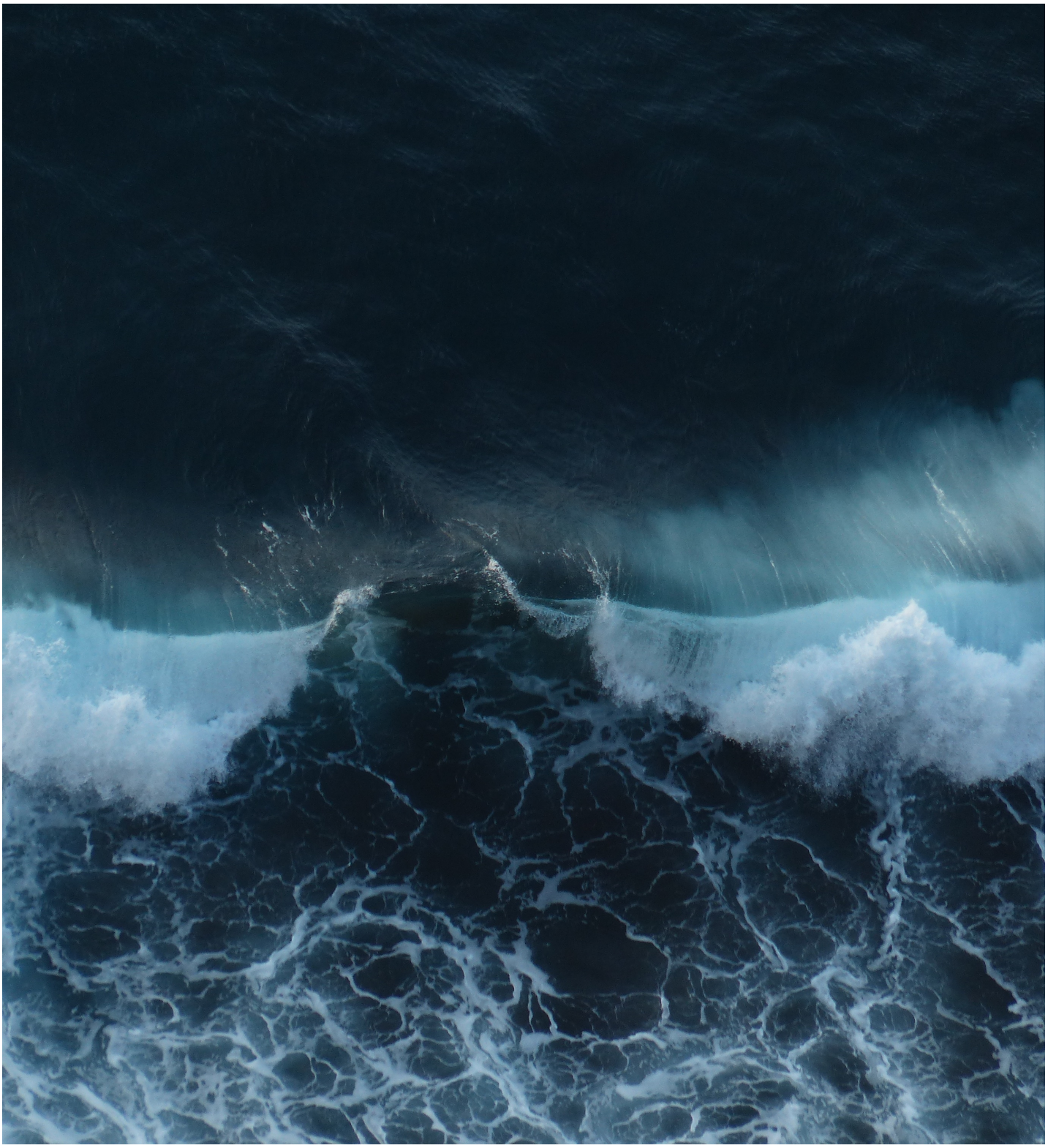
OceanSET First Annual Report 2020



OceanSET First Annual Report

April 2020

Version 1.0

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Executive summary

OceanSET, a 3-year project funded by the EU Research and Innovation Programme, Horizon 2020, is led by Sustainable Energy Authority of Ireland (SEAI). The project aims to obtain a solid understanding of the activities currently underway across Europe in the ocean energy sector, and to inform and determine how the sector can evolve.

Three annual reports will be developed over the course of the project. Data collected annually will inform Member States and the European Commission on the sector's progress and will assist in the development of future support schemes.

This first annual report provides an overview of progress in the ocean energy sector in 2018 and the range of the activities undertaken in each OceanSET work package. Key findings from the annual data collection are presented below:

- **Six Member States (out of 11) have an ocean energy policy.**
- **Ocean Energy received €26.3M funding from Member States in 2018.**
- **90 ocean energy projects were funded by Member States in 2018, two-thirds of which are supporting wave energy devices.**
- **Twelve ocean energy projects, operational in 2018, were identified as TRL 7 or above.**
- **Three Member States consented wave or tidal projects in 2018.**
- **Test sites enabling demonstration can be found in almost all of the Member States.**
- **The supply chain in most Member States is considered robust.**

At times, accurate information on the performance and costs of the different technologies has been difficult to assess via the surveys undertaken, as developers were unwilling to share this level of critical information. This issue will need to be resolved if progress in cost reductions and increased power output in the sector is to be measured precisely.

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1. Background

The European Strategic Energy Technology Plan (SET Plan), the technology pillar of the EU's energy and climate policy, was established by the European Commission to improve new technologies and bring down costs through co-ordinated national research efforts. It helps to promote co-operation among EU countries, companies and research institutions, and to deliver on the key climate and energy objectives.

An implementation plan[1] for ocean energy, prepared by a SET Plan working group comprising representatives from the European Commission, Member States and other stakeholders, was adopted on 21 March 2018 and led to the formation of the Implementation Working Group.

The OceanSET project was set up to assist the Implementation Working Group to deliver on the targets set in the implementation plan.

1.2 SET Plan Ocean Energy Implementation Plan

To date, support for the ocean energy sector has focused on the development of research and roadmaps, setting out the aspirations of the wave and tidal sector. The purpose of the implementation plan is to transform those aspirations into operational actions through outlining a structured approach that will enable both technologies to follow a development path, ensuring the commercial viability of the wave and tidal industries. The implementation plan sets out the following targets for the wave and tidal sectors:

- **Development of cost-competitive ocean energy technologies with high market potential for Europe**
- **Reduce the Levelised Cost of Energy (LCOE) for tidal stream energy to**
  - **15 ct€/kWh in 2025**
  - **10 ct€/kWh in 2030**
- **Reduce the LCOE for wave energy technology to**
  - **20 ct€/kWh in 2025**
  - **15 ct€/kWh in 2030**
  - **10 ct€/kWh in 2035**

The development timescales outlined are: 2025 for tidal and 2030 for wave. These timescales are not specific to technology development, but for the overall development of a new industrial sector, which will include large-scale manufacturing, deployment and maintenance supply chains. These will generate the economies of scale required to meet the commercialisation targets.

[1] **Implementation plan, Initiative for Global Leadership in Ocean Energy. https://setis.ec.europa.eu/actions-towards-implementing-integrated-SET-Plan/implementation-plans**

In 2018, the Working Group[2] carried out a high-level survey of current ocean energy activities in Member States and regions for the reference year 2017. The survey sought information on the following four key aspects:

- **Did the Member State or region have an ocean energy policy?**
- **If so, had it a specific owner and a responsible agency for implementation and oversight?**
- **Did the Member State have specific local technical, financial, and environmental actions?**
- **An outline of the indicative budget available for the implementation of these actions.**

The survey results gave a high-level understanding of the national intent and plans for the next three years as shown in *Table 1*.

2 https://setis.ec.europa.eu/system/files/set_plan_ocean_implementation_plan.pdf

TABLE 1: IMPLEMENTATION PLAN MAPPING

2017 mapping	Belgium	Cyprus	France	France - Normandy	Ireland	Italy	Portugal	Spain	Spain - Basque	Spain - Cantabria region	Sweden	UK - Scotland	UK -Wales	UK NI
Is there a national ocean energy policy outlined?	No*		Yes	Yes	Yes	Yes	Yes	No*	Yes		No*	Yes	Yes	Yes
Is there an assigned Ministry/ Department owner at Government level?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Is there operational responsibility for the delivery of the ocean energy programmes?	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
National Priority Actions – Technical	Un known	Yes	Un known	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes
National Priority Actions - Environmental	Un known	Yes	Un known	Un known	Yes	Yes	Yes	Un known	Un known	Un known	Yes	Yes	Yes	Yes
National Priority Actions - Financial	Un known	Yes	Un known	Un known	Yes	Yes	Yes	Un known	Yes	Un known	Yes	Yes	Yes	Yes
National Priority Actions – Other	Yes	Yes	Un known	Yes	Yes	Yes	Yes	Yes	Un known	Yes	Yes	Yes	Yes	Yes
Amount (€M) spent on ocean energy by Member States in 2016	€0.6m	€99m	Un known	Un known	€4m	€1m	€0.44 m	€1m	€2.5m	€6m	€4.3m	€15m	€3m	€0
Budget for 2017	Un known	€20m	Un known	Un known	€5m	€0.5m	€18.9 m**	Un known	€2.5m	Un known	€2.7m	€15m	€8m	€0
Estimated budget allocation from 2018-2020 (note this is not considered as a commitment, only an indicative estimate of possible allocation of budget to 2020)	Un known	Un known	Un known	Un known	Under the Offshore Renewable Energy Development Plan the Government committed €30m up to 2020	€6m EUR up to 2020 through competitive national projects	€23.15 m**	Un known	Demonstrat e° programme €5m	Un known	€3.9m allocated so far (from Swedish Energy Agency). NB: most likely more funding will be allocated	€45m	€45 m	Un kno wn

Note:
*** Denotes there is not a defined ocean energy policy. However, it is considered that the national renewable energy policy includes the ocean energy sector.**
**** Portugal clarified that the figures given for Budget 2017 included the construction of a submarine cable. Real budget for 2017 was €3.94 million and estimated budget allocation for 2018-2020 was €8.15 million .**

The survey results highlighted a need to monitor key operational actions at Member State level; this would enable progress in the ocean energy sector to be tracked against the aspirations of the strategic roadmap. The results also informed the development of the implementation plan, which identified 11 actions, as outlined below. These actions are accompanied by a detailed activity fiche with resources, targets, and ownership.

Technical Actions

Action 1.1 Tidal energy technology device development and knowledge building up to TRL 6

Action 1.2 Tidal energy system demonstration in operational environment (TRL 7-9)

Action 1.3. Wave energy technology development and demonstration up to TRL 6

Action 1.4. Wave energy system demonstration and deployment (TRL 7-9)

Action 1.5. Installation, logistics and testing infrastructure [and] supply chain development

Action 1.6. Standards and guidelines for evaluation of wave energy technologies

Financial Actions

Action 2.1. Creation of an investment fund for ocean energy farms

Action 2.2. Creation of an EU insurance and guarantee fund to underwrite project risks

Action 2.3. Pre-commercial procurement action for development of wave energy technology

Environmental Actions

Action 3.1. Development of certification and safety standards to support offshore renewable technology development

Action 3.2. De-risking environmental consenting through an integrated programme of measures

2. OceanSET

The OceanSET project is a 3-year Horizon 2020-funded project, which focuses on delivering the actions of the implementation plan. The objectives, methodology, and outcome of the work of the OceanSET project are set out below.

The partners on this project include representatives from Sustainable Energy Authority of Ireland (SEAI); Wave Energy Scotland (WES) and University of Edinburgh (UEDIN); France Energies Marines (FEM); Directorate General for Energy and Geology, Portugal (DGEG); Ente Vasco de la Energía (Basque Energy Agency; (EVE) and Oceanic Platform of the Canary Islands (PLOCAN) and; Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA). The Ocean Energy Europe (OEE) network is the industry representative. SEAI is the lead partner on the project.

2.1 Objectives

Three key objectives have been set to support the delivery of the implementation plan.

Objective 1: Facilitate the implementation of the technical actions of the implementation plan and provide support to the implementation working group

The OceanSET project activities are co-ordinated with the implementation working group and the SET Plan steering group through the SET Plan secretariat and project steering committee. Key sub-objectives include:

- **Setting up a project structure to facilitate the co-ordination and support of the implementation plan;**
- **Ensuring effective and efficient internal project communication with partners, and regular communication with the implementation working group on project activities and results;**
- **Providing annual reports to the working group with an update on the status of the ocean energy activities in Member States and regions, as well as the eleven technology development actions outlined in the implementation plan; and**
- **Co-ordinating project activities, monitoring the project's progress, and organising project meetings and workshops.**

Objective 2: Promote knowledge sharing across the European Commission, Member States, regions, and other stakeholders in the ocean energy sector

Co-operation and co-ordinated actions can only be undertaken if there is a solid understanding of the different activities that have occurred and that are currently taking place across Europe. A key objective of the OceanSET project is to promote close co-operation between the European Commission, Member States, regions, and stakeholders in the ocean energy sector. Throughout the project, stakeholders will be invited to share critical information, which will be tracked annually to monitor the development of the ocean energy sector. Dissemination and communication activities, including meetings and workshops, will maximise the impact of the project outputs.

An annual mapping and discovery exercise will be conducted by project partners, through the implementation working group, to monitor the progress of the sector and the advancement of the implementation plan actions. This will be conducted through issuing surveys to the Member States, regions, industry and key researchers (through implementation working group contact points). Surveys will be updated each year based on the previous year's responses to gage evolution within the ocean energy sector and to allow for further exploration of responses. The mapping exercise aims to support the monitoring of key metrics to chart the progress of the ocean energy sector, for example, evolving LCOE estimates provided by ocean energy stakeholders.

Objective 3: Investigate collaborative funding mechanism(s) between Member States and regions

The implementation plan recognises that significant financial support is needed to meet the specified technical actions. While there may not be a 'one-size-fits-all' solution, several paths can be considered. The OceanSET project aims to actively promote collaboration activities between the Member States, regions, and the European Commission so that effective use of funds for the sector can be optimised. The monitoring plan also aims to support transparency across the Member States, regions, industry, and the European Commission so that the level of funding being allocated to the development of the sector is evident

Relevant data from the project mapping exercise will be refined annually to assess how to maximise the benefits of the funding streams provided across the Member States, regions, and the European Commission, and to determine opportunities for blending or pooling resources. Identified opportunities for blended funding will be actively promoted to national and regional funding agencies (through the implementation working group), and opportunities to stimulate the involvement of the private sector in, for example, public-private initiatives, will also be actively pursued.

2.2 Concept and methodology

Discovery phase – annual discovery process

The key purpose of the discovery phase is to obtain a solid understanding of the current activities across Europe, with the overall objective of determining how the sector will evolve for the subsequent phases of the implementation plan.

The development of a collaborative information sharing process across the Member States and regions is at the core of the OceanSET project. This will be accomplished through the annual process, comprising four key stages: mapping, analysis, monitoring and review. The main actions comprising this process are as follows:

- **To gather information on the ocean energy sector across Europe;**
- **To compile and analyse the data collected from stakeholders and to conduct a gap analysis;**
- **To assess the progress of the ocean energy sector by tracking key metrics and to consider other factors (identification of best practices, state-of-the-art); and**
- **To provide recommendations on the next steps required to progress the implementation of the SET Plan and suggest approaches to stimulate industry and research progress in key priority areas.**

3. Overview of all work packages

The OceanSET project comprises seven different work packages, each detailing the tasks required to deliver the annual mapping, analysis, monitoring and review of key metrics. Detail of all work packages' objectives and deliverables to date is outlined below.

Table 2 **lists each work package leader. A more detailed table of the deliverables within each work package and the progress achieved to date is available in Appendix A: OceanSET work packages and deliverables.**

Table 2: Work package name and leaders

Work Package	Leader
Ethics requirements	SEAI
Mapping & analysis	SEAI
Finance	WES
Pre-commercial procurement programme development	WES
Monitoring and review	DGEG
Communication and dissemination	FEM
Management	SEAI

3.1 Ethics requirements

Overview

SEAI, as lead partner, provides oversight on the project to ensure that data is collected ethically and in line with applicable international, EU and national law (EU Directive 95/46/EC) and with the General Data Protection Regulation (GDPR) (Regulation (EU) 2016/679).

Achievements to date

OceanSET has appointed a Data Protection Officer, whose contact details are made available to all data subjects involved in the research. Informed consent procedures are also implemented for all participants and, a Privacy Policy has also been developed; this is available on the OceanSET website and was also provided to all survey participants.

3.2 Mapping and analysis

Overview

The mapping and analysis work package is focused on collecting data from stakeholders and analysing existing support actions at Member State and regional levels. The analysis of data collected on ocean energy projects is in the context of the 11 Technology Development Actions from the implementation plan. The overall aim is to survey the ocean energy sector over three years on the:

- **Ocean energy policy and funding opportunities in Member States and regions; and**
- **The technical, financial and environmental actions set out in the implementation plan.**

The data collected will be used to analyse ocean energy support activities in Member States and regions. The survey will be carried out three times over the lifetime of the project.

Achievements to date

To date, this work package has completed the first annual Mapping and Analysis Progress Report deliverable (Deliverable 2.1).

3.3 Finance

Overview

The aim of the finance work package is to review the financial requirements needed to implement the technology development actions identified in the implementation plan. Shortcomings between current funding provision and the financial requirements of the sector, will be assessed annually for each technology action in the implementation plan.

Any gaps identified in reaching the development actions will be analysed with prospective collaborative or blended funding structures proposed to support their realisation.

Recommendations on funding mechanisms will be made and these will be actively promoted through monitoring and reviewing workshops and communication and dissemination stakeholder meetings. The main aims of the finance work package are to:

- **establish the financial requirements for technical, financial, environmental and other actions;**
- **analyse funding gaps;**
- **assess the public/private divide of finances for each action; and**
- **design an insurance and guarantee fund**

Achievements to date

The first Annual Funding Gap Analysis and Recommendation Report (Deliverable 3.1), assessing progress in 2018, has been completed and produced. Overall, the ocean energy sector appears to have been well supported in 2018, with public sector funding for the implementation plan's actions aligning well with the Plan's estimates.

Work continues to confirm the funding requirements (Deliverable 3.2) to achieve the actions presented in the implementation plan.

3.4 Pre-commercial procurement programme development

Overview

The pre-commercial procurement programme development work package is defining a strategic approach to a European pre-commercial procurement programme for wave energy technology and developing a package of funding calls to drive technology development. This delivers on the implementation plan's financial action (Deliverable 2.3), particularly 'the development of a collaborative procurement model adaptation of the 'Wave Energy Scotland' approach for wave energy development at EU level using pre-commercial procurement.

This work package has four main aims, which will be completed by the end of March 2020:

- **Identify priority technology areas;**
- **Assess mechanisms for collaborative funding between partner regions;**
- **Design a funding call; and**
- **Design processes for evaluating, selecting, monitoring and management of programme calls and phase gates.**

Achievements to date

Identification of the priority technology areas and assessment mechanisms for collaborative funding between partner regions have been completed and reported. The Refined Technology Strategy (Deliverable 4.1) sets out the technical focus for a future cross-border multi-partner joint pre-commercial procurement programme for wave energy technology. This strategy is benchmarking the technical aspects that may be hindering the realisation of a commercial wave energy sector against existing strategies and priorities already in place in Member States and regions to support the nascent wave energy sector. The Agreed Pre-Commercial Procurement Programme Strategy (Deliverable 4.2) sets out a mechanism for the financial interactions in such a programme, which complies with the EU model for a pre-commercial procurement programme, encourages the broad participation of Member States and regions and, maximises the use of available Member State and regional funding.

The outcome of this work package to date demonstrates that the pre-commercial procurement programme's phased development of solutions has a naturally close association with a systems-engineering approach to the design, creation and operation of complex systems such as wave energy converters. The overarching common challenge, that of developing technically and economically viable machines, is a system integration problem. It involves solutions that will emerge from focusing on the development of subsystems and on 'learning by doing at a meaningful scale'.

Three technology priority areas for a cross-border, multi-partner, joint pre-commercial procurement programme for wave energy technology are recommended:

- **Scaled prototype testing;**
- **Technology for off-grid applications; and**
- **Mooring and anchoring systems.**

An inclusive approach to funding is recommended whereby members of the buyers' group target their investment on subsystems which match their particular interests, capabilities, and available budgets. The approach has the potential to broaden involvement in the buyers' group and thereby to maximise the overall pre-commercial procurement programme budget.

3.5 Monitoring and review

Overview

The monitoring and review work package assesses how the ocean energy sector is progressing towards attaining the SET Plan targets. Monitoring is achieved using survey data to determine a set of key metrics and, through mapping and funding gap analyses. Metrics and overall information from one year are compared to the previous year, to identify if progress is being made and where.

The monitoring process is complemented by knowledge sharing activities. Workshops are organised with stakeholders - innovation providers and funders – and are put together to learn about available and required technology developments and funding, and to provide insights into sector progression

This work package is monitoring the technical, financial, and environmental actions set out in the implementation plan and reviewing the progress of the ocean energy sector each year as well as sharing this information through dedicated knowledge sharing workshops.

Since the initial report on metrics for the ocean energy sector - Metrics for the ocean energy sector (Deliverable 5.1) - three further annual knowledge-sharing workshop reports (Deliverables 5.2, 5.4 and 5.6) and three monitoring and review progress reports (Deliverables 5.3, 5.5 and 5.7) will be delivered over the lifespan of the OceanSET project.

Achievements to date

At the outset of the project, the monitoring and review work package designed a tool to assess the progression of the ocean energy sector, described in the 'Metrics for the ocean energy sector' Report (Deliverable 5.1). This work package also already organised the first knowledge-sharing workshop (*Figure 3.1*) and has written a 'Report on Knowledge Sharing Workshop' (Deliverable 5.2). The first Annual Monitoring and Review Report (Deliverable 5.3) has also been completed.

The first knowledge-sharing workshop was organised on the 30 September 2019 alongside the Ocean Energy Europe conference in Dublin. The main objective of the event was to bring EU innovation providers together to share knowledge and expertise and create a meeting framework to boost the ocean energy sector. Information on the workshop can be found on the project website: www.oceanset.eu

Figure 3.1: OceanSET team at the knowledge sharing workshop in Dublin

3.6 Communication and dissemination

Overview

The communication and dissemination work package is focused on defining and implementing an efficient action plan for communicating and disseminating the project outputs; this will contribute greatly to the effective implementation of the SET Plan in the ocean energy sector. This work package has three specific aims:

- **To set up a plan for the exploitation and dissemination of results;**
- **To manage data and databases generated during the project and to develop a central document repository for the project and the implementation working group for the long-term; and**
- **To implement dissemination and communication activities such as managing the project's website, creating communication tools, publicising and promoting the annual report and, organising meetings and dissemination workshops.**

Achievements to date

Once the communication and dissemination strategy was established, the project website, www.oceanset.eu, was created, deployed in June 2019 and has been regularly updated since then. The average number of visits per month is 117. Three types of communication tools have been developed to date: leaflet, slideshows, and press releases. Information about the project has also been disseminated through 18 posts on LinkedIn and Twitter, using the tag '#OceanSET'. The newsletter layout was designed in line with the graphic charter and the first issue was released at the beginning of January 2020 and issued to 675 recipients.

3.7 Management

The management work package involves providing overall management and administration support to the project, in conjunction with the implantation working group and the SET Plan steering group. The tasks outlined in this work package have been devised to guarantee efficient project management and high-quality deliverables.

Achievements to date

To date, the management work package has completed a project management plan and quality handbook (Deliverables 7.1 and 7.2), and the First OceanSET Annual Report (Deliverable 7.3); the management of the OceanSET project is an ongoing process. OceanSET will produce 38 deliverables over its 3-year period; 17 deliverables have been achieved to date.

The OceanSET team schedules project calls every second Wednesday to keep track of tasks and deliverables.

4. Review of progress in the ocean energy sector

4.1 Data collection

Member States participating in the Ocean SET Plan partook in a survey, which gathered information on the current state of each Member State's ocean energy sector. The data collected will be used to inform the European Commission of the supports required to develop the sector. The survey focused on four areas, aligned with the requirements of the implementation plan:

1. **General information**
2. **Technical information**
3. **Financial information**
4. **Environmental information**

The survey contained two sections:

- **Section 1 captured high-level information from Member States on their ocean energy sector.**
- **Section 2 gathered detailed information on developers who have devices with a TRL 7 or greater.**

Section 1, which consisted of 27 questions (See Appendix B), was constructed to gather information from the Member States to feed into the annual report for the European Commission.

Section 2, which consisted of 22 questions (See Appendix C), was constructed to gather project specific information on developers who have devices or are undertaking projects to develop their technology to a TRL 7 or above.

The survey reference period was 2018.

4.2 Metrics

The metrics for the survey were developed in Deliverable 5.1, which is publicly available on the OceanSET website[3].

***Table 3 and Table 4* document the key metrics collected in Sections 1 and 2 in the first annual survey of the OceanSET project. These will be used as a baseline for future data collection in the OceanSET project.**

[3] www.oceanset.eu

Table 3: Key metrics collected from survey Section 1

Number of Member States with an ocean energy policy in 2018	**6 (6/11)**
Number of Member States with an assigned Ministry/Department owner at governmental level for ocean energy	**9 (9/11)**
Number of Member States with a consistent environmental impact assessment for ocean energy at governmental level	**9 (9/11)**
Number of Member State with test site facilities	**10 (10/11)**
Estimated total budget for ocean energy (wave, tidal) in 2018	**€23m***
Total amount spent on ocean energy in 2018	**€26.3m**
Estimated total budget for ocean energy (wave, tidal) in 2019	**€26m***
Number of Member States with revenue support for wave energy in 2018	**6 (6/11)**
Number of Member States with revenue support for tidal energy in 2018	**5 (5/11)**
Estimated average licencing time in 2018 (years)	**3.7***
Estimated average consenting time in 2018 (years)	**4.25***
Number of Member States with a functional (self-sufficient or well-complemented) supply chain for ocean energy in 2018	**7 (7/11)**
Number of Member States who funded TRL 7+ projects – wave and tidal	**8**

*** Metrics have been estimated because data was collected in terms of ranges.**

Table 4: Key metrics collected from survey Section 2

TRL 7+ (Stage 4-5) projects active in 2018	
Number of TRL 7+ projects – wave and tidal	12
Number of projects – wave	7
Number of projects – tidal	5
Number of TRL 7+ projects within a consortium – wave and tidal	6
Number of TRL 7+ projects addressing environmental impact assessment methodologies and tools	0
Number of TRL 7+ projects addressing enforcement of stage progression standards through scale testing	1
Total installed capacity in TRL 7+ projects (MW) – wave	0.6
Total installed capacity in TRL 7+ projects (MW) – tidal	4
Average installed capacity per project (MW) – wave	0.08
Average installed capacity per project (MW) – tidal	0.8
Annual electricity production in TRL 7+ projects (MWh/year) – wave	n.a.*
Annual electricity production in TRL 7+ projects (MWh/year) – tidal	11,500
Average annual electricity production per installed capacity (MWh/MW) – wave	n.a.*
Average annual electricity production per installed capacity (MWh/MW) – tidal	1,762
Average capacity factor in TRL 7+ projects (%) – wave	29
Average capacity factor in TRL 7+ projects (%) – tidal	32
Average annual availability (%) – wave	88
Average annual availability (%) – tidal	74
Average capital expenditure in ocean energy TRL 7+ projects (€/W) – wave and tidal	9.5
Average capital expenditure (€/W) – wave	12.7
Average capital expenditure (€/W) – tidal	7.9
Average operational expenditure in ocean energy TRL 7+ projects (€/W/year) – wave and tidal	0.4
Average operational expenditure (€/W/year) – wave	0.7
Average operational expenditure (€/W/year) – tidal	0.1
Min./max. technical lifetime in TRL 7+ projects (years) – wave	3/25
Min./max. technical lifetime in TRL 7+ projects (years) – tidal	5/25
Average LCOE (€/MWh) – wave	n.a.*
Average LCOE (€/MWh) – tidal	217
Number of jobs created in TRL 7+ projects – wave	121
Number of jobs created in TRL 7+ projects – tidal	78

*Metrics have not been included due to insufficient data. Data was considered insufficient when not available at all or when the limited data available would lead to a possible identification of the project(s) involved.

4.3 Overview of survey

Fourteen Member States, identified by the implementation working group, received the survey - see *Table 5.*

Eleven Member States responded.

90 ocean energy projects across the eleven Member States were identified as being supported in 2018:

- **57 wave projects;**
- **22 tidal projects; and**
- **11 projects categorised as 'other'.**

Of these 90 Ocean Energy projects, 19 unique projects were identified as being at TRL 7 or greater;[4] these projects were invited to complete survey Section 2. The invitation generated 22 unique responses (three of the 25 responses received were duplicates). Four of the identified projects did not respond. It appears that seven projects, which were not identified in survey Section 1, also responded to Section 2.

Of the 22 unique responses, five projects self-declared to be at TRL 6 or lower and a further five projects self-declared as ending before or starting after 2018. These were excluded from subsequent analysis. Of the twelve remaining projects, seven involved wave technology, and five involved tidal technology. *Table 5* displays which Member States and regions responded.

[4] **The Netherlands' response indicated one project at TRL 7 or greater but also that it had not supported any ocean energy projects in 2018. The same project was also identified in the UK response and has been assessed there.**

Table 5: Member State survey response rate

No.	Member State	Was a response to survey received?	Has the Member State funded projects over TRL 7 or above?
1	Ireland	Yes	Yes
2	Belgium	Yes*	No
3	Spain	Yes	Yes
4	Sweden	Yes	Yes
5	France	Yes	Yes
6	Portugal	Yes	Yes
7	Italy	Yes	Yes
8	UK	Yes	Yes
9	Germany	No response	n/a
10	Cyprus	No response	n/a
11	Finland	Yes	No
12	Denmark	No response	n/a
13	Norway	Yes	No
14	Netherlands	Yes	Yes

***Two responses received, one from the Flemish Government, and one from Ghent University**

During the survey period, OceanSET partners worked with the Member States to ensure clarity and consistency of responses; where inconsistencies or gaps were noted, requests for clarifications were made. In some cases, requests for clarifications are still open, but we hope to rectify any current inconsistencies in future surveys. Responses to survey Section 1 are available in Appendix D.

4.4 Ocean energy policy and funding opportunities in Member States

Table 6 **below shows the responses provided by the Member States to questions related to policy and funding opportunities available.**

Table 6: Ocean energy policy and funding opportunities in Member States

Country	Organisation	Is there an ocean energy policy?	Ministry / Dept owner	Budget for 2019	Did the budget for ocean energy increase or decrease from 2018 to 2019?	Budget for 2018	Amount (€m) actually spent on ocean energy in 2018
Finland	Ministry of Economic Affairs	No	No	€0	Our budget stayed the same	€0	0
The Netherlands	Ministry of Economic Affairs and Climate	No	No	less than €1m	Our budget stayed the same	less than €1m	€1
Italy	ENEA	Yes	Yes	€4m - €5m	Our budget increased	€3m - 4m	3.7
Spain	CDTI	Yes	Yes	€0	Unknown	€2m - €3m	2.9
Ireland	SEAI	Yes	Yes	€3m - €4m	Our budget decreased	€3m - 4m	2
Belgium	Flemish Government, Department Economy, Science and Innovation	No	No	€0	Unknown	€0	Unknown
Sweden	Swedish Energy Agency	No	Yes	€2m - €3m	Our budget decreased	€2m - €3m	2.7
Belgium	Ghent University	Yes	Yes	€3m - €4m	Unknown	€0	Unknown
Portugal	DGEG	Yes	Yes	€2m - €3m	Our budget increased	€1m - €2m	2
France	ADEME	No	Yes	€2m - €3m	Unknown	€2m - €3m	Unknown
Norway	The Research Council of Norway	No	Yes	less than €1m	Our budget stayed the same	less than €1m	1
UK	WES	Yes	Yes	more than €5m	Our budget increased	more than €5m	11

The survey showed that six out of 11 Member States have an ocean energy policy. ***Figure 4.1*** **overleaf maps the current ocean energy policy across the Member States. Where a country indicated that there was a policy at a regional level but not at a national level, this was recorded as a 'Yes' (for example, Spain).** ***Figure 4.2*** **illustrates the Member States with an assigned Ministry or Department.**

Figure 4.1: Current ocean energy policy outlined in your national government

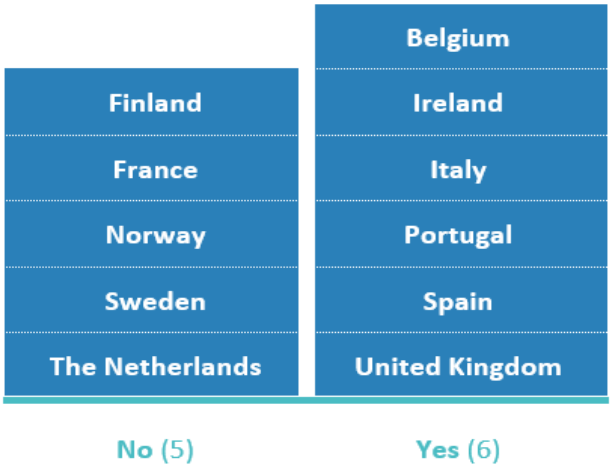
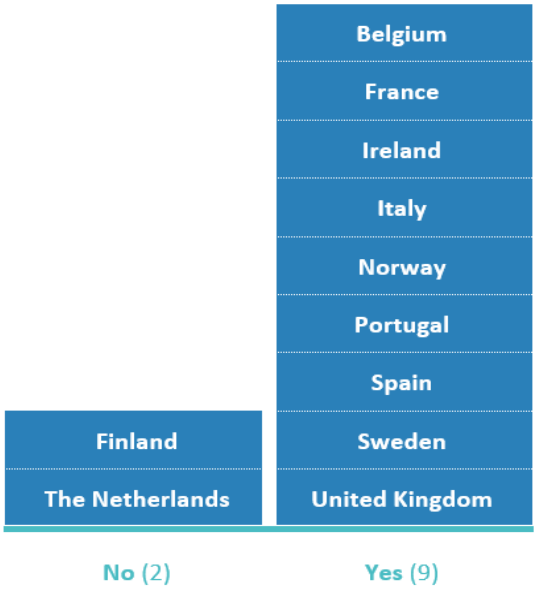


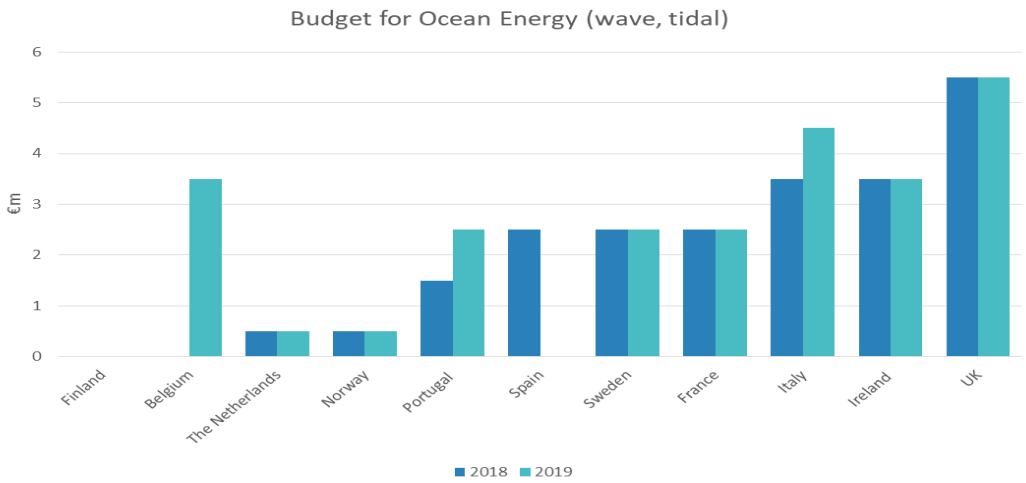
Figure 4.2: Assigned Ministry and Department owner at government level



Finland had no ocean energy policy, no Ministry or Department and no budget for ocean energy in 2018 or 2019. The Netherlands indicated no ocean energy policy, Ministry or Department; however, they had a budget of less than €1million for 2018.

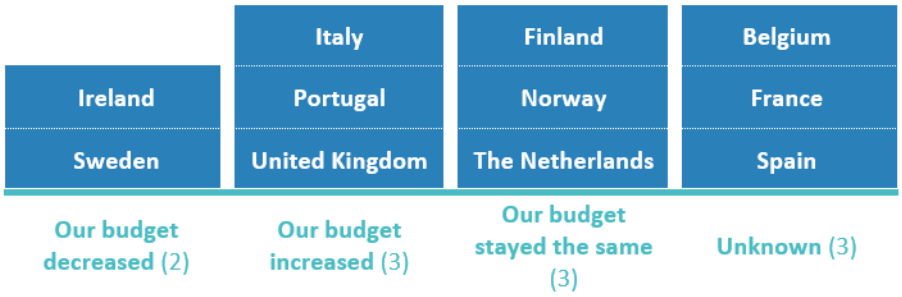
Figure 4.3 **below shows the differences in budget received by Member States from 2018 to 2019. In 2018, the UK had the highest budget for ocean energy, while Belgium and Finland reported no budget. In 2019, the UK had the highest budget for ocean energy, while Spain and Finland reported no budget.**

Figure 4.3: Budget for ocean energy (wave, tidal) per country



The survey asked member states to identify if their budget increased or decreased from 2018 to 2019. ***Figure 4.4*** **below illustrates budgetary changes from 2018 to 2019.**

Figure 4.4: Change in budget for ocean energy from 2018 to 2019



The survey did not explicitly seek to compile a list of every support mechanism in every Member State or region. Many supports are not specifically for ocean energy and can be provided by different authorities responsible for different policy frameworks (for example climate, exports, enterprise, research and innovation, energy).

Table 7 **provides illustrative examples of different supports available at a national and regional level, which may help to progress specific actions in the implementation plan.**

Table 7: Illustrative examples of current and planned support that is relevant for individual implementation plan actions

Technical Actions		Member State/Regional support (Available & Planned)
1.1	Tidal energy technology device development and knowledge building up to TRL 6	France - The 'programme des Investissements d'avenir' has funded several tidal projects.
1.2	Tidal energy system demonstration in operational environment (TRL 7-9)	Norwegian Energy Agency - capital grants for full scale demonstration of ocean energy. Scotland - £10m Saltire Tidal Energy Challenge Fund for tidal technology deployments.
1.3	Wave energy technology development and demonstration up to TRL 6	Denmark - Energy Technology Development and Demonstration Programme directed €230,000 to wave Research and Innovation in 2017. Sweden - €10.2m research programme for ocean energy.
1.4	Wave energy system demonstration and deployment (TRL 7-9)	Basque Energy Agency - €2.5m fund for wave & floating wind demonstrations.
1.5	Installation, logistics and testing infrastructure [and] supply chain development	Wales - £300,000 to fund a tidal demonstration zone.
1.6	Co-ordinate the development of standards and guidelines for technology evaluation and LCOE analysis	
Finance Actions		**Member State/Regional support (Available & Planned)**
2.1	Creation of an investment fund for ocean energy farms	Scotland - £7.5m invested into tidal array by Renewable Energy Investment Fund (in 2014).
2.2	Creation of an EU insurance and guarantee fund to underwrite project risks	No current or planned actions at present.
2.3	Pre-commercial procurement action for development of wave energy technology.	Several countries/regions – forming 'Europe Wave'.
Environmental Actions		**Member State/Regional support (Available & Planned)**
3.1	Development of certification and standards to support the offshore renewable technology sector	Interreg – MET-certified project to develop standards and certification schemes.
3.2	De-risking environmental consenting through an integrated programme of measures	United Kingdom - Offshore Renewables Joint Industry Programme brings together consenting and environmental protection authorities from different jurisdictions in the UK.

4.5 Annual pipeline of wave and tidal projects under delivery in each Member State

Table 8 **shows the annual pipeline of wave and tidal stream projects. Of the 11 Member States participating in the Ocean SET Plan, seven were funding projects in ocean energy in 2018 and all had an annual budget to support ocean energy projects.**

Table 8: Annual pipeline of wave and tidal projects

Country	How many projects funded in 2018?	Projects you supported in 'wave'	Projects you supported in 'tidal stream'	Projects you supported in 'other'	Budget
Italy	5	4	1	-	€3m - 4m
Spain	3	2	1	-	€2m - €3m
Ireland	10	3	3	4	€3m - 4m
Sweden	30	21	6	3	€2m - €3m
Portugal	10	5	1	4	€1m - €2m
France	9	4	5	-	€2m - €3m
UK	23	18	5	0	more than €5m

5. Review of progress of implementation plan actions

Responses from the survey were mapped against the 11 actions from the implementation plan to enable targeted support within Member States for the ocean energy sector to be tracked.

The results and analysis of this mapping exercise is provided below and is tracked against each of the 11 actions, under the three main headings - technical, financial, and environmental.

5.1 Technical actions

- **Action 1.1 Tidal energy technology device development and knowledge building up to TRL 6**
- **Action 1.2 Tidal energy system demonstration in operational environment (TRL 7-9)**
- **Action 1.3. Wave energy technology development and demonstration up to TRL 6**
- **Action 1.4. Wave energy system demonstration and deployment (TRL 7-9)**
- **Action 1.5. Installation, logistics and testing infrastructure and supply chain development**
- **Action 1.6. Standards and guidelines for evaluation of wave energy technologies**

Actions 1.1-1.4. Wave and tidal technology development, demonstration, and deployment

The survey results relevant to the implementation plan's technical actions, 1.1. to 1.4, are summarised below in *Table 9.*

Table 9: Number of ocean energy projects active during 2018

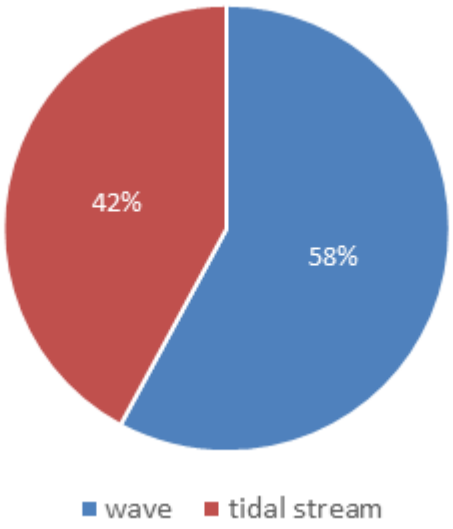
Sector	SET Plan Action	Action Title	Number of projects by sector [a]	Number of projects by TRL
Tidal	1.1	Tidal energy technology device development and knowledge building up to TRL 6	22	17 [c]
	1.2	Tidal energy system (device and array) demonstrations and knowledge building in operational environment (TRL 7-9)		5 [b]
Wave	1.3	Wave energy technology device development, including system demonstration and knowledge building up to TRL 6	57	50 [c]
	1.4	Wave energy device and array system demonstration at large-scale device and early demonstration array scale and leading onto large-scale deployment (TRL 7-9)		7 [b]

[a] from survey Section 1 responses. [b] from survey Section 2 responses.
[c] This estimated quantity should be treated with some caution. It represents the difference between the number of tidal and wave projects identified in survey Section 1 and the number of tidal and wave projects identified as being at TRL 7 or greater.

Taking actions 1.1 and 1.3 together and considering wave and tidal technologies sub TRL 7, it was difficult, in this initial survey, to collect detailed information on device development and knowledge building for the lower TRLs. What we can determine is that support of projects at this stage seems to be reasonably strong, with 17 of 22 tidal and 50 of 57 wave projects sub TRL 7 funded in 2018. In addition, *Table 9*, indicates that Member States have funded a number of support projects (11 in total) which could be considered as knowledge building. Additional work will be required in year 2 of the survey to get more intelligence and details on the projects.

Taking actions 1.2 and 1.4 together, 12 projects in total were eligible to be considered TRL 7 or above. Wave energy converters accounted for the majority of projects at TRL 7 or above undertaken during 2018, with a total of seven of the 12 projects being wave energy converters - see *Figure 5.1.*

Figure 5.1: System demonstration and deployment TRL 7-9



Of the five tidal projects identified as TRL 7 or above, developers identified 'increasing device reliability and survivability' as their development area.

Horizontal axis turbine, most predominant in tidal technology systems that have reached TRL 7 or above, accounted for four of the projects. Installation types were split; three are using fixed gravity-based installations and two are using floating semi-taut mooring.

Of the seven wave projects identified as TRL 7 or above, developers identified 'increasing device reliability and survivability' as the development area and only two chose developing novel concepts for improved power take-offs.

Unlike tidal stream, wave technology types that have reached TRL 7 or above do not show a clear front runner. The technology types are mixed between point absorbers, oscillating water column, and others. This has resulted in a high mix of installation types:

- **Two fixed gravity based**
- **Three floating slack moored**
- **One floating semi-taut moored**
- **One other, pre-tension with technical anchors**

Action 1.5. Installation, logistics and testing infrastructure and supply chain development

In survey Section 1, Member States were asked to identify if they had ocean energy test site facilities and how they would classify their ocean energy supply chain. Test site mapping relates to answers received in survey Section 1, questions 19 and 20, and supply chain classification is based on answers from question 26.

Table **10 maps out the test site facilities across the Member States. Of the 11 Member States that responded, ten had test site facilities in their countries. Some countries only focused on the 'at sea' test centres whereas others identified testing labs in addition to sea testing centres. A clarification on this will be required in the next survey.**

Table 10: Test facilities

Country	Test facilities	Number of test facilities reported
Finland	No	Skipped
The Netherlands	Yes	2
Italy	Yes	3
Spain	Yes	8
Ireland	Yes	3
Sweden	Yes	2
Belgium	Yes	1
Portugal	Yes	2
France	Yes	3
Norway	Yes	2
UK	Yes	5

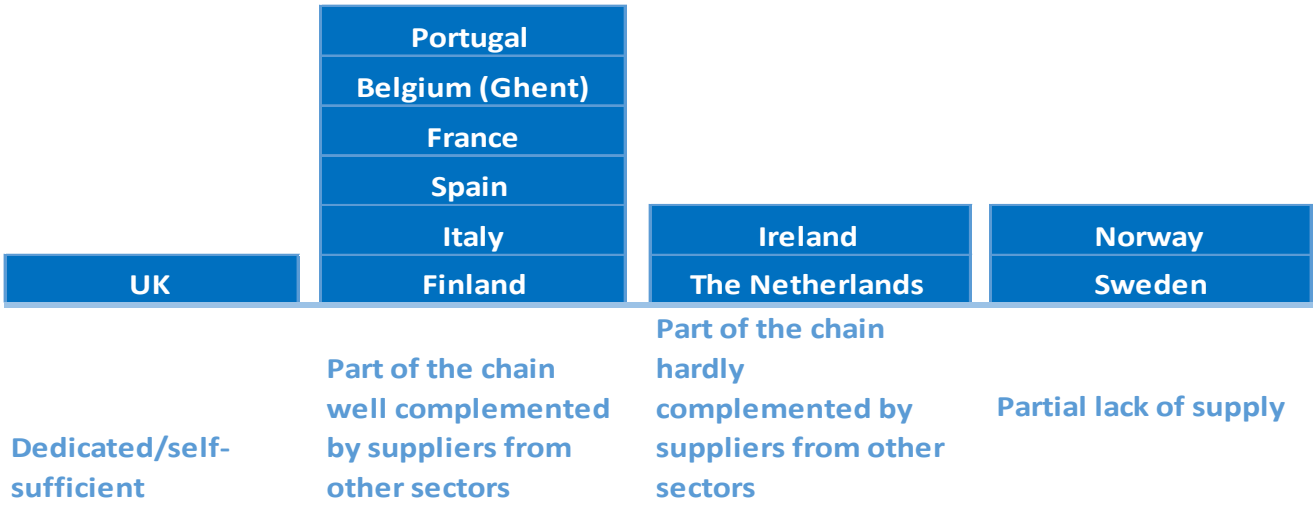
Member states were also asked to identify how much energy (MWh) was generated in their test site facilities by wave or tidal devices but not injected in the grid in 2018. All Member States answered 0MWh or unknown for this question.

Member States were asked how they would classify their ocean energy (wave, tidal stream) supply chains from the following:

- **Partial lack of supply**
- **Part of the chain hardly complemented by suppliers from other sectors**
- **Part of the chain well complemented by suppliers from other sectors**
- **Dedicated or self-sufficient.**

Figure 5.2 **below maps out the supply chain across Member States.**

Figure 5.2: Classification of supply chain



Only the UK classified its supply chain as dedicated or self-sufficient. It is recommended that more detail is sought during the next survey to get a better understanding of the gaps in the supply chain across Member States.

Action 1.6. Standards and guidelines for evaluation of wave energy technologies

To co-ordinate the development of standards and guidelines for technology evaluation and LCOE analysis, a set of technical metrics was developed during this survey; these were designed to provide additional granularity and comparability across Member States' responses. The metrics for the survey were developed in the 'Metrics for Ocean Energy Sector Report' (Deliverable 5.1), which is publicly available on the OceanSET website. The metrics were built into the survey as much as possible using a tick-box method to ensure that all answers could be compared equally. Where this was not possible, the metrics were provided to the recipient.

Q13 of survey Section 2 sought to gather the following information on the technologies:

- **Electrical energy production (MWh/year)**
- **Capacity factor (%)**
- **Availability (h/year)**
- **Capital expenditure (€/W) ***
- **Investment – equipment (€/W)**
- **Investment – installation (€/W)**
- **Operational expenditure (€/W/year) ***
- **Operational and maintenance cost - Equipment (€/W/year)**
- **Technical lifetime (years)**
- **LCOE (€/MWh)**
- **Number of jobs created**

Note: * indicates a detailed description of capital and operational expenditures were provided to respondents.

Table 11 **shows the response rate provided and the range of the answers.**

Table 11: Response rate of technology evaluation and LCOE analysis

Q13	Response rate	Range of answers
Electrical energy production (MWh/year)	42%	1.2 – 6000
Capacity factor (%)	42%	15% - 45%
Availability (h/year)	50%	4,200-8,332
Capital expenditure (€/W)	50%	4-6,100
Investment – equipment (€/W)	33%	3-10.5
Investment – installation (€/W)	33%	1-3
Operation expenditure (€/W/year)	33%	0.088 – 135
Operation and maintenance cost - Equipment (€/W/year)	0%	No answers provided
Technical lifetime (years)	67%	3-25
LCOE (€/MWh)	25%	210-240
Number of jobs created	75%	0-55

If meaningful monitoring of technology evaluation and LCOE analysis is to be achieved, developers must be willing to share this information with their Member State.

5.2 Financial actions

Action 2.1. Creation of an investment fund for ocean energy farms

While no Member State had created an investment fund for ocean energy farms in 2018, some authorities operate or are establishing financial institutions and programmes that can be used to invest in ocean energy projects or companies. For example, France's 'Bpifrance', Scotland's 'Scottish National Investment Bank', or the European Investment Bank's 'InnovFIN EDP' facility.

In practice, however, these facilities are typically not accessible to ocean energy projects, due to the requirement that such projects be 'bankable', which means that projects must demonstrate that they will deliver a direct return on the investment, over the lifetime of the project. In the absence of dedicated revenue support for ocean energy, such as a ring-fenced feed-in tariff, projects cannot generate sufficient revenues to deliver the return necessary to secure investment.

This is also a barrier to private investor participation. Beyond bankability, private investors have expressed an unwillingness to finance individual ocean energy projects, without clear indications that there will be a wider market for ocean energy technologies in the future. They cite the absence of clear national-level targets for ocean energy deployment as a deterrent. In the absence of a strategic motivation to invest (to gain a first-mover advantage in a new market), private investors are deterred by the high-risk levels of these first farms.

If ocean energy is to successfully tap into existing investment opportunities, both public and private, dedicated revenue support will be necessary. ***Table 12*** **contains the responses of national authorities to questions concerning revenue support for ocean energy.**

Table 12: Member State revenue support for ocean energy

Country	Revenue support for wave?	Revenue support for tidal?	Is revenue support ring-fenced?	Revenue support tariff for wave?	Revenue support tariff for tidal?	Revenue support paid to ocean energy in 2018?
Finland	No	No	Skipped	0	0	0
The Netherlands	Yes	Yes	No, ocean energy competes against all other renewable technologies.	100	100	not public
Italy	No	No	N/A	0	0	N/A
Spain	Yes	No	No, ocean energy competes against all other renewable technologies.		-	Subsidy to investment costs: €151,197; Subsidy to operation cost: €35,581.81
Ireland	No	No	N/A	0	0	0
Belgium	Yes	-	No, ocean energy competes against all other renewable technologies.	0	0	0
Sweden	Yes	Yes	No, ocean energy competes against all other renewable technologies.	14	14	0
Belgium (Ghent)	Yes	Yes	N/A	50	50	0
Portugal	No	No	Skipped	0	0	0
France	Yes	Yes	Yes	173	173	Unknown
Norway	No	No	N/An/a	0	0	Unknown
UK	Yes	Yes	No, ocean energy competes against all other renewable technologies.	45	45	€370,000

While several jurisdictions technically make revenue support available to ocean energy, France is the only country to ring-fence funding. In all other jurisdictions, ocean energy must attempt to compete against other, more established, renewables, which have already been able to lower costs through deploying substantial capacity. As a result, where revenue support is not ring-fenced, the payment to ocean energy projects is typically €0. [5], [6]

To harness private and public investment into the first ocean energy farms, ring-fenced revenue support is required. This can be limited to certain volumes of capacity to ensure a controlled drawdown of revenue support. Alternative means of providing revenue support can be explored – for example, in one country, the sector has formulated an approach based on tax credits. This would provide support without involving any public expenditure.

Action 2.2. Creation of an EU insurance and guarantee fund to underwrite project risks

No Member State reported that they had created an insurance fund for ocean energy projects in 2018. However, in 2018, Ocean Energy Europe submitted a successful Horizon 2020 project proposal to further define how such a fund might operate. Unfortunately, one key member of the consortium – a large re-insurance institution – subsequently withdrew, requiring the project to be cancelled. As a result, this action item in the implementation plan remains outstanding.

An EU Insurance and Guarantee Fund will help attract private investment into the first ocean energy farms. It will also significantly reduce the volumes of public funds needed to develop the sector; private investors will require lower returns, reflecting lower risks. This will translate into lower energy costs and therefore, lower levels of revenue support.

Action 2.3. Pre-commercial procurement action for development of wave energy technology

Several national and regional authorities have submitted a joint proposal in response to a Horizon 2020 call that would establish a pan-European pre-commercial procurement structure for wave energy technology. At time of writing, the proposal was provisionally approved. More work is ongoing to finalise the list of participating authorities. It is anticipated that the project agreement will be signed in the coming months, with work commencing to action the project shortly thereafter.

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[5] **The €370,000 cited by the UK is in fact a legacy of a previous renewable support scheme, which did ring-fence support specifically for ocean energy. The Renewable Obligation Certificate scheme awarded more certificates per MWh for ocean energy, compared to other technologies.**

[6] **It is not clear that the 'operational subsidies' reported by Spain refer to actual revenue support paid out for electricity generated. Regardless, the annual sum of €35,000 will not support any meaningful deployments of ocean energy.**

5.3 Environmental actions

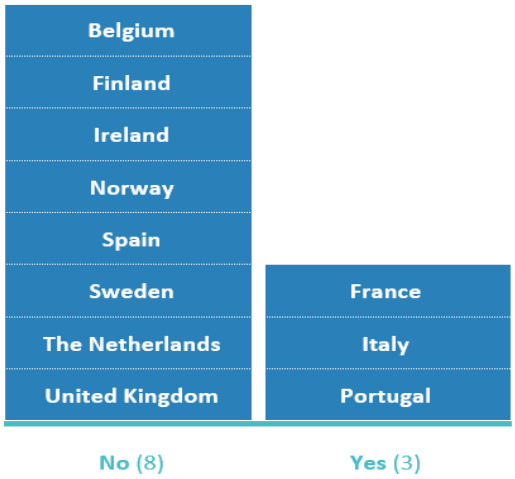
Action 3.1. Development of certification and safety standards to support offshore renewable technology development

Information for this action was not collected during the survey; it will be addressed in forthcoming surveys.

Action 3.2. De-risking environmental consenting through an integrated programme of measures

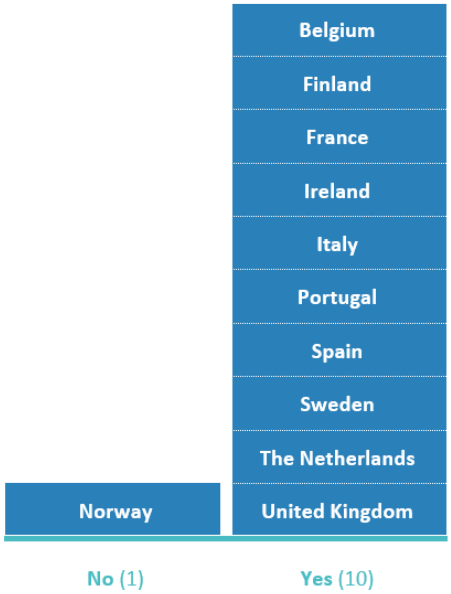
Figure 5.3 **below identifies where Member States had consented projects for development in 2018. Three out of 11 Member States consented a wave or tidal project for development in 2018, namely France, Italy, and Portugal.**

Figure 5.3: Wave or tidal projects consented for development in 2018 per Member State



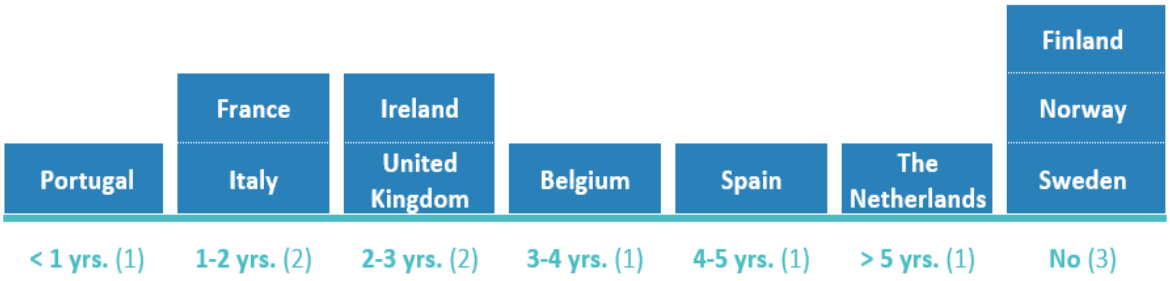
With one exception, Norway, all Member States reported a requirement for an environmental impact assessment for wave or tidal projects (*Figure 5.4*).

Figure 5.4: Consenting environmental impact assessment required per Member State



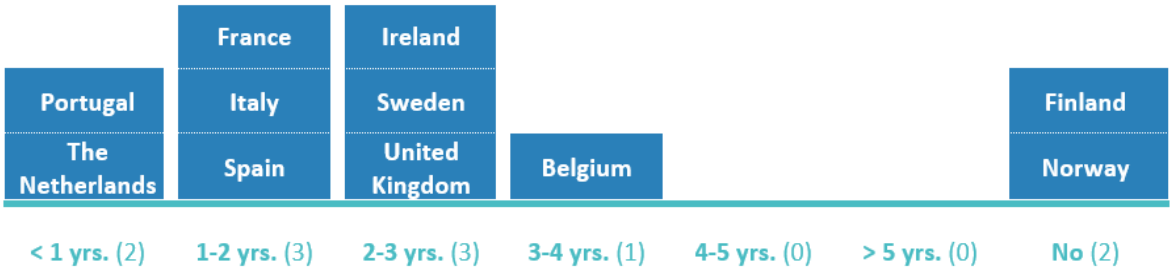
With regard to average licensing time, figures differ from one Member State to another (see *Figure 5.5)*. The values range from less than a year, in the case of Portugal, to more than five years in The Netherlands. In the case of Finland, Norway and Sweden, the answer was 'We don't have one', but it is not clear whether this means that no information about the duration of the licencing procedures was available, or that no licencing is needed in these Member States. The average licensing time for all Member States is about three years.

Figure 5.5: Average licensing time for wave and tidal projects per Member State



Figures for consenting times are lower (see *Figure 5.6)*. Whilst licensing and consenting times are the same in most cases, in Spain and The Netherlands, where licensing times are the longest, consenting times are relatively low. Whilst Sweden does not have a licensing time, it does have a consenting time of between two and three years. The response from Norway conflicts with the one given in question 24 as at least a consenting environmental impact assessment is required in this Member State. The average consenting time for all Member States is about two years.

Figure 5.6: Average consenting time for wave and tidal projects per Member State



Taking into consideration the timing durations for both procedures, Portugal has the shortest times for licensing and consenting, both being less than one year, whilst in Belgium, Spain and The Netherlands, these procedures can last about four or five years or even more if both procedures are sequential.

Italy and France are also among the Member States whose licensing and consenting times are the shortest (with a maximum of two years). It may be worth noting that the Member States with the shortest times for licensing and consenting are the Member States that confirmed consented projects in 2018.

This could indicate that lengthy processes can have a deterrent effect on developers willing to test and operate ocean energy technologies. It is therefore crucial to simplify these procedures and reduce the licensing and consenting times.

Projects like Strategic Environmental Assessment of Wave energy technologies (SEA Wave[7]) or Wave Energy in Southern Europe (WESE[8]) are working to address the lack of knowledge regarding the potential environmental impacts associated with deploying wave and tidal energy converters in the marine environment. Reducing this uncertainty would also reduce non-technological barriers, such as licensing and consenting times, that could hinder the future development of ocean energy.

Ireland, for example, has already taken steps in this matter by approving a new Marine Planning and Development Management Bill[9] in December 2019 that streamlines arrangements based on a single consent principle, that is, one state consent (Maritime Area Consent) to enable occupation of the maritime area and one development consent (planning permission), with a single environmental assessment.

[7] http://www.emec.org.uk/projects/ocean-energy-projects/environmental-monitoring/sea-wave-strategic-environmental-assessment-of-wave-energy-technologies/

[8] http://wese-project.eu/

[9] https://www.housing.gov.ie/planning/marine-spatial-planning/foreshore/marine-planning-and-development-management-bill

5.4 OceanSET progress

A traffic light system, as shown in *Table 13* is used to illustrate the progress made during year one of the discovery phase. It also gives the implementation working group a greater understanding of and the current status of the ocean energy support activities in Member States and regions and, the 11 technology development actions contained in the implementation plan.

Please note, this is a review of the progress OceanSET has made in mapping the ocean energy sector against these 11 actions, not the fulfilment of these actions.

- **Green: on track**
- **Orange: behind progress**
- **Red: no activity or progress**

Table 13: OceanSET progress

	Technical Actions	Progress
1.1	**Tidal energy technology device development and knowledge building up to TRL 6**	
1.2	**Tidal energy system demonstration in operational environment (TRL 7-9)**	
1.3	**Wave energy technology development and demonstration up to TRL 6**	
1.4	**Wave energy system demonstration and deployment (TRL 7-9)**	
1.5	**Installation, logistics and testing infrastructure [and] supply chain development**	
1.6	**Co-ordinate the development of standards and guidelines for technology evaluation and LCOE analysis**	
	Finance Actions	
2.1	**Creation of an investment fund for ocean energy farms**	
2.2	**Creation of an EU insurance and guarantee fund to underwrite project risks.**	
2.3	**Pre-commercial procurement action for development of wave energy technology.**	
	Environmental Actions	
3.1	**Development of certification and standards to support the offshore renewable technology sector**	
3.2	**De-risking environmental consenting through an integrated programme of measures**	

6. Gap analysis

The gap analysis considers the financial requirements for the implementation plan actions along with current funding provision, as established by the OceanSET mapping process, to identify where gaps in funding exist. The analysis also identifies where information is currently insufficient to make a thorough assessment of the sector's progress against the implementation plan. The potential impact of gaps, identified by the analysis, on the overall achievement of targets in subsequent phases of the Plan, is explored.

6.1 Implementation plan – targets

The implementation plan sets out the challenges for wave and tidal technologies (*Table 14)*. It outlines a structured approach and a development path for developing a commercially viable wave and tidal industry. The development timescales outlined are: 2025 for tidal, and 2030 for wave.

Table 14: Summary of technical actions in the ocean energy implementation plan

Action Title	Details	Timeframe	Proposed IP Funding	2018 Funding
1.1: Tidal energy technology device development and knowledge building up to TRL 6	Novel systems and subcomponents: tidal technologies	2018-2025 2018-2025	€145m	~€18m
1.2: Tidal energy system (device and array) demonstrations and knowledge building in operational environment (TRL 7-9)	3 x full-scale device demonstrations 4 x 10 MW arrays	2019-2022 2020-2025	€395m	0
1.3: Wave energy - technology device development, including system demonstration and knowledge building up to TRL 6	Novel sub-systems and concepts: wave technologies TRL4-6	2018-2030	€222.5m	~€17m
1.4: Wave energy – device and array system demonstration at large-scale device and early demonstration array scale and leading onto large-scale deployment (TRL 7-9)	Full-scale device demonstration Implementation of up to 4 arrays	2018-2025 2025-2030	€335m	~€12.5m
1.5: Installation, logistics and testing infrastructure as well as supply chain development for the wave and tidal sectors	Infrastructure to support ocean energy Supply chain development	2018-2030	€100m	~€12.5m
1.6: Development of stagegate metrics (technical standards and guidelines) for wave technology evaluation	Definition and implementation of EU-wide agreed stage-gate metrics for wave energy	2018-2019	€6.5m	~€3.25m
Total			€1,204m	€63.2m

The expected spend of €63.25 million for 2018 was split across industry (€20 million), Member States (€22 million) and the EU (€21.25 million) respectively.

Quantitative targets for an LCOE pathway were set for tidal stream and wave energy technology, with wave energy technology expected to follow the same pathway through convergence in technology development, but lagging by five years:

- Tidal stream energy should be reduced to at least 15 ct€/kWh in 2025 and 10 ct€/kWh in 2030.
- Wave energy: 20 ct€/kWh in 2025, 15 ct€/kWh in 2030 and 10 ct€/kWh in 2035.

The cumulative Member State budget and spend for ocean energy in 2018, reported in survey Section 1, is presented in *Table 15*. Respondents were requested to indicate a range that encompassed the budget. Actual spend in 2018 was requested as a single value.

Table 15: Member States and regions' ocean energy budget and spend

Ocean Energy Budget 2018 (€M)		2018 Spend (€M)	Ocean Energy Budget 2019 (€M)	
Low	High		Low	High
18.0	>26.0	26.3	21.0	>29.0

'Low' represents the sum of lower bounds of the selected range.
'High' represents the sum of the upper bound.
'High' is presented as a 'greater than' value as the highest selectable range in the response was 'greater than €5 million'.

Survey Section 1 did not request the breakdown of this sector-level information by technology type (for example, wave, tidal), by technology readiness level (TRL), or by category (technology development, technology demonstration, technology deployment, logistics, infrastructure, etc.

The reported project costs for ocean energy projects active in 2018 at TRL 7 and greater, amounts to a total of €95.3 million (Q16). This is likely to be an underestimate as not all respondents chose to provide this information (three respondents declined to respond, either citing confidentiality or simply skipping the question). The proportion of tidal stream technology project costs to wave technology project costs was approximately 4:1 (*Table 16*), although the true ratio is likely to be lower as the respondents that declined to provide project cost information represented wave energy technology projects.

Table 16: Total reported project costs and source of funding

	Project costs (No of responses)	
	Ocean Energy	Tidal / Wave
Total cost	**€95.3m (9 from 12)**	**€75.8m (5 from 5)**
		€19.5m (4 from 7)
Member States	**€23.2m (7 from 12)**	**€16.7m (4 from 5)**
		€6.5m (3 from 7)
European Commission	**€35.9m (9 from 12)**	**€35.9m (4 from 5)**
		€0.0m (5 from 7)
***Projects active in 2018 at TRL7 and greater [Q16 & Q17]**		

Annex 8 of the implementation plan provided estimated budgets for all actions over three periods: 2018-2020; 2021-2025; and, 2026-2030. An assessment of progress in Technical Actions 1.2[10] and 1.4[11] may be realised by considering the project costs of ocean energy projects at TRL 7 and greater, reported as active in 2018, the first year of the first period considered in the implementation plan.

It appears that progress in Technical Action 1.2 is ahead of schedule.

More than half of the estimated budget is committed to projects active in the first year of the period. Progress in the Technical Action 1.4 is less clear although it appears to be on schedule if a linear profile is assumed for the first period budget (*Figure 6.2*); approximately one-third of the estimated budget is committed to projects active in the first year of the period.

[10] Technical Action 1.2: Demonstration of tidal energy systems (devices and arrays) in operational environments (TRL 7-9).

[11] Technical Action 1.4: Demonstration of wave energy systems at large-scale device and early demonstration array scale leading onto large scale deployment (TRL 7-9)

Figure 6.1: Comparison of the implementation plan's estimated period budgets with project costs for tidal energy technology projects at TRL7 or greater, active in 2018

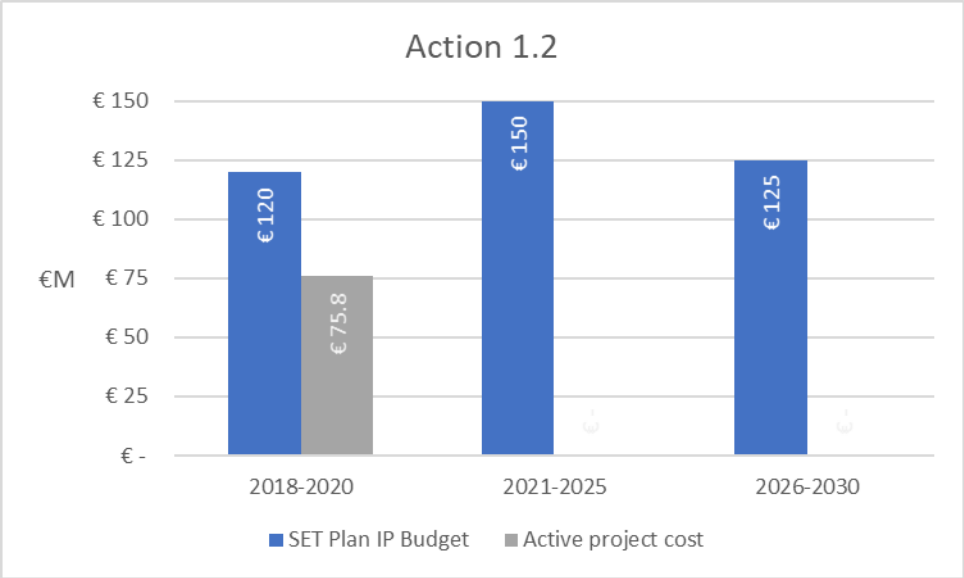
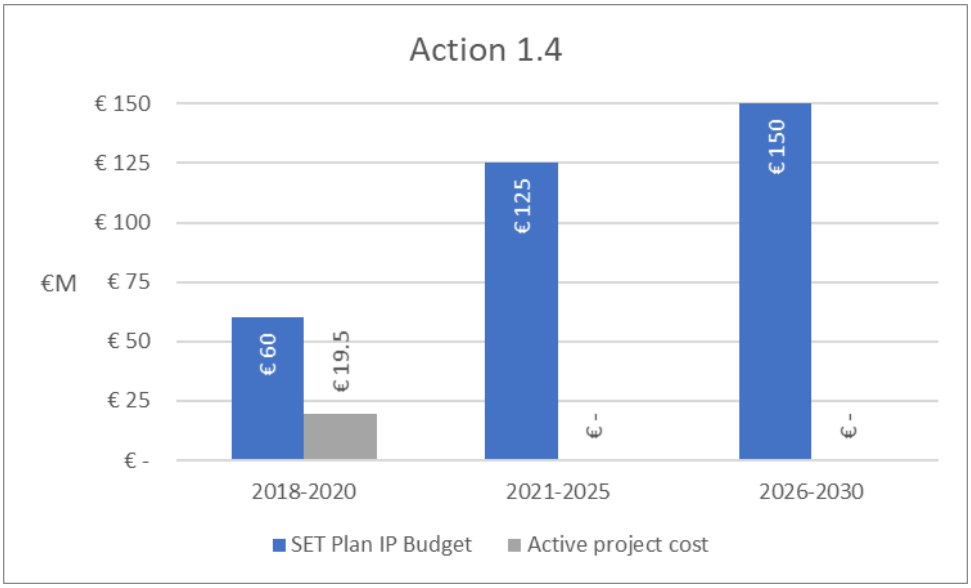


Figure 6.2: Comparison of the implementation plan's estimated period budgets with project costs for wave energy technology projects at TRL7 or greater, active in 2018 only



Reported Member State and European Commission funding contributions to these projects amounted to €23.2 million (24%) and €35.9 million (38%), respectively (*Table 16*) (Q17). The source of the balance of the total project costs (some 38%) is uncertain; survey Section 2 asked respondents to supply the value of Member State and European Commission contributions only. However, it is probably reasonable to presume that this balance was funded privately by the project partners.

Survey Section 2 explicitly requested the proportion of project costs sourced from own funding and grant funding (Q21). A substantial variation in the proportions of project funding sources is apparent. The averages of the reported values were 66% (own funding) and 31% (grant funding), broadly a 2:1 ratio (*Table 17*). This ratio appears to be the inverse of that determined from the total reported project costs, which indicated broadly a 1:2 ratio (38% [balance of funding] to 62% [Member State and European Commission funding], *Table 16*). The explanation for this apparent discrepancy is not certain.

Table 17: Source of project funding as a proportion of total project costs

Source of project funding (%) Grant funding: average (range) Own funding: average (range) (No. of responses)	
Ocean Energy	Tidal
	Wave
31% (0 - 85%) 66% (100 - 15%) (11 from 12)	44% (30 - 60%) 54% (60 - 40%) (4 from 5)
	24% (0 - 85%) 72% (100 - 15%) (7 from 7)

6.2 Funding & capacity gaps

Any assessment of the progress in the development of the ocean energy sector to the end of 2020 – compared with the expectations of the implementation plan – needs to take account of the scale and technical maturity of the ongoing research and demonstration projects and the amount of public funding provided to support these projects. Assessment of the capability gap is made for each of the technical actions in the implementation plan.

Action 1.1 Tidal energy technology device development and knowledge building up to TRL 6

Seventeen (17) sub-TRL 7 tidal technology projects are inferred as being active in 2018 (subject to the caveat in *Table* 9). There are some details of sub-TRL 7 projects being developed that demonstrate novel concepts, such as: GEMSTAR as a vertical axis concept. Within the higher TRL projects, there is also evidence of sub-system innovation with the long-term objective of reducing LCOE. More detailed breakdown of information will be required from future surveys.

Action 1.2 Tidal energy system demonstration in operational environment (TRL 7-9)

Demonstration of full-scale tidal energy devices is expected to begin in 2019 with demonstration at array level in 2020. The results of the survey show that the sector is ahead of the targets sets for this action in the implementation plan, with five projects at >TRL 7 and €75.8 million of funding being committed.

Action 1.3 Wave energy technology development and demonstration up to TRL 6

The number of sub-TRL 7 wave energy projects (57) inferred from the surveys is substantial (see *Table 9*) and the associated caveat), but no detail is provided for these projects. Future surveys will require a more detailed breakdown of information.

Action 1.4 Wave energy system demonstration and deployment TRL 7-9

Several large-scale wave energy technology projects were active in 2018. In the UK, the Wello Penguin was deployed at the European Marine Energy Centre (EMEC) for the whole year at a full scale of 0.5MW; Marine Power Systems tested their DualSub device and CorPower Ocean deployed their HiWave 5. In Portugal AW-Energy continued to test their SURGE2 technology.

The implementation plan did not quantify the scale and number of devices required in this action, but sufficient technology is needed to feed into the next stage of development of four wave arrays by 2025. At this stage, four wave concepts (submerged pressure differential, oscillating water column, point absorber, and oscillating wave surge convertor) appear insufficient to achieve this aim given the historical failure rate of wave energy technology.

Action 1.5 Installation, logistics and infrastructure

Of the 11 responses to Q26 of survey Section 1, which examined the maturity of the ocean energy sector's supply chain, all but one response indicated the supply chain was only partially developed; although six responses suggested that the supply chain was well complemented by other sectors. This suggests that there may be significant work to be done in this area and that more information should be gathered through the next survey.

Action 1.6 Standards and guidelines for evaluation of wave energy technologies

The definition of stage-gate metrics for wave energy is being delivered through a co-ordinated international effort; this will deliver EU-wide, and indeed global, consensus on technology evaluation through two connected routes:

- **DTOceanPlus – a Horizon 2020-funded project which will deliver an open-source suite of software design tools to accelerate the development and deployment of the ocean energy sector. One part of the suite of tools - the Stage Gate design tool - will define a set of stages, metrics and engineering activities for sub-systems, devices and arrays. Within this defined process, the DTOceanPlus deployment and assessment design tools will deliver design and development support with technical evaluation of the specified metrics.**

- **IEA-OES Task 12 – an international activity working under the auspices of the International Energy Agency (IEA) Ocean Energy Systems Group - will deliver an internationally agreed technology evaluation framework for ocean energy.**

Both activities cover wave and tidal stream energy and are building on experience of Wave Energy Scotland, and the US Department of Energy. There are also informed by a series workshops hosted by OCEANERA-NET and the European Energy Research Alliance (EERA).

The outputs can be implemented in future wave energy innovation programmes to ensure that the agreed metrics are evaluated using data derived from the recommended engineering activities, with confidence levels increasing as the development progresses.

Progress with stage-gate development is in line with the implementation plan and funding support is appropriate to meet the Plan's targets.

7. Review and lessons learned

2018 was the reference year for the OceanSet project; the information collected will now become baseline data for the project with more in-depth monitoring yet to be undertaken.

Data collected in 2018 has confirmed that:

- **Six Member States (out of 11) have an ocean energy policy.**
- **Ocean energy received €26.3M funding from Member States in 2018; this surpasses the €21.25 million estimated requirements of the implementation plan.**
- **Ninety (90) ocean energy projects were funded by Member States in 2018, two-thirds of which are supporting wave energy devices.**
- **Twelve (12) ocean energy projects, operational in 2018, were identified as TRL7 or above.**
- **Three Member States consented wave or tidal projects in 2018.**
- **Test sites enabling demonstration can be found in almost all Member States.**
- **The supply chain in most Member States is considered robust.**

7.1 Lessons learned: Year 1 of OceanSET

The data collected in 2018 confirm that the sector was well supported, with €26.3 public funding from Member States and regions allocated to funding technology development activity and delivery of the actions set down in implementation plan. This aligns well with the estimated requirements of the €21.25 million assigned in the Plan.

Further refinement of the survey structure will be required, prior to the next issue, to ensure that an increased understanding of project costs and associated funding can be ascertained. A more targeted approach will also be required to collect data on relevant ocean energy projects from EU funders.

Analysis of the results of the OceanSET survey highlights the difficulty in accessing accurate information on the funding of ocean energy projects and the performance of technologies in terms of energy generation and cost. Industry partners are reluctant to provide accurate information about their technology and investments for commercial reasons. This lack of granularity means detailed analysis is not possible, but a partial, high-level, assessment of adherence to the implementation plan can be made with the information that has been received.

Information on funding levels from public resources at EU, Member State and regional levels are more readily available and, good quality information was received from these sources.

A significant number of concepts are being developed in tidal technology, with five technologies at or above TRL 7. Demonstration at first array scale is underway and progressing ahead of the expectations of the implementation plan.

Wave technology also showed a significant number of sub-TRL 7 technologies in development. Demonstration of full-scale wave energy technology was progressing broadly in line with the implementation plan.

The information gathered by the first OceanSET survey focussed primarily on the technical and financial progress made, particularly for higher TRL technology. Other areas that should be included in the second survey to widen the understanding on the development of the ocean sector as a whole, include:

- **Infrastructure development and the capacity of the supply chain;**
- **Development of environmental standards, safety standards and best practice; and**
- **More granular information on the early-stage developments being supported.**

With regard to the lessons learned from the overall OceanSET project, the timing of the three annual deliverables: mapping and analysis report; gap analysis report and, the monitoring and review report, was too tight. All were due at the same time and this gave very little room for detailed interaction and analysis of data. A recommendation for next year is that the mapping and analysis report be completed a month earlier, to allow more time for the gap analysis and the monitoring and review report to be carried out.

Finally, a number of questions in survey Section 1 should be revisited in year 2 to guarantee clarity on the levels of funding support available from Member States for licensing and consenting systems and test centres.

7.2 Communication and exploitation of results

The primary goal of the communication work package in the first year was to launch the project and raise awareness of the project objectives.

Indicators defined at the beginning of the project were used to assess the effectiveness of the communication and dissemination actions on a monthly basis. A report on these indicators was sent to the project partners every month, which allowed for careful monitoring of the actions and corrective steps to be taken, if necessary.

The OceanSET project was officially launched in late March 2019. In terms of dissemination and communication actions, the first nine months of this project were primarily dedicated to defining clear work package goals, the development of appropriate communication tools and avenues of dissemination, and the organisation and reporting of the first public project events. While some of the initial communication and dissemination goals have yet to be achieved, it is expected that the increased production and analysis of project information in the next two years will help to improve the performance of the numerous tools and actions already in place.

Increased effort on dissemination and communication activities by the consortium will be needed in 2020 if a broad distribution of public results from the project is to be attained. These efforts will, in turn, be summarised in the next annual report and presented in a short video to be shared with all sectoral stakeholders. Industry partners remain reluctant, for commercial reasons, to provide information about their technology, development activities and investments. It is recommended that the OceanSET project be promoted through appropriate networks to ensure improved engagement from developers in the ocean energy sector.

Overall, the objectives initially set have been achieved *(Figure 7.1)* A number of tools are already in place, and others will soon be available, which will facilitate dissemination and communication for the rest of the project.

Figure 7.1: Target and degree of achievement in terms of initial objectives for the entire project period

	Objectives	% of achievement
No. of visits / month on website	200	58%
Duration of visit (sec) on website	90	174%
No. of downloaded files / month from website	10	40%
No. of interactions / month on social media	50	106%
No. of video views on YouTube	1,000	Not started yet
No. of press releases	4	25%
No. of articles in magazines	4	125%
No. of TV or radio appearances	2	0%
No. of released newsletters / year	2	50%
No. of newsletter recipients	200	338%
No. of meeting with EU Commission / year	1	0%
No. of meetings with each Member State	2	Not started yet
No. of meetings with each regional authority	2	Not started yet
No. of knowledge-sharing workshop / year	1	100%
No. of dissemination workshop / year	1	Not started yet
No. of attendees / dissemination workshops	50	Not started yet
No. of communication at conferences/congresses	9	Not started yet
Presence at trade fairs	3	33%

Appendix A: OceanSET work packages and deliverables

Code	Del. No.	Del. Owner	Name	Date	Status
WP 1	Deliverable 1.1	SEAI	Project handbook	15/06/2019	Complete
	Deliverable 1.2	SEAI	H - Requirement No. 1	15/06/2019	Complete
WP2	Deliverable 2.1	SEAI	1st Annual Mapping and Analysis Report	15/02/2020	Complete
	Deliverable 2.2	SEAI	2nd Annual Mapping and Analysis Report	15/02/2021	
	Deliverable 2.3	SEAI	3rd Annual Mapping and Analysis Report	15/02/2022	
WP3	Deliverable 3.1	WES	1st Annual Funding Gap Analysis and Recommendation Report	15/02/2020	Complete
	Deliverable 3.2	WES	Financial requirements for SET PLAN	15/09/2020	
	Deliverable 3.3	SEAI	Design of insurance and guarantee fund	15/01/2021	
	Deliverable 3.4	WES	2nd Annual Funding Gap Analysis and Recommendations Report	15/02/2021	
	Deliverable 3.5	WES	3rd Annual Funding Gap Analysis and Recommendations Report	15/02/2022	
	Deliverable 3.6	WES	Public and private financing ratio for each action, or bundle of actions, in the implementation plan	15/02/2022	
WP4	Deliverable 4.1	WES	Refined Technology Strategy	15/09/2019	Complete
	Deliverable 4.2	WES	Agreed pre-commercial procurement operating mechanism	15/10/2019	Complete

	Deliverable 4.3	WES	Call documentation for pre-commercial procurement	15/07/2020	
WP5	Deliverable 5.1	DGEG	Metrics for ocean energy sector	15/07/2019	Complete
	Deliverable 5.2	ENEA	Report on Knowledge Sharing Workshop	15/01/2020	Complete
	Deliverable 5.3	DGEG	First Annual Monitoring and Review Report	15/02/2020	Complete
	Deliverable 5.4	FEM	Report on 2nd Knowledge Sharing Workshop	15/12/2020	
	Deliverable 5.5	DGEG	2nd Annual Monitoring and Review Report	15/02/2021	
	Deliverable 5.6	FEM	Report on 3rd Knowledge Sharing Workshop	15/12/2021	
	Deliverable 5.7	DGEG	3rd Annual Monitoring and Review Report with recommendations	15/02/2022	
WP6	Deliverable 6.1	FEM	Project website	15/06/2019	Complete
	Deliverable 6.2	FEM	Plan for communication of results	15/08/2019	Complete
	Deliverable 6.3	SEAI	Project Data Management Plan	15/09/2019	Complete
	Deliverable 6.4	FEM	The deliverable will review the dissemination activities and their effectiveness (Annual Report) and include updates to the plan for exploitation and dissemination (PEDR) of results. These updates will be fed into the periodic and final reports to the European Commission.	15/02/2020	Complete
	Deliverable 6.5	FEM	The deliverable is a public version of the OceanSET Annual Report, which will be distributed, and promoted to stakeholders.	15/04/2020	Complete

	Deliverable 6.6	**FEM**	**Report on 1st Dissemination Workshop**	**15/04/2020**	
	Deliverable 6.7	**FEM**	**2nd Annual Report on Dissemination and Communication**	**15/02/2021**	
	Deliverable 6.8	**FEM**	**Publication and promotion of 2nd OceanSET Annual Report**	**15/04/2021**	
	Deliverable 6.9	**FEM**	**Report on 2nd Dissemination Workshop**	**15/04/2021**	
	Deliverable 6.10	**FEM**	**3rd Annual Report on Dissemination and Communication Activities**	**15/02/2022**	
	Deliverable 6.11	**FEM**	**Publication and promotion of 3rd OceanSET Annual Report**	**15/03/2022**	
	Deliverable 6.12	**SEAI**	**Report on Project Closure Meeting**	**15/03/2022**	
WP7	**Deliverable 7.1**	**SEAI**	**Project Management Plan**	**15/06/2019**	**Complete**
	Deliverable 7.2	**SEAI**	**Quality Handbook**	**15/06/2019**	**Complete**
	Deliverable 7.3	**SEAI**	**First OceanSET Annual Report**	**15/03/2020**	**Complete**
	Deliverable 7.4	**SEAI**	**OceanSET Annual report**	**15/03/2021**	
	Deliverable 7.5	**SEAI**	**3rd OceanSET Annual Report**	**15/03/2022**	

Appendix B: Survey Section 1 – questions

OceanSET sent a survey to all SET Plan Member States.

General information

No	Question	Answer format	Answer required?
1	Please state what country you are answering for?	Text answer	Mandatory
2	What is the name of the organisation answering this survey?	Text answer	Mandatory

Policy (high-level information on the country)

No	Question	Answer format	Answer required?
3	Is there a current ocean energy policy outlined in your national government?	Y/N answer No Yes (please provide a link and the title (identify good national policies that could be considered best practice in supporting the industry). Text answer & link	Mandatory
4	Is there an assigned Ministry/Department owner at government level?	Y/N answer No Yes (please provide the name of the Ministry/Department).	Mandatory

Finance (spend)

No	Question	Answer format	Answer required?
5	What is the budget for ocean energy (wave, tidal) in your country this year (in 2019)?	Selection (€0, <€1m, €1-€2m, etc)	Mandatory
6	Did your budget for ocean energy increase or decrease from 2018 to 2019?	Choice answer: Increase, decrease or stay the same>	Mandatory

7	What was the budget for ocean energy (wave, tidal) in your country in 2018?	Selection (€0, <€1m, €1-€2m, etc)	Mandatory
8	What amount (€m) was actually spent on ocean energy (wave, tidal) in your country in 2018? – (Please include all expenditure – that is, cost of R&D, and policies and measures implementation).	Text €	Mandatory

Finance (Revenue support)

No	Question	Answer format	Answer required?
9	Is there a mechanism for ocean energy to get revenue support that pays for every unit of electricity provided to the grid (for example, contracts for difference or feed-in tariffs)?	Tick-box answer: • Wave – Y/N • Tidal – Y/N	Mandatory
10	If you answered yes in Question 9 above, is such revenue support ring-fenced for ocean energy (please, tick the most appropriate)?	Tick-box answer: • Yes • No, ocean energy competes against all other renewable technologies. • No, ocean energy competes only against other emerging renewable technologies such as offshore wind. • N/A	
11	Please specify revenue support tariff for ocean energy. Please indicate the amount. If there were different amounts, please provide the average.	Text answer from list • Wave €/MWh: • Tidal stream €/MWh:	Mandatory
12	How much revenue support was paid to ocean energy in 2018 (€)?	Text answer	Mandatory

Technical (prototypes)

No	Question	Answer format	Answer required?
13	How many ocean energy projects were funded in 2018?	Text	Mandatory
14	Please give the number of projects supported for wave, tidal, other.	Wave: text Tidal: text Other: text	Mandatory

	Please see metrics provided for breakdown of other technologies from wave and tidal.		
15	**How many of the wave and tidal projects reached TRL7 or higher? (TRL 7 - system prototype demonstration in operational environment)?**	**Text or selection**	**Mandatory**
16	**Please provide name(s) of the projects that have reached TRL7 or higher. (A supplementary survey will follow to gather detailed information on these projects which the developers will answer).**	**Project name 1. 2. 3. ETC.**	

Technical (capacity & installation)

No	Question	Answer format	Answer required?
17	**How much ocean energy (wave, tidal) capacity (MW) was installed in your country during 2018?**	**Text**	
18	**How much energy (MWh) generated in the ocean by wave or tidal devices was injected in the grid in 2018?**	**Text**	
19	**Are there test site facilities in your country for ocean energy (prototypes)?**	**Y/N answer**	**Mandatory**
20	**Please provide the name(s).**	**List answer**	
21	**How much energy (MWh) was generated in test sites by wave or tidal devices but not injected in the grid in 2018?**		

Environmental

No	Question	Answer format	Answer required?
22	**Were any wave or tidal projects consented for development in 2018?**	**Text**	
23	**What is the average licencing time for wave and tidal projects in your Member State?**	**<1yr, 1-2yr, 2-3yr, 3-4y ,4-5yr, 5yr+**	**Mandatory**
24	**Is there any consenting environmental impact assessment required for wave or tidal projects?**	**Y/N**	**Mandatory**
25	**What is the average consenting time for wave and tidal projects in your Member State?**	**<1yr, 1-2yr, 2-3yr, 3-4y, 4-5yr, 5yr+**	**Mandatory**

26	**How would you classify in your Member State the ocean energy (wave, tidal) supply chain (please, tick the most appropriate)?**	**Tick box answer:** • **Partial lack of supply** • **Part of the chain hardly complemented by suppliers from other sectors** • **Part of the chain well complemented by suppliers from other sectors** • **Dedicated or self-sufficient**	
27	**If you weren't able to answer any of these questions, please let us know why?**	**Dropdown option** • **We do not have this data** • **We do not have an ocean energy policy in our country** • **The questions were too detailed** • **Other (please specify)**	**Mandatory**

Appendix C: Survey Section 2 – questions

Questions and metrics issued to developers with demonstration of full-scale prototype system in operational environment at pre-commercial stage (stage 4/TRL 7+).

General questions

No	Question	Answer Format	Answer required?
1	Please state the name of the project.	Text answer	Mandatory
2	What is the name of your company which is carrying out this project?	Text answer	Mandatory
3	Are you the lead co-ordinating partner on this project?	Answer Yes or No If no (please provide the name of the company who is the lead partner).	Mandatory
4	What is the timeframe of this project (in months)?	Text answer (in months)	Mandatory
5	Please give the start and end date for this project as set out in in the agreement with the granting authority	Start date – end date (dd/mm/yyyy – dd/mm/yyyy)	Mandatory
6	Estimated progress toward completion of the project (%)	Text answer in %	Mandatory

Technical (prototypes)

No	Question	Answer Format	Answer required?
7	What development areas are addressed in the project?	Dropdown options • Developing novel concepts for improved power take-offs • Increasing power take-off reliability • Investigating novel devices before moving towards convergence of design • Increasing device reliability and survivability • Developing subsystems related to the balance of plant, for example, electrical connection technology	Mandatory

		• **Development of electrical power conditioning and storage solutions** • **Development of moorings, foundations and associated connection sub-systems** • **Investigating alternative materials and manufacturing processes for device structures** • **Defining and enforcing standards for stage progression through scale testing** • **Developing and implementing optimisation tools** • **Investigating resource availability** • **Developing environmental impact assessment methodologies and tools**	
8	**Which type of technology is the project addressing?**	**Dropdown options** • **Wave – attenuator** • **Wave - overtopping/terminator device** • **Wave - oscillating water column** • **Wave - rotating mass** • **Wave - submerged pressure differential** • **Wave - point absorber** • **Wave - oscillating wave surge converter** • **Wave - bulge wave** • **Tidal Steam - horizontal axis turbine** • **Tidal Steam - vertical or cross-axis turbine** • **Tidal steam - oscillating hydrofoil** • **Tidal steam - enclosed tips (Venturi)** • **Tidal steam - archimedes screw** • **Tidal steam - Tidal kite**	**Mandatory**

		• **Other (please specify and specify if it is wave or tidal)**	
9	**Please specify the installation type**	**Dropdown Options** • **Floating - slack moored** • **Floating - taut moored** • **Floating - semi-taut moored** • **Fixed – monopile** • **Fixed - jacket structure** • **Fixed - gravity base** • **Fixed - shoreline mounted** • **Other (please specify)**	**Mandatory**
10	**Please indicate current development stage of the device**	**Dropdown options** • **Stage 0 - basic research. principles postulated and observed but no experimental proof available (TRL 1)** • **Stage 1 - technology formulation. Concept and application have been formulated (TRL 2-3)** • **Stage 2 - testing of small-scale (e.g. 1/30th - 1/20th scale) prototype in a laboratory environment. Numerical model complete (TRL 4)** • **Stage 3 - testing of large-scale (for example, half scale) prototype in representative environment (TRL 5-6)** • **Stage 4 - demonstration of full-scale prototype system in operational environment at pre-commercial stage (TRL 7)** • **Stage 5 - full commercial application, technology available for consumers (TRL 8-9)**	**Mandatory**
11	**In what specific innovation objectives is the project focused (cost reduction, demonstration of**	**Text answer**	

	survivability over typical winter period, etc.)?		
12	**What capacity (MW) is to be installed during the project?**	**Choice of** • **already installed - text answer and, or** • **Foreseen – text answer**	**Mandatory**
13	**Please present the performance of the project or technology at the current stage, providing as many of the following metrics as possible:**	**Filling in the following:** • **Electrical energy production (MWh/year)** • **Capacity factor (%)** • **Availability (h/year)** • **Capital expenditure (€/W)** • **Investment – equipment (€/W)** • **Investment – installation (€/W)** • **Operational expenditure (€/W/year)** • **O&M cost – equipment (€/W/year)** • **Technical lifetime (years)** • **LCOE (€/MWh)** • **Number of jobs created**	**Mandatory**
14	**If you didn't answer some of the previous questions, please indicate why.**	**Text answer**	

Finance (spend)

No	Question	Answer Format	Answer required?
15	**Does the project include partners or are you the sole grantee?** ***Please note that these questions are broken up to gather data for those who carried out projects as part of a consortium as well as those who did not. If your project does not included***	**Tick box:** • **The project is made up of a consortium** • **Only my company is involved**	**Mandatory**

	consortium, please skip to Q19.		
16	**What is the overall cost of your project? (including other partners costs, in-kind costs, etc. if applicable)**	**Text answer €**	
17	**What total funding did you receive from Member State and/or European Commission funding for this project? (over the entire project)**	**Text answer** • **National Government funding (€)** • **European Commission funding such as H2020, Interreg, etc. (€)**	
18	**Please provide the Financing breakdown (%) for your part of the project**	**Numerical answer:** • **Grant %** • **Own resources %** • **Other (such as in-kind)**	

No	Question	Answer Format	Answer required?
19	**What is the cost to you to carry out this project only? (Please only include your cost from the start and end date as per your grant agreement with the funding authority)**	**Text answer**	
20	**From your costs only, what funding did you receive from Member State or EC funding for this project?**	**Text answer** • **National Government funding (€)** • **European Commission funding such as H2020, Interreg, etc. (€)**	
21	**Please provide the Financing breakdown (%) for this project (excluding in-kind costs)**	**Numerical answer:** • **Grant (%)** • **Own resources (%)**	

No	Question	Answer Format	Answer required?
22	**If you didn't answer the previous question, please indicate why.**	**Dropdown option** **I don't have this information** • **I don't want to give this information** • **I didn't understand the question(s)** • **Other (please specify)**	

Appendix D: Survey Section 1 answers

Policy (high-level information on the country)

Q1	Q2	Q3	Q3	Q4
Country	Organisation	Is there an ocean energy policy?	link	Ministry or Department owner
Finland	Ministry of Economic Affairs	No		No
The Netherlands	Ministry of Economical Affairs and Climate	No		No
Italy	ENEA	Yes	Strategia Energetica Nazionale: https://www.mise.gov.it/images/stories/documenti/Testo-integrale-SEN-2017.pdf	Yes
Spain	Centre for the Development of Industrial Technology (CDTI)	Yes	The Energy Strategy for the Basque Country 2030 (3E2030) defines objectives and strategic 'Wave Energy Basque Country' programme http://www.waveenergybasquecountry.com/en/	Yes
Ireland	SEAI	Yes	Offshore Renewable Energy Development Plan (OREDP) & Climate Action Plan	Yes
Belgium	Flemish Government, Department Economy, Science and Innovation	No		No
Sweden	Swedish Energy Agency	No		Yes

Belgium	**Ghent University**	**Yes**	**Law of use of EEZ + Marine Environment + Marine spatial plan (mainly focussed on demonstrations and pilots)**	**Yes**
Portugal	**DGEG**	**Yes**	**Estratégia Industrial e Plano de Ação para as Energias Renováveis Oceânicas (Industrial Strategy and Action Plan for Renewable Ocean Energy) - https://dre.pt/home/-/dre/114248654/details/maximized**	**Yes**
France	**French Environment and Energy Management Agency (ADEME)**	**No**		**Yes**
Norway	**The Research Council of Norway**	**No**		**Yes**
UK	**WES**	**Yes**		**Yes**

Finance (spend)

	Q5	Q6	Q7	Q8
Country	**Budget for 2019?**	**Did the budget for ocean energy increase or decrease from 2018 to 2019?**	**Budget for 2018?**	**What amount (€m) was spent on ocean energy in 2018?**
Finland	**€0**	**Our budget stayed the same**	**€0**	**0**
The Netherlands	**Less than €1m**	**Our budget stayed the same**	**Less than €1m**	**1**
Italy	**€4m - €5m**	**Our budget increased**	**€3m - €4m**	**3.7**
Spain	**€0**	**Unknown**	**€2m - €3m**	**2.9**
Ireland	**€3m - €4m**	**Our budget decreased**	**€3m - 4m**	**2**
Belgium	**€0**	**Unknown**	**€0**	**Unknown**
Sweden	**€2m - €3m**	**Our budget decreased**	**€2m - €3m**	**2.7**
Belgium	**€3m - €4m**	**Unknown**	**€0**	**Unknown**
Portugal	**€2m - €3m**	**Our budget increased**	**€1m - €2m**	**2**
France	**€2m - €3m**	**Unknown**	**€2m - €3m**	**Unknown**

Norway	**Less than €1m**	**Our budget stayed the same**	**Less than €1m**	**1**
UK	**More than €5m**	**Our budget increased**	**More than €5m**	**11**

Finance (spend)

	Q9	Q9	Q10	Q11	Q11	Q12
	Revenue support for wave?	Revenue support for tidal?	Is revenue support ring-fenced?	Revenue support tariff for wave?	Revenue support tariff for tidal?	Revenue support paid to ocean energy in 2018?
Finland	**No**	**No**	**Unknown**	**0**	**0**	**0**
The Netherlands	**Yes**	**Yes**	**No, ocean energy competes against all other renewable technologies**	**100**	**100**	**N/A**
Italy	**No**	**No**	**N/A**	**0**	**0**	**N/A**
Spain	**Yes**	**No**	**No, ocean energy competes against all other renewable technologies**	**136930**		**Subsidy to investment costs: 151.197 €; Subsidy to operation cost: 35.581,81 €**
Ireland	**No**	**No**	**N/A**	**0**	**0**	**0**
Belgium	**Yes**	**Skipped**	**No, ocean energy competes against all other renewable technologies**	**0**	**0**	**0**
Sweden	**Yes**	**Yes**	**No, ocean energy competes against all other renewable technologies**	**14**	**14**	**0**
Belgium	**Yes**	**Yes**	**N/A**	**50**	**50**	**0**
Portugal	**No**	**No**	**Unknown**	**0**	**0**	**0**
France	**Yes**	**Yes**	**Yes**	**173**	**173**	**N/A**
Norway	**No**	**No**	**N/A**	**0**	**0**	**Unknown**

UK	Yes	Yes	No, ocean energy competes against all other renewable technologies	45	45	€370,000

Technical (prototypes)

	Q13	Q14	Q14	Q14	Q15
	How many projects were funded in 2018?	Projects you supported in wave?	Projects you supported in tidal?	Projects you supported in other?	Projects that reached TRL 7+?
Finland	0	0	0	0	0
The Netherlands	0	0	0	0	1
Italy	5	4	1	Unknown	3
Spain	3	2	1	Unknown	3
Ireland	10	3	3	4	1
Belgium	0	0	0	0	0
Sweden	30	21	6	3	2
Belgium	1	1	0	1	0
Portugal	10	5	1	4	1
France	9	4	5	Unknown	2
Norway	Unknown	0	0	0	0
UK	22	19	3	0	7

Technical (Capacity & installation)

	Q17	Q18	Q19	Q20	Q21
	MW installed in 2018?	MWh generated in 2018?	Test facilities?	Names of test sites?	MWh from test sites in 2018?
Finland	0	Skipped	No	Skipped	Skipped
The Netherlands	0	not public	Yes	Tocardo, Den Oever	Unknown
Italy	N/A	N/A	Yes	Pantelleria, ReggioCalabria, Napoli	N/A

Spain	0	260 MWh.	Yes	BIMEP-EVE (Basque Country) PLOCAN - (Canarian Island) CEHIPAR - Madrid IHCantabria - Cantabria The Marine Corrosion Test Site "El Bocal" (MCTS "El Bocal") - Components Technological Center - Cantabria Centro Tecnológico Naval y del Mar - Hydroacoustics Laboratory - Murcia-Spain	0
Ireland	0	0	Yes	Lir Tank Test Galway Bay Atlantic Marine Energy Test Site	0
Belgium	0	0	Yes	Blue Accelerator test platform, Oostend	0
Sweden	0	Not known	Yes	Lysekil test site (wave) and Söderfors project (river current but technology applicable for ocean current)	Unknown
Belgium	0	0	Yes	Blue Accelerator	0
Portugal	0	0,069 MWh	Yes	Aguçadoura test site Viana do Castelo Pilot Zone	0
France	1.32	Unknown	Yes	SEENEOH (Bordeaux)Paimpol-Bréhat test siteSEM REV (Le Croisic)	Unknown
Norway	0	0	Yes	Runde Environmental Centre MetCentre	0
UK	11	8227.8MWh	Yes	EMEC wave and tidal: Wave 7MW Capacity Tidal 4MW Capacity East Anglesey Demonstration Zone. South Pembroke Demonstration Zone Wave Hub – capacity 20MW FaB Test – Falmouth Bay	Unknown

Environmental

	Q23	Q24	Q25	Q26	Q27
	Average licencing time?	Is an EIA required?	Average consenting time?	How would you classify ocean energy?	If you weren't able to answer these questions?
Finland	We do not have one	Yes	We do not have one	Part of the chain well complemented by suppliers from other sectors	We don't have an ocean energy policy in our country.
The Netherlands	More than 5 years	Yes	Less than 1 year	Part of the chain hardly complemented by suppliers from other sectors	I was able to answer them.
Italy	1 - 2 years	Yes	1 - 2 years	Part of the chain well complemented by suppliers from other sectors	We do not have this data.
Spain	4 - 5 years	Yes	1 - 2 years	Part of the chain well complemented by suppliers from other sectors	Related questions 5 to 8: provided information in these points is related to national Research and Innovation budget for ocean technologies. At national level, there is not a specific budget per technologies and per year. Our national Research and Innovation funding programmes are open to all technologies, in a non-competitive call open throughout the year. In 2019, no R&D projects on ocean technologies (wave or tidal) are being approved so far.
Ireland	2 - 3 years	Yes	2- 3 years	Part of the chain hardly complemented	I was able to answer them.

				by suppliers from other sectors	
Belgium	**We do not have one**	**No**	**We do not have one**	**Skipped**	**We don't have an ocean energy policy in our country. The questions were too detailed. We do not have this data, Other (please specify): The questions were not related to only R&D but many questions relate to deployment and energy policy and are therefore not directly linked with SET Plan Research and Innovation targets.**
Sweden	**We do not have one**	**Yes**	**2- 3 years**	**Partial lack of supply**	**Other - Not sure if the demonstration projects that are outside of Sweden could be included or not (they are right now).**
Belgium (Ghent)	**3- 4 years**	**Yes**	**3 - 4 years**	**Part of the chain well complemented by suppliers from other sectors**	**Other - Belgium has specific boundary conditions which couldn't be explained in this survey.**
Portugal	**Less than 1 year**	**Yes**	**Less than 1 year**	**Part of the chain well complemented by suppliers from other sectors**	**Other Regarding questions number 5, 6, 7 and 8: there is not a specific figure for ocean energy (wave, tidal) in the national budget.**

France	**1 - 2 years**	**Yes**	**1 - 2 years**	**Part of the chain well complemented by suppliers from other sectors**	**Other** **Please note I am unsure about the budget mentioned on questions 5 and 7: some budget is dedicated to our agency, some of it also goes to Agence Nationale De La Recherche and France Energies Marines. This is a rough estimation which needs to be consolidated. Please also note that the number mentioned at Q. 11 probably rose up as it was the actual number back in 2014. Furthermore, it was a feed-in-tariff for tidal energies, but I believe it could be applied to WEC according to the current legislation. Again, this would need to be double-checked.**
Norway	**We do not have one**	**No**	**We do not have one**	**Partial lack of supply**	**We don't have an ocean energy policy in our country.**
UK	**2 - 3 years**	**Yes**	**2- 3 years**	**Dedicated or self-sufficient**	**N/A**

Abbreviations and acronyms

CAPEX	**Capital Expenditure**
DGEG	**Directorate General for Energy and Geology, Portugal)**
EC	**European Commission**
EERA	**European Energy Research Alliance**
EMEC	**European Marine Energy Centre**
ENEA	**Italian National Agency for New Technologies, Energy and Sustainable Economic Development**
ETIP Ocean	**European Technology & Innovation Platform for Ocean Energy**
EU	**European Union**
EVE	**Ente Vasco de la Energía (Basque Energy Agency)**
FEM	**France Energies Marines**
GDPR	**General Data Protection Regulation**
H2020	**Horizon 2020**
IEA	**International Energy Agency**
IP	**Implementation Plan**
IWG	**Implementation Working Group**
LCOE	**Levelised Cost of EnergyEVE**
MS	**Member States**
O&M	**Operation and Maintenance**
OE	**Ocean Energy**
OEE	**Ocean Energy Europe**
OPEX	**Operational Expenditure**
PCP	**Pre-Commercial Procurement**
PEDR	**Plan for Exploitation and Dissemination of Results**
PLOCAN	**Plataforma Oceánica de Canarias (Oceanic Platform of the Canary Islands)**
R&D	**Research and DSRIAlopment**
SEAI	**Sustainable Energy Authority of Ireland**

SET Plan	**Strategic Energy Technology Plan**
SRIA	**Strategic Research and Innovation Agenda**
TEC	**Tidal Energy Converter**
TRL	**Technology Readiness Level**
UEDIN	**University of Edinburgh**
WEC	**Wave Energy Converter**
WES	**Wave Energy Scotland**
WP	**Work Package**
WPL	**Work Package Leader**

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