	520	840	1000
	Medium	266	520	520	520	520	840
	Pessimistic	266	520	520	520	520	520
OTEC	Optimistic	0.2	0.5	0.5	19	29	29
	Medium	0.2	0.5	0.5	2	19	19
	Pessimistic	0.2	0.5	0.5	2	18	18

It is worth noting that tidal stream is expected to take off in the medium run, moving from 45.27 MW in 2017 to 427.8 MW in 2020, which correspond to a +944% increase in the optimistic scenario or a +150% increase in the medium scenario (113.3 MW).

2 Estimating investments

2.1 Methodology

Using as starting point the surveys and databases described in the previous section, the costs associated with the different projects were analysed to verify the expected trends of the industry.

Based on these trends, and published forecasts for future costs and cost reductions, the CAPEX and OPEX of the projects for which there was no reported data were estimated. This estimation assumed there would be cost reductions associated with economies of scale, and a learning rate of 12% was used for all scenarios and across all technologies.

Investments for each sector were then calculated based on the CAPEX and OPEX of the projects. CAPEX investments were assumed for the year before the project starts, and OPEX investments through the lifetime of the project. This means that the investment figures presented below refer only to direct investment into projects. There are indirect investments in the sector that have not been considered, such as infrastructure development, R&D, and mergers and acquisitions.

The typical financing breakdown for projects was also analysed for the survey data in order to determine the level of private, public and debt financing associated with each scenario. There was no difference in unit costs between scenarios, with the exception of cost reductions associated with the use of learning rates; neither were there differences in financing breakdown.

All costs have been converted to 2017 EUR.

2.2 Ocean energy cost data

2.2.1 Wave

Wave energy CAPEX and OPEX figures were analysed to verify commonly assumed cost trends, including cost variation based on project size, TRL, cumulative capacity or chronology. From this analysis the project capacity and TRL were found to have a stronger impact on determining project cost, with cumulative capacity playing a smaller role.

It is important to note that in some cases the costs reported may not correspond to the entirety of the project, as the use of existent infrastructure and test centres allows for cost savings in terms of project development costs (surveys, licensing, etc.) and grid infrastructure costs. Furthermore, there is significantly less information on operational expenditures, which restricted the finding of meaningful trends. Finally, the reported OPEX – especially in the case of future projects – is likely to be based on literature estimates rather than operational experience.

The unitary CAPEX and OPEX were then plotted against the project capacity and the Technology Readiness Levels. In the figures below, it can be see that the unitary CAPEX/OPEX (bubble size) decrease as projects increase in capacity and as they reach upper readiness levels.

Figure 29 - Wave unitary CAPEX trend based on project capacity and TRL

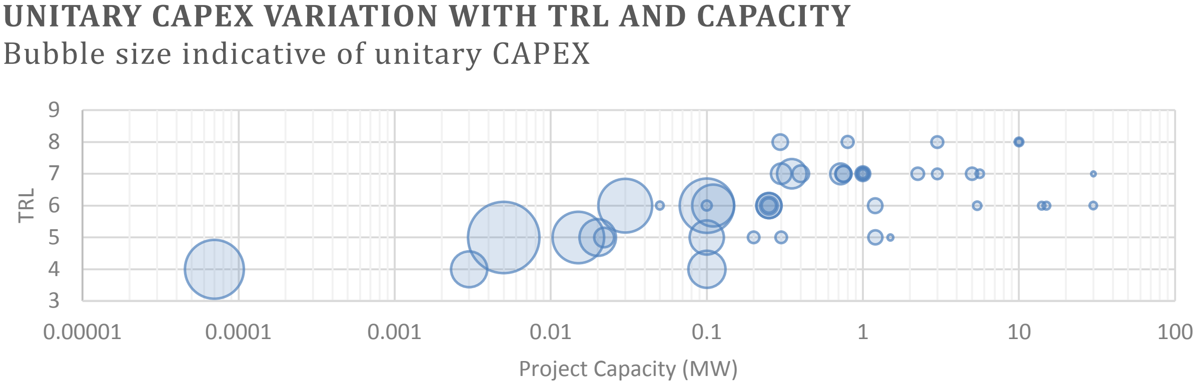
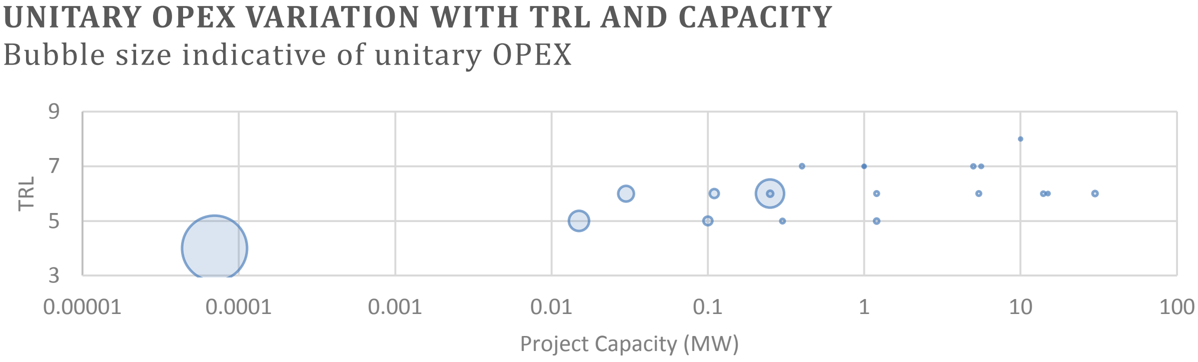


Figure 30 - Wave unitary OPEX trend based on project capacity and TRL



Based on the trends above, ten capacity categories were defined between 0 MW and 250 MW and used to form a matrix crossing TRL levels.

Table 7 shows the reported data for the unitary CAPEX and Table 8 shows the unitary OPEX, for each capacity bin and TRL level. The information under TRL 0 corresponds to cost information for the capacity bin, across all TRLs.

Table 7 - Wave Unitary CAPEX extracted from reported data

		TRL						
	M€/MW	All TRLs	4	5	6	7	8	9
Project Capacity (MW)	**]0 - 0.001]**	216.5	216.5	216.5				
	]0.001 - 0.009]	229.7	81.3	229.7	318.7			
	]0.009 - 0.02]	119.7		119.7	119.7			
	]0.02 - 0.1]	82.2	86.4	74.3	81.2	88.5		
	]0.1 - 0.3]	25.7		8.3	27.6	34.1	20.5	14.9
	]0.3 - 0.9]	20.3				23.3	20.3	8.9
	]0.9 - 3]	8.6		6.8	8.8	9.1	8.5	8.3
	]3 - 7]	5.8			4.3	5.8	6.7	
	]7 - 20]	3.7			3.7	3.7	3.7	3.7
	]20 - 250]	2.4			3.3	2.4	1.4	

Table 8 - Wave Unitary OPEX extracted from reported data

		TRL						
	M€/MW	All TRLs	4	5	6	7	8	9
Project Capacity (MW)	**]0 - 0.001]**	69.83	69.83	69.83				
	]0.001 - 0.009]							
	]0.009 - 0.02]	6.67	6.67	6.67	6.67			
	]0.02 - 0.1]	1.92	1.26	1.92	1.92	4.14		
	]0.1 - 0.3]	4.01	0.33	4.01	4.01	5.81		
	]0.3 - 0.9]	0.28			0.28	0.28	0.28	0.28
	]0.9 - 3]	0.22	0.42	0.38	0.22	0.17	0.10	0.10
	]3 - 7]	0.25		0.32	0.25	0.25	0.21	0.21
	]7 - 20]	0.20		0.22	0.22	0.20	0.15	0.15
	]20 - 250]	0.42		0.42	0.42	0.42		

From the IEA-OES Levelised Cost of Energy Report[16] and the renewableUK "Channeling the Energy" report[17], the following tables were generated for the unitary CAPEX.

Table 9 - Wave unitary CAPEX (derived from IEA-OES and renewableUK

		TRL						
	M€/MW	All TRLs	4	5	6	7	8	9
Project Capacity (MW)	**]0 - 0.001]**	376	215	200	177	155	106	63.6
	]0.001 - 0.009]	167	107	92.9	83.5	74.2	53.4	34.3
	]0.009 - 0.02]	124	83.3	70.3	63.5	56.8	41.6	27.4
	]0.02 - 0.1]	68.6	50	40.1	36.6	33.1	25.1	17.4
	]0.1 - 0.3]	45.8	35.3	27.4	25.1	22.9	17.8	12.8
	]0.3 - 0.9]	30.7	24.9	18.7	17.3	15.8	12.6	9.37
	]0.9 - 3]	19.8	17	12.3	11.4	10.6	8.64	6.68
	]3 - 7]	14.6	13	9.14	8.56	7.97	6.63	5.26
	]7 - 20]	9.96	9.32	6.34	5.97	5.61	4.77	3.92
	]20 - 250]	4.02	4.19	2.63	2.52	2.4	2.16	1.92

Table 10 - Wave unitary OPEX derived from IEA-OES and renewableUK

		TRL						
	M€/MW	All TRLs	4	5	6	7	8	9
Project Capacity (MW)	**]0 - 0.001]**	68.2	9.45	66.7	29.7	6.57	6.11	5.69
	]0.001 - 0.009]	31.2	5.53	19.9	10.1	2.89	2.65	2.41
	]0.009 - 0.02]	23.6	4.55	12.9	6.83	2.15	1.95	1.76
	]0.02 - 0.1]	13.6	3.07	5.31	3.1	1.18	1.06	0.94
	]0.1 - 0.3]	9.36	2.35	2.91	1.81	0.78	0.7	0.61
	]0.3 - 0.9]	6.47	1.8	1.59	1.05	0.52	0.46	0.4
	]0.9 - 3]	4.33	1.34	0.82	0.58	0.33	0.29	0.25
	]3 - 7]	3.27	1.09	0.52	0.38	0.24	0.21	0.18
	]7 - 20]	2.31	0.84	0.29	0.23	0.16	0.14	0.12
	]20 - 250]	1.01	0.45	0.07	0.07	0.06	0.05	0.04

Both tables were combined, averaging the data and following the identified trends. The resulting tables (Table 11 for CAPEX and Table 12 for OPEX) were then used in the analysis to estimate the costs of projects for which no data had been reported.

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[16] OES, 'International Levelised Cost Of Energy for Ocean Energy Technologies'.

[17] RenewableUK. (2010). Channeling the Energy: A Way Forward for the UK Wave & Tidal Industry Towards 2020. Tech. rep., renewableUK.

Table 11 - Wave unitary CAPEX used on the analysis

		TRL						
	M€/MW	All TRLs	4	5	6	7	8	9
Project Capacity (MW)	**]0 - 0.001]**	360.4	215.8	208.1	177	154.9	106.5	63.58
	]0.001 - 0.009]	172.9	94.28	161.3	201.1	114.5	79.96	48.92
	]0.009 - 0.02]	123.6	76.52	95.01	91.6	79.7	56.83	35.92
	]0.02 - 0.1]	69.93	68.2	57.24	58.9	60.78	35.12	23.24
	]0.1 - 0.3]	43.81	39.56	17.86	26.36	28.49	19.15	13.82
	]0.3 - 0.9]	29.64	27.83	18.04	20.94	19.59	16.44	9.149
	]0.9 - 3]	18.67	18.95	9.525	10.11	9.833	8.561	7.507
	]3 - 7]	13.69	14.34	8.163	6.407	6.907	6.639	5.542
	]7 - 20]	9.333	10.23	5.617	4.831	4.648	4.237	3.811
	]20 - 250]	3.852	4.634	2.24	2.925	2.379	1.766	1.909

Table 12 - Wave unitary OPEX used on the analysis

		TRL						
	M€/MW	All TRLs	4	5	6	7	8	9
Project Capacity (MW)	**]0 - 0.001]**	68.41	39.64	68.25	29.73	6.566	6.108	5.692
	]0.001 - 0.009]	49.82	22.58	44.1	19.92	4.73	4.376	4.049
	]0.009 - 0.02]	21.95	5.607	9.765	6.748	3.174	2.915	2.669
	]0.02 - 0.1]	12.43	2.163	3.618	2.511	2.662	1.642	1.482
	]0.1 - 0.3]	8.826	1.341	3.456	2.906	3.297	1.01	0.899
	]0.3 - 0.9]	5.848	1.215	1.512	0.664	0.398	0.367	0.336
	]0.9 - 3]	3.916	0.878	0.598	0.402	0.249	0.194	0.173
	]3 - 7]	2.964	0.733	0.417	0.316	0.245	0.211	0.195
	]7 - 20]	2.098	0.567	0.256	0.226	0.184	0.145	0.134
	]20 - 250]	0.95	0.287	0.244	0.242	0.24	0.049	0.042

The data reported above was then subject to cost reductions due to learning, by applying a learning rate of 12%.

2.2.2 Tidal Stream

The same exercise was conducted for the tidal stream sector. The trends for unitary CAPEX and OPEX (below) based on project capacity and TRL were identified, showing the same pattern of decreasing costs as projects get bigger and closer to commercialisation.

Figure 31 - Tidal steam unitary CAPEX trend based on project capacity and TRL

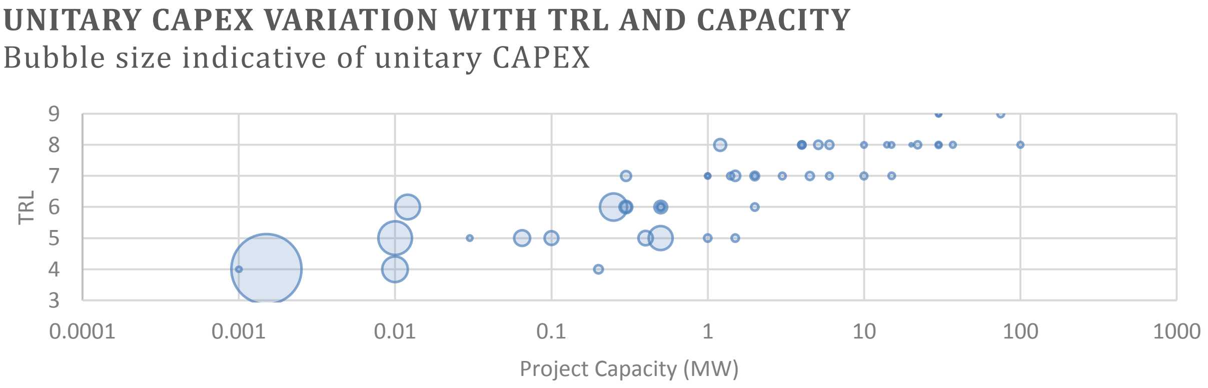
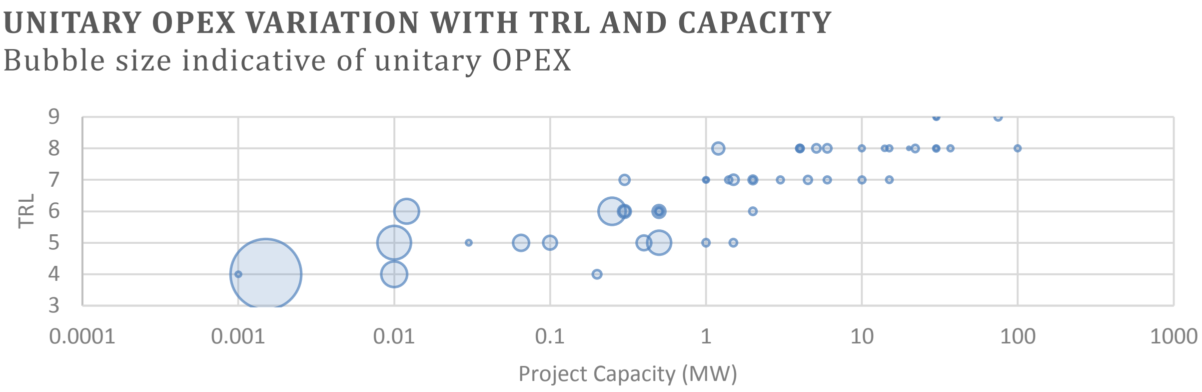


Figure 32 - Tidal stream unitary OPEX trend based on project capacity and TRL



The project capacities were divided into 10 bins between 0 MW and 410 MW and arranged in a matrix with the TRLs. Below are the tables extracted from the data, for CAPEX (Table 13) and OPEX (Table 14).

Table 13 - Tidal stream unitary CAPEX extracted from reported data

				TRL				
	M€/MW	All TRLs	4	5	6	7	8	9
Project Capacity (MW)	**]0 - 0.002]**	419.4	419.4	419.4				
	]0.002 - 0.007]							
	]0.007 - 0.08]	47.1	92.6	43.1	43.2	85.6		
	]0.08 - 0.3]	32.0	9.9	15.5	42.5	36.4	13.7	
	]0.3 - 0.9]	29.7		57.8	29.7	12.8		
	]0.9 - 2]	8.4		7.5	7.6	7.4	8.7	19.8
	]2 - 5]	7.4				8.4	7.4	6.4
	]5 - 20]	4.8				6.1	4.8	4.3
	]20 - 90]	5.0					4.8	5.0
	]90 - 410]	4.6					4.6	4.6

Table 14 - Tidal stream unitary OPEX extracted from reported data

				TRL				
	M€/MW	All TRLs	4	5	6	7	8	9
Project Capacity (MW)	**]0 - 0.002]**	427.3	427.3	427.3				
	]0.002 - 0.007]							
	]0.007 - 0.08]							
	]0.08 - 0.3]	1.88		1.88	1.88	1.88		
	]0.3 - 0.9]	7.05	10.90	7.05	7.05	3.97		
	]0.9 - 2]	0.31		0.38	0.31	0.31	0.29	0.29
	]2 - 5]	0.31			0.35	0.31	0.31	0.31
	]5 - 20]	0.32			0.55	0.32	0.32	0.32
	]20 - 90]	0.17				0.24	0.17	0.17
	]90 - 410]	0.17				0.17	0.17	0.17

From the IEA-OES Levelised Cost of Energy Report[18] and the renewableUK "Channeling the Energy" report[19], the following tables were generated for the unitary CAPEX and unitary OPEX.

Table 15 - Tidal stream unitary CAPEX derived from IEA-OES and renewableUK

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[18] OES, 'International Levelised Cost Of Energy for Ocean Energy Technologies'.

[19] RenewableUK. (2010). Channeling the Energy: A Way Forward for the UK Wave & Tidal Industry Towards 2020. Tech. rep., renewableUK.

			TRL					
	M€/MW	**All TRLs**	**4**	**5**	**6**	**7**	**8**	**9**
Project Capacity (MW)	**]0 - 0.002]**	202	53.4	36.8	25.9	16.2	12.5	8.91
	]0.002 - 0.007]	130	41.8	29.2	21.2	13.8	10.8	7.93
	]0.007 - 0.08]	57.4	25.9	18.6	14.4	10.2	8.28	6.33
	]0.08 - 0.3]	37.5	20	14.6	11.7	8.7	7.15	5.6
	]0.3 - 0.9]	26.6	16.1	11.9	9.78	7.6	6.33	5.06
	]0.9 - 2]	20.9	13.7	10.3	8.61	6.88	5.79	4.7
	]2 - 5]	16	11.5	8.69	7.45	6.15	5.23	4.31
	]5 - 20]	10.8	8.74	6.73	5.97	5.18	4.49	3.79
	]20 - 90]	7.25	6.5	5.1	4.7	4.3	3.8	3.3
	]90 - 410]	4.96	4.82	3.86	3.69	3.57	3.21	2.87

Table 16 - Tidal stream unitary OPEX derived from IEA-OES and renewableUK

			TRL					
	M€/MW	**All TRLs**	**4**	**5**	**6**	**7**	**8**	**9**
Project Capacity (MW)	**]0 - 0.002]**	5.42	2.04	6.61	3.75	1.61	1.53	1.48
	]0.002 - 0.007]	4.34	1.77	4.28	2.58	1.22	1.14	1.07
	]0.007 - 0.08]	2.89	1.35	1.84	1.25	0.71	0.64	0.57
	]0.08 - 0.3]	2.35	1.16	1.16	0.85	0.53	0.47	0.4
	]0.3 - 0.9]	2	1.02	0.79	0.61	0.42	0.36	0.3
	]0.9 - 2]	1.78	0.94	0.6	0.48	0.35	0.3	0.24
	]2 - 5]	1.56	0.84	0.44	0.37	0.28	0.24	0.19
	]5 - 20]	1.29	0.72	0.27	0.24	0.21	0.17	0.13
	]20 - 90]	1.05	0.61	0.16	0.16	0.15	0.12	0.09
	]90 - 410]	0.87	0.51	0.09	0.1	0.11	0.08	0.06

Finally, both set of tables were combined, averaging the data and following the identified trends. The resulting table (Table 17 for CAPEX and Table 18 for OPEX) was then used in the analysis to estimate the costs of projects for which no data had been reported.

Table 17 - Tidal stream unitary CAPEX used on the analysis

			TRL					
	M€/MW	**All TRLs**	**4**	**5**	**6**	**7**	**8**	**9**
Project Capacity (MW)	**]0 - 0.002]**	223.4	236.4	228.1	25.86	16.16	12.46	8.912
	]0.002 - 0.007]	176.8	139.1	128.6	23.52	15	11.65	8.423
	]0.007 - 0.08]	56.35	59.23	30.84	28.78	47.94	9.253	6.939
	]0.08 - 0.3]	36.94	14.92	15.03	27.07	22.53	10.43	5.985
	]0.3 - 0.9]	26.93	13.75	34.87	19.73	10.19	7.762	5.33
	]0.9 - 2]	19.66	11.11	8.89	8.094	7.15	7.251	12.25
	]2 - 5]	15.12	8.824	8.084	10.49	7.254	6.319	5.379
	]5 - 20]	10.21	6.265	5.528	8.186	5.647	4.656	4.022
	]20 - 90]	7.025	4.471	3.846	6.227	5.076	4.303	4.163
	]90 - 410]	4.932	3.261	2.769	4.708	4.008	3.925	3.752

Table 18 - Tidal stream unitary OPEX used on the analysis

		TRL						
	M€/MW	All TRLs	4	5	6	7	8	9
Project Capacity (MW)	**]0 - 0.002]**	47.61	214.7	217	3.749	1.606	1.528	1.483
	]0.002 - 0.007]	25.97	108.2	110.6	3.166	1.412	1.332	1.276
	]0.007 - 0.08]	11.87	84.38	86.6	2.977	1.347	1.267	1.208
	]0.08 - 0.3]	2.306	51.09	1.879	1.879	1.879	1.145	1.082
	]0.3 - 0.9]	2.503	10.9	7.055	7.055	3.975	1.069	1.004
	]0.9 - 2]	1.631	11.17	0.384	0.311	0.311	0.29	0.29
	]2 - 5]	1.436	6.328	0.269	0.351	0.308	0.308	0.308
	]5 - 20]	1.192	4.241	0.122	0.545	0.318	0.318	0.318
	]20 - 90]	0.965	2.583	0.046	0.371	0.245	0.166	0.166
	]90 - 410]	0.795	0.783	0.004	0.183	0.165	0.165	0.165

The data reported above was then subject to cost reductions due to learning, by applying a learning rate of 12%.

2.2.3 *Tidal Range*

For tidal range there was not enough data to extract trends. The cost information was based on the data reported and estimates by Ernst & Young Black & Veatch[20]. The data was analysed based on project capacity, which was divided into 6 bins, between 0 MW and 3500 MW; and TRLs were not considered. Table 19 shows the CAPEX cost assumptions, and Table 20 shows the OPEX.

Table 19 - Tidal range unitary CAPEX (M€/MW) used on the analysis

Project Capacity (MW)					
]0 - 0.25]	]0.25 - 0.5]	]0.5 - 3]	]3 - 143]	]143 - 304]	]304 - 3500]
2.921	2.921	2.921	2.921	1.750	2.867

Table 20 - Tidal range unitary OPEX (M€/MW/year) used on the analysis

Project Capacity (MW)					
]0 - 0.25]	]0.25 - 0.5]	]0.5 - 3]	]3 - 143]	]143 - 304]	]304 - 3500]
0.285	0.285	0.285	0.285	0.285	0.178

The data reported above was then subject to cost reductions due to learning, by applying a learning rate of 12%.

2.2.4 *OTEC*

As far as OTEC is concerned, there was not enough data to extract trends. The cost information was based on the data reported and estimates by the IEA-OES Report[21].

Table 21 - OTEC unitary CAPEX (M€/MW) derived from IEA-OES

Project Capacity (MW)					
]0 - 0.01]	]0.01 - 0.2]	]0.2 - 0.3]	]0.3 - 0.6]	]0.6 - 4]	]0 - 0.01]
100	48.3	43.8	37	23.3	11.2

Table 22 - OTEC unitary OPEX (M€/MW/year) derived from IEA-OES

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[20] Ernst&Young, Black&Veatch. (2010). Cost of and financial support for wave, tidal stream and tidal range generation in the UK.

[21] OES, 'International Levelised Cost of Energy for Ocean Energy Technologies'.

Project Capacity (MW)					
]0 - 0.01]	]0.01 - 0.2]	]0.2 - 0.3]	]0.3 - 0.6]	]0.6 - 4]	]0 - 0.01]
0.81	0.61	0.59	0.55	0.46	0.35

The data was analysed based on project capacity, which was divided into 6 bins, between 0 MW and 50 MW; and TRLs were not considered. Table 23 shows the CAPEX cost assumptions, and Table 24 shows the OPEX.

Table 23 - OTEC unitary CAPEX used on the analysis

Project Capacity (MW)					
]0 - 0.01]	]0.01 - 0.2]	]0.2 - 0.3]	]0.3 - 0.6]	]0.6 - 4]	]0 - 0.01]
100	47.5	43.4	36.7	23.1	12.2

Table 24 - OTEC unitary OPEX used on the analysis

Project Capacity (MW)					
]0 - 0.01]	]0.01 - 0.2]	]0.2 - 0.3]	]0.3 - 0.6]	]0.6 - 4]	]0 - 0.01]
0.81	0.71	0.64	0.60	0.50	0.36

The data reported above was then subject to cost reductions due to learning, by applying a learning rate of 12%.

2.2.5 Financing breakdown

The breakdown of project financing into public grants, debt, and private investment (equity and own financing) was analysed for the projects with reported data. The main source of this information was the survey sent to developers, where they stated the required and committed levels of financing divided into 4 categories: Public, Debt, Private and Own Equity. Some of the developers reported actual values, while others reported only percentages of the financing breakdown. For each technology, at different TRLs[22], the average contribution of public and debt financing was calculated, based on data from the survey as well as from WavEC database. The private investment contribution was assumed to be the remainder. It should be noted that the level of information related with financing of OTEC and Tidal Range projects is low, meaning that the breakdowns below may not correspond entirely to the trend of the sector. Furthermore, many of the Tidal Range projects have been established under a centrally-owned power system and were at the time (and some still are) state-owned.

Figure 33 shows how the financing is divided for each technology (and for wave and tidal stream, across the different TRLs). This information was used to estimate the required capital from different sources, for each scenario.

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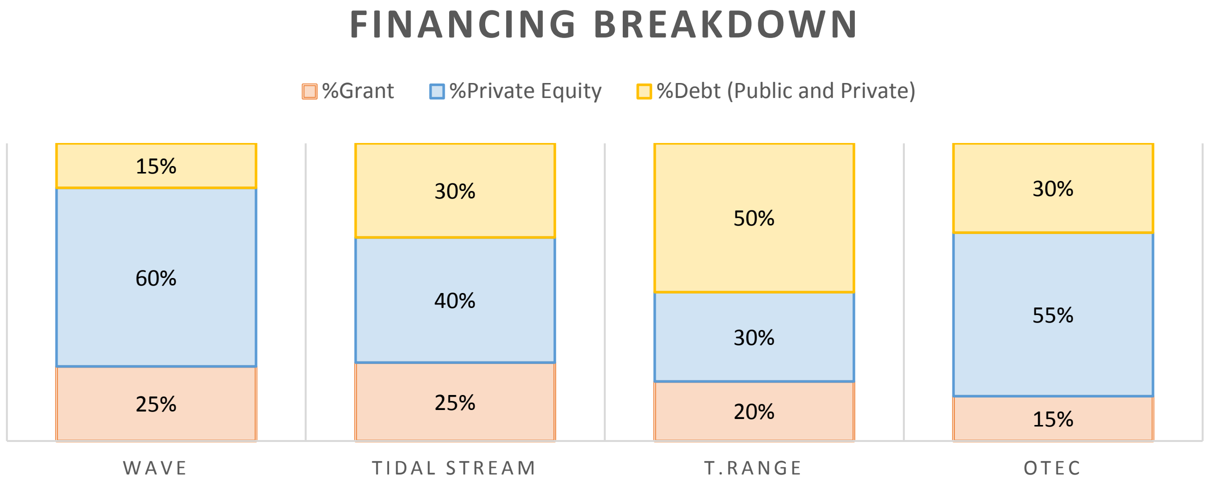
[22] For tidal range and OTEC no TRL separation was considered.

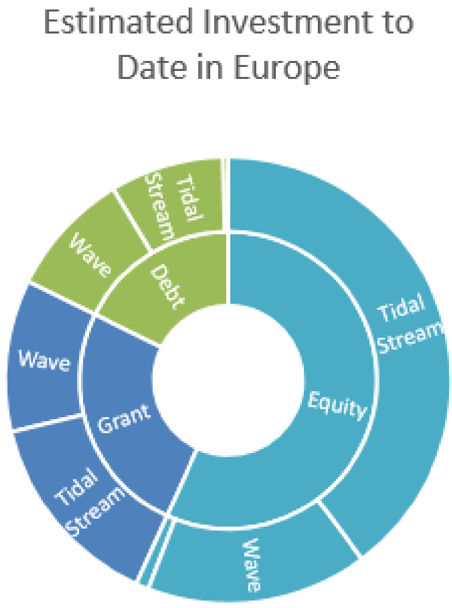
Figure 33 - Typical financing breakdown, based on technology



One of the most interesting findings of this exercise is that most of the financial resources injected in the sector come from private and own equity rather than from public money. This becomes more evident as TRLs increase; while there are no significant variations in the share of equity, the grant component shrinks in favour of a higher proportion of debt, reflecting the fact that mature projects find it easier and less costly to borrow capital from banks and lending institutions.

2.2.6 Investment to date

Figure 34 - Estimated direct investment to date



Using the information described above, the investment to date on project development can be estimated.

Looking at worldwide projects from 1978 to 2017, over 6 billion euros have been invested into projects. This number excludes R&D projects that did not lead to technology deployment, infrastructure investments such as test centres, and private in companies.

The majority of the investment comes from private sources (81%). Grant financing represents around 900 million euros[23], of which tidal range projects represent almost 50%.

This value lines up with figures published from different countries/regions.

The EC has provided 190 million euros for R&D since 2004[24].

The US Department of Energy has also provided at least 65 million euros to ocean energy[25] and has seen and increasing level of funding for hydropower and marine and hydrokinetic energy (around 60 million euros in 2016)[26].

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[23] This value has been actualised to 2017 euros using OECD data on Producer price indices (PPI). Published figures may not be actualised.

[24] Soede, M. and Magnana, D., 2017, Ocean Energy in the EU Policy and R&D Funding (presentation to OES)

[25] WavEC, 2018, WavEC database.

[26] US Department of Energy, 2018, Water Power Program Budget.

The Australian agency ARENA has also invested at least 60 million euros in wave energy alone[27].

The UK, through many agencies, has also invested at least 115 million euros in wave and tidal energy [28].

Other countries, such as Canada, Denmark, Sweden, Portugal, France and Spain have also provided public financing through national agencies.

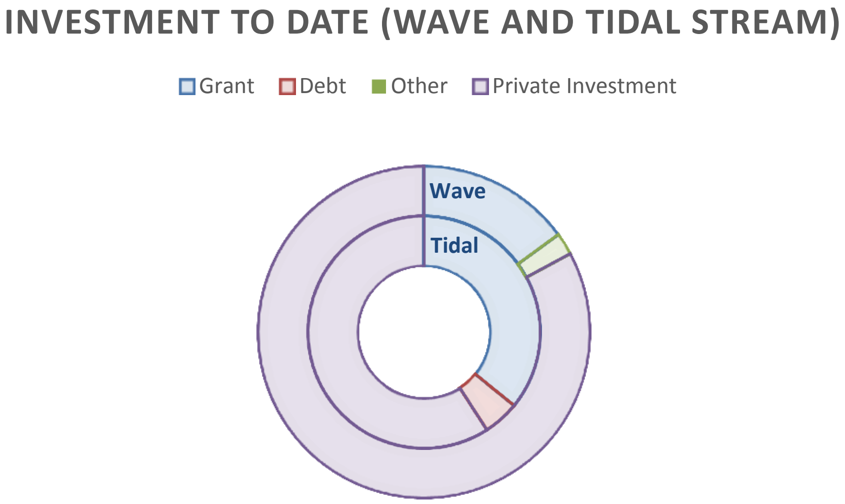
Investment in the testing infrastructures EMEC, WaveHub, SEM-REV, and BiMEP represents over 150 million euros from public grants [29].

From data collected by WavEC on investment and funding[30], an additional 700 million euros can be traced to investments in companies for smaller (TRL 1-3) projects, R&D activities and equity, for wave and tidal stream.

As with the direct investment in projects, the majority of these funding sources are private (Figure 35). Debt financing represents a very small percentage of funding so far, but this is likely to change as the sector progresses. Around 175 million euros have been provided through public financing.

The funding of wave and tidal stream is evenly balanced overall.

Figure 35 - Investment to date in wave and tidal stream in activities other than project development



Like any other form of renewable energy, ocean energy tends to have relatively higher capital expenditure costs (e.g. installing devices in the water) but lower operational expenditure costs (e.g. maintenance, fuel, etc.). Therefore, if projects prove to be successful, in time the initial investments will be repaid by the capacity generated, which will come at lower operational costs than the carbon sector. The LCOE of fossil energy might remain lower than ocean energy's for a long time; but the higher

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[27] Magagna, D., Uihlein, A., 2015, Ocean energy development in Europe: Current status and future perspectives, International Journal of Marine Energy.
[28] WavEC, 2018, WavEC database.
[29] Magagna, D., Uihlein, A., 2015, Ocean energy development in Europe: Current status and future perspectives, International Journal of Marine Energy.
[30] WavEC, 2018, WavEC database.

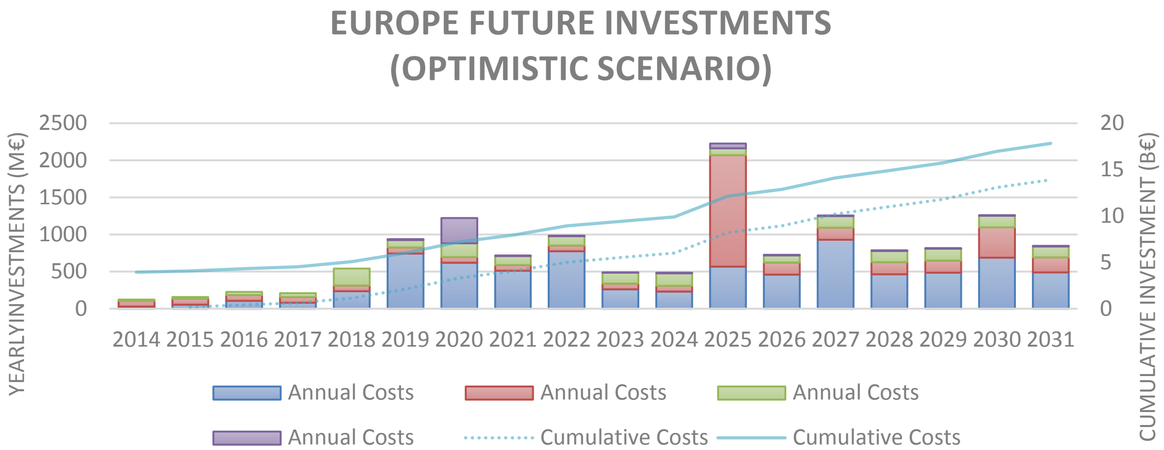
CAPEX/OPEX ratio of ocean energy is promising because it reveals that money are being spent to create long-term value.

2.3 Analysis

2.3.1 Optimistic Scenario

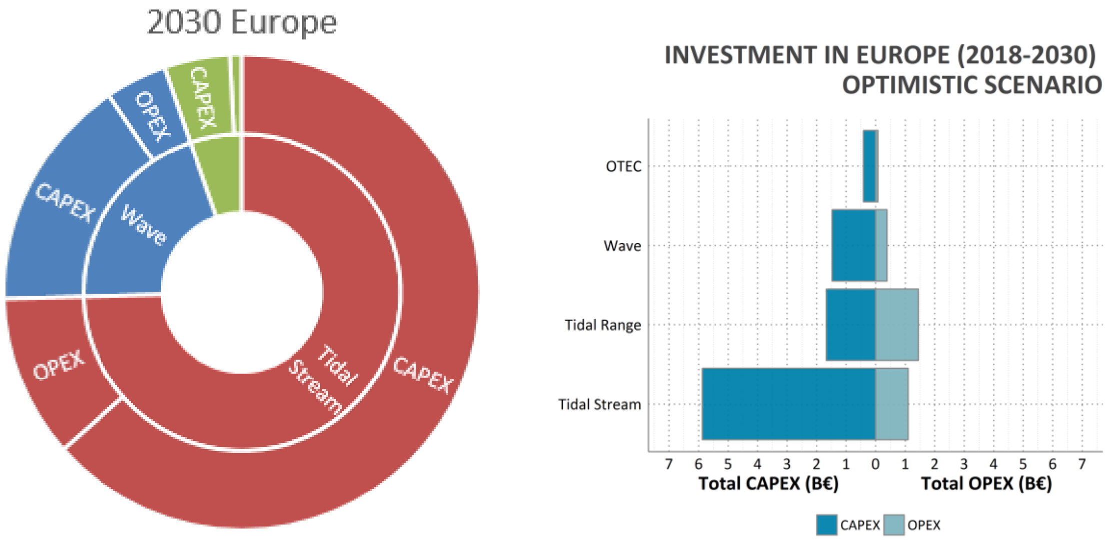
Under the optimistic scenario, the 3.9 GW of cumulative capacity in 2030 corresponds to a cost of 12.5 billion EUR in European projects (Figure 36).

Figure 36 - Future Investments under the optimistic scenario



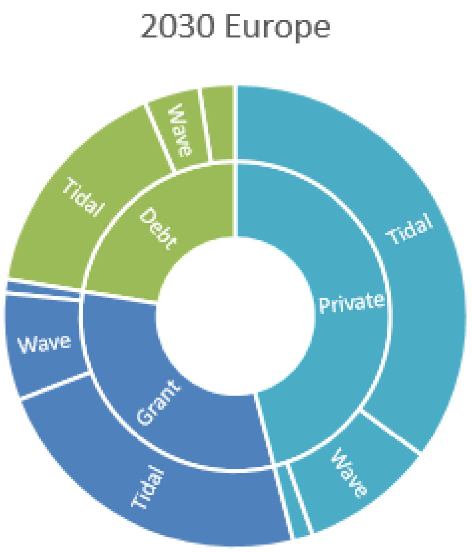
The required investments until 2030 will be mainly into tidal projects: new tidal stream projects, new tidal range projects and operating existing tidal range projects (Figure 37).

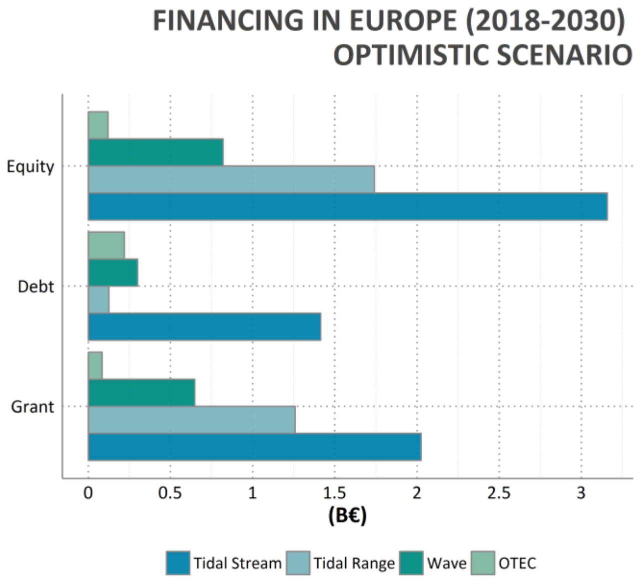
Figure 37 - Breakdown of investments by technology and cost type



The financing of the projects is expected to fall primarily under private equity (Figure 38), although debt financing also makes a significant contribution. Public grant contribution amounts to 2.7 billion EUR in Europe for the period 2018-2030 for wave, tidal stream and OTEC. For tidal range projects, up to 1.2 billion EUR in grants could be used.

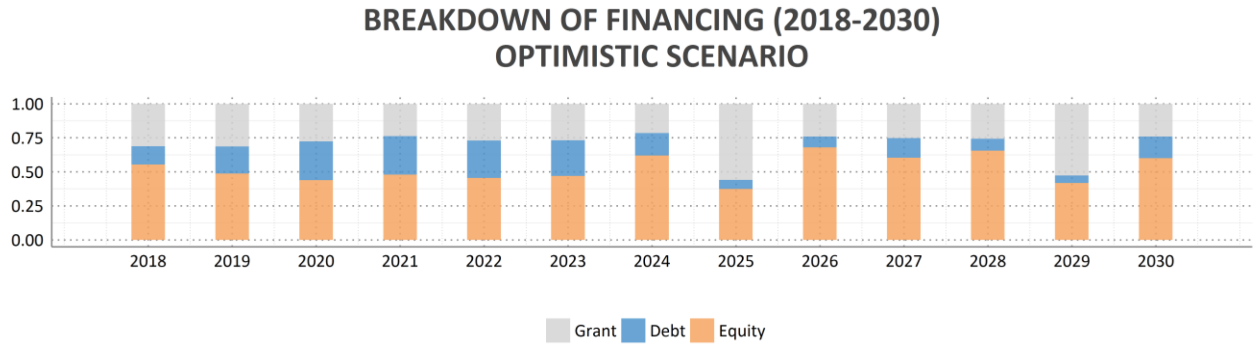
Figure 38 - Breakdown of financing type in 2030 (optimistic)





The evolution of financing sources (Figure 39) shows that while until 2030 public grants are expected to make a significant contribution to the development of the ocean energy sector, as project evolve towards commercialisation, the contribution of public financing will decrease, with an increase in debt financing and private equity.

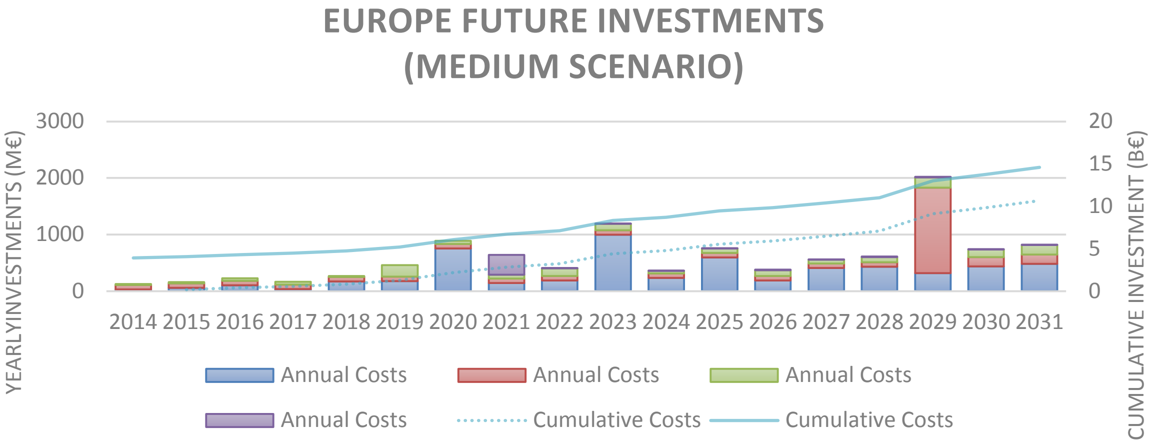
Figure 39 - Breakdown of financing (optimistic)



2.3.2 Medium Scenario

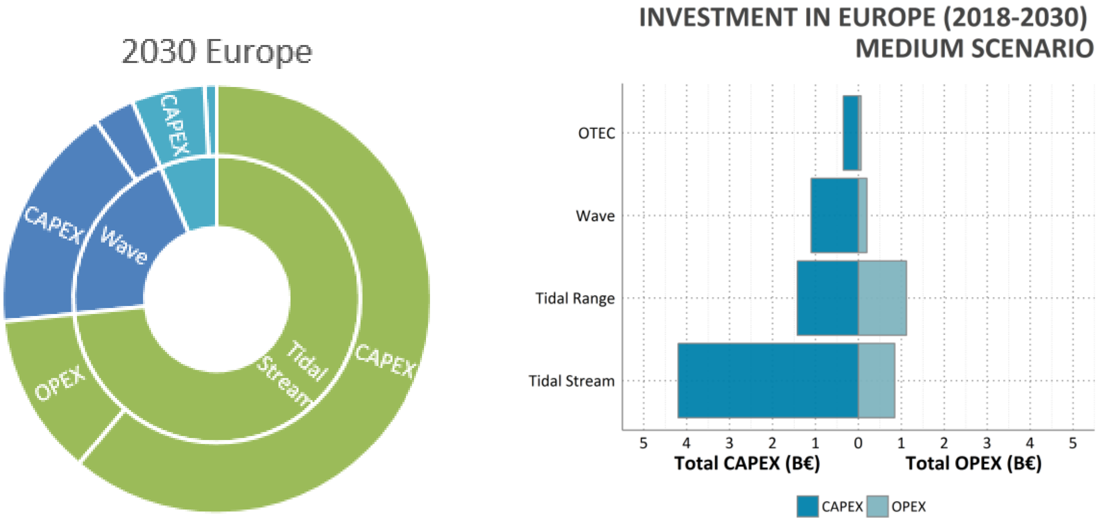
Under the medium scenario, the 2.8 GW of cumulative capacity in 2030 corresponds to a total cost of 9.3 billion EUR in European projects (Figure 40). Compared with the optimistic scenario, the investments are more spread-out throughout the years, mirroring the trend of the pipeline analysis.

Figure 40 - Future Investments under the medium scenario



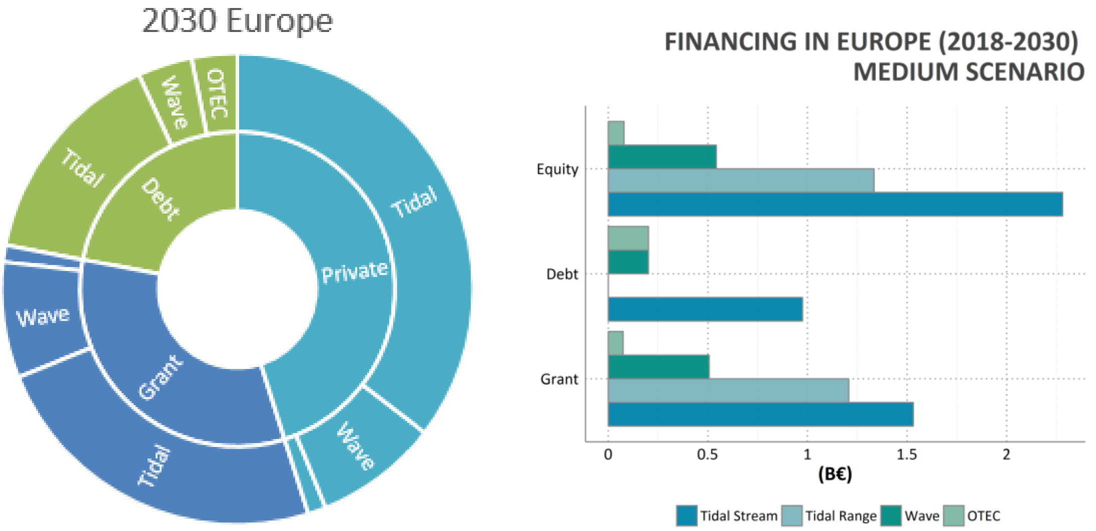
As with the optimistic scenario, the required investments until 2030 will be mainly into tidal projects: new tidal stream projects, new tidal range projects and operating existing tidal range projects (Figure 41).

Figure 41 - Breakdown of investments by technology and cost type



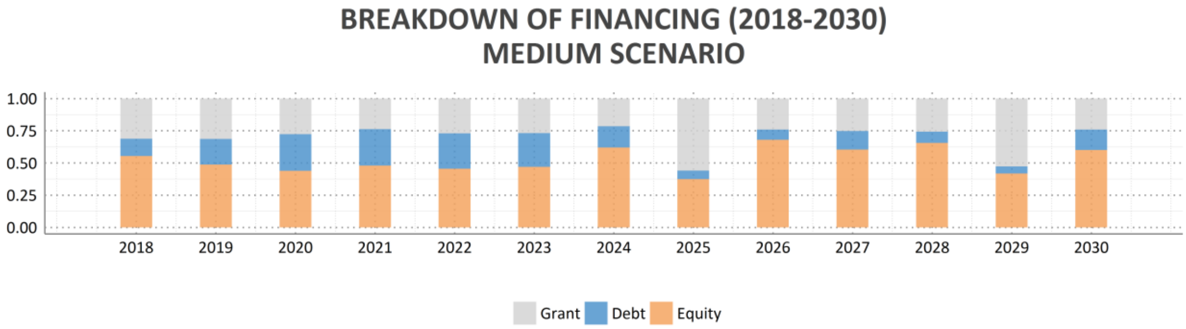
The financing of the projects is still expected to fall primarily under private equity (Figure 42), but to a lesser extent than in the optimistic scenario, with debt financing increasing its contribution. Public grant contribution amounts to 2.1 billion EUR in Europe for Wave, Tidal Stream and OTEC, in the period 2018-2030. Tidal Range projects can represent another 1.2 billion EUR.

Figure 42 - Breakdown of financing type in 2030 (medium)



The evolution of financing sources (Figure 43) shows that, while until 2030 public grants are expected to make a significant contribution to the development of the ocean energy sector.

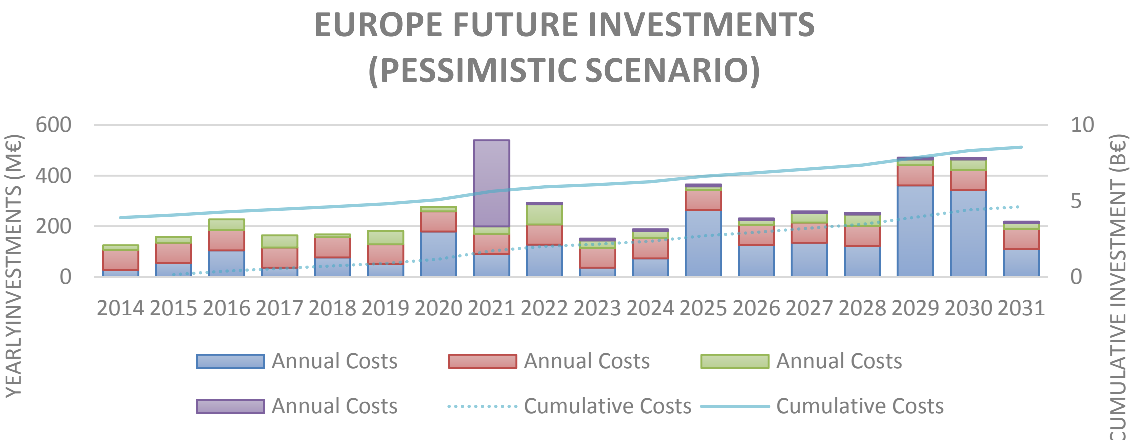
Figure 43 - Breakdown of financing (medium)



2.3.3 *Pessimistic Scenario*

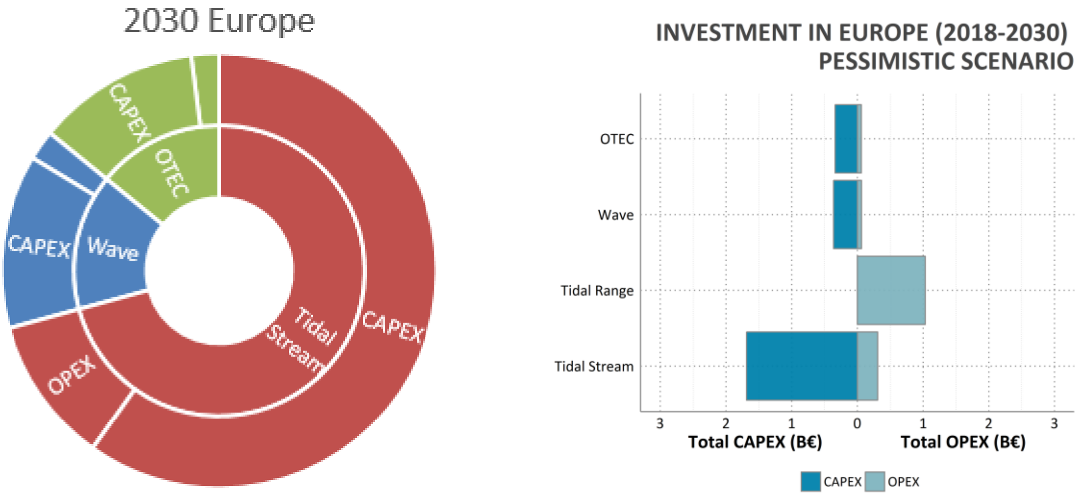
Under the pessimistic scenario, the 1.3 GW of cumulative capacity in 2030 corresponds to a total cost of 3.8 billion EUR in European projects (Figure 44).

Figure 44 - Future Investments under the pessimistic scenario



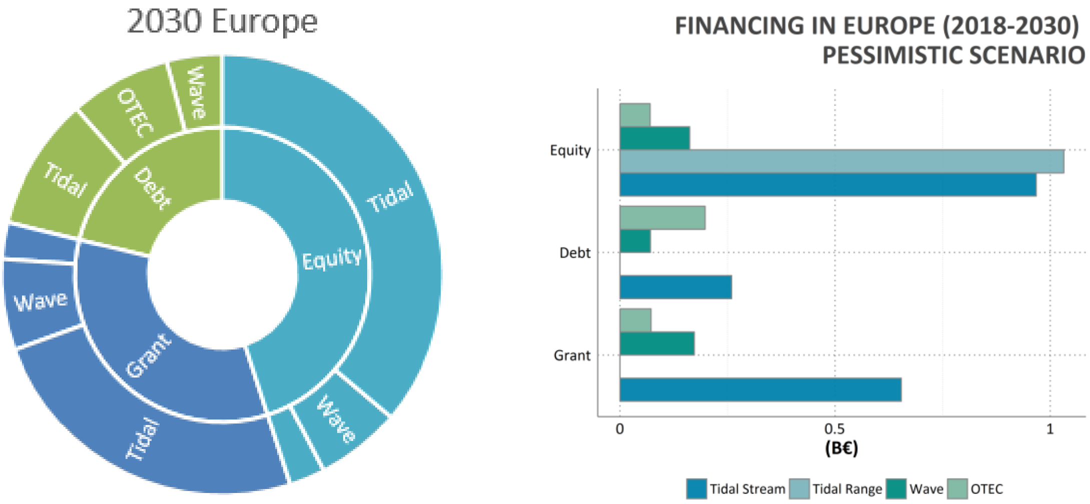
Compared with the other two scenarios, the required investments until 2030 worldwide will be concentrated in operational costs related with tidal range projects, and new tidal streams projects. OTEC projects have a higher contribution to the investments in ocean energy (Figure 45).

Figure 45 - Breakdown of investments by technology and cost type



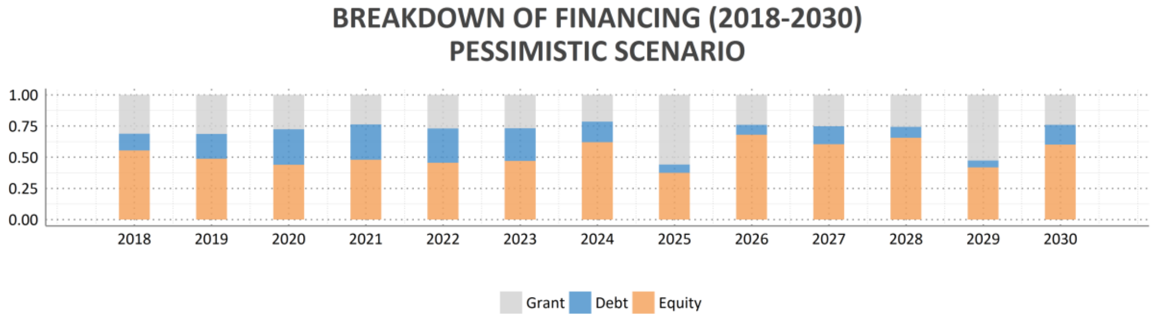
The financing of the projects is still expected to fall primarily under private equity (Figure 46), especially worldwide, as both debt and public financing are expected to decrease. Public grant contribution amounts to 900 million EUR in Europe.

Figure 46 - Breakdown of financing type in 2030 (pessimistic)



The evolution of financing sources (Figure 47) shows that public grants are expected to make a contribution in the development of the ocean energy sector until 2030.

Figure 47 - Breakdown of financing (pessimistic)



3 Lessons learned

3.1 Introduction

Discussing the financial challenges that the ocean energy sector will have to address in the next few years is not an easy task. First of all, one should consider that "ocean energy" is an umbrella term that includes a plethora of technologies, at differing development stages, ultimately having in common the fact that they seek to exploit marine resources to produce energy. Wave energy and tidal energy share a common environment, but the concepts behind their functioning are inherently different, and also happen to be at varying stages of development, with tidal energy slightly higher up the ladder of commercialisation. Wave energy epitomises this granularity, with several competing technologies under the same sector, none of which has yet emerged as dominant.

This is to say that a thorough overview of financial challenges in the ocean energy sector should take into account the stage of development of the different technologies involved. Having said that, it is also true that ocean energy technologies have something more in common that simply being located in the same environment; as of today, ocean energy technologies are mainly in the initial demonstration phase of single units, largely involving short-term tests, with only a few prototypes starting the first steps into the marketing phase. As such, at a broad scale, the ocean energy sector in its entirety shares many commonalities with other sectors at an early development stage, where companies often find it difficult – or too costly – to access credit.

The aim of this section is to discuss the lessons learned on financing ocean energy in the past few years, as well as to make comparisons with other sectors, so as to provide a benchmark against which one can measure how the ocean energy sector has performed, and what can be done in the future.

3.2 Overview of financial challenges

In the past few years, ocean energy projects in Europe have been financed mostly through private investments and grants, i.e. non-repayable funds disbursed by public authorities, either at EU or national/local level. This model has worked rather well because the scale of the projects financed was relatively small, being these mostly prototypes or test projects. Grants are quite effective to develop sectors that are far from being mature from a commercial standpoint, because they provide cash otherwise unavailable through traditional profit-driven channels. By doing so, financial resources from grants make it possible to carry out research and tests that will or should eventually lead to commercial maturity.

Commercialisation of a technology normally marks a different approach to raising funds. There is a twofold explanation to this assertion. On the one hand, commercial projects tend to be at a much larger scale than prototypes and demonstrations, and as such they require vast resources that cannot be provided by the public sector because of their size, or because, if granted selectively, they may distort competition. On the other hand, commercial projects have by their nature an expectation to generate revenue, and thus may attract institutional and retail investors alike.

The grant-based financing model is thus unsustainable in the long run, and may also become detrimental to the sector because protection from competition – including competition for capital – creates perverse incentives, slows down innovation, and leads to inefficient allocation of resources, ultimately hindering further development of the sector itself.

With several ocean energy technologies on the verge of commercialisation or pre-commercialisation, one of the toughest challenges that the sector is facing consists of gathering the necessary financial resources to scale-up energy production so as to compete on the energy market.

Generally speaking, offshore renewable energy projects do not lend themselves neatly to direct investment; long time horizons, complicated project planning, and coordination of multiple public- and private-sector partners make it difficult to structure deals. Traditional models of financing pose difficulties for investment in offshore renewable energy. As of today, many installations are of a scale that will not attract interest from traditional financial institutions, as transaction costs would be too great. At the same time, even though the long-term nature of energy projects may fit the profile of institutional investors and national or international financial institutions, it may not fit their risk appetite. Due to its pre-commercial nature and/or unproven technologies, the ocean energy sector is usually too risky for market-based finance, and hence considered not "bankable". In addition, ocean energy projects may be considered too capital-intensive for venture capital investment and too risky for private equity financing. To be considered that venture capitalists and private equity are accustomed and actively seek risky investments, often to an extent that is unbearable by other investors. Nonetheless, one of the key principle of finance is that high risk is associated with high expected return on investment. That is to say, certain investors are willing to take on risky investments – which ultimately are investments with a higher probability to fail – because they expect they can reap bigger rewards than with a "safe" investment. The problem with ocean energy project is that, even though they are considered risky investments, their expected return does not match the prospects of venture capital and private equity. According to a survey carried out by the Milken Institute for a study on energy infrastructure projects in Africa, investors look for at least 25% to 35% internal rate of return (IRR) if the investment is part of their private equity allocation (as opposed to the purchase of debt instruments), and of that group, a small percentage aimed for 35% or more. Unfortunately, on average, energy infrastructure projects (in Africa) have yielded 16 percent to 18 percent IRR, based on 20-year cash flow projections[31].

With all due differences between the African and the EU market, the gap still is remarkable. Traditionally, project financing is based on the prediction of future cash flows. In the power sector, cash flows are determined by the amount of energy an independent power producer generates and then sells to a utility or to another third party. Project finance is structured to include early-stage equity from deal "sponsors", usually a developer backed by a private equity firm or corporate investor, that is then supplemented by mezzanine (mid-term) and long-term debt provided by commercial banks or public-sector funding. Typically, the project finance requires a mix of investors and debt providers to diversify away the risk to any one particular partner. But, as explained above, the risk and return profile of a renewable energy project

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[31] Innovative Financing Models for Energy Infrastructure in Africa, Milken Institute, May 2015.

investment may not conform well to traditional energy investment classification. Renewable energy projects are capital intensive but have low operating costs and zero fuel costs. This investment profile was suggested to more closely resemble financial assets, such as a fixed-income investment (e.g. a bond), an infrastructure investment (e.g. a toll road), or a real estate investment[32]. Hence, education about the risk and return profile of renewable energy projects may allow institutional investors to consider these opportunities more broadly.

To make things worse, several commercial banks in Europe and worldwide are still highly capital-constrained, and may have limited appetite for long-term investments. Furthermore, stricter financial regulations (such as Basel III and Solvency II in the EU, and the Dodd-Frank Act in the US) could impede capital flowing to renewable projects that have investment periods of 20 or 25 years.

Also, renewables with high upfront costs generally must be financed over the life of the asset with strong profit returns delayed until the out years, discouraging private investment. Lack of long-term performance information hinders accurate valuation of the return on investment for many renewable energy assets.

The lack of historical, publicly available data addressing renewable energy risks is one of the greatest challenges in engaging untapped capital. In particular, there is an immediate need for publicly available performance data for all renewable energy technologies both within and outside of equipment warranty periods. Additionally, historical data on default rates by the energy purchaser was noted as critical to assess creditor risks and develop solutions through financial innovation. Data and knowledge are critical to risk mitigation. The industry requires larger and more comprehensive datasets to enable improved evaluation of risk and the pricing of products and services that mitigate such risks.

What has been described seems to indicate a gloomy future for the ocean energy future, but in fact it is common to several industries, and is known as the "commercialisation valley of death", i.e. the point at which investment needs are greatest but so are risks associated with potential failure, thus creating very high disincentives to participation in funding projects.

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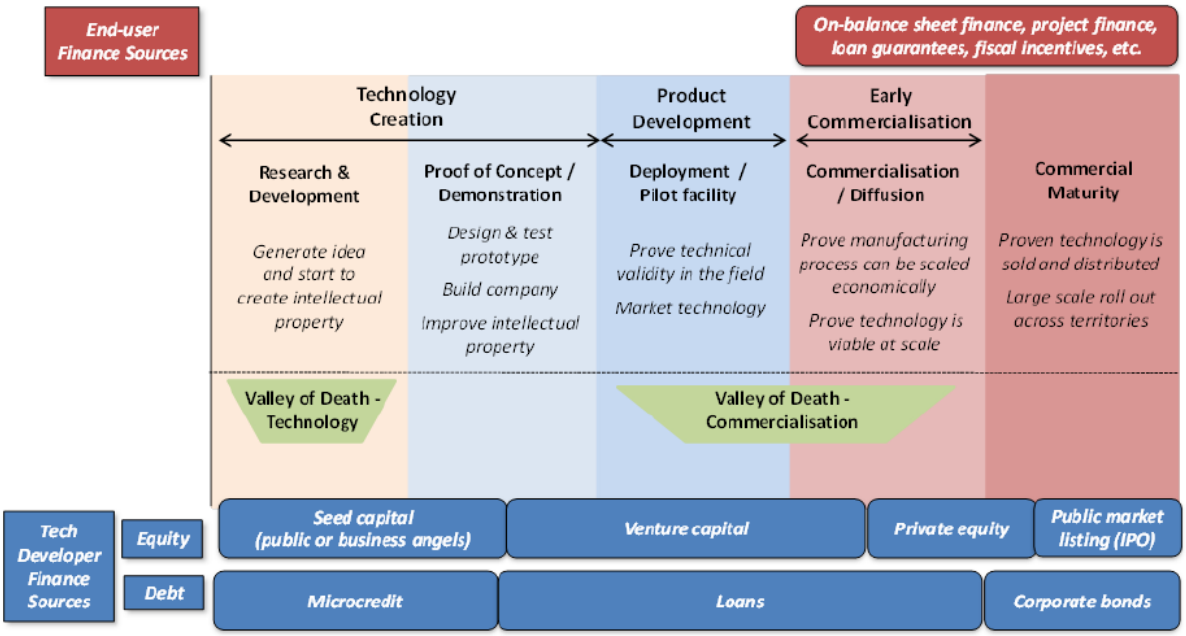
[32] Schwabe P. et al., Mobilizing Public Markets to Finance Renewable Energy Projects: Insights from Expert Stakeholders, NREL Technical Report, June 2012.

Figure 48 - The commercialisation 'valley of death'



Source: Innovative Financial Instruments for First-of-a-Kind, commercial-scale demonstration projects in the field of Energy, ICF, September 2016.

3.3 A comparison with the UK offshore wind sector

A 2013 report by Mazars on the offshore wind sector in the UK[33] offers a good overview of the financial challenges that the ocean energy sector will have to address over the next few years, as projects scale up from test to actual energy production.

Being at a far more advanced stage of development, the scale and complexity of offshore wind development have increased as project sizes have increased accordingly. In practice, this has meant that much of the project development has been driven by large utilities, defined broadly to include all major international electricity and gas producers. In total, utilities own 90% of operational capacity, 81% of projects currently being constructed, all the projects that are currently consented and 89% of projects earlier than this stage,

As project sizes have increased, it has become common for utilities to develop projects together in consortia, thus sharing capital, risk and expertise.

As to independent developers, which currently dominate the ocean energy market, in the UK offshore wind sector their number has decreased as project sizes – and development costs – have increased. Typically, the business model of independent developers is to incur their share of project development costs and then to sell their stake in the projects at some point following receipt of planning consent.

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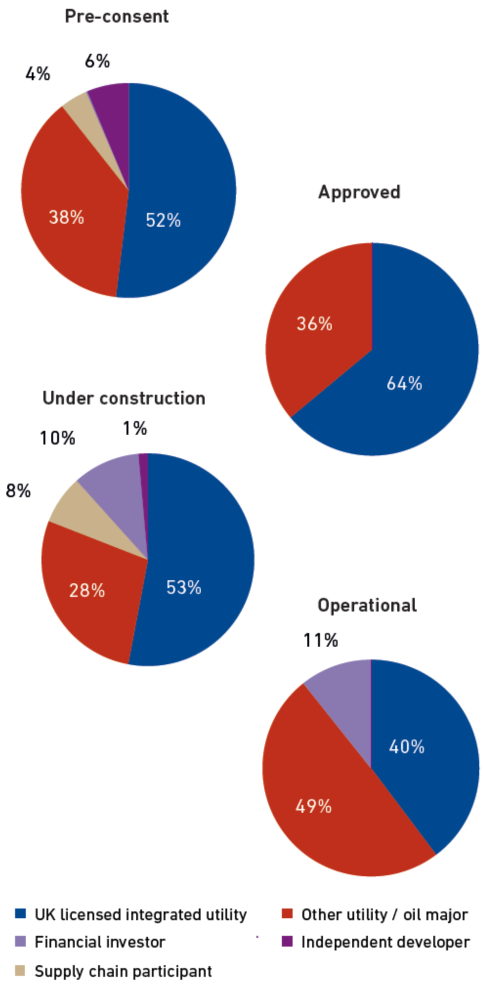
[33] UK OFFSHORE WIND – INVESTMENT LANDSCAPE STUDY, Report for Scottish Enterprise, Mazars, September 2013.

Figure 49 - Categories of owner for UK offshore wind energy projects



Source: Mazars, 2013

Supporting the development of offshore wind projects is a large supply chain. The services of contractors are required at every stage of the development of an offshore wind project, and contractors will typically have many sub-contractors of their own. A small number of supply chain participants have also developed and invested in projects directly, in partnership with major utilities.

Large integrated utilities are typically highly cash generative; however, they are constrained in their ability to incur capital expenditure by their balance sheets and in particular, their need to retain strong credit ratings in order to underpin a low cost of capital. Business models vary, and therefore the challenges to business models also vary, but many utilities have been hit in recent years by lower electricity demand, sharply falling spreads (especially for gas generation) and adverse regulatory changes (notably in Germany). This has meant that levels of allocated capital expenditure are often significantly lower than may have been planned a few years ago. At the same time, there is increasing pressure on utilities to drive up the return on capital employed in the face of concerns from shareholders that large capital expenditure programmes have failed to deliver shareholder value. The return on capital required by utilities has therefore increased at the same time as the level of capital they are able to commit has reduced. This has led to increasing investment attention on where to prioritise – both in terms of sector and geography.

Traditionally, utilities have avoided turning to project finance as a funding solution. Instead, utilities have sought to optimise their capital structure at the corporate level, including raising debt from bonds, money markets, commercial lenders and other sources, up to gearing levels in line with guidance for target corporate credit ratings. In this context, project finance has generally been seen as expensive and inflexible and, importantly, lacking credit ratings advantages. On the other hand, it has been rather more common for utilities to turn to the European Investment Bank for debt funding which is linked to projects but typically injected at corporate level.

Quite similarly to ocean energy, albeit on a different scale, offshore wind may well be an attractive sector for many project finance lenders: it offers large-scale opportunities, involves major corporate sponsors and provides a long, visible forward pipeline. Against that, long-term lending in general has been affected by new regulatory requirements for lenders to maintain higher capital ratios under Basel III: under these conditions, tying up funds for the long-term is costlier (as it requires equity to be set aside for that period), and many banks have therefore reduced debt tenors or, in some cases, withdrawn from project finance activities altogether. In addition, not all commercial lenders are prepared to take on the risks attached to offshore wind projects, especially construction risk in the absence of bankable guarantees.

In addition to commercial lenders, multilateral lending institutions have played an important role in the financing of offshore wind projects across Europe. Prominent amongst these has been the European Investment Bank (EIB), with export credit agencies also playing a crucial role in helping to reduce project risks to a level which commercial banks are able to tolerate. Aside from the EIB, the main public lending institution active in the UK offshore wind sector is the Green Investment Bank (GIB).

A look of the possible funding models can serve as a benchmark for the challenges that the ocean energy sector will have to address in the coming years:

3.3.1 Equity transactions

Utilities have been recognising the need to bring in outside sources of capital in this sector for some time now and looking to find innovative solutions to building out their portfolio without the call on capital implied. Equity transactions in particular have thus been commonplace in the sector, but up to now this has not just or even primarily been about liquidity: it has just as much been driven by the desire to share risk and pool expertise, and potential strategic benefits such as preferential access to particular turbines or shipping. Equity transactions have been common at various stages of project development, with three main types of transaction as shown in the figure below:

Figure 50 - Equity transactions at different stages of offshore wind projects

Stage	Rationale	Total examples funding shortfall
Development	Partly strategic: pooling of risk and expertise. Driven also by developers manoeuvring to reach their preferred level of exposure in the sector following Crown Estate licence awards.	Acquisition of stakes in the Irish Sea and Hornsea zones by Dong Acquisition of Sea Energy Renewables by Repsol
Pre or early construction	Rounds 1 and 2 were characterised by a greater involvement of independent developers – sale of equity to utilities post-consent was core to their strategies. Liquidity has also been a driver in some cases, and is likely to become more so.	Acquisition of Dudgeon East by Statoil and Statkraft from Warwick Energy Acquisition of stake in Gwynt y Mor by Siemens from RWE
Operational	Release of capital which is then recycled to fund new developments. Regulatory drivers	Sale of stakes by Dong in Walney to PGGM and Ampere, and Gunfleet Sands to Marubeni Transfer of transmission assets under the OFTO regime

Source: Mazars, 2013

In recent years, the type of investor in the UK has started to widen with the first UK examples of equity sales to an Asian strategic investor (Marubeni), a pension fund (PGGM) and a listed dedicated renewable energy fund (Greencoat Capital). Outside the UK, notable investors have included Blackstone, one of the few private equity funds to look at this sector, and Kirkbi – parent company to LEGO. There has also been somewhat greater pension fund involvement outside the UK, with Pension Danmark particularly active. In some instances, this involvement has even taken place at construction or pre-construction stage, an outcome achieved by the developer retaining the construction risk. The role of pension funds may be especially interesting to the ocean energy sector. Like any other investor, they need to diversify their portfolio – and so might be interested in investing in a new emerging sector – and look for steady returns in a long time horizon. They are not necessarily interested in high returns, as long as these are steady. The main problem currently is that ocean energy projects might be seen as too risky by pension funds. Therefore, devising a strategy to "de-risk" them might prove effective in attracting this type of investor. The loan of 35 million EUR by Danish pension fund, Pension Danmark, alongside a consortium of commercial banks, to the 216MW Northwind offshore wind project, was the first time a pension fund had ever provided debt to an offshore wind project. It was able to do so – even though this was a pre-construction loan – because the loan was guaranteed by the Danish export credit agency EKF.

3.3.2 Debt transactions

Debt transactions have encompassed a range of different funding and project structures. In the UK context, all but one transaction has taken place post-construction, and this offers further food for thought when making a comparison with the ocean energy sector. Up until recently, lenders have struggled with the combination of construction, counterparty, revenue and price risk. A significant constraint on the market also is the limited number of banks which are willing to lend on a long-term basis. Long-term pre-construction financings have been more common elsewhere in Europe, typically on the basis of a number of common features:

- European Investment Bank involvement, both to provide liquidity and, in a number of cases, to guarantee portions of the commercial debt.

- Export credit agency involvement, typically to guarantee portions of the commercial debt or other structures that help to reduce the risk exposure of commercial lenders. The most prominent example of an export credit agency in this sector in the past has been the Danish export credit agency, EKF in relation to projects using turbines manufactured by Vestas (Danish company) or Siemens (in the past manufactured in Denmark). More recently, KfW – the German equivalent – has helped finance a number of projects, including Lincs, Northwind and Butendiek.

- In the case of European projects, a fixed feed in tariff structure that has meant that banks are not exposed to market power price fluctuations.

Financial guarantees have been of key importance in allowing commercial lenders to participate pre-construction. In the European context, typically these have been provided by export credit agencies, with a view to supporting either domestic exporting companies or non-domestic companies with significant domestic manufacturing interests. In July 2012, the UK Government announced the introduction of a sovereign-backed guarantee to support infrastructure projects seeking to raise finance. Although there is wide discretion over how a guarantee is structured, the basic principle is that the UK Government guarantees some or all debt principal repayments and interest payments to the lender(s), for which the borrower pays a fee and undertakes to reimburse any payment made under the guarantee. The effect of this is to boost significantly the credit profile of the loan, as it is backed by the UK Government.

One particular recent development in the UK renewable energy sector more generally is the setting up of listed specialist funds. These have included:

- Greencoat UK Wind, which raised an initial £260 million on the basis of a seed portfolio comprising stakes in six operating wind projects, including a 24.95% stake in the offshore wind project, Rhyl Flats;

- The Renewables Infrastructure Group, which raised an initial £300 million with a seed portfolio of 18 assets (including 14 onshore wind projects and 4 solar PV projects).

- Bluefield Solar Income Fund, which raised £130 million focusing on large-scale agricultural and industrial solar assets.

What all of these funds have in common is that they have sought to attract institutional investors in particular by offering stable, low-risk yield, typically in the region of 6%. They have done this by targeting operational assets, especially in the onshore wind and solar PV sectors, and by diversifying investment across a number of assets to ensure that the fund is not over-exposed to any individual project. Because of this, they are unlikely to target very large offshore wind investments, still less pre-construction investments, although there may be further transactions comparable to Rhyl Flats.

3.3.3 Conclusions

Mazars conclude by stating that the current financing model is not sufficient to bridge the funding gap in the UK offshore wind industry, given the increase in project sizes and continuing pressure on utility finances. For this to happen, there will likely need to be a number of new funding strategies developed, and these can be broadly divided into two:

1. more systematic strategies for recycling capital from operational projects;

2. strategies to awaken the interest from pension funds and infrastructure funds on the equity side and commercial lenders on the debt side at the pre-construction stage.

Yet – Mazars note – most, if not all, of these funds will have looked at the opportunities presented by the UK offshore wind market at some point in the past and decided not to invest. For these decisions to reverse therefore, one or more of the following will need to change:

- The risk profile of offshore wind will need to decrease. The introduction of fixed prices under the Electricity Market Reform may help to de-risk the revenue stream to some degree, but also important will be the emergence of a larger number of strongly capitalised supply chain participants, a more substantial track record for larger turbines, and reduced regulatory risk (in particular, reduced reliance of the sector on state subsidy).

- Levellised cost of energy will need to come down. The aim of the UK Government and leading developers to reduce levellised costs from current levels of £150 per MWh to £100 per MWh, if successful, would have an enormous impact on the industry, improving project economics and reducing the reliance on Government subsidy.

- The project financing market will need to grow and become more active in financing projects preconstruction (as has been more common elsewhere in Europe). This is likely to be particularly important for infrastructure funds, which generally require leverage to increase equity returns.

- Projects will need to be structured to facilitate outside investment. This may include the provision of construction guarantees, long-term performance warranties, the long-term retention of power off take and/or the inclusion of long-term operations and maintenance agreements to ensure that utility partners remain fully involved and incentivised to deliver strong project performance.

3.4 Funding sources

NER 300 (EU): Managed by the EU Commission and the European Investment Bank, NER 300 was one of the world's largest funding programmes for innovative low-carbon energy demonstration projects. The programme was conceived as a catalyst for the demonstration of environmentally safe carbon capture and storage (CCS) and innovative renewable energy (RES) technologies on a commercial scale within the European Union. The aim of NER 300 was to establish a demonstration programme comprising the best possible CCS and RES projects and involving all Member States. The programme intended to support a wide range of CCS technologies (pre-combustion, post-combustion, oxyfuel, and industrial applications) and RES technologies (bioenergy, concentrated solar power, photovoltaics, geothermal, wind, ocean, hydropower, and smart grids).

NER 300 also sought to leverage a considerable amount of private investment and/or national co-funding across the EU, boost the deployment of innovative low-carbon technologies and stimulate the creation of jobs in those technologies within the EU.

NER 300 is so called because it is funded from the sale of 300 million emission allowances from the New Entrants' Reserve (NER) set up for the third phase of the EU emissions trading system (EU ETS). The funds from the sales are to be distributed to projects selected through two rounds of calls for proposals, covering 200 and 100 million allowances respectively.

The second award decision took place in July 2014 and the programme is now to be considered closed. However, some awarded NER 300 projects may be cancelled. By the end of 2016, this already resulted in 4 withdrawn projects and undisbursed NER 300 funds of at least 436 million EUR. The Commission has proposed reinvesting such resources from the first NER 300 call through existing EU financial instruments. To this end, on 19 May 2017 Member States approved, in the Climate Change Committee, a relevant amendment to the NER 300 Decision, which is now subject to a three-month scrutiny period by the European Parliament and Council.

InnovFin Large Projects (EU): managed by the EIB, InnovFin Large Projects aims to improve access to risk finance for research and innovation (R&I) projects emanating from larger firms; universities and public research organisations; R&I infrastructure (including innovation-enabling infrastructure); public-private partnerships; and special-purpose vehicles or projects (including those promoting first-of-a-kind, commercial-scale industrial demonstration projects). Loans and guarantees from EUR 25m to EUR 500m will be provided directly by the EIB. The product has been discontinued for the appraisal of new operations since 1 July 2017.

InnovFin Energy Demo Projects (EU): this product provides loans, loan guarantees or equity-type financing typically between EUR 7.5 million and EUR 75 million to innovative demonstration projects in the fields of energy system transformation, including but not limited to renewable energy technologies, smart energy systems, energy storage, carbon capture and storage or carbon capture and use, helping them to bridge the gap from demonstration to commercialisation. The product is deployed directly by the EIB.

The technologies demonstrated in the project should be innovative in relation to others in the market. Innovation may relate to a specific technology, processes, products or services. The innovative aspect may consist of the innovative combination or innovative application of existing technologies.

Technologies shall be at pre-commercial level or early commercialisation stages (i.e. the successful operation of the technologies should facilitate their subsequent commercial deployment). The project/investment should be sufficiently mature for demonstration at the proposed commercial scale (technologies validated and demonstrated through previous testing) with reasonable prospects of successful demonstration.

The projects financed are also expected to generate sufficient revenues to have the potential to become bankable. This requirement relates to all aspects of the project that are relevant for future project performance and loan repayment. Promoters, sponsors and/or operators must be willing to substantially co-fund the project.

Quite importantly, InnovFin EDP has already been amended to enable it to absorb unspent NER 300 funds. Consequently, extra resources coming from NER 300 are foreseen to become available through InnvoFin EDP towards the end of 2017.

European Fund for Strategic Investments (EU): EFSI is an initiative launched jointly by the EIB Group – the European Investment Bank and European Investment Fund – and the European Commission to help overcome the current investment gap in the EU. EFSI is one of the three pillars of the Investment Plan for Europe that aims to revive investment in strategic projects around the continent to ensure that money reaches the real economy. EFSI is a EUR 16 billion guarantee from the EU budget, complemented by a EUR 5 billion allocation of the EIB's own capital. The total amount of EUR 21 billion aims to unlock additional investment of at least EUR 315bn by 2018.

With EFSI support, the EIB Group is providing funding for economically viable projects, especially for projects with a higher risk profile than usually taken on by the Bank. It will focus on sectors of key importance for the European economy, including renewable energy and resource efficiency.

Large businesses, special purpose vehicles and medium-sized companies with up to 3 000 employees (also called midcaps) can benefit from project loans or loans to finance research and innovation. Midcaps and small of less than 250 employees) can also apply for growth finance or intermediated lending provided by financial partners, and may benefit from EIF's intermediated equity or guarantee products.

Energy Technology Development and Demonstration Programme (DK): managed by the Danish Energy Agency, the Energy Technology Development and Demonstration Program) supports private companies and universities to develop and demonstrate new energy technologies. Support is given in accordance with EU state aid rules. Foreign project participants can receive ETDDP aid according to the same rules as Danish participants. However, the main applicant must be a Danish registered company or university. ETTDP can support energy technologies widely such as renewable energy technologies, energy efficiency technologies, conversion technologies such as fuel cells and hydrogen, integration of energy systems including storage, more efficient methods for recovery of oil and gas and storage of CO_2. Since 2007, the EUDP has supported more than 600 RDD projects through funding of almost DKK 3 billion out of a total budget of almost DKK 6 billion. Of these projects, around 400 are ongoing and have been granted a total commitment of around DKK 2 billion.

Market Development Fund (DK): The aim of the Market Development Fund is to promote growth, employment and export, particularly for small and medium-sized enterprises in areas where Denmark has particular strengths and potential. In 2016 the fund was allocated 56,4 million DKK. The fund is technology and sector neutral. Grants are focused on the testing and adaptation of products under real-life conditions. Guarantees are directed at end-users to mitigate buyer uncertainty about investing in novel technologies. In this case, the risk is split between the manufacturer (20%), the Market Development Fund (60%) and the buyer (20%), i.e. if the product deviates substantially from the initial promise, the customer will get back up to 80% of the price.

To qualify for a grant, the project needs to be mainly implemented in Denmark and completed within 3 years. To qualify for a guarantee, the innovative product must be fully developed and ready for market introduction. The Fund prefers not to invest in small projects and companies as there is a perception that projects below a certain “critical mass” struggle to make a significant impact on the market. Successful projects should lead to job creation and exports. The innovation should be new to the global market. The project must have a business plan and a realistic growth forecast. Part of this assessment must be based on documented market interest. Competencies within the company must match what is necessary for a successful project including both business and technical experience. The sponsor’s experience in bringing new technologies to market, as well as their market knowledge and industry collaborations are also evaluated by the Fund. The additionality of the project funding is also essential.

Programme Investissements d’Avenir (FR): the PIA exists to finance innovative projects aimed at creating and developing key industrial sectors and, ultimately, strengthening France's strategic competitive advantages. Funding is targeted at projects in energy generation and smart grids as well as transport, recycling and ‘circular’ economy. The PIA offers grants and reimbursable loans/repayable advances dedicated primarily to projects at TRLs 6 and 7; and equity-based financing dedicated to projects at TRLs 8 and 9.

Contractually, it is expected that project sponsors or partners contribute substantially to financing the project. For every individual project, it is expected that net equity be in excess of the amount of funding offered by ADEME. One rule of thumb is that every euro financed by the PIA scheme must be matched by an equal or higher amount of equity from project sponsors or private partners.

Energy Technologies Institute (UK): The ETI is a public-private partnership between global energy and engineering companies and the UK Government. Its role is to act as a conduit between academia, industry and the government to accelerate the development of low carbon technologies. ETI has no specific eligibility criteria. Instead it sets out the selection criteria in each call for proposal. One of the most important aspects is that projects should have a UK angle. It is also important that the ETI member companies see some strategic value and alignment of their own corporate objectives in the projects awarded funding.

ETI also operates no standard contractual conditions; nor are there clawback conditions applied to projects. However, financial payback (if applicable) is linked to project deliverables. Project developers must also cashflow the project from the start. In many projects, such as knowledge building, no royalties are involved.

It has provided grants, debts and equity, but its funding agreement is due to expire in 2017. According to a report by ICF[34], demonstration is a key focus area of the ETI. However, the fund’s financial model (partly financed through annual contributions made by its members) has proved to be unsustainable. The lack of real commercial success from the projects backed to date illustrate the challenge of getting innovative technologies into the market, even when backed by some of the most prominent and financially-secure companies in the world. A low success rate for commercialisation

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[34] Innovative Financial Instruments for First-of-a-Kind, commercial-scale demonstration projects in the field of Energy, written by ICF in association with London Economics for the EU Commission, September 2016.

makes it hard to convince private funders to co-invest into what are often very high risk ventures. A financial model practised by the fund in which support is based on clear deliverables could be replicated at the EU level. The fund does not pay upfront, and companies only get the support if they can provide tangible deliverables (for example, commissioning of a demonstration project). This means, that companies have to cash-flow the project. For smaller companies, this might pose a key barrier to enter funding competitions.

Marine Energy Array Demonstrator (UK): In June 2012, the UK announced funding of up to £20m to support innovation in marine energy technologies, subject to value for money assessments. MEAD aimed at supporting two pre-commercial projects to demonstrate the operation of wave and/or tidal devices in array formation for an extended period of time.

There were a few conditions to be eligible for financing. The array had to expect to generate at least 7 GWh per year when complete and had to include at least three generating devices. Arrays at or in excess of 10GWh annual energy production were assessed more favourably and we expect to support arrays of between 5MW and 10MW nameplate capacity. The technology used must have been previously demonstrated at full-scale in real-sea conditions with comparable resource to the project site and using devices of equivalent design and scale to those to be installed in the MEAD project.

MEAD awarded £10m to the Meygen project, the first array of tidal energy in the EU.

In addition to public support schemes, funding can also be raised through the private sector. It is impossible to list all the actors that could potentially finance ocean energy projects, therefore this section will simply list the available options:

Equity investments: some projects have significant risks and financial requirements that investors are not necessarily willing to take. In such cases, it is possible to make equity investments, which directly inject capital to grow the operation of a project or a firm and allow it to leverage further resources, as they mitigate the risk for other investors. Equity investors own part of the company or assets and therefore depend on the results of the project to secure a financial return on their investments; they do not have any guarantee of repayment or return. In the case of failure of a project, the debt holders involved in the project have priority on any available returns over the equity investors. Equity is used when the probability of failure of the investment is high, but there still remains a probability of success and, therefore, of return to the equity holder. Because equity investments are quite risky, investors usually look for quite high returns too. This is a problem when it comes to ocean energy, as the sector has not yet proved a source of revenue, and expected rates of returns do not match the needs of equity investors.

Debt: while owned capital is referred to as equity, borrowed capital is referred to as debt. Debt instruments are assets that require a fixed payment to the holder, usually with interest. While participation in equity shows interest of ownership in a project, debt instruments are solely a financial, interest-earning investment. As a result, debt instruments typically offer a correspondingly lower potential return on investment than equity. Debt investments are not centrally traded but are traded over-the-counter (i.e. not under the supervision of an exchange, like in the stock market). Bonds are the leading form of debt investments, although mortgages are also included in this asset category. In the event a company is liquidated, bondholders are the first to be paid.

While in Europe the cost of debt has been relatively low, it should be noted that it might not be easy for a developer to obtain credit from a bank or other private financial institution. Long-term lending – such as is required for an ocean energy project – has been affected by new regulatory requirements for lenders to maintain higher capital ratios under Basel III: under these conditions, tying up funds for the long-term is costlier (as it requires equity to be set aside for that period), and many banks have therefore reduced debt tenors or, in some cases, withdrawn from project finance activities altogether.

Debt swaps: debt conversion or debt swaps occur when an existing debt stock or stream of debt service payments is converted into another obligation or type of asset. Usually a debt swap involves the voluntary exchange of a debt instrument by a creditor with its debtor for cash, another asset, or a new obligation with different repayment terms. This type of scheme has been used for environmental funding through debt-for-nature operations. Such swaps often involve a third party, which buys the debt from the creditor at a discount. Another debt swap modality involves the creditor and debtor transacting directly in relation to bilateral debt. In these cases, the creditor cancels out all or a portion of the debt and the debtor agrees to use the amount of the cancellation to fund mutually agreed activities.

Concessional or soft lending: the upfront transfer of resources from one party to another with the agreement that the money will be repaid on conditions more favourable than market terms is known as concessional or soft lending. This practice lowers the cost of capital and reduces the risk to all participants by offering low or no interest rates, longer repayment and/or grace periods, or a combination of these features. Intrinsically, concessional lending includes a grant component that can be quantified based on how favourable the lending terms are. Concessional lending is used when financing at market terms is not available or would make the investment unviable. Concessional lenders generally consider the existing debt levels and capacity to repay of the loan recipient, before extending financing to borrowers.

Some investments entail inadequate risk-adjusted returns to investors or governments and fail to attract capital through debt on terms that could ensure the feasibility of the project. **Guarantees** help mitigate or manage such risks. Guarantee instruments are commitments in which a guarantor undertakes to fulfil the obligations of a borrower to a lender in the event of non-performance or default of its obligations by the borrower in exchange for a fee. Guarantees can cover the entire investment or just a portion of it.

Concessional resources can also be used as **risk buffers to cover first losses in waterfall payment mechanisms** that assign the payment of revenues to senior risk tranches held by public finance institutions and private investors. Under such a structure, different risk tranches of capital are created, where the first loss may be covered by concessional resources and the upper tiers by finance and commercial investors. A waterfall repayment mechanism assigns the first payment of revenues to the senior tranches and the last to the first-loss tranche. The use of concessional resources under this structure allows additional commercial funds to be leveraged at a large scale for development purposes. The risk buffers of the higher-risk tranches also provide more risk-adverse investors with significant comfort.

This type of scheme works for an energy company repaying more than one loan. The company would make principal and interest payments on the costlier loan, and make only interest payments on the remaining loans. Once the more expensive loan is paid off, the company can make all interest and principal payments on the next, more expensive loan. The process continues until all loans are repaid.

Performance-based payments refer to a grant or a concessional loan that is disbursed in tranches against the verified fulfilment of predefined targets or quantified emission reductions in a project. Payment is conditional on measurable actions being undertaken. In many instances, carbon credits or units may be seen as a special type of performance-based payment.

A **Public-Private Partnership (PPP)** is a contractual agreement between a public agency and a private sector entity. In addition to the sharing of resources, each party shares the potential risks and rewards associated with the delivery of the service and/or facility. An example of a PPP is the Bulgaria Energy Efficiency Fund, in which the World Bank, the UNDP and the Austrian, together with a private sector fund management consortium and local financial institutions in Bulgaria, joined efforts to create the combine capacity of a lending institution, a credit guarantee facility and a consulting company. They provided Bulgarian enterprises with technical assistance in developing energy efficiency investment projects and assisted their financing and cofinancing and played the role of guarantor for other financing institutions.

Infrastructure project bonds: project bonds have been used in Europe and in the US to finance infrastructure projects. The debt can be government-issued or a corporate offering: until the global financial crisis, these bonds were "wrapped" with monoline insurance as a credit enhancement. After 2008, the monoline industry collapsed due to the participation of these insurers in the subprime market. Project bonds have become more attractive since Basel III, as conditions make bank lending more difficult, and public-sector funds are limited.

Credit bonds: covered bonds are securities that are backed by a pool of loans. Unlike mortgage-backed securities issued in the US, covered bonds stay on the credit issuer's balance sheet, ensuring that insiders use their own money to buy stock in the company they are running. And, because the issuer maintains ownership, the loans within the cover pool can be switched out, depending on their performance. The bonds are attractive because of the double recourse they offer to both the issuer and the pool of loans itself. In addition, the diversification of the pool can help mitigate the impact of a default. Banks in Europe have moved towards the bonds because the retained ownership removes compliance issues with Basel III.

3.4.1 EU and national Funds

When it comes to ocean energy, European structural funds – more specifically the European Regional Development Fund – are a relatively overlooked source of funding, even though the ERDF he focuses its investments on several key priority areas, among which is 'low-carbon economy', whose objectives are perfectly in line with ocean energy.

The ERDF is managed locally by NUTS-2 regions and it would thus be difficult and time consuming to analyse all operational programmes in the current programming period (2014-2020). Therefore, it was decided to look at ERDF operational programmes in the regions which are at the forefront of ocean energy, namely Galicia, Brittany, and Ireland and Scotland.

Galicia[35]: one of the challenges that the OP intends to address is to develop a new model of managing natural and cultural resources, so as to modernised Galicia traditional sectors, by introducing innovations that can improve the efficiency of local resources and their conversion to alternative uses with higher added value, especially in the fields of energy, aquaculture, pharmaceutics, cosmetics, food and culture.

Priority 1.3 especially mentions the diversification of the energy sector, prioritising biomass and ocean energy. Thematic Objective 4 addresses this priority by "supporting the transition to a low carbon economy in every sector". Under this objective there is an investment priority which aims to foster the production and distribution of energy from renewable sources. Overall, EUR 152 907 438 are budget

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[35] Operational Programme and annual execution reports available at https://www.conselleriadefacenda.es/es/areas-tematicas/planificacion-e-fondos/periodo-comunitario-2014-2020/programas-operativos-2014-2020/po-feder-galicia-2014-2020

for TO 4, with EUR 27 700 000 specifically destined to supporting biomass and ocean energy. However, looking at the annual execution reports available at the time of writing, no ocean energy projects have yet been funded.

Brittany[36]: the ERDF OP of Brittany supports ocean energy through various measures. First of all, under Axis 2 'Research, innovation and economic development', objective 2.2 aims to increase the innovation effort enterprises in Brittany, by supporting projects that entail collaborative research (action 2.2.3). Although not specific to ocean energy, the OP expressly mentions that ocean energy projects can be financed *(Par exemple, les projets collaboratifs de recherche issus du Pôle Mer ou de FEM pourront viser la recherche, le développement et l'expérimentation autour des énergies marines*).

Secondly, Priority Axis 3 deals with supporting the transition to a low carbon economy in Brittany, and, as a specific objective, aims to increase the production of renewable energy (Specific Objective 3.1). Under this objective, there is an investment priority which intends to support the transition towards a low carbon economy by fostering the production and distribution of energy from renewable sources. In the OP, ocean energy is considered as a priority investment. It is stated that Brittany is the most important maritime region in France, and is endowed with exceptional natural resources that can make it possible to exploit several types of energy (wind, wave, current, tidal).

Unfortunately, annual execution reports are not available online to establish how much has been spent on ocean energy. EUR 275 053 501 are budget for the whole Axis 3, but it is not known how much of it is earmarked for ocean energy.

Ireland[37]: The Border Midland and Western (BMW) Region Operational Programme mentions marine renewable energy as one of Ireland's research priorities. A section of the OP details the contribution of the ERDF to the Atlantic Strategy Action Plan. Ocean energy is mentioned again, when it comes to Priority 2: Protect, secure and develop the potential of the Atlantic marine and coastal environment – this includes actions to exploit the potential of off-shore energy, one of the potential areas that may be supported by a proposed financial instrument focussed on the renewable energy sector. It will also be supported by research investment in the marine energies and biotechnology sectors under the Regional OPs. In practice, this has translated into contributing to funding projects such as Foresea[38], under Interreg North-West Europe. The exact amount of funding is not known and this remains a problem with other regions as well, since in theory all the other OPs might be used to support ocean energy under transnational cooperation programmes.

Scotland[39]: Under investment priority 3.d Supporting the capacity of SMEs to grow in regional, national and international markets, and to engage in innovation processes, action 8 deals with enabling infrastructure for Smart Specialisation sectoral development, and regionally important sectoral development. It is mentioned that "infrastructure investment in regionally significant business infrastructure will be catalytic in the development of Smart Specialisation sectors and subsectors including energy (particularly offshore wind, wave and tidal) […]. No other information is known.

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[36] Operational Programme available at http://europe.bzh/jcms/preprod_234402/fr/feder

[37] Operational Programme available at http://www.nwra.ie/competitiveness/bmw-regional-operational-programme-2014-2020/

[38] http://www.nweurope.eu/projects/project-search/funding-ocean-renewable-energy-through-strategic-european-action/

[39] Operational Programme available at http://www.gov.scot/Resource/0046/00467309.pdf

One of the questions this Study seeks to answer is how much public and private funding has been made available to the ocean energy sector in the EU in the last few years. While it is relatively simple to gather data on certain EU-funded programmes (e.g. FP7, Horizon 2020, Interreg), it is not straightforward to give a complete overview of public funding, because many programmes are managed at national level, with only limited and fragmented data available. Some of this funding has been made available via EU structural funds, for which, in theory, annual execution reports should detail if and which ocean energy projects have been funded. However, quite often annual execution reports are not publicly available or are published with some delay. In addition, there is also a multitude of national initiatives that may be difficult to survey, even though it is believed they contribute to funding the sector to a very large extent.

Therefore, in view of estimating as closely as possible the amount of public funding made available to the ocean energy sector, the following sources have been used:

1. CORDIS database for FP7 and H2020 projects (downloaded from the EU Open Data Portal[40])
2. Keep database for Interreg projects[41]
3. News articles and desk-based research for national programmes

While the amount of funding made available through FP7, H2020 and Interreg can be considered reliable, the survey of national initiatives is by no means exhaustive, and its results should be taken with a grain of salt. At the same time, it should be noted that the amount reported probably underestimates the total amount of funding made available, as it was impossible to retrieve information for some projects.

Table 25 - Ocean energy funding via FP7, H2020 and Interreg programmes

EU Programme	Period	Amount of funding
FP7	2008 to 2014	€ 95,292,215.47
H2020	2014 to June 2017	€ 171,438,725.25
Interreg	2000 to 2017	€ 21,066,417.31

Table 26 - Ocean energy funding via national/regional programmes

Region	Project	Amount of funding
Basque Country (ES)	Mutriku	€ 2,300,000[42]
	BIMEP	€ 22,000,000[43]
	Oceantec	€ 2,500,000[44]
	Energy Strategy 2016-2030	€ 1,100,000,000, which about 10% for marine energy[45]
Canary Islands (ES)	PLOCAN	€ 21,900,000 (85% of which through the ERDF)[46]

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[40] https://data.europa.eu/euodp/en/data/dataset?q=cordis&ext_boolean=all&sort=views_total+desc

[41] https://www.keep.eu/keep/

[42] http://www.irekia.euskadi.eus/es/news/6858-euskadi-dispone-primera-planta-europea-que-suministra-energia-traves-las-olas
http://www.noticiasdegipuzkoa.com/2016/07/18/economia/la-planta-de-energia-de-olas-de-mutriku-la-mas-productiva-del-mundo-

[43] http://www.deia.com/2015/07/23/economia/inauguran-en-armintza-bimep-que-situara-a-euskadi-como-referente-en-energia-marina-

[44] http://www.tecnaliaventures.com/oceantec-implantara-en-mar-el-primer-convertidor-undimotriz-del-estado/ http://www.infocif.es/licitaciones/oceantec-energias-marinas-sl

[45] http://www.euskadi.eus/contenidos/informacion/estrategia_energetica_euskadi/es_def/adjuntos/3E2030_Estrategia_Energetica_Euskadi_v3.0.pdf

[46] http://www.boe.es/boe/dias/2008/04/05/pdfs/A18902-18908.pdf
Modification: https://www.boe.es/boe/dias/2013/02/26/pdfs/BOE-A-2013-2155.pdf and http://www.plocan.eu/index.php/es/sobre-nosotros/quienes-somos/descripcion

Region	Project	Amount of funding
	APC-PISYS	€ 14,000,000[47]
	Undigen	€ 709,048.12 (funded through INNPACTO 2011 – ERDF)[48]
Cantabria (ES)	Ubiarco and Santoña[49]	€ 18,000,000
Brittany (FR)	Sabella	€ 10,000,000[50]
	Various projects	€ 10,000,000[51]
	Port of Brest	€ 42,328,080.00 (15,000,000 of which through the ERDF)[52]
Pays de la Loire (FR)	Ocean energy supply chain until 2020	€ 180,000,000[53]
Normandy (FR)	Port of Cherbourg	€ 100,000,000 (45% of which from the Normandy Region)[54]
	OpenHydro	€ 1,000,000[55]
	LM Wind Power	€ 8,000,000[56]
New Aquitaine (FR)	4 prototypes	€ 1,500,000[57]
Flanders (BE)	Wave Pioneer	€ 2,400,000[58]
Denmark	MAWEC	€ 111,503.69[59]
	Mooring Solutions for Large Wave Energy Converters	€ 1,000,000[60]
Sweden	National Ocean Energy Programme until 2019	€ 5,700,000[61]
Netherlands	Energising Deltas	€ 549,980[62]
Ireland	Budget for ocean energy development 2013-2016	€ 26,300,000[63]
	ESB WestWave	€ 23,000,000[64]
	15 projects	€ 4,300,000[65]
Scotland (UK)	Wave Energy Scotland, 61 projects	£ 25,400,000[66]
	Scotrenewables Tidal Power	£ 1,240,000[67]
	Meygen	£ 17,200,000[68]
Wales (UK)	Seagen Skerries	£ 10,000,000[69]

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[47] http://www.greenplanet.es/2016/02/green-energy-from-waves-in-canary-island.html

[48] https://www.boe.es/boe/dias/2015/04/01/pdfs/BOE-A-2015-3563.pdf
https://www.boe.es/boe/dias/2016/01/20/pdfs/BOE-A-2016-516.pdf
https://www.boe.es/boe/dias/2015/01/02/pdfs/BOE-A-2015-33.pdf

[49] http://www.eldiariomontanes.es/v/20101009/economia/destacados/centros-pruebas-energia-marina-20101009.html

[50] http://www.cgedd.developpement-durable.gouv.fr/IMG/pdf/35Hydroliennes_cle51217d.pdf

[51] https://www.ecologique-solidaire.gouv.fr/energies-marines-renouvelables-0

[52] http://www.bretagne.bzh/jcms/prod_404635/fr/-port-de-brest-quai-energies-marines-renouvelables

[53] http://www.paysdelaloire.fr/no_cache/actualites/actu-detaillee/n/energies-marines-renouvelables-en-pays-de-la-loire-pari-tenu/
http://www.emr-paysdelaloire.fr/

[54] https://www.normandie.fr/les-energies-marines-renouvelables

[55] https://actu.fr/societe/normandie-45-millions-deuros-investis-dans-les-energies-marines_599785.html

[56] https://actu.fr/societe/normandie-45-millions-deuros-investis-dans-les-energies-marines_599785.html

[57] http://enr.fr/userfiles/files/Colloque/ficheregions.pdf

[58] https://www.deme-group.com/sites/default/files/flansea_electricity_from_the_sea_eng.pdf

[59] https://setis.ec.europa.eu/energy-research/project/mawec-energy-production

[60] https://tethys.pnnl.gov/sites/default/files/publications/OES-Annual-Report-2016.pdf p 76

[61] https://tethys.pnnl.gov/sites/default/files/publications/OES-Annual-Report-2016.pdf p. 148

[62] http://ec.europa.eu/regional_policy/en/projects/netherlands/energising-the-worlds-deltas

[63] https://www.irishtimes.com/business/energy-and-resources/ocean-energy-to-receive-government-funding-boost-1.1683990

[64] https://www.esb.ie/tns/press-centre/2014/2014/07/08/4094

[65] https://www.ouroceanwealth.ie/ga/node/368

[66] http://www.waveenergyscotland.co.uk/

[67] https://subseaworldnews.com/2012/12/14/scotrenewables-secures-funding-for-tidal-energy-project-in-uk/

[68] http://www.4coffshore.com/windfarms/tidal-meygen-tidal-stream-phase-1-united-kingdom-tidalid147.html

Region	Project	Amount of funding
	Holyhead Deep Project	€ 13,000,000[70]
	Morlais	£ 300,000[71]
	Structural funds prioritised for marine energy in Wales (2014-2020)	€ 100,428,444[72]. N.B.: Holyhead Deep received € 13,000,000 out of the funds earmarked for marine energy.
Cornwall (UK)	CETO	£ 9,551,962[73]
UK	Meygen	£ 23,300,000[74]

The amounts cannot be aggregated as the time scales in each region are quite different from each other. As mentioned above, this list may not be exhaustive, as it has not been possible to retrieve information for all of the existing projects. Nonetheless, it gives a good idea of the extent of financial resources that have been made available by the public sector for ocean energy projects. By looking at the footnotes, it is clear that so far the ocean energy sector has been funded through a variety of programmes at national and/or local level, and the total extent of resources that have been mobilised has been remarkable.

3.5 Business models

Because energy projects are dependent on off-takers (sellers along the distribution chain) for repayment, revenue is entirely linked to the creditworthiness of the utility or other partner. However, some models for infrastructure funding can diversify the potential "payers" so as to include other companies that would benefit from the development of the new energy asset. Most practically, this has worked in other energy sectors with small, off-grid energy generators, such as solar plants, which can be built for a group of companies that pay for the power.

This concept of shared-use infrastructure can enhance the risk profile of an independent power producer, lowering capital costs and allowing for more competitive power rates. The best example of this potential partnership is with mining companies in sub-Saharan Africa. Mining companies have explored options for power generations, including partnering with different mines or companies from other area industries to invest in a power plant connected to the grid, or, alternatively, forming a direct relationship with a power producer to serve as a principal off-taker. In the latter case, the mining company could create a joint venture with the independent power producer that would sell both back to the company and to the designated utilities to diversify revenues and work around the total dependence on the creditworthiness of the utility.

As of today, an ocean energy project can generate revenue by selling power to the grid or to a third party (e.g. a port). A developer or a utility must bear CAPEX (capital expenditure) and OPEX (operational expenditure) costs. Generally speaking, ocean energy projects – and renewable energy – are characterised by high CAPEX costs and relatively low OPEX costs. High CAPEX costs are mainly due to the fact that the innovative technologies involved require intensive R&D effort and need to be built in such a way as to operate in extremely harsh environments. OPEX costs are comparably lower, mainly because there are no fuel costs, although the maintenance costs of a structure located in the ocean should not be underestimated. Furthermore, projects to date have not run for the expected project lifetime of commercial projects,

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[69] https://cleantechnica.com/2013/03/01/wales-approves-10-million-funding-for-its-first-commercial-tidal-power-project/
[70] https://minesto.com/news-media/welsh-government-invests-13-million-euros-eu-funds-marine-energy-leader-minesto-start
[71] https://tidalenergytoday.com/2017/09/26/morlais-tidal-demo-zone-gets-gbp-4-5m-boost/
[72] http://www.marineenergywales.co.uk/about/funding/
[73] https://www.renewableenergymagazine.com/ocean_energy/carnegie-wave-energy-receives-erdf-grant-for-20161107
[74] http://www.4coffshore.com/windfarms/tidal-meygen-tidal-stream-phase-1-united-kingdom-tidalid147.html

meaning that the data available is skewed towards high CAPEX projects with a smaller contribution from OPEX, in comparison.

The revenue of the project will depend on the price at which the energy produced will be sold. That price in turn will depend on the cost (CAPEX+OPEX) for producing energy. This is normally referred to as "Levelised cost of electricity" (LCOE), which represents the per-kWh cost (in discounted real euros) of building and operating a generating plant over an assumed financial life and duty cycle.

However, besides the LCOE of an ocean energy projects itself, one also needs to consider the LCOE of other forms of energy; the more the LCOE of ocean energy is competitive with other forms of energy, the easier will be to sell power to the grid and so to generate revenue for the developer/utility.

As of today, this is not yet the case for ocean energy, whose LCOE is relatively high. For instance, while the LCOE of offshore wind is now below 20 cEUR/kWh – and is projected to decrease below 10 cEUR/kWh in the coming years – the LCOE of wave energy ranges between 60 cEUR/kWh and 110 cEUR/kWh, with a reference value of about 85 cEUR/kWh; the LCOE of tidal energy, on the other hand, ranges 54 and 71 cEUR/kWh, with a reference value of about 62 cEUR/kWh[75].

An effective way to reduce LCOE for both tidal and wave energy could be to reduce CAPEX, but doing so requires technological advancement. Sharing infrastructure, as mentioned at the beginning of this paragraph, could also lower both CAPEX and OPEX, thus leading to an overall reduction of LCOE.

Another way to reduce LCOE is to devise "demand pull mechanisms", the most common of which are "feed-in tariffs". Feed-in tariffs (FITs) are government mandated renewable energy subsidies requiring utilities to purchase renewable energy at a subsidised rate. Feed-in tariffs have played an important role in incentivising customer uptake of renewable energy. FITs legally obligate utilities to purchase electricity from renewable energy producers at favourable, higher-than-market rates. The government, for a certain period of time, typically guarantees the favourable rates assured by FITs[76].

The table below outlines pull mechanisms in place in the EU:

Table 27 - Pull mechanisms for ocean energy in the EU

Country	Rate and eligibility
Denmark	Maximum tariff of 0,08 EUR/kWh for all renewables including ocean energy
France	Feed-in tariff for renewable electricity. Currently 15 cEUR/KWh for ocean energy
Germany	Feed-in tariff for ocean energy between 3,5 and 12,5 cEUR/KWh, depending on installed capacity.
Germany	Feed-in tariff for electricity from hydro power, wave and tidal at least 7,67 cEUR/kWh
Ireland	Market support tariff for ocean energy set at €260/MWh and strictly limited to 30 MW
Italy	0,34 EUR/kWh tariff (capacity installed until 2012)
Italy (from 2012)	For projects until 5 MW 0,3 EUR/kWh For projects >5 MW 0,194 EUR Kwh

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[75] JRC Ocean Energy Status Report 2016 Edition.

[76] Ottinger R., Bowie J., Innovative Financing for Renewable Energy, Pace Environmental Law Review, July 2015.

Country	Rate and eligibility
The Netherlands	The SDE+ (feed-in premium) supports ocean energy with a base support of 15 cEUR/KwH minus the average market price of electricity in the Netherlands (support is given for a 15 year period). Total budget for SDE+ capped (EUR 8 billion in 2016)
United Kingdom	Renewable Obligation (RO) Scheme. Renewable Obligation Certificates (ROCs) price set to 44,33 GBP in 2015/16. It was replaced by a Contract for Difference (CfD)[77] scheme in 2017. Wave and tidal energy technologies will be allowed to bid for CfDs, however they are currently expected to compete with other technologies (e.g. Offshore Wind) to access CfDs.

Source: NREAPs update reports and JRC, 2016

Feed-in tariffs may be quite a useful instrument to “protect” the ocean energy sector until it reaches commercial viability. However, they can also become a double-edge sword. If a feed-in regime is announced, investors will take it into account only if they genuinely believe that the regulatory framework is not going to change. On the other hand, if, for any reason, they believe that it might be revoked because of financial constraints, they will not consider it for their investment.

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[77] In the UK, A CFD is a private law contract between a low carbon electricity generator and the Low Carbon Contracts Company, a government-owned company. A generator party to a CFD is paid the difference between the ‘strike price’ – a price for electricity reflecting the cost of investing in a particular low carbon technology – and the ‘reference price’– a measure of the average market price for electricity in the GB market. It gives greater certainty and stability of revenues to electricity generators by reducing their exposure to volatile wholesale prices, whilst protecting consumers from paying for higher support costs when electricity prices are high.

4 Recommendations to address actions 2 and 3 of the Ocean Energy Roadmap

The Ocean Energy Roadmap[78] published in November 2016, amongst other things, proposed two actions to foster the development of the ocean energy sector in the EU:

Action 2: EU and National Authorities should set up a 250 million EUR Investment Support Fund providing flexible capital and enabling further private capital to be leveraged

Action 3: EU and National authorities should set up a 50m-70 million EUR Insurance and Guarantee Fund for ocean energy demonstration and pre-commercial projects, covering risks that are currently not covered by either insurance products or manufacturers guarantees.

The roadmap acknowledges that there is a difficulty of sourcing private capital for ocean energy projects, in that risk remains too high for commercial debt providers, in a market without long-term visibility and where traditional investors – power producers – are no longer strategically investing in innovative renewables. Therefore, public support might be required to take on some of those risks that operators alone cannot carry nor insure, and stimulate participation of private financiers, at least until the sector (or some of the technologies within it) matures and reaches commercial self-sufficiency.

In light of the above, the aim of this section is to propose recommendations as to how the funds could be structured so as to effectively address the needs outlined in the Ocean Energy Roadmap.

4.1 Method

The process that led to the recommendations outlined in the next section is quite straightforward and can be summed up as follows:

1. A list was compiled with all the objectives and the characteristics that both funds should have, as these are outlined in the Ocean Energy Roadmap. The list was the starting point against which to check all the options that emerged as the analysis progressed.

2. A survey was launched at the beginning of the study[79]. Project and technology developers, as well as international organisations and public and private financiers were asked specific questions as to the potential structure of the two funds proposed in the Ocean Energy Roadmap. The answers received highlighted certain common key features that the funds should have.

3. International best practices were looked at, so as to draw on successful experiences. More specifically, an analysis of public-private funding mechanism addressing ocean and renewable energy was carried out. The mechanisms that matched the objectives and requirements outlined In the Ocean Energy Roadmap were singled out. At the end of this process, three funds stood out as being particularly in line with our goal: the Renewable Energy Investment Fund (Scotland, UK), the Renewable Energy Venture Capital Fund and the Innovation Fund, the latter both set up by the Australian Renewable Energy Agency.

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[78] Ocean Energy Strategic Roadmap, Building Ocean Energy for Europe, November 2016, https://webgate.ec.europa.eu/maritimeforum/sites/maritimeforum/files/OceanEnergyForum_Roadmap_Online_Version_08Nov2016.pdf

[79] Please see § 1.

4. By matching the results of the previous steps, a set of recommendations was developed.

4.2 Proposed structure of the Investment Support Fund

The Ocean Energy Roadmap proposes to "create a Fund for financing single demonstration/pre-commercial projects, able to provide different types of finance and able to help developers access other financing sources, whether public or private". It is also recommended that "the Fund provide investment support as upfront capital, and ideally be able to mix grant, equity, and debt. Grants can be repayable, pending the right repayment conditions". While the principle is clear, it should be noted that this proposal might be confusing, as grants are normally not repayable; on the other hand 'concessional lending'[80] may provide loans that on certain conditions might be repaid on more-favourable-than-market terms or not repaid at all, thus implicitly including a 'grant component'.

As both the Ocean Energy Roadmap and the Tendering Specifications of this study highlight, it is paramount that the fund help leverage additional private capital and reduce the finance costs. Other key features of the fund according to the Ocean Energy Roadmap should be:

- The Fund should aim at making itself obsolete for a given technology: funding projects until a technology has been de-risked enough to be able to source commercial debt/private equity without it.

- Learnings from publicly funded projects need to be made available to the funding authorities and the industry broadly while preserving IP as necessary.

- Estimated budget is 200-300 million EUR over a 5-10 year period. However, the total budget for the Fund would ideally be determined by the market: as soon as commercial funding is available for a given technology, the appropriate number of projects will have been funded and the Fund can stop considering that technology.

- The Fund should provide finance flexibly (grant, debt or equity) to suit the diverse profiles of projects while requesting a strong due diligence, reducing risks for the Fund itself and providing a seal of approval helping to access further private finance at reduced cost

Besides the Ocean Energy Roadmap, the stakeholders and developers interviewed for this study highlighted the key characteristics that the fund should have. It should be noted that not all the persons interviewed are finance experts, hence their opinion had to be interpreted and translated into practical recommendations. Interestingly, overwhelming consensus has been reached on certain common characteristics:

- Virtually everybody agreed that the Fund should provide capital in the form of both equity and debt, and possibly also grants to demonstration projects.

- Some argued that the Fund should focus on supporting a small number of large projects, while others pointed out that it would be wise to limit support to a maximum number of MW per technology per project, to avoid that a small number of developers might quickly use all of the available resources.

- Support to wave and tidal technology should be differentiated so as to reflect the different level of development of the two sectors. It was suggested that the

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[80] See § 3.4

Fund might support demonstration projects for wave energy, but should focus on commercial and pre-commercial projects for tidal energy.

- Virtually all interviewees agreed that some revenue support mechanisms (e.g. feed-in tariffs) should also be set in place, otherwise the Fund may well contribute to making more investments, but these might never generate enough revenue to attract private investors. The main problem with revenue support mechanisms is that they are decided and implemented by the Member States. As shown in this Study, there is indeed a number of revenue support mechanisms in several EU Member States, but the existence of different models and the lack of harmonisation create uncertainty, which is often worsened by ever changing policy decision. It was noted that in the UK and in other countries, revenue support policies have changed significantly over time, thus making it difficult to identify and quantify the short to medium term business opportunities. No matter how well designed the Fund could be, investors will never risk their money over investment that have little prospects of generating revenue.

Furthermore, from an analysis of existing funds around the world, it has emerged that the Renewable Energy Investment Fund in Scotland, and the Renewable Energy Venture Capital Fund and the Innovation Fund in Australia have similar characteristics.

It may be useful to provide a quick overview of these funds:

Renewable Energy Investment Fund (Scotland)	Renewable Energy Venture Capital Fund (Australia)	Innovation Fund (Australia)
Provides financial assistance for projects that will deliver energy from a renewable source, reduce the cost of renewable energy or provide key solutions for renewable energy generation. It is a discretionary fund, with projects assessed on a case by case basis. It provides loans and equity investments, all on fully commercial terms. Priority is given to: • Deployment and operation of arrays, as a step towards commercialisation for devices that have already been demonstrated at full-scale prototype stage. • Demonstration of innovative technologies that will decrease costs and remove risks associated with the installation, operation and maintenance of marine energy devices in arrays. It funded the MeyGen Project, which is now the poster child for marine energy sector globally.	It encourages investment in innovative Australian renewable energy companies to strengthen their chance of success. It makes equity, convertible debt, warrants and options investments in early-stage renewable energy companies to help them overcome capital constraints, develop technologies, increase skills and forge international connections. Committed capital of up to $ (AUD) 120 million with 50% from ARENA (public money) and 50% from private capital It is managed by a private sector fund manager.	It is a $ (AUD) 200 million programme supporting the growth of innovative clean energy technologies and businesses which are critical to Australia's clean energy transformation. It targets technologies and businesses beyond the research and development stage, have a long-term commercial outlook, and so can benefit from early stage seed or growth capital to help them progress to the next stage of their development. The Innovation Fund considers clearly documented applications for investment in new and innovative opportunities that are commercially viable and where there is a demonstrable pathway to the return of capital. The Innovation Fund does not provide grants. It is managed by the Clean Energy Finance Corporation (CEFC), an Australian Government-owned Green Bank, in consultation with ARENA.

In light of the above, it is recommended to take into account the following recommendations for the structure of the investment support Fund:

- It is recommended that the Fund be managed by a private-sector fund manager, to be selected via a competitive merit-based process. The fund manager might be paid an annual management fee from the capital of the Fund and a performance fee from any profits of the fund, both to be clearly outlined in the fund manager’s licence. It is believed that this form of management may foster a market-driven approach, whereby funding will go to projects that have excellent prospects of success. Special attention should be paid to strike a correct balance between the annual management fee and the performance fee; possibly, the performance fee should be comparatively higher than the annual management fee, thus creating an incentive for the fund manager to select projects with a solid business case, regardless of technology or project scale (e.g. demonstration, pre-commercial, etc.).

- The licence agreement with the fund manager should include a provision whereby the fund manger is obliged to raise a certain amount of private sector co-investment. The amount of co-investment raised might also be part of the criteria to select the fund manager. In ARENA’s venture capital fund, for instance, the fund manager has a committed capital of $ (AUD) 120 million, with 60 million coming from ARENA and 60 million from private investors. In the case of the EU Fund, the same commitment would make available 500 million euros of capital. The 50-50 proportion might be unrealistic to achieve in Europe, because the public share of capital is considerably higher than in Australia, and because the Australian fund targets more forms of energy than just marine. Nonetheless, if the amount of co-investment becomes a criterion for the selection of the fund manager, it is in any case assured that the Fund total committed capital is maximised, because the Fund will be managed by the private-sector entity that commits to raising more capital from private investors.

- The investment instruments of the Fund should be equity and debt. It is easy to imagine that the Fund Manager might prefer to use equity to invest in projects that offer potentially higher rates of return, and there might be few projects like these in the ocean energy sector in the coming years. Therefore, the Fund should also use debt as an investment strategy. Considering that the sector has not yet reached commercial maturity and still needs public support before it proves to be able to generate revenue, it is recommended to factor in concessional loans, i.e. loans that can be repaid on conditions more favourable than market terms, thus lowering the cost of capital and reducing risk. As suggested in our survey, the ‘concessional component’ might consist in low or no interest rates, longer repayment and/or grace periods, or a combination of these features as long as a project is not generating revenue. As suggested during the survey, concessional lending might consist in debt to be repaid at a reduced rate if the project delivers certain generation targets (this enables a revolving fund to be created). Another option might be to provide conditional debt structured as a grant until developers start making revenue, then turn it into debt that is paid back on percentage of annual sales. The debt would thus stay off the balance sheet during the product development phases, which could contribute to attracting more private financiers.

  Concessional lending thus implies an intrinsic ‘grant component’, because there is the possibility that the debt is never paid off. It seems particularly appropriate for the current situation of the ocean energy sector, where there are technologies still at the demonstration stage, and technologies that are at the pre-commercial stage. Regardless of the technology, a developer may apply for a loan which will be repaid only on condition that certain targets have been achieved. The targets will be determined case by case, so as to be realistic, and will be part of the loan agreement.

- Concessional resources might also be used to create risk buffers that will cover first losses in waterfall payment mechanisms. Different risk tranches may thus be created, with first loss covered by public money and upper tiers by private capital. The waterfall mechanism will assign the first payment of revenues to tranches held by commercial investors, and the last to the firs-loss tranche hold by public finance. It is believed that such a mechanism might reassure the more-risk averse commercial investors, thus making it easier to raise private capital.

- An EU institution could be responsible for setting up the Fund and formulate its guidelines. The EU institution would:

    - ensure that the policy objectives of the Fund are met;
    - be a contact point for stakeholders;
    - manage the selection process of the fund manager;
    - draft the terms of reference for the selected fund manager (including fees, etc.);
    - monitor the compliance of the fund manager with the contract;
    - monitor the financial implementation of the fund and conduct reviews.

  Any profit made by the EU institution in connection with this Fund might be reinvested in the Fund. It has also been suggested that there could be a mechanism where successful private-sector asset owners pay a proportion of generated revenue back into the fund, via a reduction to their corporate tax based on the amount returned to the fund. While this mechanism is undoubtedly interesting, there is many a concern as to how it could actually be implemented, considering the jurisdiction on Member States. Even if a solution were found, this mechanism might make it more difficult for extra-EU investors to invest in EU companies.
- The Fund should only finance projects with TRLs from 5 to 9. On the fund manager – and on the applicant – to decide whether to use equity or debt. It is believed that the decision between equity or debt is better addressed if a market-based approach is adopted. The fund manager, which earns their revenue on an annual management fee and on a performance-based fee, will maximise their interest by funding the projects that can either generate returns or meet the targets set for concessional lending. Again, it is recommended that the performance-based fee be considerably higher than the management fee, so as to strengthen the incentive to the fund manager.

- It is believed that projects with lower TRLs can be more effectively funded through existing mechanisms, and are outside the scope of this Fund.

- The Fund should not make an investment (or any other form of funding) in or to any one project of more than a certain percentage of the Fund's total capital (20% in ARENA's fund, but might be lower in the EU Fund, considering the total endowment). While this undoubtedly constitutes a limitation to the strategic behaviour of the fund manager, the provision ensures that the funding is channelled to several projects, thus making it possible to reach the desired policy objectives.

- As recommended in the Ocean Energy Roadmap, lessons learned from funded projects need to be made available to the funding authorities and the industry broadly while preserving intellectual property as necessary.

The overall approach to the structure of the fund is market-driven, albeit not entirely, since the fund manager will have to comply with certain requirements laid down in their contract. The economic theory predicts that the private-sector fund manager will act so as to maximise their revenue, a behaviour that in principle might go to detriment of innovation and research. Nonetheless, the Australian experience confirms that it is possible to strike a correct balance between public and private interest to the greater benefit of the sector. As mentioned above, it is fundamental to draft the terms of reference for the fund manager so as to limit their capacity to a point where there still is an incentive for them to participate in the market, but the public interest is also preserved. This can be done primarily by clearly defining the priorities of the fund, in terms of number of projects, maximum funding per MW or technology, priorities, targets, etc., bearing in mind that over-regulation might become counter-productive. At the same time, it is pivotal to set in place the right incentives for the fund manager, by linking a share of their revenue to the performance of the fund as such, as well as to the attainment of the desired policy objectives.

Three options are proposed in view of setting up the Fund:

Option 1: Put the capital into an existing instrument (InnovFin Energy Demo Projects)

Option 2: Set up a new fund managed by the European Investment Bank

Option 3: Set up a new fund managed by the EU Commission

Table 28 – Pros and cons of different options for the Investment Support Fund

	Option 1	Option 2	Option 3
Pros	• Faster than setting up a new instrument. • Lower transaction costs (compared with other options). • Instrument already well-known. • EIB already has expertise.	• Fund entirely dedicated to ocean energy. • Market-oriented approach in line with the needs of developers. • EIB has long-standing experience in managing Funds and fund managers. • Quality stamp and due diligence by EIB.	• Fund entirely dedicated to ocean energy. • Market-oriented approach in with the needs of developers. • EU Commission retains full control on the fund (and on its manager).
Cons	• InnovFin structure may not be perfectly compatible with the proposed structure and requirements • Competition with other projects (although capital could be earmarked for ocean energy). • Less visibility, compared with a dedicated instrument. • InnovFin has not funded many ocean energy projects.	• Time to set up a new instrument. • Higher transaction costs (compared with Option 1). • EIB might not be available/willing to be in charge.	• Time to set up a new instrument. • Higher transaction costs (compared with Option 1). • EU Commission might not have the expertise to set up the fund.

There are advantages and disadvantages to each option, and it is not the purpose of this study to make a final decision. Nonetheless, it is highly recommended to set up a dedicated fund for ocean energy, as this will ensure visibility and adherence to the consultation process carried out within the Ocean Energy Roadmap as well as this study. Having the fund managed by the EIB might be a good option to take advantage of the expertise developed by the EU's bank; on the other hand, managing the fund directly would entail for the EU Commission to retain full control over its functioning. Furthermore, it should also be noted that the EC is already considering setting up investment vehicles for the European Blue Economy; an Ocean Energy Fund might well fit into the scope of this initiative, so as to exploit scale economies.

Most importantly, it should be noted that the Fund alone will most likely not be sufficient to reach the tipping point after which the sector can stand on its own feet, without strong and stable public support to the sector as a whole. The injection of public money via the Fund will certainly lower the level of risk for private investors, but these will continue seeking investments based on projected returns. Hence, a form of revenue support is of paramount importance to accompany the Fund and maximise its effectiveness. Revenue support mechanisms are partially outside the scope of this Study – they have been surveyed, but it makes little sense to propose EU action in a domain that pertains to Member States. It is thus highly recommended to take action towards the implementation of revenue support mechanisms, as much as possible consistent across Member States, so as to create certainty.

4.3 Proposed structure of the Insurance and Guarantee Fund

The Ocean Energy Roadmap proposes to set up a 50-70 million EUR Insurance and Guarantee Fund for ocean energy demonstration and pre-commercial projects, covering risks that are currently not covered by either insurance products or manufacturers guarantees.

It is believed that currently there are gaps in insurance products and OEM warranty structures in the ocean energy sector, and an EU fund would make it possible to underwrite risks and fill these gaps. These would ultimately reduce the risk profile of ocean energy projects, thus making marine energy demonstrations and arrays more 'bankable'.

As pointed out by Ecorys et al., "given the youth of the sector and the novelty of projects, it is unsurprising that there is lack of sufficient understanding of full operational risks, especially in the later stages of a project's lifetime. For example, the full cost of installation and maintenance as well as later decommissioning operations are little understood. This means that either a large contingency budget needs to be kept (bringing down returns and thus putting off investors), or the project is evaluated as highly risky. For tidal energy the full costs are understood to a greater extent, due to past experiences. However detailed cost data are rarely shared and the lack of understanding remains limited. For wave energy the sector is at an earlier stage of development and, therefore, the level of cost knowledge is even lower. As a consequence of the lack of understanding of total costs and technological reliability, the sector currently has hardly any access to insurance or warranties"[81].

As a consequence, insuring an ocean energy project – albeit with differences related to technology – entails a relatively high cost, especially compared with other renewables. This high cost is charged in terms of premium mainly on project developers, thus limiting their pool of potential equity finance and making it difficult to leverage their funds to access commercial project finance.

According to the Ocean Energy Roadmap, an Insurance and Guarantee Fund might underwrite project risks such as availability, output performance, mechanical breakdown and defect, and could provide long-term decommissioning bonds. It would be subject to suitable acceptance, risk-sharing and eligibility criteria. A relatively small amount of risk underwriting capital should be able to leverage a considerably larger amount of finance into the projects. The Fund should have the following objectives:

- encourage the European Commission and potentially the EIB to provide seed capital to the insurance fund, as a justifiable use of public monies;

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[81] Ecorys et al., Study on lessons for ocean energy development, Final Report, 2017. Available online at https://publications.europa.eu/en/publication-detail/-/publication/03c9b48d-66af-11e7-b2f2-01aa75ed71a1/language-en/format-PDF/source-32210477

- provide a recognised seal of approval to external investors and project financiers in addition to filling the gaps required for their financial approval;

- ensure that initial seed funding can be recycled after some years, as projects already insured mature, become closer to a regular power curve and can find equivalent insurance packages on the commercial insurance market (provided they will have been created);

- potentially, if judged appropriate by the sector, provide a platform to bring in private risk capital to bolster the seed capital as the number of suitable projects and thus need for risk capital expands.

In addition, it is expected that the Fund might have the following impact on the sector:

- **Better use of public funds**: because at the time being insurance (and decommissioning) costs tend to be relatively high, any form of funding (both private and public) is inevitably diverted to cover them, whereas it could be used, for instance, to increase project capacity. If the Fund manages to reduce insurance costs as expected, as expected, national and EU funding, as well as equity investment and debt, would be put to better use.

- **Leveraging more private finance**: the main objective of the Fund is to drastically reduce insurance and decommissioning costs, which in turn would reduce technological and operational risks. And if technological and operational risks are reduced, ocean energy projects should also become more attractive to private investors. There is indeed a strong link between the Investment Fund and the Insurance Fund, in that the existence of the latter will strengthen the effect of the former.

- **Generating data**: one of the reasons why insurance costs are high is that at the time being ocean energy projects are ‘inherently risky’, as the technologies used have not yet reached a level of maturity and operate in ‘harsh’ environments. However, to correctly assess risk, data on devices’ production patterns are fundamental; the relatively low number of projects installed at sea results in an equally low number of data, which in turn increase uncertainty and contribute to pricing risk high. If, through the Fund, private insurers and reinsurers are encouraged to enter the market, it is expected that more data on production patterns will be generated, thus contributing to better appreciation of risk and reduction of costs.

- **Creating a commercial insurance offer**: the ultimate goal of the Fund is to create the conditions to make insurance ‘affordable’ for the ocean energy sector. While in the short term this will be achieved by subsidising the sector with public money, in the long-term availability of data and experience should stimulate the creation of a commercial offer.

The Ocean Energy Roadmap also mentions some issues related to the structure of the fund, on which further consideration is needed, namely:

- Using an insurance policy or cash in escrow account (bearing in mind the ability to reduce capital requirements through portfolio and risk-sharing mechanisms);

- If an insurance, consider captive re-insurance structures to allow a well-rated insurance company to participate;

- How comprehensive a “wrap” would the insurance policy, etc, need to be? There are differences between insurance policies and warranties that would need careful thought and structuring;

- How re-insurances might be brought into play to mitigate risk;
- How to assess the appropriate risk premium in each instance;
- Governance procedures to protect the fund and ensure it is deployed in line with its objectives.

In contrast with the Investment Support Fund, the survey carried out for this Study has not received as much input from stakeholders when it comes to the Investment and Guarantee Fund. This might be due to the fact that the interviewees could be not very familiar with the insurance sector, as well as to lack of similar initiatives worldwide. The input received is very much in line with the work of the Ocean Energy Forum. Among the considerations received are:

- The Insurance and Guarantee fund should be available to provide investors with support in marine technology. Standard conditions should be placed on any device for it to be eligible for insurance/guarantee fund support, e.g. the device or array must have reached industry minimum performance (either at a recognised test centre or own site with independent data review). This industry minimum should relate to factors including operational hours, electricity generation hours, down time, % of max power reached and devices/arrays should have been operational for a minimum period of time, e.g. 6 or 12 months.
- Care need to be taken to ensure that there remain incentives for technology developers to transition to providing warranties (perhaps the insurance only pays out 80-90% of loss, 10-20% needs to come from Technology Company). Additionally, consideration should be given to limiting or not providing this support for any developer that is owned by a parent with a meaningful balance sheet which could actually support providing warranties.
- There might be a gap between the requirements of insurance underwriters/companies and what is achievable by technology developers. This may be the case where an underwriter expects certification but the standards to certify against are not appropriate. This is partially addressed by IECRE Systems (Certification to Standards Relating to Equipment for Use in Renewable Energy Applications).
- A pool of demonstration and commercial array projects could be insured with a maximum notional exposure to any one project of perhaps 25 million EUR, and in many instances significantly less, with coverage for a three- to five-year period underpinning technological risks and supplier warranties.
- The Fund should also provide a credible but achievable due diligence process, including adequate prior proving, e.g. at a test site, in addition to other independent expert sign-off prior to risk acceptance. This due diligence process should be robust enough to provide credibility to financiers that the technology has been suitably assessed and is credible as part of the “quality stamp” process.
- A captive reinsurance company might be established and funded. This captive reinsurer might then reinsure original policies of insurance issues by a well-rated direct insurer which might bear a part of the risk. Once a number of projects are insured and there is some diversification into a portfolio, it should be possible to draw in other support from other reinsurers to dilute the exposure to the captive reinsurer on each technology. As earlier projects no longer require protection, funds can be released to support future projects.

- The Fund might not be limited to the marine energy sector, and could address other sectors, as long as the underlying expertise is available, so as to provide a credible due diligence and quality stamp framework.

In light of the above, it is recommended to take into account the following options for the structure of the investment support Fund:

- It is proposed to set up a reinsurance fund rather than an insurance fund. Reinsurance is defined as 'insurance for insurers', and as such its underlying principles are akin to insurance. Insurers buy reinsurance when there are risks that can or prefer not to retain fully themselves. In doing so, they reduce the volatility of underwriting results, benefit from capital relief and access to reinsurers' expertise in understanding and assessing risks better, pricing, and manging claims. This ultimately benefits consumers (policy holders) who can get the same level of protection at a lower cost.

- The main reason why it is proposed to set up a reinsurance fund is that this mechanism would still make it necessary for project developers and OEMs to have commercial insurers underwrite their risk. In this way, the use of public funds might distort the market to a lesser extent, because, while in the short term commercial insurers would benefit from the flow of public money, in the long term they would acquire the necessary data and expertise to enable them to correctly assess and price risks. The Fund would thus accompany the insurance industry, but at the same time would contribute to building up a proper market in the long term. A Reinsurance Fund would also make it easier for small insurers to enter the market. Suppose, a small insurer spots a niche in the market for ocean energy. They might want to specialise in this, but they would end up having great concentration in the same risk; reinsurance would undoubtedly offer capital relief for such small players. Last but not least, it should be considered that the premiums charged to policy holders for an insurance policy are determined (especially in the non-life market) by and large by the contracts which the issuing company has with their reinsurers. This implies that even a Reinsurance Fund would still reach the goal of reducing insurance price for project developers and OEMs in the ocean energy sector.

- Among the possible structures of the fund, three options are envisaged:

    - **Establishing a captive company**: captive insurance is an alternative to self-insurance, whereby a company (often a multinational company) or group of companies establish another company (the captive) to provide insurance for itself/themselves. Captive insurance is often use to reduce insurance costs, underwrite difficult risks and transfer liabilities from one balance sheet to another. Even though normally captive structures are used for insurance – one of the advantages being easier access to reinsurance – it is possible to establish them also for the reinsurance market. However, in the case of the EU fund, it is believed that establishing a captive company may entail high transaction costs, and may not be received favourably by project developers, who would have to pool their resources to cover for risks other than their own.

    - **Setting up a fund managed by an EU Institution**: the reinsurance fund could be set up and managed by an EU institution, such as the EC or the EIB. Project developers and OEMs would seek for insurance from a commercial insurer, who in turn might apply for reinsurance from the fund at a lower cost. The contract between the project developer/OEM and the primary insurer would entry into force only on condition that a wording is drawn up between the commercial insurer and the authority managing the fund (reinsurer). The institution managing the fund would carry out the necessary due diligence process and require that the project possesses some minimum requirements, such as certification in a test centre. The exact requirements are to be determined case by case.

  - **Setting up a fund managed by a private fund manager**: the Fund might be set up by the EC or the EIB, as with the Investment Support fund, but then manged by a private fund manager to be selected via a competitive process. The fund manager would have the obligation of raising a certain amount of private capital as well, e.g. so that the total committed capital of the Fund is made up of 50% public money and 50% private investment. While the EU institution would remain in charge when it comes to decide the basic functioning and characteristics of the Fund, the private fund manager would use their expertise to raise as much private capital as possible. The EU institution would also remain in charge of the due diligence process, as this would be regulated in the terms of the licence agreement with the fund manager. This option for the structure of the Fund has also the advantage of stimulating a commercial offer for reinsurance, and not only for the insurance market. Different risk tranches might be created, with EU institutions taking first losses, and private investors taking senior position. In this way the Fund would basically offer a guarantee to private reinsurers. If this option is accepted, the overall functioning of the Fund would resemble the functioning of the Investment Support Fund.

- **Insurance policy or guarantee:** both insurance and guarantees are an agreement by insurer or the guarantor to pay part of the costs or losses incurred by a party upon a specified event occurring, in return for the payment of a fee or premium. However, while insurance is a two-party relationship between the policy holder and the insurer, a guarantee entails a third party (the guarantor) offering the guarantee to one entity (the financier) against the performance of the entity receiving the finance. Guarantees tend to be more one-off or bespoke in nature involving the guarantor in extensive due diligence and in the design of the project, while insurance tends to be better suited to more developed markets. While in principle both could be used in the Fund, it is recommended that only reinsurance is provided, as guarantees tend to have higher transaction costs. When it comes to the type of reinsurance provided, it is recommended that the Fund be not too prescriptive, leaving it up to the Fund manager and the insurer to negotiate what kind of coverage best fits their needs.

- **Decommissioning bonds**: both the Ocean Energy Roadmap and the survey carried out ford this Study underline the importance of providing mechanisms to support developers when it comes to decommissioning bonds. In many countries, licencing authorities require developers to set aside a budget for decommissioning, once their concession expires. This might be a problem the expected amount of decommissioning costs has frequently to be fully cash-collateralised in advance of the project – thereby increasing the amount needing to be financed. However, the cost of decommissioning might also be part of a specific insurance policy that would replace the immediate requirement for a decommissioning bond or escrow arrangement. This option is to be favoured because it does not impact the balance sheet of developers, and also makes the overall structure of the Fund easier to manage. Insurers might of course want to charge a higher premium if they factor in the risk (which may sometimes be a certainty) of decommissioning.

- **Risk premium**: if one of the objectives is to stimulate a commercial offer, some risk premium should be charged either to policy holders or to insurers in the case of reinsurance. If the proposal for a Reinsurance Fund is accepted, the premium would be charged to insurers, albeit at a rate lower than market. The exact percentage of premium to be charged should not be defined in advance, but should be decided case by case, based on considerations such as amount of risk retained by insurer and project developer and technology supplier under warranty, type of technology involved, TRL, insurer creditworthiness, etc. At the same time, it should be noted that the structure of the Fund itself, with the EU Commission/EIB taking junior positions, would naturally push down reinsurance premiums. Any profit made by the EU Commission/EIB could be reinvested in the Fund.

- **Exposure**: the Ocean Energy Roadmap has assumed that a maximum level of exposure to the proposed fund might be 20 million EUR per project, based on data from existing projects such as MeyGen. In the survey carried out for this Study, a limit of 25 million EUR has also been proposed, although at the same time it has been noted that for the vast majority of projects actual exposure could be much lower, MeyGen currently is more the exception than the rule. In case the Fund is managed by a private fund manager, the problem becomes less relevant because to maximise their self-interest, the fund manager will limit exposure for each project to a level that is considered acceptable. The fact that junior positions will be taken by EU institution might be an incentive for the fund manger to insure projects that would normally be considered too risky; therefore, it is important to calibrate the ratio between the management fee and the performance fee paid to the fund manager.

- **Eligible parties**: if the proposal for a Reinsurance Fund is accepted, all insurers that underwrite risks for ocean energy projects in the EU would be eligible for funding. The admissible risks could be availability, output performance, mechanical breakdown and defect, decommissioning costs, etc. Project developers and OEMs, regardless of their nationality, may seek for insurance on the market and insurers in turn may seek for reinsurance from the Fund, as long as the project is to be developed in EU waters.

- **Risk diversification**: support should be limited to a maximum MW per technology, so as to diversify risk as much as possible. Nonetheless, such a diversification may still not suit the risk portfolio of private reinsurers and might also threaten the solvency of the Fund itself. Therefore, in the survey carried out for this Study, it has been suggested to investigate whether the 50m-70m Fund – either for insurance or reinsurance – could be extended to other sectors than marine energy, so as to further diversify risk.

- **Data sharing:** it is paramount to envisage a mechanism whereby the data generated by the insured projects can be made available publicly (barring confidential information), so as to create a knowledge base that will make it possible to assess and price risks correctly, as well as to develop bespoke insurance products, whereas many developers today can only buy ‘all risks’ policies.

- **Involvement of commercial insurers/reinsurers in the design of the Fund**: it is highly recommended that commercial insurers and reinsurers are involved in the final design of the Fund, as this will might benefit their sector, besides ocean energy. A workshop could be organised by the EC/EIB to fine-tune the final structure of the Fund.

As can be noted, the proposed structure recalls the approach suggested for the Investment Support Fund. The underlying idea is to use public money to stimulate the market and interfere with it as little as possible, in light of building up a standalone commercial offer. The overall functioning mechanisms would be very simple: a project developer or an OEM would buy insurance on the private market, and the insurer in turn will buy reinsurance through the Fund. This has two main advantages:

1. Commercial insurers will actually start underwriting ocean energy project risks, because they will have access to reinsurance at a lower cost, as well as to the expertise of EU institutions and the fund manager which will carry out the due diligence process, thus helping the insurer better assess and price risks.

2. Project developers and OEMs will have access to insurance at a lower cost. Because insurers will be able to reduce their risk exposure by buying reinsurance at a lower cost, the premium charged to policy holders will reduce accordingly. To what extent premiums will be reduced is difficult to estimate, because of the lack of data in the sector.

The injection of public money in the sector will thus lower the cost of insurance in the short term and contribute to creating a commercial offer in the long term, because it is believed that if insurers and reinsurers are encouraged to participate in the market, they will develop better understanding of risks and will collect data that will make it possible to correctly assess and price risks. If the Reinsurance Fund will be managed by a private fund manager, on condition that they raise private capital from other reinsurers, then the Fund will also contribute to creating a commercial offer for reinsurance.

On the other hand, it should be noted that a Reinsurance Fund, as opposed to an Insurance Fund, has the disadvantage of introducing a slightly more complicated procedure, as project developers would not apply for the Fund themselves, but would have to do so via their insurer. The table below sums up the pros and cons of an insurance vs a reinsurance fund:

Table 29 – Pros and cons of insurance vs reinsurance fund

	Insurance Fund	Reinsurance Fund
Pros	• Application process should be easier. • Direct relationship with developers and OEMs.	• Risk is shared between three parties: developer/OEM, insurer and the Fund. • Small insurers might find it easier to enter the market.
Cons	• Risk exposure is higher.	• Application procedure might be more complicated.

Unlike the Investment Support Fund, there are no existing instruments that could be used and neither the EIB nor the EC have specialised in providing insurance or reinsurance to the ocean energy sector. Therefore, regardless of the final choice between insurance and reinsurance, it is strongly recommended to set up an entirely new instrument to be managed by a professional fund manager.

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