OceanSET Second Annual Report | 2021

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Version 1.0

Disclaimer

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OceanSET

How it works

The **SET Plan** is the technology pillar of the EU's energy and climate policy

An **Implementation Plan** was developed for ocean energy actions in the SET Plan

The **Implementation Working Group** will deliver actions

OceanSET

Overview of OceanSET

OceanSET aims to obtain a solid understanding of **evolution in the European ocean energy sector** in order to **optimally tailor future funding** for member states, regions and the European Commission.

3 years (Mar 2019 – Feb 2022)

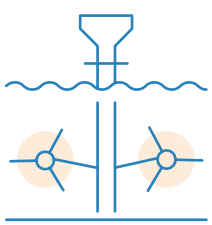
Budget of €1 million

Funding from Horizon2020

Annual report key findings – 2019

16 responses received (from 14 member states). Ref year 2019.

A total of **127** **ocean energy projects** supported



Annual report key findings – 2019

16 responses received (from 14 member states). Ref year 2019.

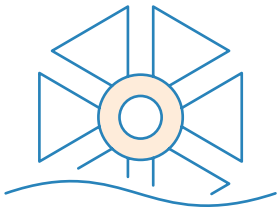
€42.7 **million in public funding** from member states and regions

8 member states have an **ocean energy budget**

10 member states have **test site facilities**

9 member states have an **ocean energy policy**

10 member states were **funding ocean energy projects** and **9** were funding TRL 7+



Ocean energy projects survey

Member states reported 25 projects over TRL 7 active in 2019. Developers reported target values from a selection of projects.

11 tidal projects

- Mainly horizontal axis turbines

For 1 – 2 MW rated capacities:

- **67%** **average** annual availability for tidal prototypes
- **8.38** **€/W** average capital expenditure
- **1.08** **€/W/year** average operational expenditure

12 wave projects

- No technology front runner
- Technologies included attenuator, point absorber and oscillating wave surge converter

For 0.15 – 1.15 MW rated capacities:

- **67%** **average** annual availability for wave prototypes
- **2.01** **€/W** average capital expenditure
- **0.32** **€/W/year** average operational expenditure

2 other projects

EXECUTIVE SUMMARY

To provide support to Ocean Energy implementation in line with the SET Plan, the OceanSET project was launched in March 2019. This EU H2020 project helps to paint a clear picture of Ocean Energy sector development across Europe within the SET Plan framework. This second annual report provides an overview of the activities performed within each work package in year two of the project, as well as an annual update of progress in the Ocean Energy sector for the year 2019.

Overall funding of activity in the technical actions suggests that the sector continued to be well supported. Investment committed to projects was almost at, or exceeding, the level of investment envisaged in the Implementation Plan for Ocean Energy which was created to outline a path for developing a commercially viable wave and tidal industry.

An increase in the number of active projects was observed in all subsectors for 2019, however, this may be explained in part by an apparent greater diligence of the Member States in identifying projects. Of the 127 projects identified, 16 were European funded projects with an overall budget of €115M and a grant aid of €83M. Of the 111 Member State funded projects, 11 were ERANET projects with 26 different partners. This data points to a capacity to collaborate on projects across the sector and further efforts to build on this should be encouraged.

Wave energy subsector activities were generally technology focused and the focus appears to be on low TRL projects which outnumber high TRL projects by around 4-to-1. Six separate device concepts were being developed or deployed in high TRL projects. While this is viewed positively, continued support for concept development activity is recommended. Activity in the tidal energy subsector's low TRL action appears to be less than anticipated.

This second OceanSET Annual Report sets out detailed results of the second mapping and analysis exercise based on surveys capturing high-level information from Member States and detailed information from developers having devices with a TRL 7 or greater.

The main results of these surveys can be summarized as follows:

- 9 Member States declare having an Ocean Energy policy;
- Ocean Energy received €42.7M funding in 2019 from Member States;
- Member States declared that 127 Ocean Energy projects were funded in 2019, out of which nearly 60% are supporting wave energy devices;
- There were 25 Ocean Energy projects identified as TRL 7 or above in 2019
- Test sites enabling demonstration can be found in almost all Member States;
- 7 Member States described their supply chain as self-sufficient or well complemented.

Although slightly more data was available for analysis for 2019, challenges remain in attempting to gather information from various states and developers. Accessing accurate information regarding performance and costs of the different technologies has improved compared to 2018. However, the number of respondents means some results are sensitive to individual answers and can be skewed. We have attempted to highlight this where necessary in the 2019 results.

The prospect of successful outcomes for the device concepts found to be approaching the upper limit of wave energy technology development and demonstration up to TRL 6 is encouraging. However, further investment should be made available to continue to progress the development of these low TRL device concepts. Regarding wave energy system demonstration and deployment for TRL 7-9, there clearly needs to be sufficient technology to feed into the next phase of the Implementation Plan, which anticipates the development of four wave energy arrays in the period 2020 to 2025.

The Implementation Plan expects demonstration of full-scale tidal energy devices to begin in 2019 and demonstration at array level in 2020. The data for 2019 reveals 11 high TRL projects were active, with 5 of these projects classified as 'whole-system' projects; 1 classified as a 'support' project which is known to be supporting the deployment of a number of 'whole-systems'; and some projects classified as 'sub-system' which are known to be integral elements of larger 'whole-system' projects. This insight suggests that an investment of some €106M is targeting activities which are directly relevant to this expectation.

However, there appears to be a lack of breadth in tidal energy technology device development and knowledge building up to TRL 6. Only four low TRL "system" projects were reported as being active in 2019 of which a single "whole-system" project accounts for 81% of combined investment. The projects in the low TRL category are targeting the achievement of development stage 3 (TRL 5 or 6) by its conclusion, i.e. at the upper limit of the low TRL category. It is conceivable that follow-on projects would target achieving higher TRL categories, presuming successful outcomes in the current project.

The data collected for 2019 suggests that the legal and administrative processes for testing ocean energy technologies within Member States could have a detrimental impact on consenting times, specifically for trials outside existing test sites. An urgent need still remains to reduce the permits and consenting times in order to favour and develop a competitive ocean energy industry in Europe.

Some Member States and regions expressed a desire for establishing local test facilities that would appear to replicate an existing provision in another Member State or region. An alternative approach to addressing this may be to improve and enhance support for cross-border access to test facilities. Further work is required in every Member State to develop an appropriate understanding of the current supply chain provision, the requirement of the ocean energy sector, and the actions necessary to close the gaps which may exist.

The recent publication of the IEA-OES Framework for the evaluation of ocean energy technology maintains progress in the realisation and adoption of an EU-wide standard. The next step is to communicate the content of Framework effectively at both Member State and regional levels to encourage its uptake.

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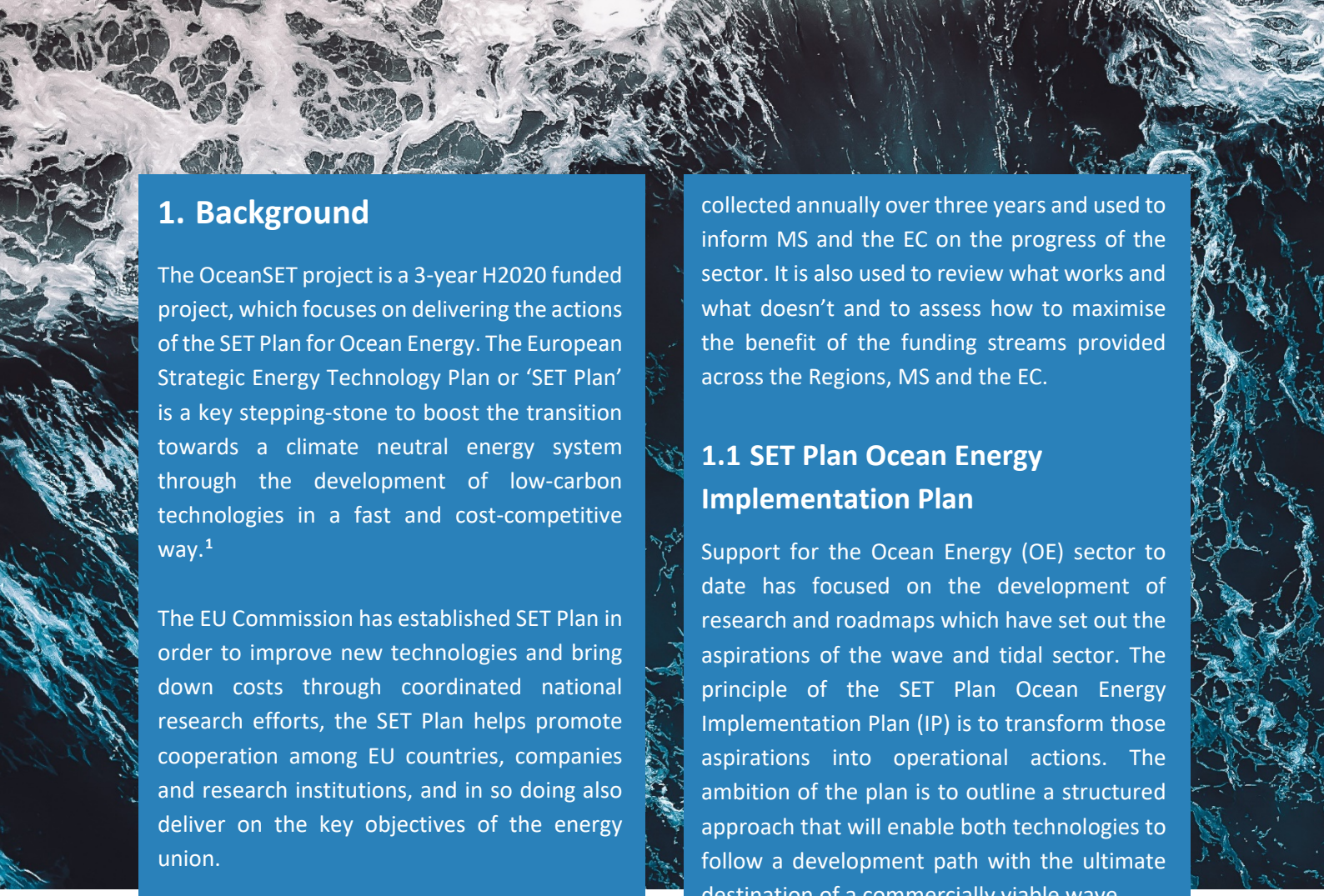
ABBREVIATIONS AND ACRONYMS

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 Energy
MS	Member States
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)
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



1. Background

The OceanSET project is a 3-year H2020 funded project, which focuses on delivering the actions of the SET Plan for Ocean Energy. The European Strategic Energy Technology Plan or 'SET Plan' is a key stepping-stone to boost the transition towards a climate neutral energy system through the development of low-carbon technologies in a fast and cost-competitive way.[1]

The EU Commission has established SET Plan in order to improve new technologies and bring down costs through coordinated national research efforts, the SET Plan helps promote cooperation among EU countries, companies and research institutions, and in so doing also deliver on the key objectives of the energy union.

Under the SET Plan an Implementation Plan (IP)[2] for Ocean Energy was elaborated by a temporary working group comprising representatives from the European Commission (EC), Member States (MS) and other stakeholders and was adopted on 21 March 2018. For the execution of the IP, the temporary working group has evolved to assume the role of an Implementation Working Group (IWG). The OceanSET project will assist the IWG to deliver on the targets set in the IP.

OceanSET focuses on assessing the progress of the Ocean Energy sector and monitors National and European Union (EU) funded projects in delivering successful supports. Relevant data is collected annually over three years and used to inform MS and the EC on the progress of the sector. It is also used to review what works and what doesn't and to assess how to maximise the benefit of the funding streams provided across the Regions, MS and the EC.

1.1 SET Plan Ocean Energy Implementation Plan

Support for the Ocean Energy (OE) sector to date has focused on the development of research and roadmaps which have set out the aspirations of the wave and tidal sector. The principle of the SET Plan Ocean Energy Implementation Plan (IP) is to transform those aspirations into operational actions. The ambition of the plan is to outline a structured approach that will enable both technologies to follow a development path with the ultimate destination of a commercially viable wave

Thus, the IP sets out the following **targets** for **wave** and **tidal** sector:

- Development of cost competitive Ocean Energy technologies with high market potential for Europe
- Reduce the 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

[1] https://ec.europa.eu/energy/topics/technology-and-innovation/strategic-energy-technology-plan_en

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

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 including large scale manufacturing and deployment supply chains which will enable the economies of scale required to meet the commercialisation targets.

The SET Plan IP for Ocean Energy outlines three high level actions:

- **Co-ordination** between the Member States and Regions to share and track critical information annually, to demonstrate the clear development of the ocean energy technologies.
- **Collaboration** between the Member States, Regions and the European Commission to ensure the effective use and appropriate blending, if possible, of funds to drive large scale deployment.
- The need for **annual monitoring of progress** with a review carried out at the end of each phase, to reach a go/no go decision to the next phase.

Within the SET-Plan IP for Ocean energy, 11 Technology Development Actions have been identified to progress at a national and EU level. The actions are both cross-cutting (i.e. relating to all ocean energy technology), and, technology specific (i.e. relating to either wave or tidal). They include six Technical Actions to ensure support for all TRLs to ensure development of tidal arrays and to drive convergence in wave technologies; three Financial actions to ensure investment and insurance support funds are available to support the development of the sectors; and two Environmental actions to share knowledge on safety and environmental matters.

These actions are detailed as follows:

Technical Actions

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 (PCP) 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

2. OceanSET

The OceanSET project is a 3-year H2020 funded project, which focuses on delivering the actions of the SET Plan for Ocean Energy. Objectives, methodology and outcome of the work of the OceanSET project are set out below.

The partners on this project include representatives from **Ireland** (SEAI), **UK** (WES and University of Edinburgh), **France** (FEM), **Portugal** (DGEG), **Spain** (EVE, PLOCAN), **Italy** (ENEA) and from the industry, represented by the **Ocean Energy Europe** (OEE) network. The Sustainable Energy Authority of Ireland (SEAI) is the lead partner on the project.

2.1 Objectives

The OceanSET project has identified three key objectives to achieve the goal of supporting the realisation of the Ocean Energy SET Plan IP.

Objective 1: Facilitate the implementation of the Technical Actions of the Implementation Plan and provide support to the IWG

Objective 2: Promote knowledge sharing across the EC, MS, Regions and other stakeholders in the Ocean Energy sector

Objective 3: Investigate collaborative funding mechanism(s) between MS and Regions

2.2 Concept and methodology

2.2.1 Discovery phase – annual discovery process

The OceanSET project provides support during the Discovery Phase of the SET Plan IP, building a strong foundation for the development of the SET Plan IP during subsequent Development, Deployment, and Delivery phases. Focusing on wave and tidal technologies, 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 SET Plan 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 is 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 WPs

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 1 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.

Work Package	Leader
Ethics requirements	SEAI
Mapping & Analysis	SEAI
Finance	WES
Pre-Commercial Procurement Programme Development	WES
Monitoring & Review	DGEG
Communication & Dissemination	FEM
Management	SEAI

TABLE 1: Work Package name and Leaders

3.1 Ethics requirements

OVERVIEW

As a lead partner, SEAI 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) with the General Data Protection Regulation (GDPR) (Regulation (EU) 2016/679).

ACHIEVEMENTS TO DATE

All deliverables were submitted in the first year of the project.

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 is 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

The second Mapping and Analysis exercise has been completed and produced (D2.2).

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 are assessed annually for each technology action in the Implementation Plan.

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

Recommendations on funding mechanisms are made and actively promoted through monitoring and reviewing workshops and communication and dissemination stakeholder meetings.

The main aims of the finance work package are to:

- Establish financial requirements for Technical, Financial, Environmental and other actions
- Analyse funding gaps
- Assessment of the public/private divide of finances for each action, and
- Design an Insurance and Guarantee Fund

ACHIEVEMENTS TO DATE

The second Annual Funding Gap Analysis and Recommendation Report (Deliverable 3.4), assessing progress in 2019, has been completed and produced. The findings of this report suggest that the sector continued to be well supported in 2019. The investment committed to projects addressing Technical Actions active in 2019 is almost at, or exceeds, the level of investment envisaged in the Implementation Plan. The exception to this being low TRL activities in the tidal energy subsector. Further detail on this report is outlined in section 7.1.

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.

ACHIEVEMENTS TO DATE

All deliverables were submitted in the first year of the project.

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 activity. 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

A second knowledge-sharing workshop was organised online and the 'Report on Second Knowledge Sharing Workshop' (Deliverable 5.4) has been completed and produced. The Second Annual Monitoring and Review Report (Deliverable 5.5) has also been completed.

The second knowledge-sharing workshop was organised on the 03 December 2019 alongside the Ocean Energy Europe online conference. 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.

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 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

After the communication and dissemination strategy was set up, the project website oceanset.eu was created, deployed in June 2019 and regularly updated since then. During the second year of the project, the average number of visits per month was 176.

Three types of communication tools have been developed so far: leaflet, slideshows and press release. Information about the project was also disseminated through 41 posts on LinkedIn and Twitter using the tag '#OceanSET'. The newsletter layout was designed according to the graphic charter and the first issue was released at the beginning of January 2020 to 675 recipients.

3.7 Management

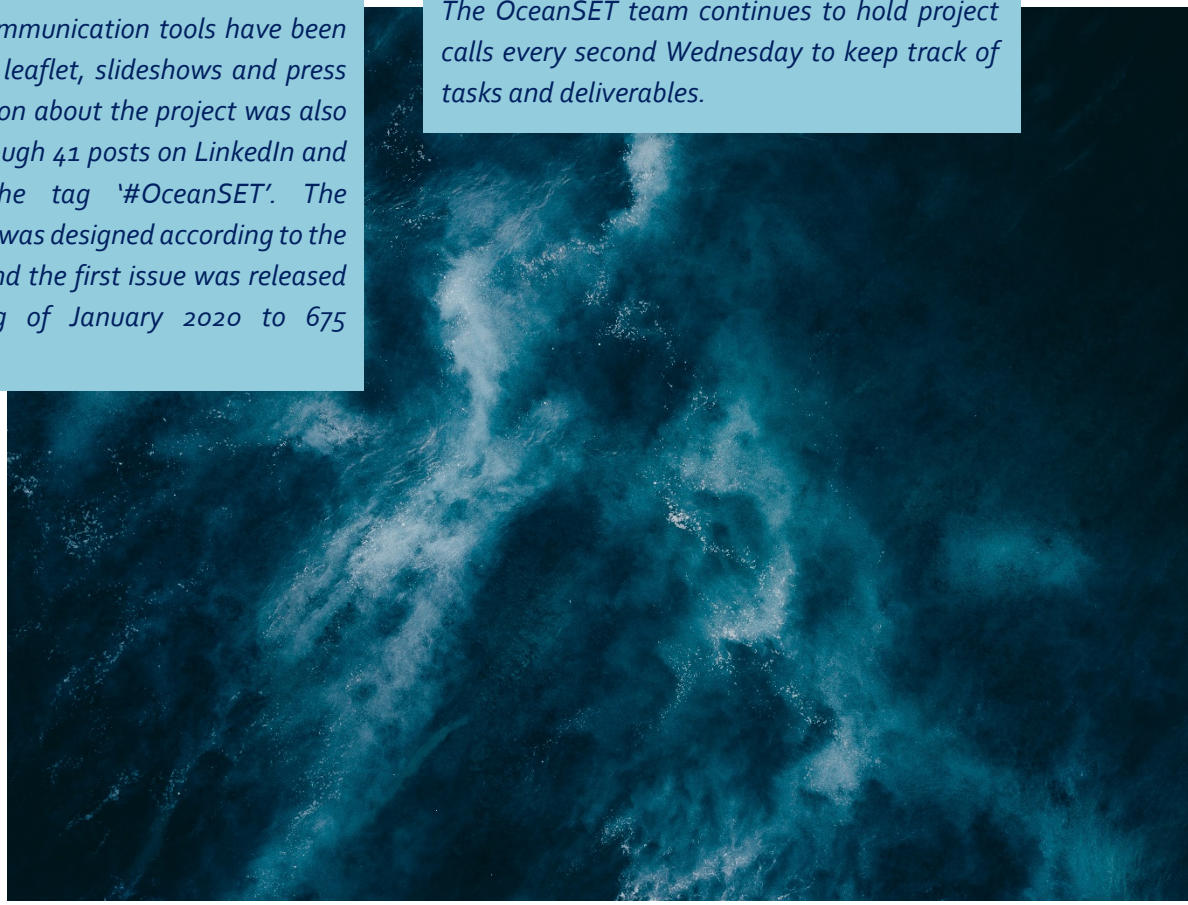
OVERVIEW

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

The management of the OceanSET project is an ongoing process. OceanSET will produce 38 deliverables over its 3-year period; 25 deliverables have been achieved to date. A Periodic Report covering the first half of the project has also been completed and produced.

The OceanSET team continues to hold 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 OceanSET Plan partook in a second survey, which gathered information on the 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:

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

The Member States survey consisted of 31 questions (See Appendix B) and was constructed to gather information from the Member States to feed into the annual report for the European Commission. The Developers survey, which consisted of 24 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 2019.

4.2 Metrics

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

Table 2 and Table 3 document the key metrics collected from Member States and developers in the second annual survey of the OceanSET project. The figures for Active TRL 7+ projects (table 3) are based on an analysis of whole-system projects only (see table 9).

[3] www.oceanset.eu

Policy/Deployment	2019
Number of MS with an OE policy	9
Number of MS with an assigned Ministry/Department owner at governmental level for OE	9
Number of MS with consistent environmental impact assessment for OE at Governmental level (outside test site)	8
Number of MS with consistent environmental impact assessment for OE at Governmental level (inside test site)	6
Number of MS with test site facilities	10
Estimated total budget for OE (wave, tidal) (€M)	42.7
Total amount spent on OE (€M)	44.8
Estimated average consenting time (years) - outside test site	2.7
Estimated average consenting time (years) - inside test site	1.3
Number of MS with a functional (self-sufficient or well complemented) supply chain for OE	7
Number of MS who funded TRL 7+ projects – wave and tidal	9

TABLE 2: Key Metrics Collected from Member States Survey

Active TRL 7+ (Stage 4-5) projects	2019
Number of projects – wave and tidal - whole system	11
Number of projects – wave - whole system	7
Number of projects – tidal – whole system	4
Number of projects addressing environmental impact assessment methodologies and tools	1
Number of projects addressing enforcement of stage progression standards through scale testing	4
Total installed capacity (MW) – wave	4.4
Total installed capacity (MW) – tidal	5.25
Average installed capacity per project (MW) – wave	0.73
Average installed capacity per project (MW) – tidal	1.31
Total average annual electricity production (MWh/year) – wave	1825
Total average annual electricity production (MWh/year) – tidal	13250

Average annual electricity production per installed capacity (MWh/MW) – wave	1468*
Average annual electricity production per installed capacity (MWh/MW) – tidal	2550*
Average annual availability (%) – wave	67*
Average annual availability (%) – tidal	67*
Average CAPEX (€/W/year) – wave and tidal	5.65
Average CAPEX (€/W) – wave	2.01*
Average CAPEX (€/W) – tidal	8.38*
Average OPEX (€/W/year) – wave and tidal	0.76
Average OPEX (€/W/year) – wave	0.32*
Average OPEX (€/W/year) – tidal	1.08*
Min. - max. technical lifetime (years) – wave	5 - 20
Min. - max. technical lifetime (years) – tidal	15 - 25
Average LCOE (€/MWh) – wave	207
Average LCOE (€/MWh) – tidal	375

* Metrics have been estimated because data was collected in terms of ranges. The methodology consisted in assigning a value by averaging the maximum and the minimum in the range; in the lowest range the average included its lower value, zero; in the highest range the minimum of the range was considered instead of an average.

TABLE 3: Key metrics collected from developers' survey

Regarding the technical performance figures in table 3 above, it should be noted that metrics are based on target data from projects in the 0.15 to 2 MW rated capacity range. Most respondents did not answer questions related to the actual achieved performance from a deployment. Some outliers in tidal data are skewing the average. Removing outliers, tidal average OPEX would be 0.28 instead of 1.08 and tidal average LCOE would be 200 instead of 375.

As there was a small number of responses available for 2019 there is considerably uncertainty in the averaged results. Since OceanSET started just last year, there are so far only two data points in key metrics. This is insufficient to identify tends in a reliable way. Information may be sought differently in the third and final survey next year, in order to gain more information and build a more accurate picture of the sector.

4.3 Overview of the survey

Fourteen Member States, identified by the implementation working group, received the survey – see Table 4.

Thirteen Member States responded. Of these, three Member States reported they had no activity in the sector in 2019 and therefore did not submit a response to the Member States survey. 127 ocean energy projects were identified as being supported in 2019:

- 74 wave projects;
- 24 tidal projects; and
- 29 projects categorised as 'Ocean/other'.

Of these 127 Ocean Energy projects, 25 unique projects were identified as being at TRL 7 or greater and were invited to complete the Developers survey (Section 2). 20 unique responses were received, corresponding to 11 projects from the 'Wave' and 8 projects from 'Tidal' sectors. One of the twenty projects was classified as 'Ocean/Other' and 'Support' and therefore not included in the analysis. Of the 19 eligible projects, it was possible to further categorise these into projects concerning the development of an ocean energy device ('whole-system') or the development of technology ('sub-system') with a main device being developed under a different project. Table 4 displays which Member States and regions responded and which had projects of TRL 7 or greater.

No.	Member State	Was a response for Survey received?	Has the Member State funded projects over TRL7 or above?
1	UK	Yes*	Yes
2	Germany	Yes	Yes
3	Italy	Yes	No
4	Spain	Yes	Yes
5	Portugal	Yes	Yes
6	Sweden	Yes	Yes
7	Ireland	Yes	Yes
8	Netherlands	Yes	Yes
9	France	Yes	Yes
10	Denmark	Yes	Yes
11	Cyprus	No activity to report	n/a
12	Finland	No activity to report	n/a
13	Norway	No activity to report	n/a
14	Belgium	No activity to report	n/a

**Three UK responses received, one from Cornwall, one from Scotland and one from Wales*

TABLE 4: Member State survey response rate

4.4 Ocean energy policy and funding opportunities in Member States

Table 5 below shows the responses provided by the Member States in relation to policy and funding opportunities available. The 2019 budget figures are to the nearest million euro.

Country	Responding organisation	Is there an Ocean Energy Policy?	Is there an assigned Ministry/ Department owner?	OE (wave/tidal) Budget in 2019	Amount actually spent on OE in 2019 *(excluding private funding)*
UK	Offshore Renewable Energy Catapult (Cornwall); Welsh European Funding Office; and Wave Energy Scotland	Yes	Yes	€22m	€23.3m
Germany	Fraunhofer IEE	Yes	Yes	€1m	*Not available per annum*
Italy	ENEA (Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile)	Yes	Yes	€2.54m	€2.54m
Spain	AEI (Agencia Estatal de Investigación) and CDTI (Centro par el Desarrollo Tecnológico Industrial).	Yes	Yes	€2.7m	€0.4m
Portugal	DGEG (Directorate General for Energy and Geology)	Yes	Yes	-	-
Sweden	Swedish Energy Agency	Yes	Yes	€4.7m	€4.7m
Ireland	SEAI (The Sustainable Energy Authority of Ireland)	Yes	Yes	€4m	€3.8m
Netherlands	Ministry of Economic Affairs and Climate, with input from RVO and DMEC	No	No	€0	€1m
France	ADEME (Ecological transition Agency)	Yes	Yes	€5.8m	unknown
Denmark	Danish Energy Agency/Ramboll	Yes	Yes	€0	€9m

TABLE 5: Ocean energy policy and funding opportunities in Member States

The survey showed that nine out of ten Member States have an ocean energy policy. This compares with six in the previous year's survey. All nine Member States also reported having an assigned Ministry or Department for Ocean Energy in 2019. The UK had the highest budget for Ocean Energy in 2019 with €22m allocated. France was next highest with a budget of €5.8m. Italy, Spain Sweden and Ireland had budgets of between €2m and €4.7m, while Germany had one of the lowest budgets with €1m allocated. Netherlands, Belgium, Denmark, Finland, Norway and Cyprus had no budget in 2019 for wave or tidal projects.

A per annum figure for Germany's amount actually spent on OE in 2019 (excluding private funding) was not available. For Portugal, there was not enough information to answer the questions on the budget or amount actually spent accurately for 2019, but this should not be interpreted as Portugal having a €0 budget.

Member States were requested to identify national and regional funding programmes that were open during 2019 to support ocean energy technology development and demonstration projects. Table 6 outlines funding programmes in each Member State, along with the TRL this fund was targeting.

MS	Funding Programmes	TRL targeted
UK	Ocean ERA-NET	3-6+
	Wave Energy Scotland Programmes	2-3 to 5-6
	Saltire Tidal Energy Challenge Fund	7-8
	West Wales and the Valleys ERDF Programme	5-6
Germany	7th Energy Research Programme of the federal Government/Applied Energy Research	All
Italy	Ricerca di Sistema Elettrico (RdS) - National programme - Ministry of Economic Development	5-6
	Cluster Blue Italian Growth - Ministero dell'Università e della Ricerca - National Programme	4
	Tecnonidi Programme - Regione Puglia - Regional Programme	5-6
	Ministero dell'Università e della Ricerca - National Programme	5-6
Spain	Retos Colaboracion 2019	3 to 6-7
	Retos Investigación	3 to 6-7
Portugal	Ocean Energy ERA-NET Cofund	3-6 to 4-8
	Blue Fund & Portugal Ventures	7-9
Sweden	Marine Energy Conversion programme	ca 3-7
	Pilot and demonstration programme	5-8
Ireland	OceanERANET Cofund	3+
	National RDD programme	All
Netherlands	NWO-regeling	1-3
	MOOI	4-6
	DEI+	5-8
	SDE+	6-9
	Waddenfonds (regional fund)	4-8
France	Call for projects "sustainable energy systems, cities and territories"	3-5
Denmark	EUDP	4-8
	Innovation Fund Denmark	1-8

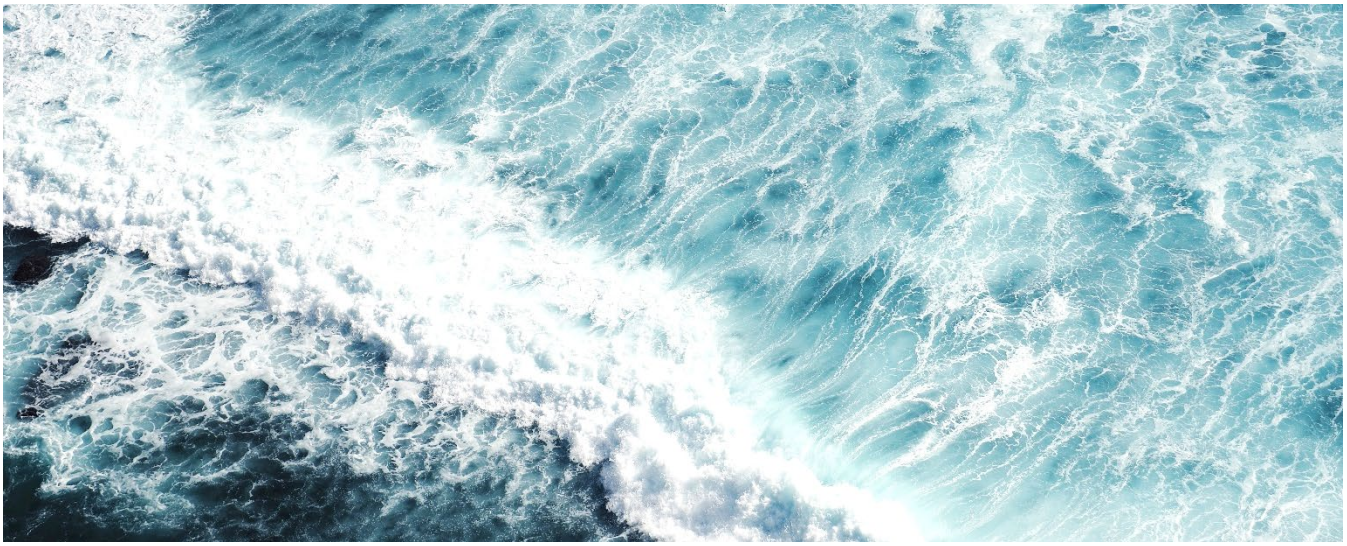
TABLE 6: Member States Funding Programmes in 2019 for OE Technology Development and Demonstration

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

Of the Member States participating in the Ocean Energy SET Plan, ten were funding projects in ocean energy in 2019 and eight had an annual budget to support ocean energy projects. Table 7 shows the annual pipeline of wave and tidal stream projects.

Country	TRL 1-6	TRL 7 +	Unknown	Total
Denmark	**7**	**3**	**1**	**11**
Wave	7	3	1	11
EU	**3**	**2**	**11**	**16**
Ocean/Other	1	1	8	10
Tidal		1	3	4
Wave	2			2
France	**2**	**1**		**3**
Tidal	1	1		2
Wave	1			1
Ireland	**6**	**3**	**2**	**11**
Ocean/Other	3		2	5
Tidal		2		2
Wave	3	1		4
Netherlands	**2**	**1**	**1**	**4**
Tidal	1	1	1	3
Wave	1			1
Portugal	**6**	**4**	**5**	**15**
Ocean/Other			4	4
Tidal	1	1		2
Wave	5	3	1	9
Spain	**6**	**1**		**7**
Ocean/Other	1			1
Tidal	1			1
Wave	4	1		5
Sweden		**3**	**19**	**22**
Ocean/Other			4	4
Tidal		1	3	4
Wave		2	12	14
UK	**19**	**6**	**4**	**29**
Ocean/Other		1	2	3
Tidal	1	3	1	5
Wave	18	2	1	21
Italy	**5**		**1**	**6**
Ocean/Other	2			2
Wave	3		1	4
Germany	**2**	**1**		**3**
Tidal		1		1
Wave	2			2
Grand Total	**58**	**25**	**44**	**127**

TABLE 7: Annual pipeline of wave and tidal projects



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

5.2 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 8.

Sector	SET Plan Action	Action Title	Number of projects by sector [a]	Number of projects by TRL [b]
Tidal	1.1	Tidal energy technology device development and knowledge building up to TRL6	24	5
	1.2	Tidal energy system (device and array) demonstrations and knowledge building in operational environment (TRL 7-9)		11
Wave	1.3	Wave energy technology device development, including system demonstration and knowledge building (up to TRL6)	74	46
	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).		12
Ocean	-	Up to TRL6	29	7
	-	TRL7 or greater		2

[a] From Survey 1 MS responses.
[b] The total number of projects by TRL doesn't equal the total by sector as the Survey 1 MS responses indicated the TRL as unknown for some projects.

TABLE 8: Number of Distinct ocean energy projects Reported as active during 2019

Of the 25 projects identified as TRL 7 or above, 11 were tidal, 12 were wave and 2 were ocean/other projects. The pie chart below (figure 1) shows that wave energy accounted for almost half of reported projects at TRL 7 or above that occurred during 2019. An assessment was carried out to determine if the 25 projects listed by Member States as having reached TRL 7 or above were within the parameters set in the survey. To be eligible to be considered in Action 1.2 or 1.4, the project needed to have achieved a TRL of 7 or above and taken place during 2019. The analysis was carried out by reviewing the responses received by ocean developers who responded to the Developers survey.

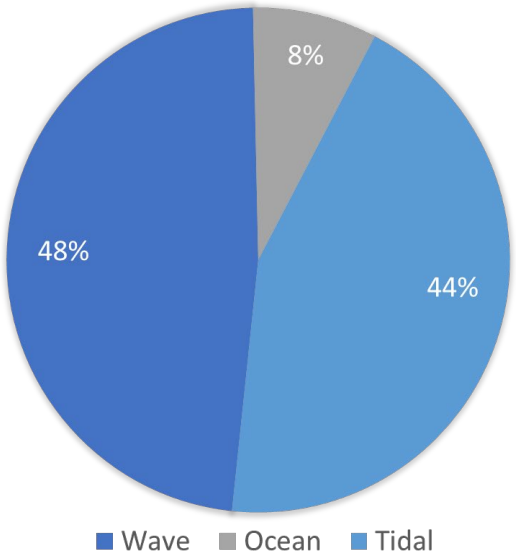


FIGURE 1: System Demonstration and Deployment TRL 7-9

For more detailed analysis of the projects surveyed, the wave and tidal projects were further categorised as set out in table 9:

Category	Description
Wave Whole-System	Project is focused on developing a technology in the wave energy subsector
Tidal Whole-System	Project is focused on developing a technology in the tidal energy subsector
Ocean/Other Whole-System	Project is focused on developing a technology in another ocean energy subsector (non-tidal, non-wave)
Wave Sub-System	Project is focused on developing a subsystem for wave technology/technologies
Tidal Sub-System	Project is focused on developing a subsystem for tidal technology/technologies
Ocean/Other Sub System	Project is focused on developing a subsystem for technology/technologies in more than one ocean energy subsector
Wave Support	Project is focused on developing support mechanisms for the wave energy subsector (technology & non-technology)
Tidal Support	Project is focused on developing support mechanisms for tidal energy subsector (technology & non-technology)
Ocean/Other Support	Project is focused on developing support mechanisms for the ocean energy sector generally or more than one ocean energy subsector

TABLE 9: Oceanset Review Categories

Of the 25 TRL 7 or greater projects identified, a total of 20 responses were received from developers, corresponding to 11 projects from 'Wave' and 8 projects from 'Tidal' sectors. It was possible to identify some projects as concerned with the development of an ocean energy device (whole-system) while others concerned the development of technology (sub-system) contributing to a main device being developed under a different project. Such analysis allowed secondary categorisation among 'whole-system' and 'sub-system' projects. One of the twenty projects was classified as 'Ocean/Other' and 'Support' and was therefore omitted. The split of TRL 7-9 projects collected in the Developer survey (survey Section 2) and considered in further analysis is presented in Table 10.

Wave	**Whole-system**	7
	Sub-system	4
Tidal	**Whole-system**	4
	Sub-system	4

TABLE 10: Number of TRL 7-9 Projects by Category from Developers Survey

Tidal stream projects reported in the Developers survey (survey Section 2) were either whole-system or sub-system at Stage 4 (TRL 7-8) of development. The whole-system projects involved devices in the 1 to 2 MW range. All whole-system and most sub-system projects involved horizontal axis turbine technology, while one sub-system involved vertical axis. Tidal-stream projects reported the installation of devices through technologies like floating taut and semi-taut moored or fixed gravity base. Excluding the taut-moored, this is the same range of device and installation technologies identified in last year's survey.

This year developers were asked if they would accommodate the transfer of technology. Tidal-stream developers (whole and sub-system) mentioned the following sectors in this regard:

- offshore renewable energy in general;
- wind energy;
- wind energy sector on pitch control;
- connectors/generators;
- tidal turbines; and
- composite manufacturing.

Whole-system wave projects identified in the Developers survey (survey Section 2) involve devices mainly in the 0.15 to 1.15 MW range and include several categories of technologies – attenuator, oscillating wave surge converter, point absorber and 'other'. All sub-system projects reported were related to point absorber technology. Among the installation technologies mentioned by the wave whole-system projects that responded to the survey were:

- floating devices,
- slack or taut moored,
- fixed through gravity base, or
- installed through 'other' technology.

Sub-system projects included slack, taut and semi-taut floating technologies as well as one categorised as 'other'. Both wave whole-system and sub-system projects responding to the survey are benefiting from technology transfers including from the oil and gas and marine (composite manufacturing) sectors.

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

In the Member States survey (Section 1), respondents were asked to identify if they had ocean energy test site facilities and how they would classify their ocean energy supply chain. All ten respondents reported having test site facilities in their country for ocean energy (prototypes). These include tank and open ocean test facilities in all Member States who responded. 80% of Member States facilitate tests up to TRL 7 and 50% up to TRL 9. A full list of the TRLs of Member States' test site facilities is outlined in figure 2.

Seven Member States consider their test infrastructure sufficient to support sector development while three (Denmark, France and Spain) consider it insufficient.

The Netherlands has 7 organisations providing a total of 24 test facilities. However, there is potentially a gap in testing in terms of more international cooperation, more offshore testing opportunities (multi-purpose wind parks), larger scale turbine testing (Zeeland) and more near shore device testing (The Hague & North Holland).

Of the three countries that do not believe there is sufficient test infrastructure in their member state to support the sector development, Denmark cited the need of test rigs for PTO, components tests and grid connection at sea test site for this view; France already has test sites for tidal and wave energy (Paimpol-Bréhat and SEM-REV respectively) but would welcome dedicated test site(s) for sub-system testing; Spain commented that the test infrastructure was sufficient at high TRLs (PLOCAN and BIMEP) and medium TRLs (CEHIPAR,CEDEX, IHC, etc.) but that more infrastructure for medium TRLs is needed (such as test sites in real conditions but protected), as well as for tidal, current, salinity gradient and thermal gradient technologies. For validation of devices in arrays, Spain also considered that test infrastructures would be needed.

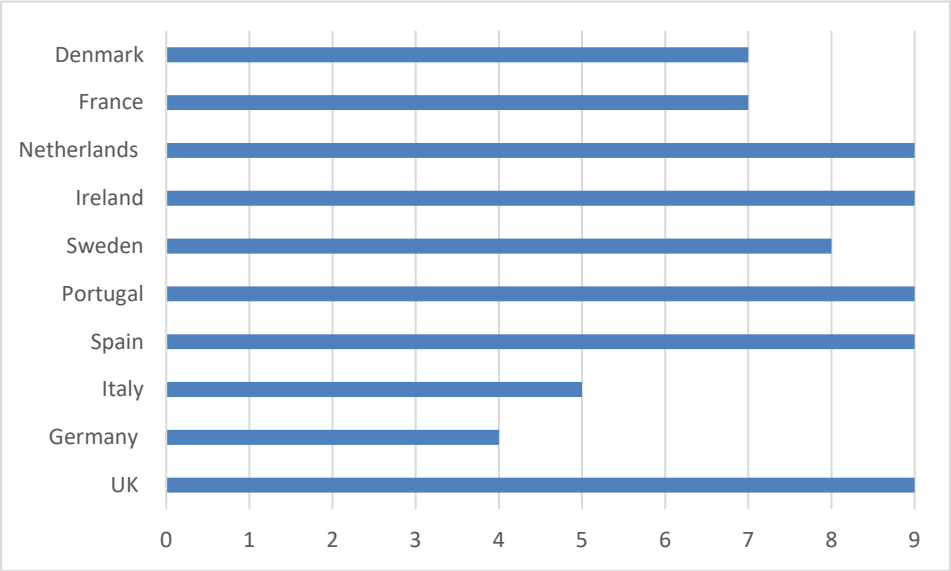


FIGURE 2: TRLs of Member States Test Site Facilities

Supply chain

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

- Dedicated/self-sufficient
- Part of a supply chain which is well complemented by suppliers from other sectors
- Part of a supply chain which is partially complemented by suppliers from other sectors
- Poor supply chain

Figure 3 below maps out the supply chain across Member States.

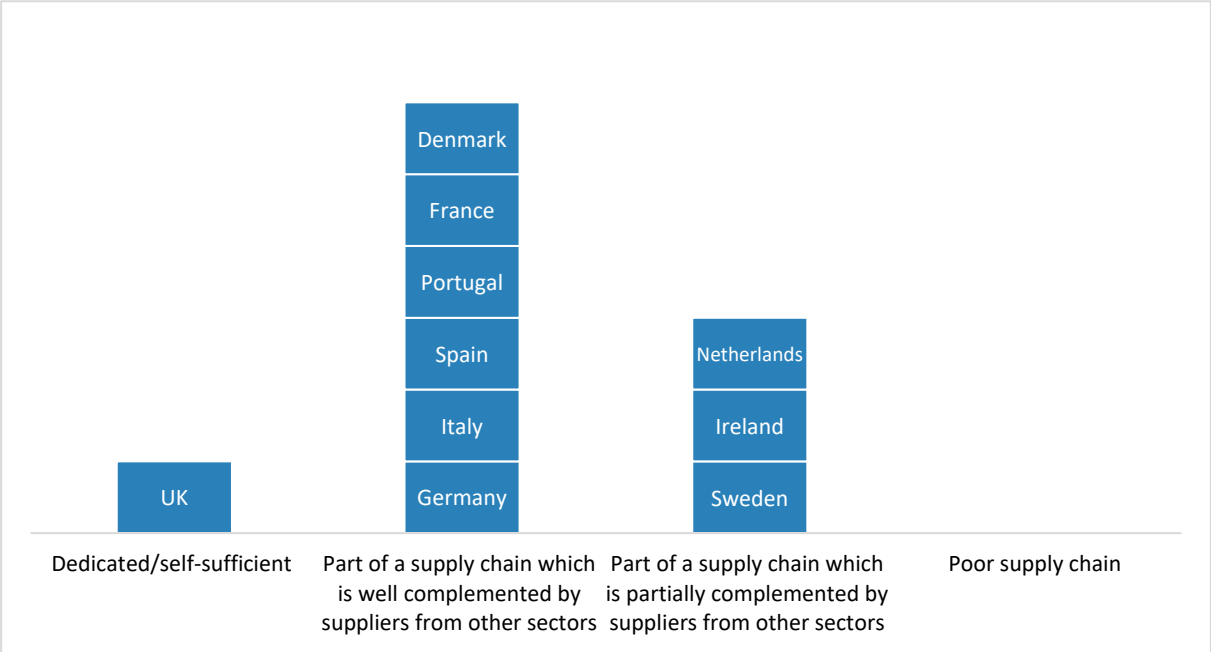


FIGURE 3: Classification of Member States' Ocean Energy (Wave, Tidal Stream) Supply Chains

Further information was sought to get a better understanding of the supply chain across Member States. There was some regional variation in the UK's response with Wales and Cornwall also classifying the ocean energy supply chain as part of a supply chain which is well complemented by suppliers from other sectors, but Scotland classifying it as a "dedicated/self-sufficient supply chain". The region of Cornwall further commented that while there has been some transition from oil and gas, more is needed more from the aerospace, automotive and defence sectors. France, too, commented that works associated with offshore operations probably need suppliers from other sectors.

With only 3 devices currently under development, Germany reported no particular supply chain challenges. Spain commented that while there is not a supply chain exclusively for ocean energy, the country does have positive actors in the marine wind sector, such as Navantia (jackets, mooring structures); Vicinay Marine (mooring, anchoring); Windar (wind tower); and Navacell (shipyard in the Basque country region).

The Netherlands commented that it has one of the highest densities of offshore know-how and capabilities in the world, including for example, installation vessels, Huisman, All Seas, Heerema, Bluewater, etc. They also have water management Research Infrastructure (Deltares, NIOZ, TNO), Consultancy (Arcadis, AnteaGroup etc) and Contractors (Van Oord, Boskalis, Ballast Nedam, Strukton etc). All of these supply chain companies are or have been involved in Marine Energy projects in the Netherlands and abroad.

For qualitative analyses of the sector in Member States, respondents were asked how they would classify existing port facilities and grid infrastructure to support the sector within the next ten years, as well as the ocean energy (wave, tidal) supply chain in their Member State. The responses are outlined in figures 4 and 5 below:

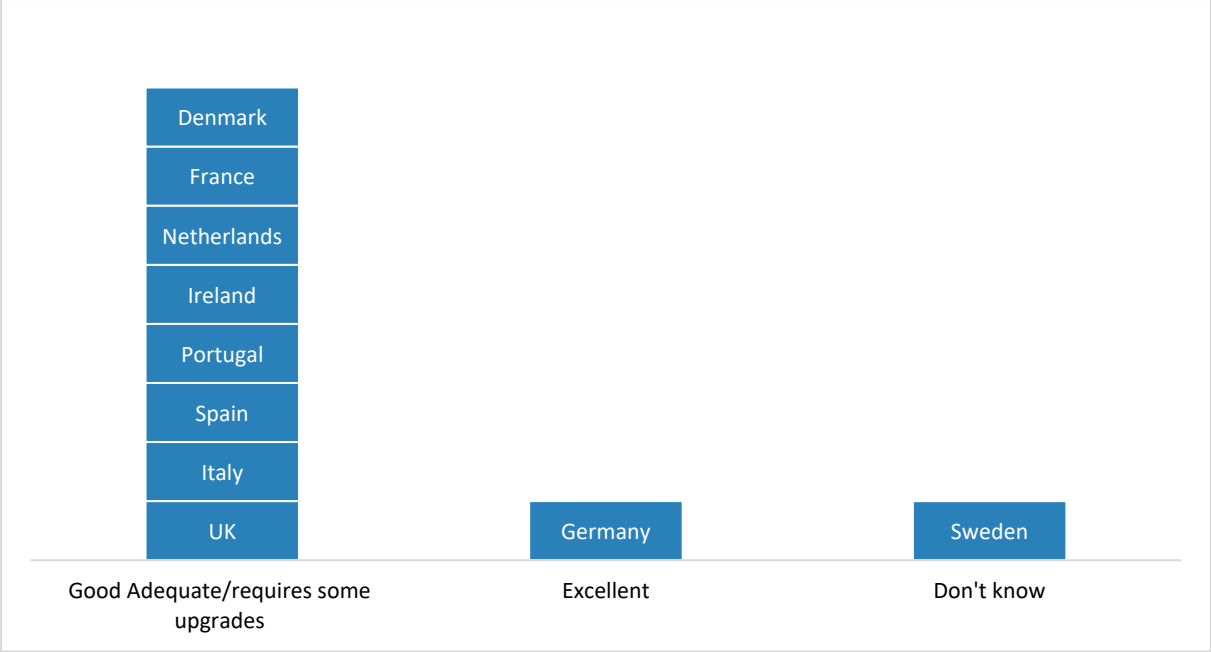


FIGURE 4: MS Classification of Port Facilities to support sector in next 10 years

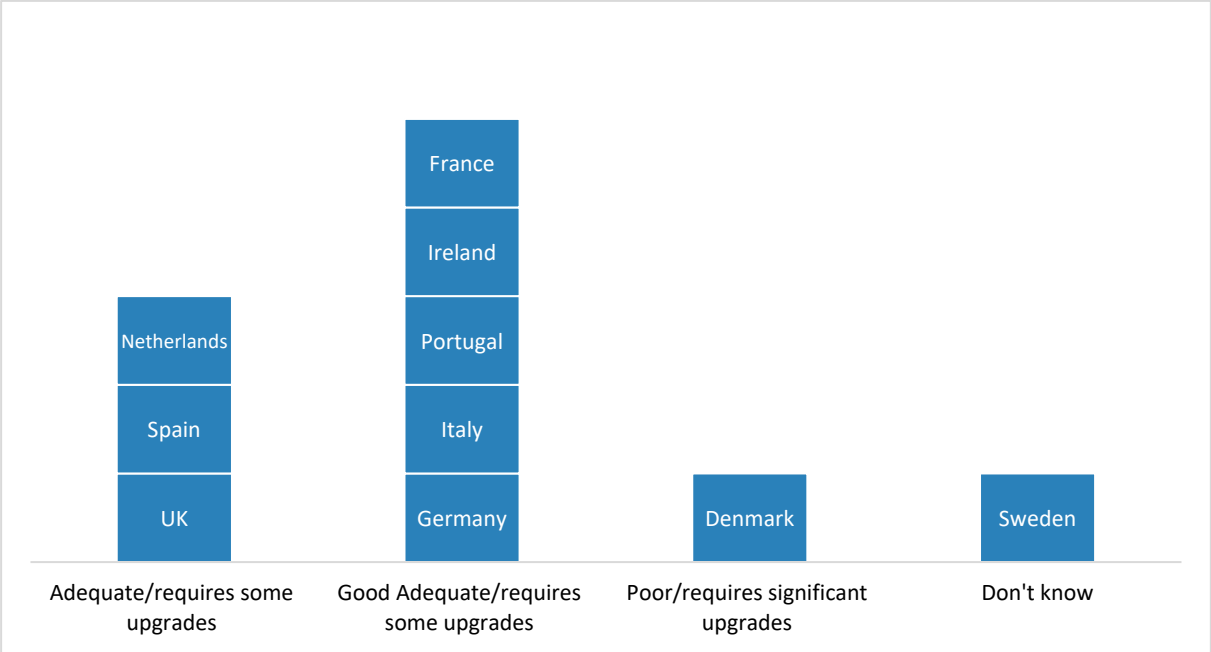


FIGURE 5: MS Classification of Grid Infrastructure to support sector in next 10 years

Member States were requested to identify any studies undertaken to review infrastructure and supply chain needs of the ocean energy sector (including grid, port, research, test facility, supply chain). The UK reported publications including Crown Estate Scotland's *Ports for offshore wind: A review of the net-zero opportunity for ports in Scotland*, and in Wales the *Wave & Tidal Cost Reduction Study 2018* and *Tidal Stream: Opportunities for Collaborative Action*. In Ireland, several reports have been published including *Harnessing our potential - Investment and jobs in Ireland's offshore wind industry*, the OPIN value chain study, and the Irish Maritime Development Office *IPORES 2018 Review of Irish Ports Offshore Renewable Energy Services*.

Sweden also mentioned several reports including *Havsbaserat testområde 2014* related to the Sotenäs and Islandsbergs test site; and a study on the Skagerrack test site. Oskarshamn municipality looked into the possibilities for a test site on the east coast for wave energy. Project ELBE and ELBE+ are reviewing the Swedish supply chain.

The Dutch Ministry of Infrastructure and Water Management, together with STOWA and RWS, commissioned a literary review on the ocean energy sector in the Netherlands which was published in 2019. The Ministry of Economic Affairs and Climate Agreement has also commissioned a roadmap looking into the potential of the ocean energy sector.

Italy reported on the newly created website *Cluster Tecnologico Nazionale "Blue Italian Growth* (CTN-BIG), and Portugal on a Resolution of the Council of Ministers, EI-ERO.

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

In order to collect information on Member States' knowledge of performance metrics in the ocean energy sector, respondents were asked if they were aware of the Task 12 framework - the IEA-OES's internationally supported framework for the evaluation of ocean energy technology performance. If they were aware of the Task 12 framework, respondents were asked if they felt it was suitable for adoption in their Member State's funding programmes.

Only one Member State, Portugal, was unaware of the Task 12 framework, although within the UK response the region of Cornwall and country of Wales also reported that they were unaware of the framework (figure 6).

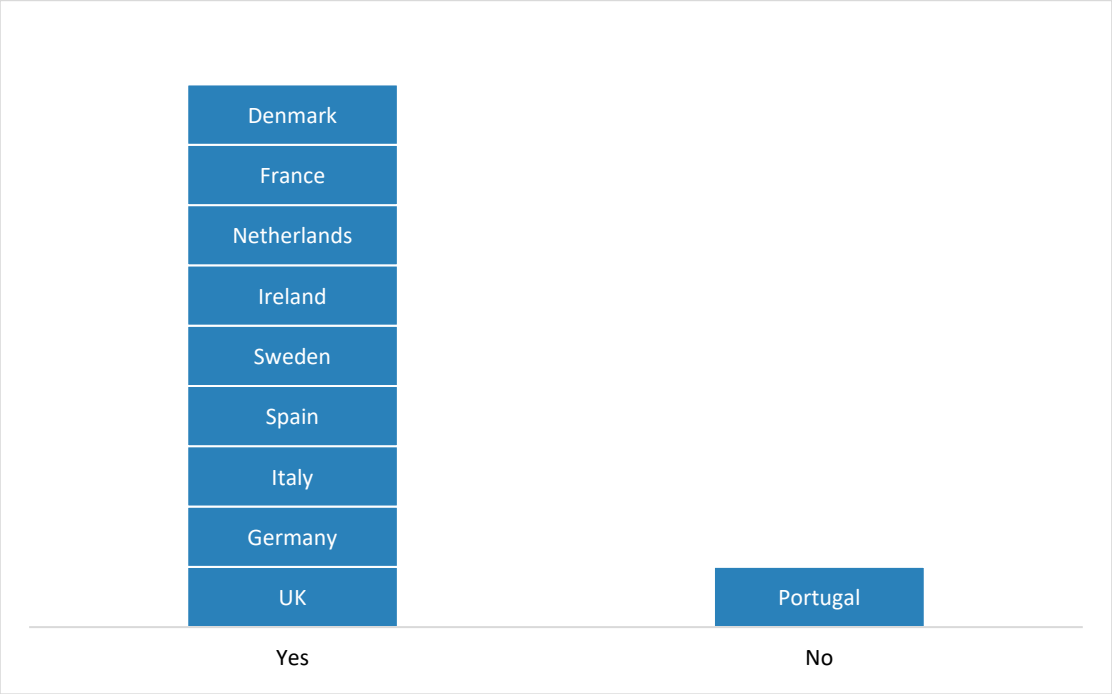


FIGURE 6: Member States Aware of Task 12 Framework (Yes/No)

Although awareness of the Task 12 framework across European Member States was high, there was less certainty about whether the framework was suitable for adoption in each state's funding programmes. As outlined below in figure 7 below the UK, Italy and Ireland considered the Task 12 framework is suitable. Most states felt they did not know enough to say. Within the UK response, the region of Cornwall and country of Wales felt they did not know enough to say. Just one country, Germany, responded that the Task 12 framework was not suitable for adoption in Germany's funding programmes.

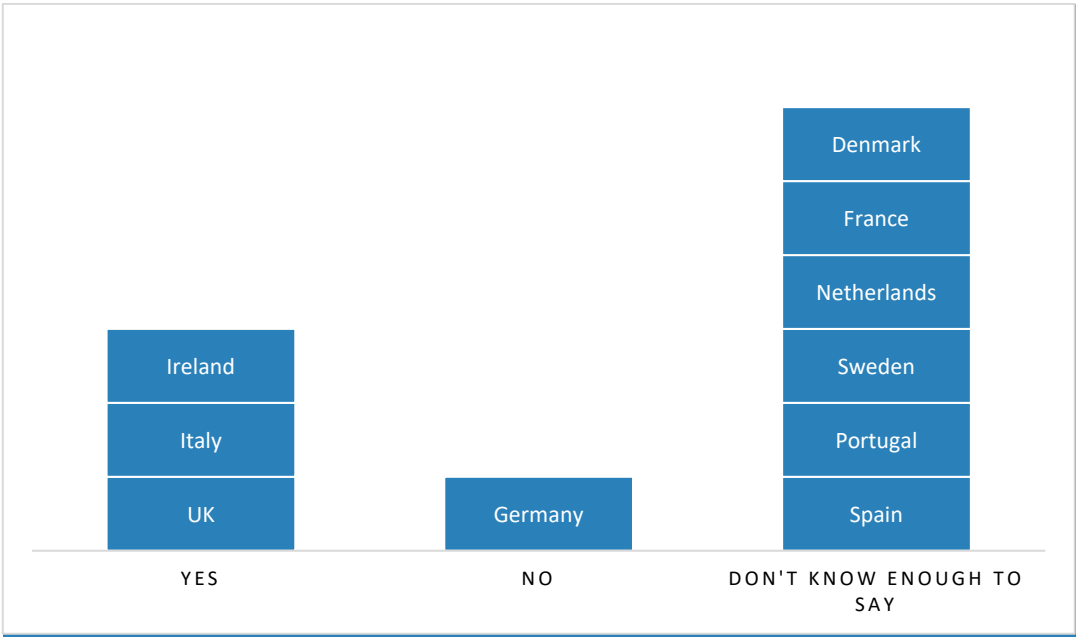
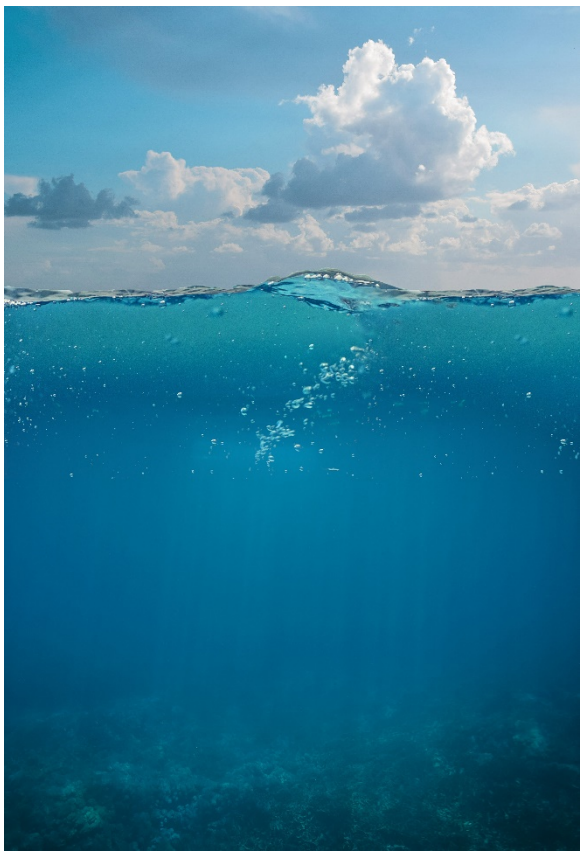


FIGURE 7: Suitability of Task 12 Framework for MS Funding Programmes

5.5 Financial Actions

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



Several Member States reported on the value of the revenue support tariff available to ocean energy technology. In states where wave and tidal technologies are treated differently, separate details were provided. Table 11 demonstrates the value available in the Member States who responded to this survey question, along with their comments.

No data was gathered directly on the creation of an investment fund for ocean energy farms. Further work is required to scope out a suitable and feasible mechanism for Member States to consider.

MS	Wave €/MWh	Tidal Stream €/MWh
UK	**45**	**45**
Germany	**12.4** (systems < 500 kW - similar to conventional hydro)	
Spain	Approx. **200** for MUTRIKU plant. (This is a specific case, applicable only to this demonstration project.)	
Sweden	**12** (annual average 2019)	**12** (annual average 2019)
Ireland	**0**	**0**
Netherlands	SDE+ (currently **130**). This is also the case for tidal energy.	Ocean Energy competes against other renewable technologies in the highest category of the SDE+ programme (0.11-0.13 cents/kWh)
France	Considered as not mature enough to receive a support tariff	case by case

TABLE 11: Value of the Revenue Support Tariff available to Ocean Energy Technology (€/MWh)

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

There was no update for Action 2.2 from the data collected from the Member States. However, there has been a significant work progressed by OceanSET in 2020, with a study commissioned to consider how a fund might be established in practice. The study will be completed in 2021 and will analyse possible options and make recommendations for establishing a viable and compliant framework.

5.5.3 Action 2.3. Pre-Commercial Procurement (PCP) action for development of wave energy technology.

In 2019, the Horizon 2020 Work programme included the call for the joint action "European Pre-Commercial Procurement Programme for Wave Energy Research & Development" [LC-SC3-JA-3-2019]. In response, a consortium of several national and regional authorities submitted a proposal. The proposal received provisional approval in November 2019. It is expected the programme will publish a request for tenders by early summer 2021.

The OceanSET project has been actively engaged in developing supporting materials for the EU Commission to underpin a European PCP and delivered the following outputs in 2019 and 2020.

- **Refined Technology Strategy** (D4.1, technical focus of a wave energy European PCP call, specifying e.g. the target technical areas and TRL levels.)

- **Agreed PCP operating mechanism** (D4.2, detailing the operating mechanism for the funding collaboration between partners.)
- **Call Documentation for PCP** (D4.3, providing a set of funding call documents for a Wave Energy Europe PCP.)

5.6 Environmental Actions

In order to ensure the progress of the ocean energy sector in line with the aspirations of the Strategic Roadmap and the work of ETIP Ocean, the SET-Plan establishes a mapping exercise, which includes, among others, the identification as to whether the Member State has specific local environmental actions. These include Actions 3.1 and 3.2 as outlined below.

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

To understand the current status of certification and safety standards for the sector, developers deploying projects were surveyed on their views regarding harmonization of environmental and safety standards, and harmonized European environmental monitoring strategy. As these questions were answered by individual developers, the responses have been anonymised and aggregated.

68% of developers responded that they did feel their project development would benefit from European-level harmonization of environmental standards with 32% saying it would not benefit their project development. In terms of safety standards, 63% of developers felt their project development would benefit from European-level harmonisation, 26% felt it would not and 11% did not know.

The majority of respondents, 83%, reported that environmental information had been made available to their project from regulators, stakeholders, researchers and/or other developers. 72% of developers surveyed said they would be willing to share environmental impact data collected in order to harmonize European environmental monitoring strategies.

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

Member States provided information on Action 3.2 by responding to questions focused on the consenting process including timeframes, permits required and activities in 2019. Technology testing was carried out both in test sites and outside of test sites in 2019, with half of the Member States having carried out trials in locations outside their testing sites.

The general average consenting period in 2019 was 2 years, a considerable decrease in comparison to 2018, in which consenting processes took an average of 4.25 years. The survey in 2018 requested

information on licensing and consenting and it was not clear if these were seen as two distinct elements by Member States and the reason for the almost doubling of time.

For the 2019 review, a differentiation was made between consenting time inside or outside test sites. Consenting times for deployment of technologies inside testing sites in 2019 tended to be one year or less for the majority of Member States, with the estimated average time of 1.3 years. The estimated average consenting time for trials outside test sites reached 2.7 years (figures 8 and 9).

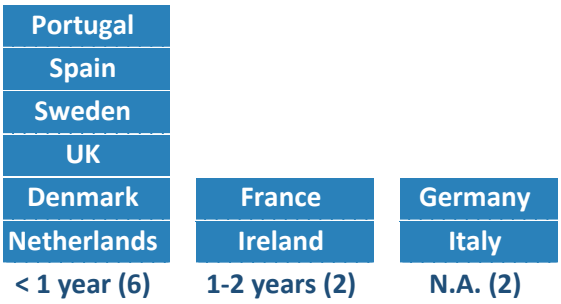


FIGURE 8: Consenting Process Times in an Existing Test Site

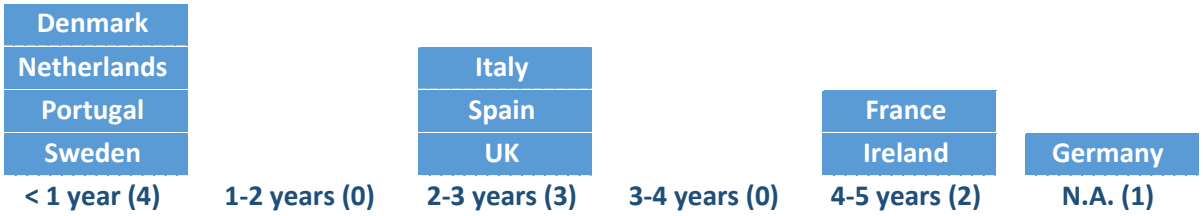


FIGURE 9: Consenting Process Times outside an Existing Test Site

An Environmental Impact Assessment (EIA) was identified as generally being required for deployments. Again, this year's survey differentiated between requirements inside and outside testing sites (figure 10).

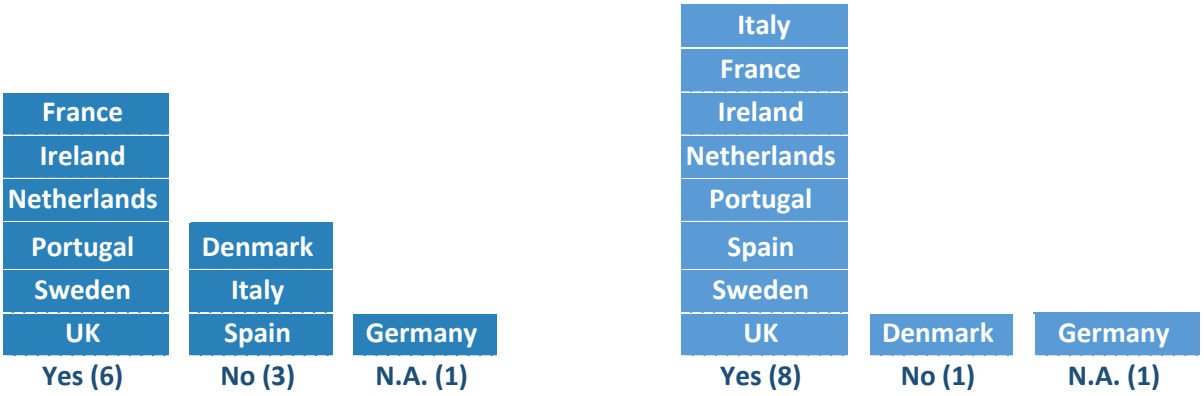


FIGURE 10: Requirement for EIA inside Test Sites (left) and outside Test Sites (right)

The data collected suggests that the legal and administrative processes for testing ocean energy technologies within Member States could have a detrimental impact on consenting times, specifically for trials outside existing test sites. An urgent need still remains to reduce the permits and consenting times in order to favour and develop a competitive ocean energy industry in Europe.

6. OceanSET progress

To enable the IWG to understand the current status of Ocean Energy support activities in Member States and Regions, the SET Plan IP 11 Technology Development Actions are outlined below by using a traffic light system to identify the progress OceanSET has made during the first year of the discovery phase. Please note, this is a review of the progress OceanSET have made in mapping the Ocean Energy sector against these 11 actions, not of the fulfilment of these actions.

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

Technical Actions		Progress Year 2
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 (PCP) 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	

7. 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.

7.1 Implementation plan – targets

The implementation plan sets out the challenges for wave and tidal technologies. 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. These timescales are not specific to technology development, but for the overall development of a new industrial sector including large scale manufacturing and deployment supply chains which will enable the economies of scale required to meet the commercialisation targets.

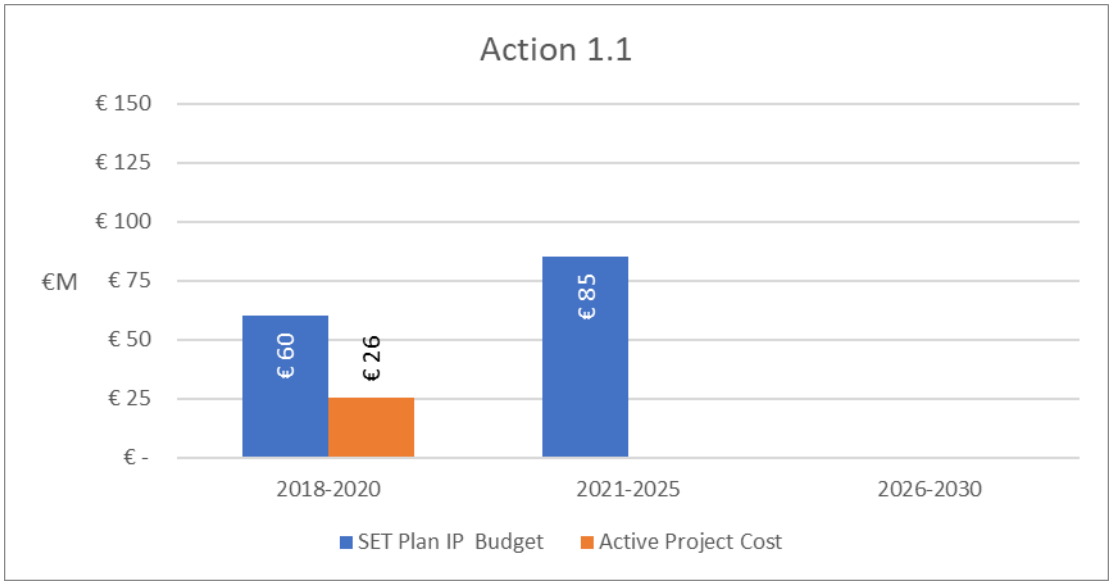
The technical actions identified by the plan for the period to 2030 are shown in table 12 below:

		Proposed IP Funding		
Action Title	**Details**	**Period**	**Total**	**Discovery Phase (2018-2020)**
1.1: Tidal Energy technology device development and knowledge building up to TRL6	Novel systems / sub components tidal technologies	18-25	€145M	€60M
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 10MW arrays	19-22 20-25	€395M	€120M
1.3: Wave energy - technology device development, including system demonstration and knowledge building (up to TRL6)	Novel sub systems / concepts wave technologies TRL4-6	18-30	€222.5M	€60M
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	18-25 25-30	€335M	€60M
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	18-30	€100M	~€10M
1.6: Development of stage gate metrics (technical standards and guidelines) for wave technology evaluation.	Definition and implementation of EU-wide agreed stage-gate metrics for wave energy	18-19	€6.5M	~€1.5M
Total			€1204M	€311.5M

TABLE 12: Summary of Technical Actions in the Ocean Energy IP

The focus of Technical Actions 1.1 and 1.2 is low and high TRL tidal energy technology respectively, corresponding to projects summarised in figure 11 (a) and (b). It appears that progress in the Technical Action 1.2 (high TRL projects) is on, or arguably ahead, of schedule (figure 11 (b)); the investment committed to projects active in the second year of the period is more than 90% of the estimated budget for the period. However, activity associated with Technical Action 1.1 (low TRL projects) appears to be lower than anticipated; the investment in projects being a little under half of the estimated budget.

(a)



(b)

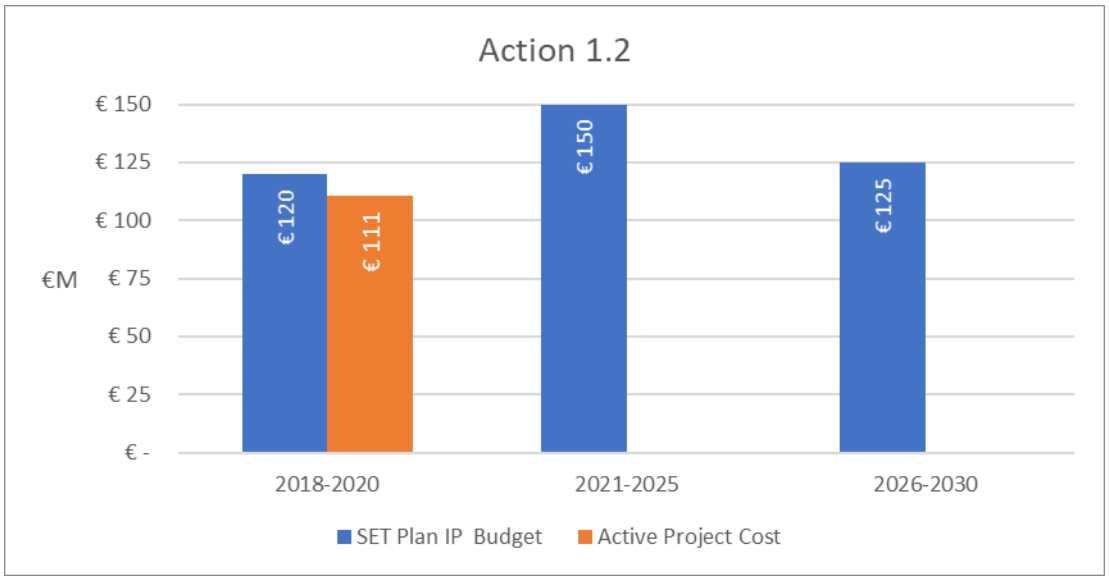
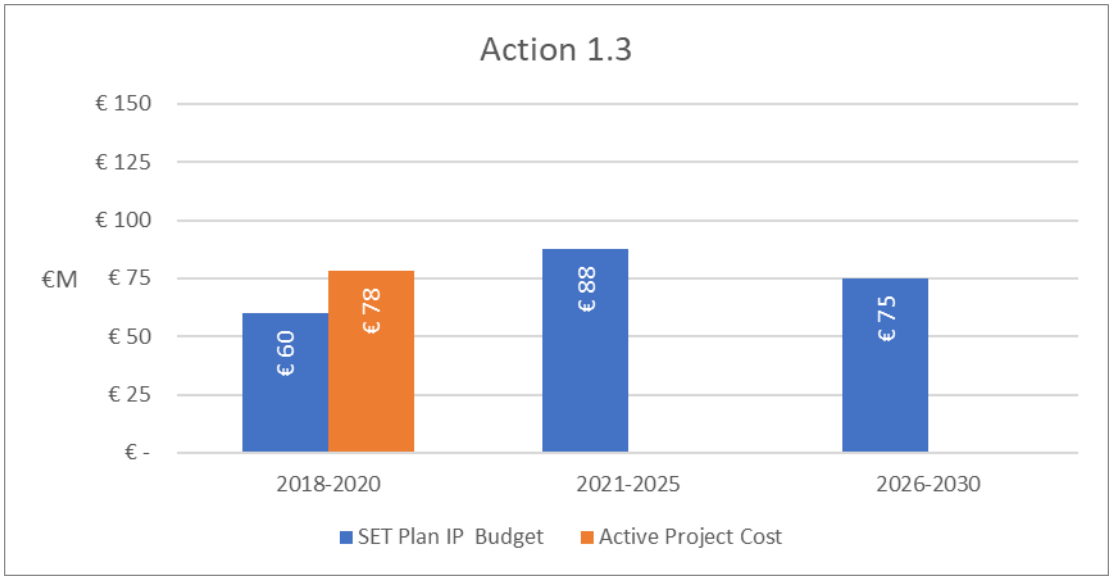


FIGURE 11: Comparison of the SET Plan OE IP's estimated period budgets with project costs for tidal energy technology projects active in the year 2019 with a target FINAL TRL of: (a) TRL 6 or lower [Technical Action 1.1]; (b) TRL 7 or greater [Technical Action 1.2].

Similarly, the focus of Technical Actions 1.3 and 1.4 is low and high TRL wave energy technology respectively, as summarised in figure 12 (a) and (b) respectively. It appears that investment in wave energy technology projects has exceeded that anticipated for the first period of the IP.

(a)



(b)

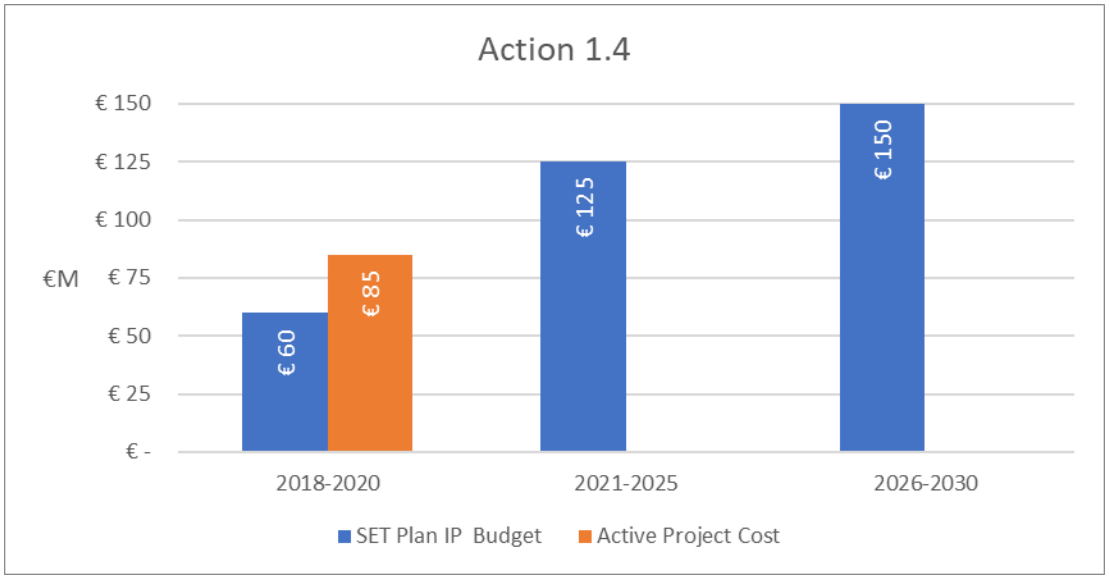


FIGURE 12: Comparison of the SET Plan OE IP's estimated period budgets with project costs for wave energy technology projects active in the year 2019 with a target final TRL of: (a) TRL 6 or lower [Technical Action 1.3]; (b) TRL 7 or greater [Technical Action 1.4].

7.2 Funding and capacity gaps

Any assessment of the progress of development in the ocean energy sector – compared with the expectations of the SET Plan Ocean Energy IP – 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 SET Plan Ocean Energy IP.

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

Considering the project cost metric, the activity in this action is lower than was anticipated for this stage, even allowing for the absence of project cost information for one "sub-system" project.

There appears to be a lack of breadth in low TRL R&D activities. Only four low TRL "system" projects were reported as being active in 2019 of which a single "whole-system" project accounts for 81% of combined investment.

The projects in the low TRL category are targeting the achievement of development stage 3 (TRL 5 or 6) by its conclusion, i.e. at the upper limit of the low TRL category. It is conceivable that follow-on projects would target achieving higher TRL categories, presuming successful outcomes in the current project.

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

The IP expects demonstration of full-scale tidal energy devices to begin in 2019 and demonstration at array level in 2020. The survey reveals 11 high TRL projects were active in 2019 with a reported investment of just under €111M.

Five of these projects were classified as 'whole-system' projects. Another project classified as a 'support' project is known to be supporting the deployment of a number of 'whole-systems', and, some projects classified as 'sub-system' projects are known to be integral elements of larger 'whole-system' projects. This insight suggests that an investment of some €106M is targeting activities which are directly relevant to expectations of this Action.

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

Activity in the low TRL category predominates in the wave energy subsector. Low TRL activity outnumbers high TRL activity by almost 4-to-1 by distinct project count, with 46 distinct projects reported.

A technology focus predominates over supporting activities, with a slight bias towards 'whole-systems' over 'sub-systems'. It is noteworthy that most projects in the low TRL category report the project to be targeting achieving development stage 3 (TRL 5 or 6) by

its conclusion, i.e. at the upper limit of the category. The reported investment in low TRL projects exceeds that anticipated in the first phase of the IP. The 24 distinct 'whole-system' projects represent an investment of a little under €61M with a further investment of over €16M in 18 distinct 'sub-system' projects.

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

Twelve distinct high TRL projects were identified as active in 2019 with a reported investment of some €85M. Again, this exceeds the investment anticipated in the first phase of the IP.

All projects had a technology focus. The seven distinct 'whole-system' projects involved the development or deployment of six separate device concepts with nominal rated capacities ranging from single kWs through a few hundred kWs to single MWs.

At least one 'sub-system' project was directly associated with one of the 'whole-system' projects.

The SET Plan IP did not quantify the scale and number of devices required in this action, but there clearly needs to be sufficient technology to feed into the next phase of the IP, which anticipates the development of four wave energy arrays in the period 2020 to 2025. It is arguably that the number of concepts currently active in the high TRL category is still insufficient to achieve this given the historical failure rate of wave energy technology.

The prospect of successful outcomes for the device concepts noted as approaching the upper limit of the low TRL category under Action 1.3 is encouraging, however, further investment should be made available to continue to progress the development of these low TRL device concepts.

Action 1.5 Installation, logistics and infrastructure

With a pan-European perspective, the provision of test infrastructure was generally considered adequate although several shortcomings were reported particularly for testing mid-TRL technology and sub-systems (both laboratory and open-water testing).

Some Member States and regions expressed a desire for establishing local test facilities that would appear to replicate an existing provision in another Member State or region. An alternative approach to addressing this desire may be to improve and enhance support for cross-border access to test facilities.

Member States reported a generally positive view concerning the availability of suitable port facilities for supporting the ocean energy sector over the period of the IP, although some upgrades were envisaged. A less positive view was expressed concerning the electricity grid with some Member States noting the need for significant upgrades.

Member States generally consider the supply chain for the ocean energy sector to be provided by operators from other sectors (to a greater or lesser extent) and that the participation of additional operators and sectors would be required. Only one region, one hosting an open-water test site, considered there to be a dedicated supply chain.

It appears that some Member States are actively considering the supply chain requirements to support installation and logistics in the ocean energy sector, albeit often as a corollary to consideration of the offshore wind sector's requirements, to which the ocean energy sector's requirements are professed to be similar.

Further work is required in every Member State to develop an appropriate understanding of the current supply chain provision, the requirement of the ocean energy sector, and the actions necessary to close the gaps which may exist.

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 to deliver EU-wide, and indeed global, consensus on technology evaluation through two connected routes:

- IEA-OES Task 12 – an international activity working under the auspices of the International Energy Agency Ocean Energy Systems group to deliver an internationally agreed technology evaluation framework for ocean energy.
- DTOceanPlus – a Horizon 2020 funded project which will deliver an open-source suite of software design tools which will accelerate the development and deployment of the ocean energy sector. One part of the suite of tools is the Stage Gate design tool which will define a set of stages, metrics and engineering activities for subsystems, 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.

Both activities cover wave and tidal stream energy and are building on experience of Wave Energy Scotland, the US Department of Energy and a series of Ocean ERA-NET, EERA and SEAI supported workshops.

The ambition for these activities is that future wave energy innovation programmes will embrace them to ensure a consistent approach for evaluating a set of agreed metrics using data derived from recommended engineering activities.

While Member States generally expressed an awareness of the development of the IEA-OES Framework, most were not familiar with its content and were uncertain about adopting it to support national funding programmes. This is not too surprising as the IEA-OES Framework was published after completion of the Member States survey. The responses of several Regions revealed a disconnect with the understanding within a Member State.

Although progress is in line with the expectation of the IP, the next step is to communicate the content of Framework effectively at both Member State and regional levels to encourage its uptake.

8. Communication and exploitation of results

Culminating with the publication of the annual reports, dissemination and communication activities are a core part of the OceanSET project. They aim to promote project outputs and provide easily accessible information to key players in the European ocean energy field and beyond. The effectiveness of the communication and dissemination actions has been evaluated for each month using indicators defined at the beginning of the project. Every month a report on these indicators is sent to the project partners. This allows a careful monitoring of the actions and corrective actions to be taken, if necessary.

Dissemination and communication objectives have been globally achieved during this second year of the project. The website is increasingly visited with an average of 176 monthly visits and 7 different public deliverables were downloaded every month. Posts on social networks showed a satisfactory rate of community engagement with 78 interactions generated per month. The objectives and first results of the project have been widely reported in 9 specialised, online magazines as well as in 3 newspapers.

The bi-annual newsletters that punctuate the progress of the project have been relayed by the consortium partners reaching more than 2,500 stakeholders in the ocean energy sector. E-workshops organised during this second year were a clear success, both in terms of the number of participants (153 for the dissemination workshop and 130 for the knowledge sharing workshop) and interest shown by the audience in the results of the mapping and analysis activities.

9. Review and Lessons Learned

Although slightly more data was available for analysis for 2019, challenges remain in attempting to gather information from various states. Research can differ by timelines and prioritisation in each Member States making it difficult to carry out a like-with-like analysis of the ocean energy sector across Europe. Good momentum is building with the project gathering data and it would be great to understand how this can be ensured long-term by identifying appropriate resources to manage this. As a result of lessons learned from the last data gathering exercise, more clarity has been sought on the TRL 1-6 projects and a good data set of projects has been gathered from the Member States. The respondents seemed to prefer providing the data in the spread sheet rather than in the survey- so this will be used for future data gathering. The main challenge with the data gathered is that total project budgets were submitted, which reflected multi-annual budgets and spend. It was difficult to compare spend per year against the projects, so more attention will be paid to this in future and further clarity and breakdown will be requested.

More data was gathered in this second survey from EU projects. Of the 127 projects identified, 16 were European funded projects with an overall budget of €115M and a grant aid of €83M. Most of these projects (13) primarily supported the industry via access to test site infrastructure and or supply chain development, only 2 of the EU projects were related to direct development of dedicated technology. It is also important to note that the information was not taken directly from the funders (i.e., Interreg, H2020, etc.) so it is unclear if this is a full inventory of relevant active EU funded projects in 2019. Efforts should be made in future data gathering exercises to get more comprehensive data sets on such projects.

Of the 111 Member State funded projects a number were ERANETs- in total 11 ERANET projects were identified for 2019 with 26 different partners. The projects had a value of €10.1M with €6.2M grant aid. The occurrence of EU and ERANET projects in the data points to a capacity to collaborate on projects across the sector and further efforts should be made to build on this.

Overall funding of technical activity against the actions of the SET Plan Ocean Energy IP suggests that the sector continued to be well supported in 2019. The investment committed to project addressing Technical Actions active in 2019 is almost at, or exceeds, the level of investment envisaged in the IP. The exception to this being low TRL activities in the tidal energy subsector.

An increase in the number of active projects was observed in all subsectors. This may be explained, in part at least, by an apparent greater diligence of the Member States in identifying projects.

In the tidal energy subsector, several concepts are in active development. Five concepts are reported in the high TRL project category. The two concepts reported in the low TRL project category are aspiring to achieve development stage 3 (TRL 5 or 6) by the conclusion of the

project and are likely to be ready to progress to the high TRL category in the follow-on project.

In the wave energy subsector, projects are generally technology focused with a slight bias towards 'whole-system' over 'sub-system'. Although low TRL projects outnumber high TRL projects, the high TRL projects are developing or deploying six separate device concepts. Once again, most low TRL projects are aspiring to achieve development stage 3 by the conclusion of the project.

The recent publication of the IEA-OES Framework for the evaluation of ocean energy technology maintains progress in the realisation and adoption of an EU-wide standard. Dissemination activities must now be put in place to promote the framework and educate relevant bodies at Member States and Regional levels as to its purpose and usefulness.

Appendix A: OceanSET WP's 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	Complete
	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	Complete
	Deliverable 3.3	SEAI	Design of Insurance and Guarantee Fund	15/01/2021	
	Deliverable 3.4	WES	2nd Annual funding gap analysis and recommendations	15/02/2021	Complete
	Deliverable 3.5	WES	3rd Annual funding gap analysis and recommendations report	15/02/2022	
	Deliverable 3.6	WES	Public/private financing ratio for each action, or bundle of actions, in the SET Plan IP	15/02/2022	
WP4	Deliverable 4.1	WES	Refined Technology Strategy	15/09/2019	Complete
	Deliverable 4.2	WES	Agreed PCP operating mechanism	15/10/2019	Complete
	Deliverable 4.3	WES	Call Documentation for PCP	15/07/2020	Complete

WP5	Deliverable 5.1	DGEG	Metrics for OE 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	Complete
	Deliverable 5.5	DGEG	2nd Annual Monitoring and Review Report	15/02/2021	Complete
	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 PEDR. These updates will be fed into the periodic and final reports to the EC.	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	Complete

	Deliverable 6.7	FEM	2nd Annual report on Dissemination and Communication	15/02/2021	Complete
	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 handbook	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	Complete
	Deliverable 7.5	SEAI	3rd OceanSET Annual Report	15/03/2022	

Appendix B: Member States Survey – Questions

OceanSET sent a survey to all SET Plan Member States.

Question Number (* denotes mandatory questions)	Question text	Format
General information		
1*	Please select the Member State you are answering for	Drop down menu
2	If you are only answering for a region in your member state please let us know what region	Open-Ended Response
3*	What is the name of the organisation answering this survey?	Open-Ended Response
National/ Regional Policy		
4*	Does your Member State have current policies which support the development and deployment of ocean energy technology?	Tick box answer: • Yes, we have a dedicated ocean energy policy • Yes, we have a general renewable policy that includes ocean energy • No • If yes, please identify the policy or policies which provide such support (policy name and URL).
5*	Is there an assigned Ministry/Department owner at Government Level?	Yes/No
Financial information		
6*	What was your budget for ocean energy (wave, tidal) in 2019?	Slider: €0 to €10m

	Please see in the note above in summary of metrics that clarifies what to include in this answer.	
7	If you know the exact budget for 2019, please let us know (€m)	Open-Ended Response
8*	What amount of public funding was actually spent on ocean energy (wave, tidal) in your country in 2019? (€m) *Please exclude any private funding. This will help us understand the gap between your budget in 2019 and what was spent in 2019 for our gap analysis.*	Open-Ended Response
9	Identify national\regional funding programmes that were open during 2019 to support ocean energy technology development and demonstration projects (consider both programmes that exclusively targeted ocean energy technology and general technology programmes).	Open-Ended Responses: • Name of fund programme(s) • what TRL was this fund targeting? • URL
Technical information		
10*	How many ocean energy projects were being funded in 2019? *(projects that were live in 2019, even if they started before 2019)* *Please note this should match the information provided in the excel spreadsheet that was also sent to you with this survey.*	Drop down menus: • Wave - TRL 1 - 6 • Wave - TRL 7 or above • Tidal - TRL 1 - 6 • Tidal - TRL 7 or above • Other - TRL 1 - 6 • Other - TRL 7 or above If you would like to make any notes or clarification, please write them here
11*	Please provide the amount you paid to these projects funded in *2019 (only what was paid by the MS for these projects in 2019 . Not the total project funds awarded.)* *Please note this should match the information provided in the excel spreadsheet that was also sent to you with this survey.*	Drop down menus: • Wave - TRL 1 - 6 • Wave - TRL 7 or above • Tidal - TRL 1 - 6 • Tidal - TRL 7 or above • Other - TRL 1 - 6 • Other - TRL 7 or above If you would like to make any notes or clarification, please write them here

12*	Please provide name(s) of the project and company that achieved TRL7 or above. *Like last year, a survey will be sent to these developers in your MS to gather detailed information on these projects which the developers will answer.* *Please note this should match the information provided in the excel spreadsheet that was also sent to you with this survey*	Open-Ended Response
13*	Which of the following best describes the revenue support mechanisms available to ocean energy technology in 2019 in your country?	Tick box answers: • Ocean energy technology has an exclusive revenue support mechanism. • Ocean energy technology competes against other emerging renewable technologies. • Ocean energy technology competes against all other renewable technologies. • Ocean energy technology competes against all technologies. • Ocean energy does not have revenue support
14	What is the value of the revenue support tariff available to ocean energy technology (€/MWh)? If wave and tidal technologies are treated differently provide separate details.	Open-Ended Response: • Wave €/MWh: • Tidal Stream €/MWh:
15*	The IEA-OES's Task 12 is an internationally supported framework for the evaluation of ocean energy technology performance. Are you aware of the Task 12 framework?	Yes/No
16	In your opinion, is the Task 12 framework suitable for adoption in your MS funding programmes?	Yes/No/I don't know enough about it to say
17*	Are there test site facilities in your country for ocean energy (prototypes)?	Yes/No
18*	Please tick the type(s) of testing infrastructure in your member state. *Multiple answers can be chosen*	Tick box answer: • Tank • Open Ocean Test facility • None

19	Please indicate up to which TRL these test sites facilitate	Slider from 'TRL 1' to 'TRL 9'
20*	Do you believe there is sufficient test infrastructure in your member state to support the sector development	Yes/No If you have answered no above- please indicate where you believe the gaps are
21*	How would you classify the port facilities in place to support the sector within the next 10 years	Tick box answer: • Excellent • Good Adequate/requires some upgrades • Adequate/requires some upgrades • Poor/requires significant upgrades • I don't know
22*	How would you classify grid infrastructure in place to support the sector within the next 10 years	Tick box answer: • Excellent • Good Adequate/requires some upgrades • Adequate/requires some upgrades • Poor/requires significant upgrades • I don't know
23*	How would you classify the ocean energy (wave, tidal) supply chain in your Member State (please, tick the most appropriate)?	Tick box answer: • Dedicated/self-sufficient supply chain • Part of a supply chain which is well complemented by suppliers from other sectors • Part of a supply chain which is partially complemented by suppliers from other sectors • Poor supply chain If you would like to make a comment or clarify anything, please write it here
24	Please identify any studies your MS has done to review infrastructure and supply chain needs of the OE sector (including grid/port/research/ test facility/supply chain)	Open-Ended Response
Environmental information		
25	How long does the consenting process take when deployment is in an existing test site?	Slider from 'less than six months' to 'more than five years'
26	For consenting in a test site, please indicate which permits are required? multiple answer can be selected	Tick box answers: • EIA • Appropriate Assessment

		• Grid connection agreement Other (please specify)
27*	Was any consented deployments permitted outside of test sites in 2019?	Yes/No
28	How long does the consenting process take when deployment is outside of a test site?	Slider from 'less than six months' to 'more than five years'
29	For consenting outside of a test site, please indicate which permits are required? M*ultiple answers can be selected.*	Tick box answers: • EIA • Appropriate Assessment • Grid connection agreement • Other (please specify)
30*	Does your marine planning strategy accommodate the harnessing of ocean renewable energies by wave and tidal stream technologies?	Yes/No
31	If you weren't able to answer these questions, please let us know why.	Tick box answer • I was able to answer them • We do not have this data • We don't have an ocean energy policy in our country • The questions were too detailed • Other (please specify)

Appendix C: Developers Survey – Questions

The set of questions and metrics directed to Developers with Demonstration of full-scale prototype system in operational environment at pre-commercial stage (stage 4/TRL 7+)
This set of questions was distribued to Developers with ocean energy projects operational in 2019 at pre-commercial stage (Stage 4 and 5 / TRL 7+)

Question Number **(* denotes mandatory questions)**	**Question text**	**Format**
General project information		
1*	To assist us in validating responses, please provide the following information about the project to which this response relates. *All information provided will be anonymised and aggregated to ensure the respondent's privacy is protected.*	Drop down menu: • Name of your company • Name of the project • The Member State that provided you with this survey • From what organisation did you receive this survey?
2*	Please provide the start and end date for this project as set out in the agreement with the granting authority. *Note: this survey is aimed at projects that were active during the period 01.01.2019 to 31.12.2019. If your project ended before 2019 or started after January 2020, please do not continue with the survey.*	Open-Ended Response: • Start date (mm/yyyy) • End date (mm/yyyy)
3*	Please indicate the technology development stage of the project. *Note: This survey is aimed at projects at Stage 4 or 5 (i.e. involving technology that will achieve TRL 7 or above by the end of the project). If your project is not at this stage please do not continue with the survey.*	Drop down menu: • Stage 0 - Concept creation (TRL 1) • Stage 1 - Concept development (TRL 2-3) • Stage 2 - Design optimisation and feasibility (TRL 4) • Stage 3 - Manufacturing and operability demonstration in representative environment (TRL 5-6) • Stage 4 - Commercial-scale demonstration (TRL 7-8) • Stage 5 - Commercial-scale demonstration in a small array (TRL 9)

Financial information		
4*	How is the project being delivered? (Select one)	Tick box answer: • Single entity • Consortium (partnership): single Member State • Consortium (lead contractor / sub-contractor): single Member State • Consortium (partnership): multi-Member State • Consortium (lead contractor / sub-contractor): multi-Member State • If this project is being led by another organisation, please provide their name.
5	If the project is being delivered as a consortium, which type of organisations are involved in the consortium? Multiple answers can be chosen.	Tick box answer: • Industrial R&D • Academic R&D • Manufacturing • Marine operations • Other (please specify)
6*	Does the project involve technology transfer from another technology sector into the wave or tidal sector?	No / Yes (Please specify the technology sector)
7*	What is the total cost of the project (include all partners costs, in-kind costs, etc.)?	Slider from €1m to €30m
8	If you know the exact cost or would like to make a clarification, please provide it below.	Free text box
9	How is the project funded? Please provide the percentage split from the options below and ensure the sum of your responses equals 100%	Open-Ended Response: • Public sector funds % • Partner's funds % • Debt % • Other %
10	If you answered 'Other' to question 9 above, please specify.	Open-Ended Response
11*	Please select the type of public funding provided. Tick all that apply.	Tick box answer: • Member state funding

		• EU funding • Private funding • Which public sector funding programmes provided the public sector funding?
12	If you have additional information to add on your funding model, please provide it here.	Open-Ended Response
Technical information		
13*	Please select your technology type, installation type and the type of device.	Drop Down Menus: Please specify: Technology types: • 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 Installation types: • Floating - Slack moored • Floating - Taut moored • Floating - Semi-taut moored • Fixed – Monopile • Fixed - Jacket structure • Fixed - Gravity base • Fixed - Shoreline mounted If other please specify here and indicate wave or tidal
14	Where the project is deploying devices, please provide the following information:	Open-Ended Responses: • The rated capacity to be installed (MW) • the number of devices to be installed • the installation date, actual or proposed (month and year)

		• the proposed deployment duration (months)
15	Where capacity is being installed in phases, report each phase separately (e.g. phase 1: 0.25MW, 1 machine, June 2019, 36 months; Phase 2: 0.5MW, 2 machines, May 2020, 24 months).	Open-Ended Response
16*	Please provide information on the technical aspects of the project to help us understand the metrics that were **targeted**. Your answer will help the European Commission design its future funding calls. *All information provided will be anonymised and aggregated to ensure the respondents privacy is protected. Please enter a value for each aspect.* **CAPEX* *The costs of capital and capital expenditures involved in project development (all initial project and site related activities), manufacturing and installation of equipment (WEC/TEC structure, rotor/prime mover, control systems, foundations and moorings, power take-off, electrical connections, submarine export cable to shore, onshore balance of plant) and commissioning of the project.* **OPEX* *The operational expenditure includes all other annual costs such as operations & maintenance, fees & charges, insurance etc.*	Drop down menus CAPEX €/W: <0.5; 0.51 – 1.00; 1.01 – 1.50; 1.51 – 2.00; 2.01 – 2.50; 2.51 – 3.00; 3.01 – 4.00; 4.01 – 5.00; 5.01 – 6.00; 6.01 – 8.00; 8.01 – 10.00; >10.01 OPEX €/W per annum: <0.1; 0.101 – 0.200; 0.201 – 0.300; 0.301 – 0.400; 0.401 – 0.600; 0.601 – 0.800; 0.801 – 1.000; 1.001 – 1.500; 1.501 – 2.000; 2.001 – 3.000; 3.001 – 4.000; >4.001 Average annual energy production (MWh per annum): <200; 201-400; 401-600; 601-800; 801-1,000; 1,001-1,250; 1,251-1,500; 1,501-1,750, 1,751-2,000; 2,001-2,500; 2,501-3,000; 3,001-3,500; 3,501-4,000; 4,001-5,000; >5,000 Availability (percentage): <30; 30-39.9; 40-49.9; 50-59.9; 60-64.9; 65-69.9; 70-74.9; 75-79.9; 80-84.9; 85-89.9; 90-94.9, 95-100 Design life (years): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, >25
17	Please provide information on the technical aspects of the project to help us understand the metrics that were **achieved**. Your answer will help the	Drop down menus CAPEX €/W: <0.5;

	European Commission design its future funding calls. *All information provided will be anonymised and aggregated to ensure the respondents privacy is protected.*	0.51 – 1.00; 1.01 – 1.50; 1.51 – 2.00; 2.01 – 2.50; 2.51 – 3.00; 3.01 – 4.00; 4.01 – 5.00; 5.01 – 6.00; 6.01 – 8.00; 8.01 – 10.00; >10.01 OPEX €/W per annum: <0.1; 0.101 – 0.200; 0.201 – 0.300; 0.301 – 0.400; 0.401 – 0.600; 0.601 – 0.800; 0.801 – 1.000; 1.001 – 1.500; 1.501 – 2.000; 2.001 – 3.000; 3.001 – 4.000; >4.001 Average annual energy production (MWh per annum): <200; 201-400; 401-600; 601-800; 801-1,000; 1,001-1,250; 1,251-1,500; 1,501-1,750, 1,751-2,000; 2,001-2,500; 2,501-3,000; 3,001-3,500; 3,501-4,000; 4,001-5,000; >5,000 Availability (percentage): <30; 30-39.9; 40-49.9; 50-59.9; 60-64.9; 65-69.9; 70-74.9; 75-79.9; 80-84.9; 85-89.9; 90-94.9, 95-100 Design life (years): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, >25
18	How much energy did this project export to the grid in 2019 (MWh)?	Open-Ended Response
19*	Please provide information on the target €/MWh LCOE of this project. *All information provided will be anonymised and aggregated to ensure the respondent's privacy is protected.*	Slider from ‘40’ to ‘1,500’
Environmental information		

20	In terms of reducing risks, do you feel project development would benefit from European-level harmonization of:	• Environmental standards (e.g. rules implemented for the treatment, maintenance and protection of the environment): Yes / No / Don't know • Safety standards (e.g. technical standards governing the design of equipment) Yes / No / Don't know If Yes or Don't Know, please explain your response.
21	Was environmental information for your zone made available to your project from regulators, stakeholders, researchers and/or other developers?	Yes / No
22	Would you be willing to share environmental impact data you have collected to help develop a harmonized European environmental monitoring strategy?	Yes / No
23*	Please indicate the development area* this project addresses. ** (The development areas relate to the ETIP Ocean SRIA 2020 Priority Topics. For more information on these topics, please see the new Strategic Research and Innovation Agenda for Ocean Energy)* Tick all that apply.	Tick box answers: • Demonstration of ocean energy devices to increase experience in real sea conditions • Demonstration of ocean energy pilot farms • Improvement and demonstration of PTO and control systems • Application of innovative materials from other sectors • Improvement of tidal blades and rotor • Advanced mooring and connection systems for floating ocean energy devices • Improvement and demonstration of foundations and connection systems for bottom-fixed ocean energy devices • Optimisation of maritime logistics and operations • Instrumentation for condition monitoring and predictive maintenance

		• Developing and demonstrating near-commercial application of ocean energy in niche markets • Quantifying and demonstrating grid-scale benefits of ocean energy • Marine observation and modelling to optimise design and operation of ocean energy device • Contributing to open-data repository for ocean energy • Improvement/assessment of the environmental and socioeconomic impacts of ocean energy • Standardisation and certification in performance assessment • Other (please specify)
24	If you didn’t answer any of the questions in this section, please indicate why.	Tick box answer: • I don't have this information • I don't want to give this information • I didn't understand the question(s) • I was able to answer the questions • Other (please specify)

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