OceanSET Third Annual Report | 2022

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March 2022

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

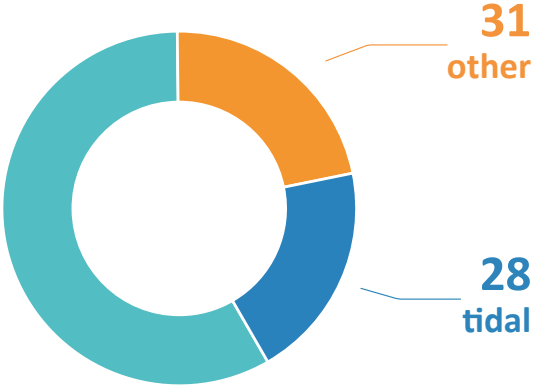
Annual report key findings – 2020

16 responses received (from 14 member states). Ref year 2020.

A total of

141

ocean energy projects supported



Annual report key findings – 2020

16 responses received (from 14 member states). Ref year 2020.

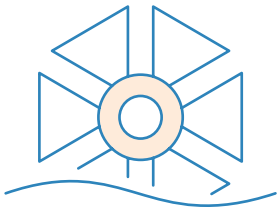
€28.7 **million in public funding** from member states and regions

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

11 member states have **test site facilities**

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

10 member states were **funding ocean energy projects** and **11** were funding TRL 7+



Ocean energy projects survey

Member states reported 34 projects over TRL 7 active in 2020. Developers reported target values from a selection of projects.

12 tidal projects

- Mainly horizontal axis turbines and tidal kite

For 0.25 – 2 MW rated capacities:

- **78%** **average** annual availability for tidal prototypes
- **3.4 €/W** average capital expenditure
- **0.5 €/W/year** average operational expenditure

17 wave projects

- Technologies included point absorber, attenuator and oscillating wave column

For 0.2 – 1.5 MW rated capacities:

- **78%** **average** annual availability for wave prototypes
- **6,4 €/W** average capital expenditure
- **0.5 €/W/year** average operational expenditure

5 **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 third annual report provides an overview of the activities performed within each work package in year three of the project, as well as an annual update of progress in the ocean energy sector for the year 2020. This report sets out the results of the third 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:

- 8 Member States declare having an Ocean Energy policy;
- Ocean Energy received €28.7m funding in 2020 from Member States;
- Member States declared that 141 Ocean Energy projects were funded in 2020, out of which 58% are supporting wave energy devices;
- There were 34 Ocean Energy projects identified as TRL 7 or above in 2020;
- Activity in all SRIA priority areas;
- Main focus on experience in real sea conditions; PTO/control systems; moorings/connections for floating devices; and novel wave devices;
- Identified funding suggests the sector continues to be appropriately supported in 2020.

There was a significant improvement in the data provided for analysis for 2020 with all IWG Member States engaging with the survey process. Accessing accurate information from Developers regarding performance and costs of the different technologies has also continued to improve year on year since 2018 with familiarity with and trust in the OceanSET project growing. However, the relatively small number of projects deemed eligible to be surveyed means some results are sensitive to individual answers and can be skewed. We have attempted to highlight this where necessary in the 2020 results.

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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 established the 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 a three-year period and used to inform Member States and the European Commission 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 IP is to outline a structured approach that will enable both wave and tidal technologies to follow a development path with the ultimate destination of a commercially viable wave and tidal industry. 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 Ocean Energy IP 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 Ocean Energy IP, eleven 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 provide support at 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

The Ocean Energy IP specifies the need to monitor these actions at a national and regional level to track the progress of the ocean energy sector. OceanSET has been assisting the IWG in assessing the progress of the ocean energy sector and how National and EU funded projects are delivering successful supports. Relevant data has been collected annually along the three years of the project and used to inform Member States and the European Commission on the progress of the sector. It is also used to review what works and what does not and to assess how to maximise the benefit of the funding streams provided across Member States, regions and the European Commission.

Following the publications of the EU's '*Strategy on Offshore Renewable Energy*' by the European Commission in November 2020, and the European Technology and Innovation Platform for Ocean Energy (ETIP Ocean) '*Strategic Research an Innovation Agenda for Ocean Energy*' in June 2020, the actions of the Implementation Plan were revised in 2021. A revised Ocean Energy IP was drafted and the above actions were substituted by a new set of operational priority actions identified from the Strategic Research and Innovation Agenda. The revised Ocean Energy IP was not yet in the public domain by the date of the publication of this Annual Report. The proposed new set of actions is presented in Table 1.

Technical Actions	
Design and Validation of Ocean Energy Devices	1.1 - Demonstration of ocean energy devices to increase experience in real sea conditions
	1.2 - Demonstration of ocean energy pilot farms
	1.3 - Improvement and demonstration of PTO and control systems
	1.4 - Application of innovative materials from other sectors
	1.5 - Development of novel wave energy devices
	1.6 - Improvement of tidal blades and rotor
Foundations, Connections and Mooring	1.7 - Advanced mooring and connection systems for floating ocean energy devices
	1.8 - Improvement and demonstration of foundations and connection systems for bottom-fixed ocean energy devices
Logistics and Marine Operations	1.9 - Optimisation of maritime logistics and operations
	1.10 - Instrumentation for condition monitoring and predictive maintenance
Integration in the Energy System	1.11 - Developing and demonstrating near-commercial application of ocean energy in niche markets and hybrid systems.
	1.12 - Quantifying and demonstrating grid-scale benefits of ocean energy
Data Collection & Analysis and Modelling Tools	1.13 - Marine observation and modelling to optimise design and operation of ocean energy device
	1.14 - Open-data repository for ocean energy operation and performance
Cross-Cutting Challenges	1.15 - Standardisation and certification
Environmental, Policy and Socioeconomic Actions	
2.1 - De-risking of Environmental Consenting through an integrated programme of measures	– Promoting open data sharing on environment, consenting procedures and policy among MS – Promoting the development of environmental standards and certification – Encouraging a circular economy approach in the design of ocean energy technologies* – Promoting simplified consenting procedures (including cross-border deployments)
2.2 - Promoting Ocean Energy in Marine Spatial Planning	
2.3 - Promoting political support and public backing for ocean energy	
Market Uptake and Financial Actions	
3.1 - Dedicated revenue support for the first wave & tidal demonstration farms, to allow developers to attract the necessary private investment to action these deployments.	
3.2 - Create of an Investment Support Fund for ocean energy farms.	
3.3 - Encourage the creation of an EU Insurance and Warranty Fund to underwrite various project risks, as envisaged in the OceanSET dedicated report.	
3.4 - Funding from EU, national, regional and private sector to support demonstration and innovation projects under the Technical and Environmental, Policy and Socioeconomic Actions	
3.5 - Support the development of novel mechanisms to close funding gaps (such as a Public Procurement of Innovative Solutions)	

*A circular economy approach will be an integral part of all technical actions – in particular, all actions concerned with the Design & Validation of Ocean Energy Devices.

TABLE 1: PRIORITY ACTIONS OF THE REVISED SET-PLAN IMPLEMENTATION PLAN FOR OCEAN ENERGY

2. OceanSET

The OceanSET project is a 3-year H2020 funded project, which focuses on delivering the actions of the Implementation 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 SET Plan Ocean Energy 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 Ocean Energy IP, building a strong foundation for the development of the Ocean Energy IP during subsequent Development, Deployment, and Delivery phases [3]. 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 during the subsequent Phases of the Ocean Energy Implementation Plan.

[3] Discovery Phase (2018 -2020); Development Phase (2020-2025); Deployment Phase (2026-2030); Delivery Phase (2031 onwards). Further details in the Implementation Plan.

The development of a collaborative information sharing process across the Member States and regions is at the core of the OceanSET project. This 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 SET Plan Ocean Energy Implementation Plan and suggest approaches to stimulate industry and research progress in key priority areas.

3. Overview of all WPs

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

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

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 2: 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 for the Ethics Requirements WP 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 eleven 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 third Mapping and Analysis exercise has been completed and produced (D2.3).

All deliverables for the Mapping and Analysis WP have been submitted.

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 the public/private divide of finances for each action, and
- Design an insurance & guarantee fund

ACHIEVEMENTS TO DATE:

The third Annual Funding Gap Analysis and Recommendation Report (Deliverable 3.5), assessing progress against the aspirations of the Ocean Energy Implementation Plan has been completed. The findings of this report suggest the ocean energy sector continues to be appropriately supported with investment committed to projects addressing Technical Actions approaching, and in some instances exceeding, the level of investment envisaged in the Implementation Plan. The exception being in low TRL activities in the tidal energy subsector.

The commissioning by the OceanSET project of a feasibility study into the requirements of and possible structures for a European Insurance and Guarantee Fund to support the first demonstration and pre-commercial deployments of ocean energy devices has contributed directly to progress in one of the three Financial Actions of the Implementation Plan. The findings of the study provide a sound assessment of the necessary focus for the fund and a proposed structure for its implementation.

At the time of writing, all deliverables of this work package have been submitted with the exception of the final deliverable (D3.6) which is scheduled for submission in March 2022.

3.4 Pre-Commercial Procurement Programme Development

OVERVIEW

The pre-commercial procurement programme development work package defined a strategic approach to a European pre-commercial procurement programme for developing wave energy technology and developed a package of funding calls to drive technology development.

ACHIEVEMENTS TO DATE:

All deliverables in the Pre-Commercial Procurement Programme Development 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 Ocean Energy Implementation 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. Dedicated knowledge sharing workshops are organised with stakeholders - innovation providers and funders – who are brought together to learn about available and required technology developments and funding, and to provide insights into sector progression.

ACHIEVEMENTS TO DATE

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) have been delivered over the lifespan of the OceanSET project.

A third knowledge-sharing workshop was organised online and the 'Report on Third Knowledge Sharing Workshop' (Deliverable 5.6) has been completed and produced. This third workshop was held online on the 08 December 2021 alongside the Ocean Energy Europe annual conference. The event comprised an introductory note from the Ocean Energy IWG Chair; two presentations focusing on the most up-to-date results of the OceanSET project including new Member State and Developer survey data; and a final presentation on the EuropeWave pre-commercial procurement programme.

A third-year data analysis exercise to determine 2020 key metrics and monitor the actions of the OE SET Plan IP was completed. The number and content of Member State funded projects were assessed as well as the technical and cost performance data for TRL 7 or above devices, as outlined in the completed Third Annual Monitoring and Review Report (Deliverable 5.7).

All deliverables for the Monitoring and Review WP have been submitted.

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

Since its creation, the project website[4] has been regularly updated. During the third year of the project, the average number of visits per month was 212, reaching the objective of 200. Different communication mediums were released on the website: press releases, newsletters and video recording of events.

Two newsletters were published during the third year and shared with all OceanSET partners for dissemination. Information about the project was also disseminated through 45 posts on LinkedIn and Twitter using the tag '#OceanSET'.

All deliverables in the Communication and Dissemination WP are expected to be submitted on time.

3.7 Management

OVERVIEW

The management Work Package involves providing overall management and administration support to the project, and to the implementation 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 OceanSET project team held project calls every second Wednesday throughout the third year of the project to keep track of tasks and deliverables. Over 370 actions were recorded and worked on during the three years of these meetings.

OceanSET will produce 38 deliverables over its 3-year period; 36 deliverables have been achieved to date with the final 2 expected to be completed shortly. A Final Report detailing the tasks and deliverables completed over the lifetime of the project will be submitted in mid-2022.

[4] https://www.oceanset.eu

4. Review of progress in the Ocean Energy sector

4.1 Data Collection

Member States participating in the Ocean Energy Implementation Plan partook in a third and final OceanSET 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.

As the OceanSET survey is now in its third year, a good level of awareness and trust has been established with respondents. For this reason, steps were taken to make the survey easier and quicker for respondents to complete. The Member States survey consisted of 26 questions (See Appendix B) and was constructed to gather information from the Member States to feed into the annual report for the European Commission. To make the survey easier to complete and avoid repetition for respondents that replied the previous year, the Member State survey was divided into several parts with questions on whether there were any changes compared to their 2019 response. Where no changes were reported, respondents could skip forward to the next relevant section.

The Developers survey, which consisted of 30 questions (See Appendix C), was constructed to gather project specific information from developers who have devices or are undertaking projects to develop their technology to TRL 7 or above.

The survey reference period was 2020.

4.2 Metrics

The metrics for the survey were developed in Deliverable 5.1, which is publicly available on the OceanSET website[5].

Table 3 and table 4 document the key metrics collected from Member States and developers in the third annual survey of the OceanSET project. From the 2020 mapping and analysis exercise performed through survey Section 1, it is possible to conclude that, despite several key metrics being the same in all three, or the latest two years, of the OceanSET project, evolution has occurred in terms of internal Member State activity on ocean energy policy. For example, despite some Member States not having a dedicated ocean energy policy, organisations in these Member States are participating in ocean energy projects or are providing ocean energy test facilities. A year-on-year comparison of key metrics over the three years of OceanSET (2018, 2019, 2020) has been provided in Appendix E.

[5] www.oceanset.eu

Policy/Deployment	2020
Number of MS answering the survey	13
Number of MS with an OE policy	8
Number of MS with an assigned Ministry/Department owner at governmental level for OE	8
Number of MS with consistent environmental impact assessment for OE at Governmental level (outside test site/inside test site)	8/6
Number of MS with test site facilities	11
Estimated total budget for OE (wave, tidal) (€M)	28.7
Total amount spent on OE (€M)	30.9
Number of MS with revenue support for wave energy	6
Number of MS with revenue support for tidal energy	5
Estimated average consenting time (years) (outside test site/inside test site)	2.7/ 1.3
Number of MS with self-sufficient/well complemented supply chain for OE	12
Number of MS who funded TRL 7+ projects	11

TABLE 3: KEY METRICS COLLECTED FROM SECTION 1 OF SURVEY

The figures for active TRL 7+ projects (table 4) are based on an analysis of whole-system projects only.

Active TRL 7+ / Stage 4-5 projects – Target technology performance data	2020
Number of projects answering the survey – wave and tidal	20
Number of projects – wave	13
Number of projects – tidal	7
Number of projects within a consortium – wave and tidal	11
Number of projects addressing environmental impact assessment (EIA) methodologies and tools	3
Number of projects addressing enforcement of stage progression standards through scale testing	6
Total installed capacity (MW) – wave	4,6
Total installed capacity (MW) – tidal	3.5
Average installed capacity per project (MW) – wave	0,8
Average installed capacity per project (MW) – tidal	1,2
Total annual electricity production (MWh/year) – wave	2207
Total annual electricity production (MWh/year) – tidal	2933
Average annual electricity production per installed capacity (MWh/MW) – wave	6826
Average annual electricity production per installed capacity (MWh/MW) – tidal	1830
Average annual availability (%) – wave	78
Average annual availability (%) – tidal	78
Average CAPEX (€/W) – wave and tidal	5.5
Average CAPEX (€/W) – wave	6.4
Average CAPEX (€/W) – tidal	3.4
Average OPEX (€/W/year) – wave and tidal	0,5
Average OPEX (€/W/year) – wave	0.5
Average OPEX (€/W/year) – tidal	0.5
Min./max. technical lifetime (years) – wave	20/30
Min./max. technical lifetime (years) – tidal	20/25
Average LCOE (€/MWh) – wave	272
Average LCOE (€/MWh) – tidal	200

TABLE 4: KEY METRICS FOR WHOLE-SYSTEM TRL 7-9 DEVICES, COLLECTED FROM DEVELOPERS' SURVEY

The key metrics in table 4 above are based on data from survey Section 2, Developers' survey. This table captures key metrics concerning ocean energy TRL 7-9 projects active in 2020. Technology performance and cost key metrics in this table were determined from target data provided by whole-system projects, i.e. aiming to develop devices for electricity production at the utility scale. Hybrid and small-scale devices are considered separately for comparability reasons. In addition, most projects surveyed have yet to deploy their wave or tidal devices and so technology performance parameters were delivered as 'target' values (i.e. data expected at the end of the project).

A year-on-year comparison of Developers' survey key metrics over the three years of OceanSET (2018, 2019, 2020) has been provided in Appendix E. Since OceanSET started its reporting activity in 2018, identifying trends in certain key metrics has been uncertain, especially when few respondents are involved in the mapping exercises. The

trends identified in target data arising from new projects answering the survey or projects with more accumulated experience, point to a decrease in CAPEX both in wave and tidal and an increased availability.

Comparing across 2018 to 2020, the number of projects in wave/tidal and reported to be addressing SRIA priority areas related to EIA and to standardised technology performance evaluation have been increasing in number, indicating developers' increased focus on these matters. Other technology metrics present a variability which can be explained by the devices involved however a clear trend cannot yet be defined.

4.3 Overview of the Member State survey

Fourteen Member States, identified by the implementation working group, received the OceanSET survey. All 14 Member States responded when asked for information. Of these, one reported no activity in 2020 (Finland) and therefore did not fill out a survey.

Thirteen survey responses were received, and one of these (Cyprus) was only partially completed. The UK sent three individual responses (covering England, Scotland and Wales). For the purposes of this report, the three UK regional entries have been presented as one set of results covering the UK. The Belgian response covered mainly the Flemish region.

Of the fourteen Member States, eleven reported projects at TRL 7 or above in 2020. Table 5 below displays which Member States and regions that responded.

141 **ocean energy projects** across the fourteen Member States were identified as being supported in 2020:

- **82** **wave** projects;
- **28** **tidal** projects; and
- **31** projects categorised as **'Ocean/other'**.

Of these 141 ocean energy projects, 34 unique projects were identified as being at TRL 7. Following a review process, 26 of these projects were deemed eligible for the Developers survey (Section 2). Another project was subsequently identified by a Member State and included in the list of eligible projects, bringing the total number of projects eligible for the Developers survey to 27.

21 unique responses were received. One project was classified as 'Support' and therefore not included in the analysis. Of the 20 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 5 displays which Member States and regions responded and which had projects of TRL 7 or greater.

Member State	Was a response for Survey received?	Has the Member State funded projects over TRL7 or above?
Germany	Yes	Yes
UK*	Yes	Yes
Belgium**	Yes	Yes
Denmark	Yes	Yes
Sweden	Yes	Yes
Portugal	Yes	Yes
Netherlands	Yes	Yes
Italy	Yes	Yes
Spain	Yes	Yes
Ireland	Yes	Yes
Norway	Yes	No
France	Yes	Yes
Cyprus	Yes	No
Finland	No	No

*UK response comprised responses from Scotland, England and Wales
**Belgian response covered mainly Flemish region

TABLE 5: MEMBER STATE SURVEY RESPONSE RATE

4.4 Ocean energy policy and funding opportunities in Member States

Table 6 below maps the responses provided by the Member States in relation to policy and funding opportunities available. The 2020 budget is to the nearest million euro. Where figures were unknown or unspecified, this is included as a comment in the table.

Country	Responding organisation	Is there an assigned ministry/department owner for OE at government level?	Compared to 2019, has your MS updated existing, or created new, policies in 2020 which support the development and deployment of OE technology?	OE (wave/tidal) Budget in 2020	Amount actually spent on OE in 2020 (excluding private funding)
Germany	Fraunhofer IEE	No	No	not specified	not specified
UK*	Scottish Enterprise, MEW, Offshore Renewable Energy Catapult	Yes	No	€16m	€16m
Belgium**	Flemish government, department Economy, Science & Innovation	No	Yes	no earmarked budget	€0.2m
Denmark	Energistyrelsen	Yes	No	0	€2.3m

Sweden	Swedish Energy Agency	Yes	No	€2.1m	€5.3m
Portugal	DGEG	Yes	Yes	no specific figure for ocean energy.	insufficient data
Netherlands	Ministry of Economic Affairs and Climate Policy	No	No	unknown	unknown
Italy	ENEA (Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile)	Yes	No	€2.3m	€1.8m
Spain	CDTI (Centro par el Desarrollo Tecnológico Industrial).	No	Yes	€3m	€1.2m
Ireland	SEAI (The Sustainable Energy Authority of Ireland)	Yes	No	€3.5m	€2.3m
Norway	Ministry of Petroleum and Energy	Yes	No	unknown	unknown
France	ADEME (French Agency for Ecological Transition)	No	No	€1.8m	€1.8m
Cyprus	not provided	Yes	No	unknown	unknown

TABLE 6: OCEAN ENERGY POLICY AND FUNDING OPPORTUNITIES IN MEMBER STATES

In 2020, eight Member States had an assigned ministry or department owner for ocean energy at government level. Five Member States (Germany, Belgium, Netherlands, Spain and France) reported not having an assigned ministry or department owner at government level. In the UK response, Scotland and England confirmed a ministry/department at government level, but Wales reported it did not have such a ministry/department.

Compared to 2019, only three Member States reported they had updated existing, or newly created policies in 2020 to support the development and deployment of OE technology. Portugal reported on its National Energy and Climate Plan which was published in October 2020. Spain reported that in 2020 the Spanish Government continued working in the Energy and Climate National Integrated Plan 2021-2030 (PNIEC) and the Energy Transition and Climate Change Law, with both documents setting out the framework to

develop new energy infrastructures; energy source targets for 2030; and new rules to boost renewable energy in general and, ocean energy specifically.

Belgium reported that at the end of 2017 the Flemish government approved the set-up of the "Blue Cluster" to stimulate active and sustainable innovation cooperation between companies, knowledge institutes, sector organisations and public bodies with a focus on the blue economy in the broadest sense (including innovation in ocean energy) and in view of competitiveness growth for a large group of Flemish companies.

Member States were asked if they provided any funding for national or regional programmes in 2020 to support ocean energy. As outlined in Figure 1 below, ten countries confirmed they had provided funding in 2020 to support ocean energy. Only three countries (Netherlands, Cyprus and Norway) reported they had not. Within the UK response, Scotland reported that funding to support ocean energy had been provided in 2020, whereas England and Wales reported it had not.

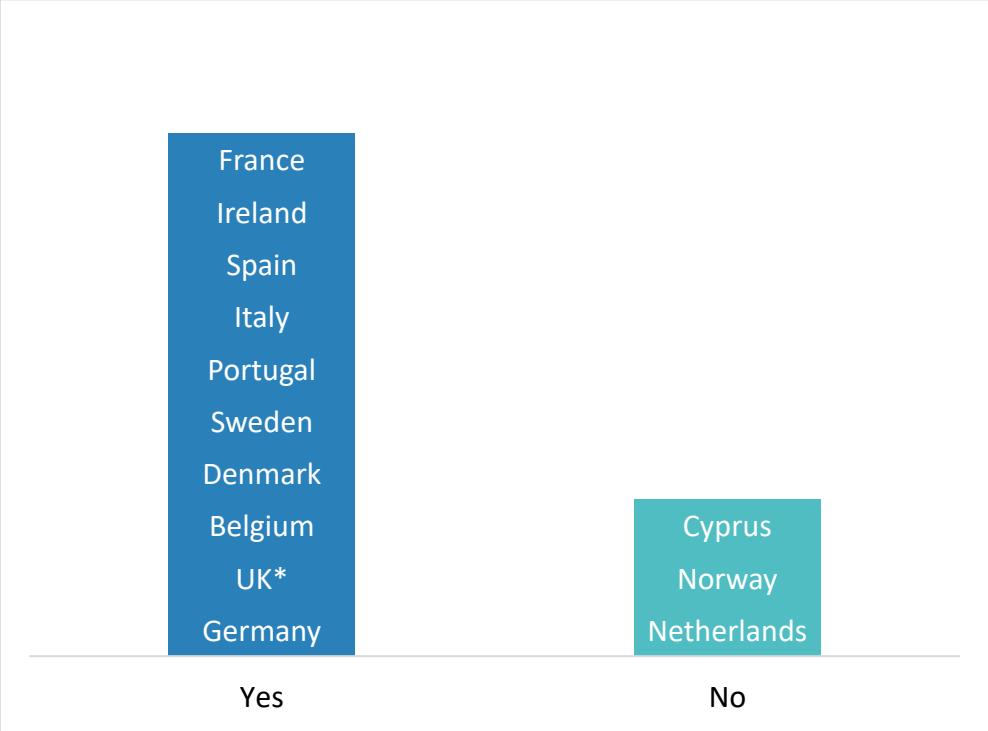


FIGURE 1: MS FUNDING FOR NATIONAL/REGIONAL PROGRAMMES TO SUPPORT OE IN 2020 (YES/NO)

** within the uk response, wales and england responded 'no' but scotland responded 'yes'.*

As outlined in Table 6 above, the UK had the highest budget for ocean energy in 2020 with €16m allocated in Scotland. Ireland was next highest with a budget of €3.5m, followed closely by Spain with a budget of €3m. France, Italy and Spain had budgets of between €1.8m and €2.3m. Sweden noted that its budget for ocean energy in 2020 also covered osmotic power and temperature gradient power. The Flemish region in Belgium reported there was no earmarked budget for OE in 2020. The actual amount spent was reported based on the IEA's 2020 budget estimate. Portugal did not have a specific OE budget in 2020.

The UK and Sweden had the highest amounts actually spent on ocean energy (excluding private funding) in 2020 at €16m and €5.3m respectively. Second highest were Ireland and Denmark with actual spends of €2.3m each, followed by Italy and France at €1.8m each. Spain's actual spend on ocean energy in 2020 was €1.2m, while the Flemish region of Belgium reported an actual spend of €0.2m. Portugal and Germany were unable to provide figures on the actual spend due to insufficient or unspecified data. Three Member States (Netherlands, Norway and Cyprus) reported that the actual spend was unknown.

Member States were also requested to identify national and regional funding programmes that were open during 2020 to support ocean energy technology development and demonstration projects. Respondents were asked to consider both programmes that exclusively targeted ocean energy technology and general technology programmes.

Table 7 below outlines funding programmes in each Member State, along with the TRL this fund was targeting, and an associated website link.

MS	Funding Programmes	TRL targeted
Germany	Energieforschungsprogramms der Bundesregierung	unknown
UK	Wave Energy Scotland	4-6
	Saltire Tidal Fund	6-7
	Ocean ERA Net	3-6
Belgium	Spearhead Cluster programme	2-7
Denmark	EUDP	1-8
	Innovationsfonden	1-8
Sweden	Marine Energy Conversion programme	3-7
	Pilot and demonstration programme	5-8
Portugal	EEA Grants Blue Growth Programme	1-9
Italy	POR (Regional Funding)	7-8
	Local Academic Funding	7-8
Spain	CDTI- R&D Programme	5-7
	Basque Energy Agency (EVE)'s Demonstration and validation of emerging marine renewable energy technologies	7-8
	AEI (state funding agency for research) 2020 call for research projects	Low TRLs
France	Call for projects "Systèmes énergétiques, villes et territoires durables"	5

TABLE 7: MS FUNDING PROGRAMMES IN 2020 FOR OE TECHNOLOGY DEVELOPMENT AND DEMONSTRATION

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

Of the fourteen Member States participating in the Ocean Energy Implementation Plan, ten reported funding ocean energy programmes in 2020 and seven reported having an annual budget to support ocean energy projects in 2020. Table 8 shows the pipeline of wave and tidal stream projects.

Country	TRL 1-6	TRL 7+	unknown / not applicable	Grand Total
Belgium				**1**
Wave		1		1
Denmark				**7**
Wave	3	4		7
EU				**19**
Other	2	2	8	12
Tidal stream		1	3	4
Wave	2		1	3
France				**4**
Tidal stream	2	1		3
Wave	1			1
Germany				**2**
Tidal stream		1		1
Wave	1			1
Ireland				**7**
Other			1	1
Tidal stream	1	2		3
Wave	2	1		3
Italy				**8**
Other	2			2
Wave	3	2	1	6
Netherlands				**4**
Tidal stream		2		2
Wave	2			2
Portugal				**12**
Other			4	4
Tidal stream		1		1
Wave	3	2	2	7
Spain				**11**
Other	1	1		2
Tidal stream	2			2
Wave	4	2	1	7
Sweden				**26**
Other			1	1
Tidal stream			3	3
Wave		3	19	22

UK				**40**
Wave	19	2	1	22
Tidal stream	3	4	2	9
Other	4	2	3	9
Grand Total	**57**	**34**	**50**	**141**

TABLE 8: ANNUAL PIPELINE OF WAVE AND TIDAL PROJECTS REPORTED BY MS, SUBSECTOR AND DEVELOPMENT STAGE.

5. Review of progress of Implementation Plan actions

Responses from the survey were mapped against the 11 original actions from the original 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

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

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

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	28	8
	1.2	Tidal energy system (device and array) demonstrations and knowledge building in operational environment (TRL 7-9)		12
Wave	1.3	Wave energy technology device development, including system demonstration and knowledge building (up to TRL6)	82	40
	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).		17
Ocean	-	Up to TRL6	31	9
	-	TRL7 or greater		5

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

TABLE 9: NUMBER OF DISTINCT OCEAN ENERGY PROJECTS REPORTED AS ACTIVE DURING 2020

For a more detailed analysis of the projects surveyed, in our mapping and analysis we further differentiated between wave, tidal stream, and ocean, and between whole-system, sub-system and support, as set out in Table 10 below.

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 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 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 Support	Project is focused on developing support mechanisms for the ocean energy sector generally or more than one ocean energy subsector

TABLE 10: OCEANSET REVIEW CATEGORIES

Of the 34 projects identified as TRL 7 or above, 12 were tidal (35%), 17 were wave (50%) and 5 were ocean projects (15%) (Figure 2).

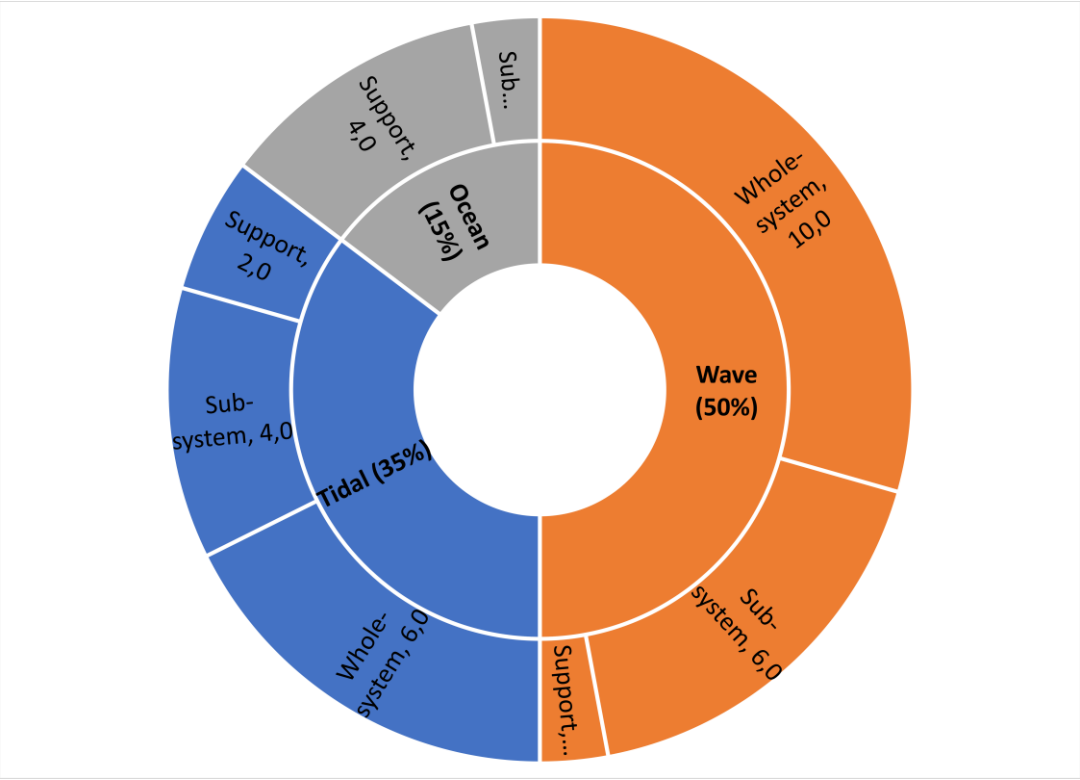


FIGURE 2: SYSTEM DEMONSTRATION AND DEPLOYMENT TRL 7-9

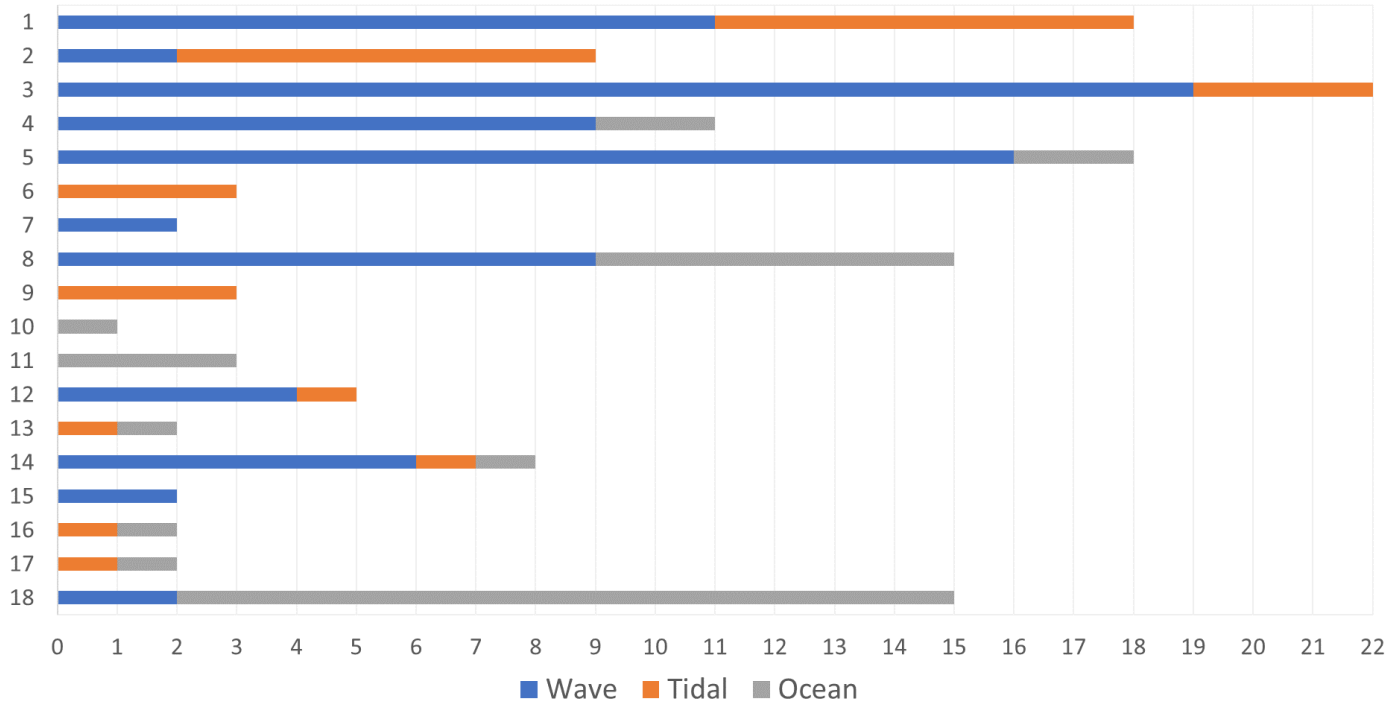


FIGURE 3: NUMBER OF PROJECTS BY SRIA PRIORITY DEVELOPMENT AREA ACROSS WAVE, TIDAL STREAM AND OCEAN CATEGORY (ALL TRLS, INCLUDING UNKNOWN AND NOT APPLICABLE)

Legend (priorities):

1. Demonstration of ocean energy devices to increase experience in real sea conditions
2. Demonstration of ocean energy technology at array scale
3. Improvement and demonstration of PTO and control systems
4. Application of innovative materials from other sectors
5. Development of novel wave energy devices
6. Improvement of tidal blades and rotor
7. Development of other ocean energy technologies
8. Advanced mooring and connection systems for floating ocean energy devices
9. Improvement and demonstration of foundations and connection systems for bottom-fixed ocean energy devices
10. Optimisation of maritime logistics and operations
11. Instrumentation for condition monitoring and predictive maintenance
12. Developing and demonstrating near commercial application of ocean energy in niche markets
13. Quantifying and demonstrating grid scale benefits of ocean energy
14. Marine observation modelling and forecasting to optimise design and operation of ocean energy devices
15. Open-data repository for ocean energy
16. Improvement of the environmental and socioeconomic impacts of ocean energy
17. Standardisation and certification
18. none

Following the publication of the Strategic Research and Innovation Agenda (SRIA) for Ocean Energy [6] by ETIP Ocean in 2020, Member States were asked which SRIA best corresponded to the projects listed in their Registry of Projects. Figure 3 shows activity in each SRIA priority area reported per wave, tidal and ocean projects across all TRLs (including those reported as unknown or not applicable). Projects classified as 'none' in Figure 3 indicate that no corresponding SRIA priority area could be identified. Many of those projects organise test site facilities or funding for sector development.

Technology specific areas with more activity are **improvement and demonstration of PTO and control systems** and **advancement of moorings and connections for floating devices.** These are areas addressed almost entirely by wave projects, mainly TRL 1-6 technologies but also some TRL 7-9. Technology specific projects from the tidal stream sector address mainly **foundation and connection systems for bottom-fixed devices**, mostly TRL 1-6, and **tidal blades and rotor**, mostly TRL 7-9. These four areas are addressed mainly at sub-system level, thus contributing to knowledge-building both in wave and tidal.

Increasing experience in real sea conditions, which concerns device deployment, has more projects, mostly whole-system wave TRL 1-6 but also a few tidal projects in both high and low TRL ranges. Most whole-system TRL 7-9 tidal projects concentrate on **demonstration at array scale**, together with a few TRL 7-9 from wave sector. A relatively high number of TRL 1-6 whole-system projects focus the **development of novel wave devices**.

The above mentioned and remaining SRIA priority areas are covered by at least one ocean sub-system project of any TRL, or ocean/wave/tidal project of sub-system or support types with an unknown/not applicable TRL. Of these, **application of innovative materials from other sectors** has a substantial number of projects (mainly wave sub-system), as well as **marine observation modelling and forecasting**, addressed in sub-system or support projects mainly from wave sector.

Priority areas for decreasing costs or improving the consenting process such as **maritime logistics and operations**, **instrumentation for monitoring and maintenance**, **open data repository**, and **standardisation and certification**, are covered just in a small number of projects.

Projects developing new wave devices occur mainly in Italy and Portugal (but also in UK and Denmark), while projects on PTO, innovative materials, mooring/connections for floating devices mainly in the UK (but also Portugal, Spain, Sweden, and Denmark). Demonstration of ocean energy devices to increase experience in real sea conditions is being carried out mainly in the UK and Spain (but also Portugal, France, Ireland and Denmark). Demonstration at array scale is performed in projects largely

[6] https://www.oceanenergy-europe.eu/wp-content/uploads/2020/05/ETIP-Ocean-SRIA.pdf

from the UK (but also France and Sweden). Denmark has the majority of projects addressing the development and near commercial demonstration in niche markets (but also Sweden), while Sweden has most projects for marine observation modelling and forecasting to optimise design and operation (also UK) and for optimisation of marine logistics and operations. Ireland and Portugal present projects focusing the improvement and demonstration of tidal blades and rotor. Projects for improving and demonstrating foundations and connection systems for bottom-fixed devices arise in the UK and Spain. It should be noted that this list of Member State projects is not exhaustive.

In total 20 projects at technology development Stage 4-5/TRL 7-9 responded to the Developers survey (survey Section 2), providing technical details of their technologies (Table 11). Of these, one wave and three tidal projects were from non-EU partnering countries in the IWG.

Wave		Tidal stream	
Whole-system	Sub-system	Whole-system	Sub-system
12	**1**	**5**	**2**

TABLE 11: NUMBER OF WAVE AND TIDAL PROJECTS REPORTED IN DEVELOPERS SURVEY (STAGES 4-5/TRL 7-9)

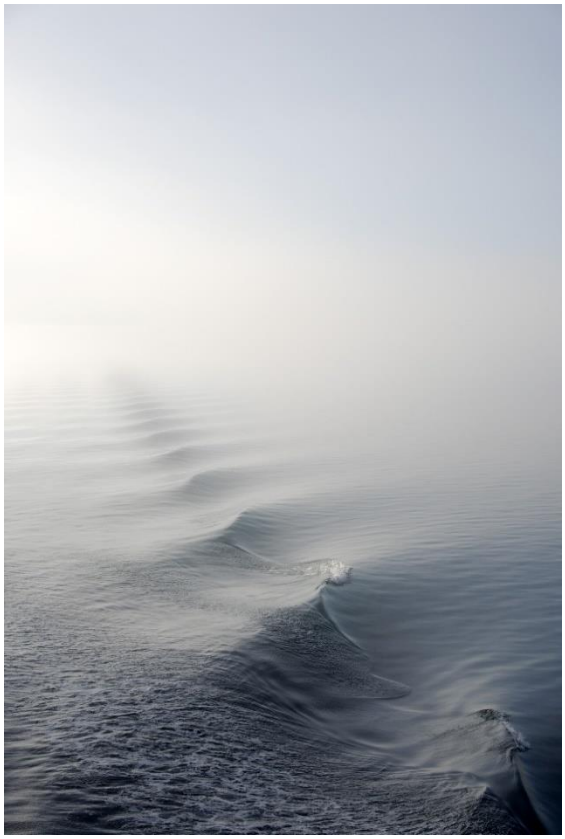
Of the 20 wave or tidal TRL 7-9 projects that responded to the Developers survey (Section 2), most were at Stage 3 at the beginning of the project, and planning to advance the technology to Stage 4. Four projects in total, including three from the wave sector, intended to advance the technology from Stages 3 or 4 to Stage 5.

Among these projects, horizontal axis turbine is the most predominant tidal technology system to have reached TRL 7 or above. Other projects reported as having reached TRL 7 or above included vertical axis turbine and tidal kite technologies. The installation types varied. Horizontal axis turbines were being installed as floating, taut, or semi-taut moored. The remaining were reported as fixed installations, gravity base or monopile types.

Three tidal-stream projects mentioned receiving technology transfer from the wind energy sector.

Point absorber is the most predominant wave technology system to have reached TRL 7 or above, followed by the attenuator and the oscillating water column types. However, four other types of device technology were also reported. Therefore, wave TRLs 7-9 do not show a clear frontrunner. Point absorber and attenuator devices were all floating, taut, or slack moored. The remaining reported a mix of installation types, either floating or fixed.

Developers of wave energy converters (whole-system projects) mentioned oil and gas, composites, industrial automation, wind industry and desalination as technology transfers. Sub-system projects mentioned offshore wind as a technology transfer.



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

5.1.2.1 Test Centres

In the 2nd Member States survey covering 2019 several questions covering the Technical Action 1.5 Installation, logistics and testing infrastructure and supply chain development were included. To avoid repetition, in the 3rd Member States survey respondents were asked if there had been any changes to the testing facilities in their country for ocean energy (prototypes) in 2020 compared to 2019. Five Member States (UK including Scotland and Wales, but not England; Sweden, Netherlands, Spain and Cyprus) confirmed that there had been changes. These five were then invited to answer follow up questions to outline the changes. Cyprus did not complete the follow up questions detailing these changes. Norway and Belgium did not answer this question in 2019 but indicated in 2020 that there were no changes.

The follow up questions asked if there were test site facilities in their country for ocean energy (prototypes). All four reported having tank facilities as well as open ocean test facilities. In the UK, these test sites facilitate up to TRL 8 in Scotland and TRL 4 – 6 in Wales. In Sweden the tank (SSPA) test site facilitates TRL 3-5, open ocean test facility (Islandsberg, Uppsala University, part of Marinet2) TRL 5-8, and the test facility for stream power (in a river in Söderfors, Uppsala University) TRL 7-8. A new test site facility, a testbed for materials in marine environment, was launched in 2020by RISE [7]. The Dutch test sites facilitate TRLs 1 – 9.

Spain reported that a new open sea test site for MRE in Galicia was authorized in July 2020. The site is located in Punta Langosteira (Arteixo), close to the outer harbour of A Coruña. It provides a location for the temporary anchoring and the deployment of marine energy devices to test and validate them under real operating conditions in the open sea. The Galicia test site is an ocean research, demonstration and operation of marine energy converters under real conditions in open waters, mainly wave energy converters. The test site can validate designs, components and materials of the devices, and assess the technical and economic feasibility of the energy converters. The BiMEP site is an open sea test area located off the coast of Armintza, in the province of Bizkaia. Operating since June 2015, the BiMEP site offers technology developers an offshore area with suitable wave and wind resources, thereby enabling the demonstration and validation of the technical and economic viability of different concepts of energy converters, equipment and materials

[7] https://www.ri.se/en/test-demo/materials-in-marine-environment

prior to commercial development. HarshLab is an advanced floating laboratory installed at the BiMEP site in September 2018, for the evaluation of standardized probes and components in an offshore environment and is suitable for testing materials and solutions against corrosion, ageing and fouling in real and monitored conditions. A second version, with greater functionality for testing components and sub-systems, is under development and scheduled for deployment at BiMEP in the summer of 2021. BiMEP is also responsible for the Mutriku Wave Power Plant, the world's first multi-turbine wave energy facility which has been operating since July 2011. The Mutriku plant provides a testbed for air turbines. PLOCAN offers a test site for marine energy converters among other uses. It includes an offshore multipurpose platform providing workshops, laboratories, classrooms, training rooms and open working areas around a test tank to facilitate sea trials and launching vehicle to the sea.

Asked if they believed there was sufficient test infrastructure in their Member State to support the sector development, all Member States answered 'Yes'. In the UK there was a slight regional variance with Wales reporting it did not believe the test infrastructure in that country to be sufficient although it did point out that this would improve when Morlais and Pembrokeshire Demo Zones come online. Wales noted however that the middle step to this will still need to be addressed via EMEC as META is not grid connected. Spain pointed out that in general there are test infrastructures at high TRL (PLOCAN and BIMEP) and medium TRL (CEHIPAR, CEDEX, IHC, etc). However, Spain considers that more infrastructures for medium TRLs could be needed (test sites in real condition but protected). Test infrastructure for tidal, current, salinity gradient and thermal gradient technologies would also be needed. For validation of devices in arrays, Spain considers that test infrastructures could also be needed.

5.1.2.2 Supply Chain

For qualitative analyses of the sector, in 2019 Member States 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. In general, port facilities and grid infrastructure to support the sector in the next decade were generally considered good, as was the ocean energy (wave, tidal) supply chain in Member States. To avoid repetition, the 3rd Member State survey asked respondents if this was still their view. All Member States responded that this was still their view.

UK (Wales) commented that its facilities should be significantly improved with the progression of the floating wind opportunity in the Celtic Sea. Spain noted that in relation to the supply chain, it has good players in the offshore renewable energy sector, including Navantia (jackets, mooring structures), Vicinay Marine (mooring, anchoring), Windar (wind tower); Navacell (shipyard in the Basque country region). Netherlands reported a small clarification: In 2019, it stated that "Part of a supply chain which is partially complemented by suppliers from other sectors" but this should have been "Part of a supply chain which is well complemented by suppliers from other sectors".

Question 20 in the survey related to technical actions in the Member States, requested information on any studies carried out to review the infrastructure and supply chain needs of the ocean energy sector (including grid/port/research/test facility/supply chain).

In the UK (Scotland), reviews have been undertaken in relation to offshore wind, but not specifically ocean energy, and in UK (Wales) two studies into grid and ports have been commissioned in the past year, the findings and recommendations of which are still awaited. In UK (Wales), ORE Catapult has produced a supply chain analysis report - however this centres around floating wind. In the Flemish region of Belgium, the Blue Cluster is member of ELBE+ (European Leaders of Blue Energy) which undertakes several activities, including market analysis, supply chain analysis, etc.

In Spain, the elaboration of the Roadmap for the development of Offshore Wind and Ocean Energies, that the Spanish government is currently carrying out, is a study on reviewing infrastructures and supply chain needs of the ocean energy sector. In the framework of the draft of the Roadmap for the development of Offshore Wind and Ocean Energies in Spain, it is foreseen that measure 2.1 "Evaluation of port infrastructure for construction, assembly or export of components associated with marine renewable installations" will be included. The objective of this is to strengthen the country's logistics and port infrastructure capacities for the manufacture and assembly of offshore wind farms and marine energy devices. PROEXCA[8], in March 2020 launched a study for the improvement of the competitiveness of Canary Islands companies in the Marine Renewable Energy sector.

Ireland reported on two reviews; the "IWEA Position Paper on Offshore Grid Options"[9] and "Harnessing our potential - Investment and jobs in Ireland's offshore wind industry"[10].

There were no relevant publications to report in Germany, Denmark, Sweden, Portugal, Netherlands, Italy, Norway, France or Cyprus.

5.1.3 **Action 1.6.** Co-ordinate the development of standards and guidelines for technology evaluation and LCOE analysis.

The second OceanSET survey, undertaken prior to the publication of the IEA-OES's Evaluation and Guidance Framework for Ocean Energy Technology, indicated that while Member States were generally aware of the development of the framework most did not have sufficient knowledge of the framework's detail to determine whether it would be adopted in national support programmes.

With the publication of the framework in January 2021 shortly before this survey, Member States were asked to indicate whether the framework was considered suitable for adoption in their Member State's funding programmes:

- Nine Member States reported the framework to be suitable for adoption. France reported that it would consider the framework suitable for adoption, but noted that it did not know if the framework could be directly adopted within each organization and call for

[8] https://proexca.es/wp-content/uploads/2020/03/Estudio_cadena_de_valor_empresas_canarias_eolica_offshore_CMC-min.pdf.

[9] https://windenergyireland.com/images/files/20191204iweaoffshoregridoptionspositionpaper.pdf

[10] https://windenergyireland.com/images/files/final-harnessing-our-potential-report-may-2020.pdf

projects (French calls are not technology oriented). However, France considered that the teams who analyse and follow ocean energy projects could definitely use the framework.

- Two Member States (Germany and Netherlands) reported the framework was not suitable for adoption.
- Norway, Sweden and Belgium indicated that they did not know if the framework would be suitable.

Within the UK response there was a slight variation with Scotland and Wales considering the framework suitable for adoption in their countries, but England reporting it unsuitable. Scotland noted that the framework was being used to inform the development of the EuropeWave programme for wave energy technology development.

Netherlands called for salinity gradient and OTEC to be included in the framework in line with the framework's statement that "Future Task 12 activity will expand to incorporate other forms of ocean energy".

5.2 Financial Actions

5.2.1 Revenue Support

The provision of a revenue support mechanism for ocean energy is considered an important aspect for enabling precommercial deployments of wave and tidal technology. Although not captured in the financial actions of the implementation plan it is highly relevant to achieving the goals of the technology actions, particularly actions 1.2 and 1.4.

Questions 10 and 11 of the Member States survey asked Member States if they had provided revenue support (€/MWh) for ocean energy in 2020, and what form those revenue support mechanisms took. Six Member States (Germany, UK, Sweden, Netherlands, Spain and Cyprus) reported that they did provide revenue support for ocean energy in 2020. Within the UK response, Scotland and England confirmed that they had provided revenue support, whereas Wales reported it had not. Figure 3 below details these revenue support mechanisms in these six countries. Germany was the only country to describe its revenue support mechanisms available to ocean energy technology in 2020 as being an exclusive revenue support mechanism. Spain, Netherlands and Sweden described their revenue support mechanisms in 2020 as being ocean energy technology that competed against all technologies[11]. Cyprus and the UK described their revenue support mechanisms as being technology that competed against other emerging renewable technologies. It should be noted that within the UK response, England described its revenue support mechanism as ocean energy technology competes against all other renewable technologies, whereas Scotland described it as ocean energy technology competes against other emerging renewable technologies.

[11] "competed against" may be interpreted as "considered alongside". It does not imply necessarily that a competition occurs. "competed against all technologies" means that the revenue support mechanism makes no distinction between technologies.

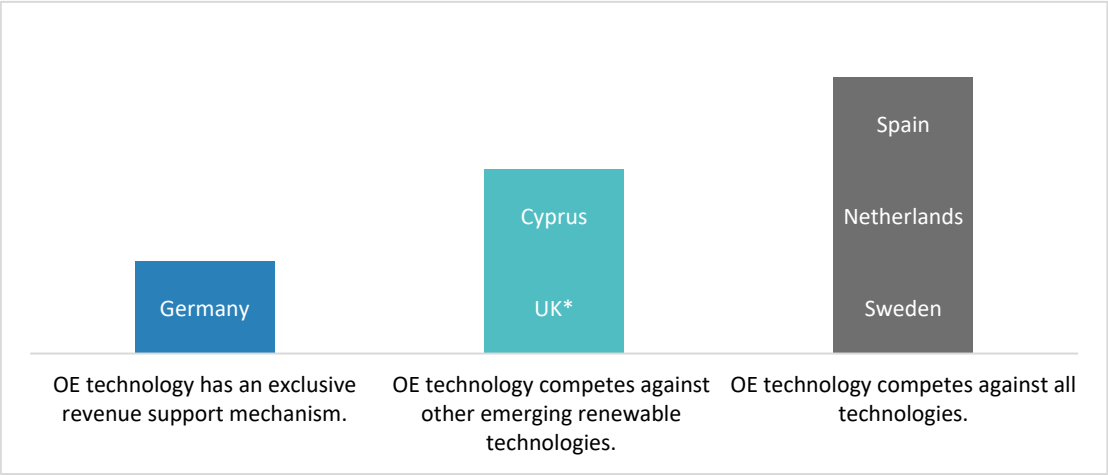


FIGURE 4: DESCRIPTIONS OF REVENUE SUPPORT MECHANISMS AVAILABLE TO OE TECHNOLOGY IN 2020

**Within the UK response, England described its revenue support mechanism as ocean energy technology competes against all other renewable technologies, whereas Scotland described it as ocean energy technology competes against other emerging renewable technologies.*

Question 12 asked for the value of the revenue support tariff available to ocean energy technology (€/MWh) in each of these Member States. Where wave and tidal technologies were treated differently, Member States were asked to provide separate details for each. Table 12 outlines these values.

The UK provided two responses from Scotland and England. The Scottish response noted that the support available for wave and tidal technologies in the UK was 320 €/MWh (281 £/MWh) and 260 €/MWh (225 £/MWh) respectively. Note, these values are the "administrative strike price" which represents the maximum support available; the actual support received is determined from a competitive auction process. It should also be noted that England responded that the wave figure was around 150 to 200 €/MWh. Sweden provided a mean value of 6.77 €/MWh for both wave and tidal but noted that the revenue support varies a lot throughout the year (market-based system). Spain's value of 200 €/MWh is a specific support tariff for MUTRIKU project. Cyprus did not provide a response to this question.

	Wave €/MWh	Tidal €/MWh
Germany	3.47 - 12.4	3.47 - 12.4
UK*	320	260
Sweden**	6.77	6.77
Netherlands	130	130
Spain***	200	
** The UK response are based on the administrative strike prices for the third CfD allocation round and therefore represent the maximum support available. The actual support obtained will depend on the outcome of a competitive auction process. England responded separately that its support for wave was around 150 to 200€/MWh.* ***Sweden provided mean values* ****Spain's value is a specific support tariff for the MUTRIKU project*		

TABLE 12: €/MWH VALUE OF THE REVENUE SUPPORT TARIFF AVAILABLE TO OE TECHNOLOGY IN MS

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

Member States were surveyed on whether they had created, or planned to create, an investment fund to support initial ocean energy farms. No Member State had created a dedicated investment fund. Within the UK, just Scotland reported it had created a general investment fund that would support initial ocean energy farms. In 2020, Scotland had a Renewable Energy Investment Fund which is now the Energy Investment Fund[12].

All other Member States reported that they had not created, nor planned to create an investment fund, apart from Portugal, Spain, Norway and Wales within the UK all of whom reported that they 'did not know'. Spain did not have accurate information, but did report that the Spanish government is working on New Financing Schemes. It is estimated about €200m public budget will support the technological development of marine renewable technologies in the period 2021-2023.

France reported that two tidal energy farms are requesting initial support and a feed in tariff (having submitted a project to the "*Systèmes énergétiques, villes et territoires durables*" project call). These two projects are being analysed and the Government is working on its position on this topic.

Member States were further asked if they would be willing to contribute to a European investment fund for ocean energy farms. Most Member States responded that they did not know, with only England within the UK response saying they would be willing to contribute to such a fund. UK Scotland however, reported they would not be willing to contribute to such a fund as any involvement would be dependent on Brexit rules. The Netherlands also said they would not be willing to contribute under the current state of play as additional studies are needed first, and then political support.

[12] https://www.gov.scot/policies/renewable-and-low-carbon-energy/energy-investment-fund/

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

There is no update for Action 2.2 from the data collected from the Member States, however, there has been a significant amount of work progressed by OceanSET in 2020 which is worthy of note here.

The Ocean Energy Forum's (OEF's) Strategic Roadmap (the "Roadmap") first proposed the concept of an EU-supported Insurance and Guarantee Fund (the "Fund") for the first ocean energy demonstration and pre-commercial deployment projects to address early stage risk for these projects. A well-designed insurance fund would mitigate the early risks associated with innovative technologies such as ocean energy, for which investors typically demand returns of 10-12%. The cost of financing can be a significant obstacle for wave and tidal developers, looking to break open a global market valued at €53bn per year. De-risking projects through an insurance fund could act as a significant catalyst for the scale-up of ocean energy. By enabling more projects to get off the ground, this will generate the data and experience necessary to meet investors' needs.

The OceanSET project commissioned and oversaw a study in the first half of 2021 to consider how such a fund might be established in practice. The study was led by renewable insurance brokers 'Renewable Risk Advisors' who won the tender for the work. The study conducted a desk study and multiple interviews with a wide range of representatives of wave and tidal technology developers, project developers, certifiers, insurers and investors/lenders. The findings were validated by a wide consultation with industry and public authorities.

The study concluded that such a Fund would make a significant and positive contribution towards the realisation of the SET Plan targets for ocean energy. The study provided detailed recommendations on how the Fund should be structured in practice. The draft report was disseminated to policy makers, and the final report will be disseminated once it has been approved by the European Commission.

The final report and associated dissemination will make an important step towards transforming the concept of the Insurance Fund into a concrete reality.

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

The EuropeWave project is the successful bid to the Horizon 2020 Work Programme's call for the joint action "European Pre-Commercial Procurement Programme for Wave Energy Research & Development" [LC-SC3-JA-3-2019]. The grant agreement was signed in early December 2020 with the project starting formally on 1 January 2021.

The preparation phase concluded in early July 2021 with the publication of the EuropeWave PCP request for tenders, the tender documentation pack being developed from deliverable D4.3 of the OceanSET project. The procurement phase concluded in December 2021 with the award of contracts to seven (7) wave energy converter developers. The contract implementation phase got underway at the beginning of January 2022. Phases 2 and 3 are scheduled to start in September 2022 and September 2023 respectively with deployments expected in spring 2025.

D4.3	Call Documentation for PCP	Complete set of call documentation ready for release upon commencement of a PCP programme. The deliverable will provide a set of funding call documents for a Wave Energy Europe PCP (Action 2.3 of the SET-Plan IP).

A fuller outline of EuropeWave is provided in the Financial Actions (Action 2.3) in the Gap Analysis in Section 6.2.2 below.

5.3 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 IP identifies two environmental actions. These include Actions 3.1 and 3.2 as outlined below.

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

Bespoke standards and certification practices are required so that project developers and investors have guarantees on machine reliability. They can also provide a basis to ease consenting processes.

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.

In the 2020 survey, developers involved in Stage 4-5/TRL 7-9 projects were asked two questions concerning technical specifications (i.e., draft technical standards) that are in development: firstly, if they are engaged with the process of creating technical specifications for ocean energy technology; and secondly, if they feel these are beneficial to the sector in its current state of development. The results are presented in Figures 4 and 5 respectively.

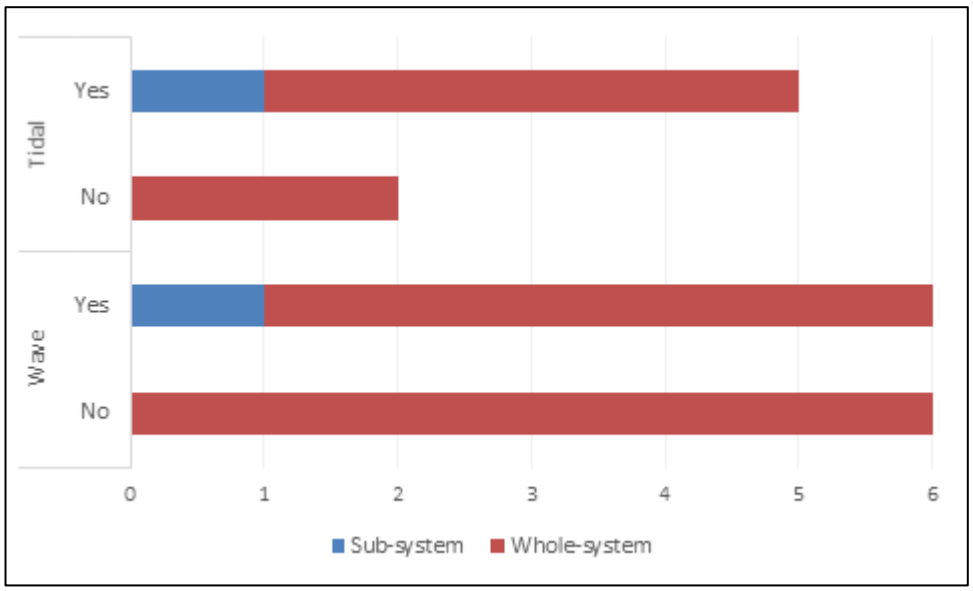


FIGURE 5: ENGAGEMENT OF DEVELOPERS OF TRL 7-9 PROJECTS IN THE CREATION OF TECHNICAL SPECIFICATIONS

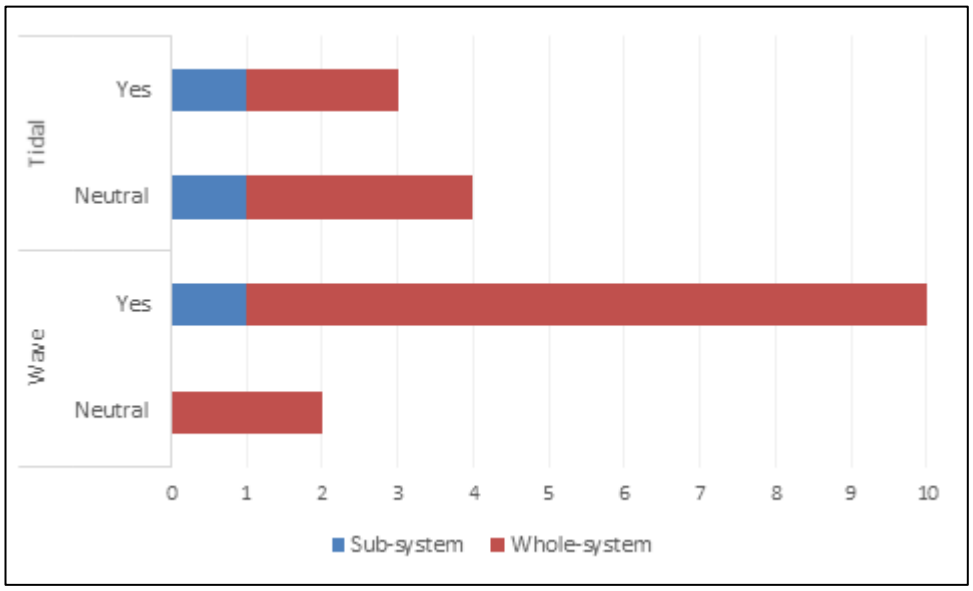


FIGURE 6: OPINION OF PROMOTERS OF TRL 7-9 PROJECTS ON THE BENEFIT TO THE SECTOR OF TECHNICAL SPECIFICATIONS

Most developers agree that technical specifications are beneficial, especially among the wave sector, most of them already being involved in their development, especially in the tidal sector.

Progressing the technical specifications and standards being developed by the *International Electrochemical Commission (IEC) Technical Committee (TC) 114 Marine energy*, and developing and sharing guidelines on optimal device operation and farm lay-out requirements is fundamental to moving the standardisation process forward.

Currently all but one Ocean Energy IWG members are also members of the IEC, with France, Netherlands, and the United Kingdom also being members of the IECRE. Together with the general acceptance seen among developers, this indicates an evolution towards standardisation and certification.

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

In the 2019 Member States survey, numerous in-depth questions were asked to gather information on Action 3.2. The questions focused on the consenting process including timeframes, permits required and activities in 2019. It was found that across Europe, there was a wish to reduce consenting times. To avoid repetition in the 2020 survey, Member states were asked if they had undertaken any steps in 2020 to speed up consenting in or outside test sites. As outlined in Table 13 below, only Portugal had taken steps to speed up consenting in and outside test sites, noting that there is an ongoing effort to simplify and speed up the consenting process. Within the UK, Wales reported it too had taken steps to speed up consenting inside test sites with META being consented to facilitate early-stage deployment testing and component and sub assembly testing.

Spain reported that, regarding the regulatory framework, no dedicated consenting process exists for ocean energy technologies but there are several legal documents affecting ocean energy projects. In June 2020 one was approved to begin the change towards a new legal framework: the Royal Decree-Law 23/2020, which approves measures in the field of energy and in other areas for economic reactivation. In addition, the Royal Decree 960/2020, of November 3, regulates the economic regime of renewable energies for electricity production facilities in Spain. Belgium and Sweden replied ‘no’ but commented that they were not aware of any steps.

Has your Member State undertaken any steps in 2020 to speed up consenting in or outside test sites?	Yes, inside test sites	No, inside test sites	Yes, outside test sites	No, outside test sites
Germany		x		x
UK	x *(Wales only)*	x		x
Belgium				x
Denmark		x		x
Sweden		x		x
Portugal	x		x	
Netherlands		x		x
Italy				x
Spain		x		x
Ireland		x		x
Norway		x		x
France		x		x

TABLE 13: MEMBER STATES STEPS IN 2020 TO SPEED UP CONSENTING IN OR OUTSIDE TEST SITES (YES/NO)

Section 2 of the survey collected data on consenting times from developers. In most cases the consenting time declared by the developer had a shorter duration than the average consenting time declared in survey Section 1 for that Member State, especially if inside a test site. Generally, testing centres count on previously agreed authorizations that accelerate the consenting process and reduce the number of permits to be delivered to the relevant authorities.

5.3.3 Marine Spatial Plans

The 3rd Member States survey returned significant updates on the Marine Spatial Plans (MSPs) in Member States. Just one Member State (Italy) reported not having published a Marine Spatial Plan, although it expected to shortly. Norway also did not have a Marine Spatial Plan. Table 14 below sets out links to each country's Marine Spatial Plan, along with commentary.

Member State Marine Spatial Plans	
Germany	https://www.bsh.de/EN/TOPICS/Offshore/Maritime_spatial_planning/maritime_spatial_planning_node.html
UK (Scotland)	https://www.gov.scot/policies/marine-planning/national-marine-planning/
UK (Wales)	https://gov.wales/marine-planning
UK (England)	https://www.gov.uk/government/publications/the-south-west-marine-plans-documents
Belgium	https://www.health.belgium.be/en/marinespatialplan.be
Denmark	https://www.dma.dk/Vaekst/Havplan/Pages/default.aspx
Sweden	Sweden is developing 3 distinct marine spatial plans for its territorial waters and exclusive economic zone. In December 2019 the Swedish Agency for Marine and Water Management submitted the plan proposals to the Swedish government. The government will adopt plans by March 2021 the latest.
Portugal	https://www.dgrm.mm.gov.pt/en/web/guest/as-pem-psoem
Netherlands	The National Water Plan provides a policy framework for MSP based on the Water Act and includes the Policy Document for the North Sea 2016-2021 as an appendix. The Policy Document includes the Netherlands' Maritime Spatial Plan and reflects the Dutch Government's policy choices for the North Sea. Every 6 years the plan is revised. The Netherlands is now in the 3rd cycle of MSP, preparing the programme for 2022-2027 which will be part of the new National Water Plan (NWP). The National Water Plan contains the North Sea Programme (Program Noordzee 2022-2027) under which the MSP will be incorporated by the Dutch government. Another process that is of relevance to MSP in the Dutch EEZ is the North Sea Agreement which contains agreements between national government and stakeholders (including offshore wind industry, fishing industry, etc.) up to 2030.
Italy	Publication pending (https://www.mit.gov.it/documentazione/pianificazione-dello-spazio-marittimo)
Spain	The Spanish government has carried out an exercise over the last 2 years with the agents of the different sectors involved to define the Maritime Spatial Planning. Recently (June 2021) the documents have been opened to public consultation. The contributions received for the first consultation of the MEOPs are being reviewed in detail by MITECO. It should be noted that the second public consultation procedure for the Strategic Environmental Assessment the maritime spatial planning began in July 2021.
Ireland	Published in 2021 https://www.gov.ie/en/publication/60e57-national-marine-planning-framework/
France	In France, each seaboard has its own strategic plan. They have been elaborated in 2019 and are now accessible to the general public for a final feedback before being validated by the French State by the end of 2021/beginning of 2022: https://www.merlittoral2030.gouv.fr/donnez-votre-avis

TABLE 14: MEMBER STATE MARINE SPATIAL PLANS

All but two Member States (Denmark and Spain) confirmed that their national Marine Spatial Plan included zones for ocean energy development. Denmark's MSP includes renewable energy but no further specification. Spain has no area classified as an ocean energy priority area. There is no restriction for R&D projects in Spain, but their MSP recommends using established R&D sites for ocean energy. Within the UK response, Wales also reported not having a Marine Spatial Plan, however strategic resource areas and locational guidance for ocean energy are anticipated soon. UK (Scotland) highlighted their MSP included a directive that proposals for commercial scale offshore wind and marine renewable energy development should be sited in preferred strategic locations identified in the Sectoral Marine Plan. The Scottish response noted that this preference should be taken into account by marine planners and decision makers if alternative development or use of these areas is being considered. Proposals are subject to licensing and consenting processes in Scotland.

While not explicitly mentioned in the MSP, ocean energy devices in Germany's Plan are theoretically included, although there has been no practical application so far. In Belgium, zones for renewable energy are foreseen, and Sweden's MSP includes test sites for ocean energy. In Portugal, renewable energy production is contemplated as a possible use and activity in the maritime space - in the water column and at the sea surface.

The Dutch Marine Spatial Plan 'Agenda voor het Waddengebied' was published in December 2020 and offers space for experiments under certain conditions for wave and tidal energy in the Waddenzee and near the North Sea coastline (p.51). Any potential upscaling of these experiments will only be possible if amongst others, it offers a substantial contribution to the objective of the Wadden islands to become self-supporting in their energy needs. The MSP document North Sea 2016-2021 identified initiatives for both wave/tidal energy, which entail knowledge of these technologies being developed and pilot projects being carried out. To identify the potential of these and other technologies, research was to be commissioned by the Dutch government during the planning period of the Policy Document on the North Sea (p.43). Relevant activities include research into the potential of new technologies, encouraging tida / wave energy and research into combined energy farms (p.114).

In Ireland, zones are to be developed under the Offshore Renewable Energy Plan by end of 2022. While in France, a zone dedicated to tidal energy is already included in the plan for Eastern Channel-North Sea, off Normandy's coastline.

6. Gap analysis

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

6.1 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 15 below:

Action Title	Details	Proposed IP Funding		
		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

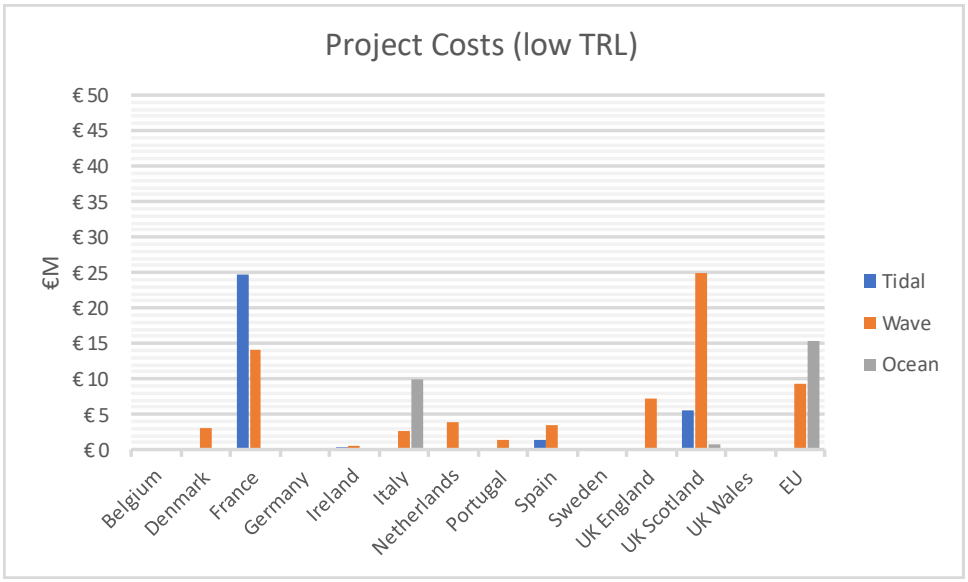
TABLE 15: Summary of Technical Actions in the Ocean Energy IP

Annex 8 of the SET Plan Ocean Energy IP provided estimated budgets for all actions over three periods: 2018-2020; 2021-2025; and 2026-2030. An assessment of progress in the Technical Actions related to

the tidal energy and wave energy subsectors, may be realised by comparing the estimated budget for the first period considered in the IP with the project costs of ocean energy projects reported as active in 2020, as indicated in Figure 6.

Differentiating the low TRL (TRL6 or less) and the high TRL (TRL 7 or more) projects reveals the focus in certain Member States is on high TRL projects predominantly irrespective of the subsector (Ireland, Portugal, Sweden, UK Wales) while in others the focus is on low TRL projects predominantly (Italy, UK England, UK Scotland) (Figure 6).

(a)



(b)

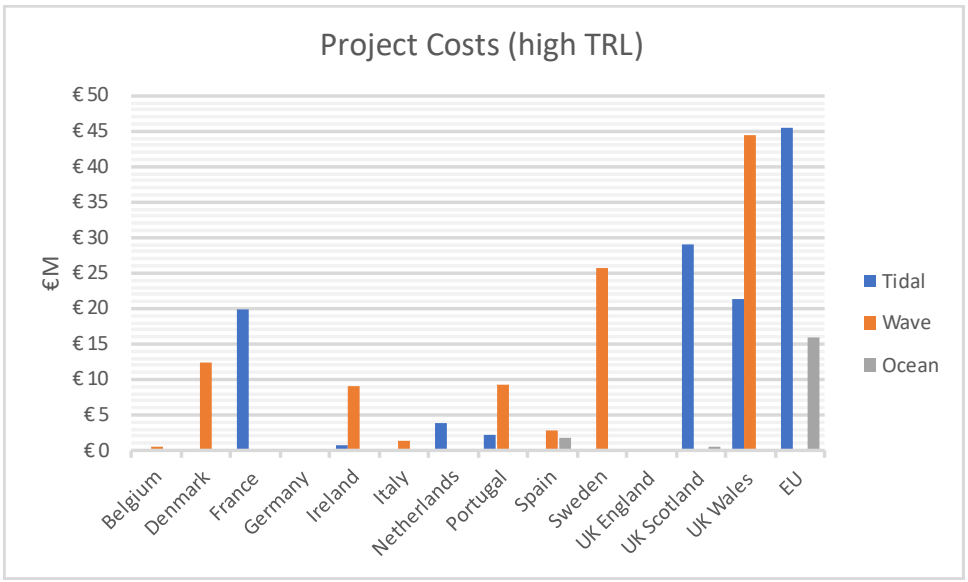
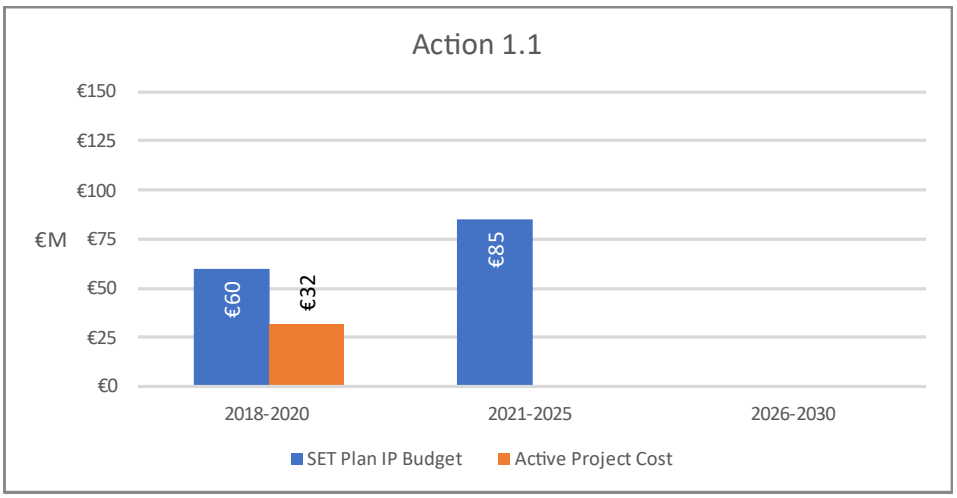


FIGURE 7: PROJECT COSTS FOR OCEAN ENERGY PROJECTS ACTIVE IN 2019, BY MS AND SUBSECTOR: (A) LOW TRL PROJECTS; (B) HIGH TRL PROJECTS.

The focus of Technical Actions 1.1 [13] and 1.2 [14] is low and high TRL tidal energy technology respectively, corresponding to projects summarised in Figure 7(a) and (b) respectively.

It appears that progress in the Technical Action 1.2 (high TRL projects) is on schedule (Figure 7(b)); the investment committed to projects active in the final year of the period marginally exceeding the estimated budget for the period. However, activity associated with Technical Action 1.1 (low TRL projects) remains lower than anticipated; the investment in projects being a little over half of the estimated budget.

(a)



(b)

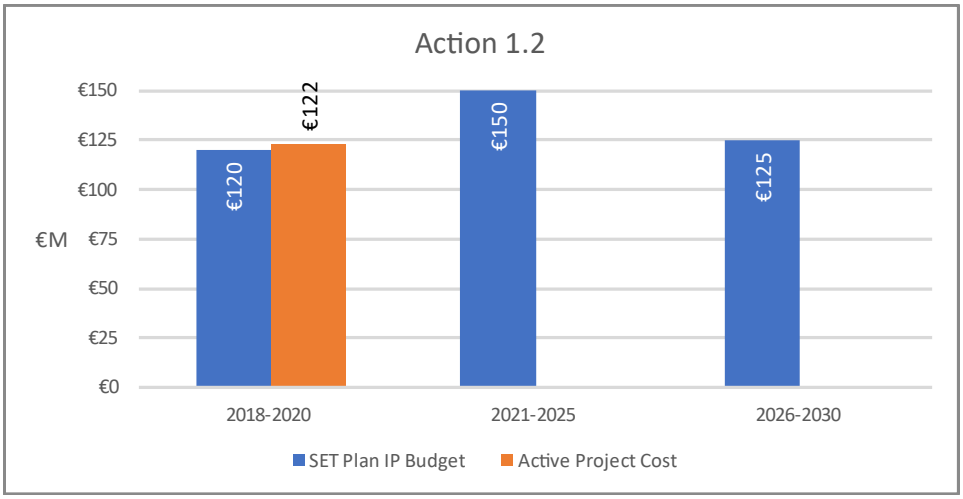


FIGURE 8: COMPARISON OF THE SET PLAN OCEAN ENERGY IP'S ESTIMATED PERIOD BUDGETS WITH PROJECT COSTS FOR TIDAL ENERGY TECHNOLOGY PROJECTS ACTIVE IN THE YEAR 2020 WITH A TARGET FINAL TRL OF:
(A) TRL 6 OR LOWER [TECHNICAL ACTION 1.1]; (B) TRL 7 OR GREATER [TECHNICAL ACTION 1.2].

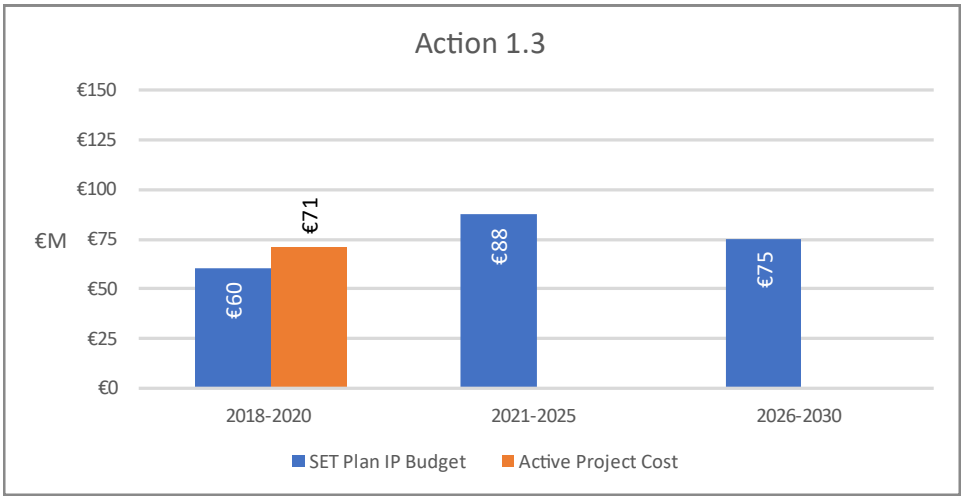
[13] Tidal energy technology device development and knowledge building up to TRL6.

[14] Tidal energy system (device and array) demonstrations and knowledge building in operational environment (TRL 7-9)

Similarly, the focus of Technical Actions 1.3 [15] and 1.4 [16] is low and high TRL wave energy technology respectively, as summarised in Figure 8(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)

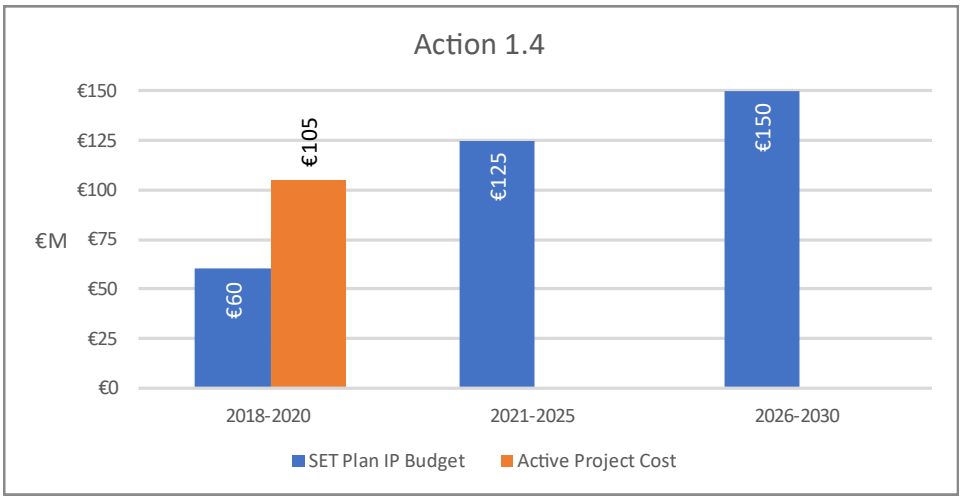


FIGURE 9: COMPARISON OF THE SET PLAN OCEAN ENERGY IP'S ESTIMATED PERIOD BUDGETS WITH PROJECT COSTS FOR WAVE ENERGY TECHNOLOGY PROJECTS ACTIVE IN THE YEAR 2020 WITH A TARGET FINAL TRL OF:
(A) TRL 6 OR LOWER [TECHNICAL ACTION 1.3]; (B) TRL 7 OR GREATER [TECHNICAL ACTION 1.4].

[15] Wave energy technology device development, including system demonstration and knowledge building (up to TRL6)

[16] Wave energy system (device and array) demonstration at large scale device and early demonstration array scale and leading onto large scale deployment (TRL 7-9).

6.2 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.

6.2.1 Technical Actions

An assessment of the capability gap is made for each of the technical actions in the SET Plan Ocean Energy IP.

1.1 Tidal Energy technology device development and knowledge building up to TRL6

Considering the project cost metric, the activity in this action is lower than was anticipated for this stage.

There continues to be an apparent lack of breadth in low TRL R&D activities. Only seven low TRL "system" projects were reported as being active in 2020 of which a single "whole-system" project accounts for 20.8€M of the reported €31.9m combined investment (some 65%).

It is noteworthy that 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 of the current projects.

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

The IP expects demonstration of full-scale tidal energy devices in the period 2019 to 2022 (three distinct technologies) with a progression to demonstration at array level in the period 2020 to 2025 (four distinct arrays).

The survey reveals 10 high TRL projects were active in 2020 with a reported investment of just under €122m.

Six of these projects were classified as 'whole-system' projects. Another project classified as a 'support' project is known to be supporting the deployment of several '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 120€M is targeting activities which are directly relevant to expectations of this Action. Furthermore, the expectation of three full-scale device deployments has been met.

1.3 Wave energy technology development and demonstration up to TRL 6

Activity in the low TRL category continues to predominate in the wave energy subsector. Low TRL activity outnumbers high TRL activity by almost 3-to-1 by distinct project count, with 40 distinct projects reported.

A technology focus predominates over supporting activities, with a moderate bias towards 'whole-systems' over 'sub-systems' in both categories. 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 21 distinct 'whole-system' projects represent an investment of approximately €53m with a further investment of over €16m in 17 distinct 'sub-system' projects.

1.4 Wave energy system demonstration and deployment TRL 7-9

17 distinct high TRL projects were identified as active in 2020 with a reported investment of some €105m. Again, this exceeds the investment anticipated in the first phase of the IP.

Projects had a technology focus generally; a single low project value 'support' project was reported. The 10 distinct 'whole-system' projects involved the development or deployment of 9 separate device concepts with nominal rated capacities ranging from single kW through a few hundred kW to single MW.

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

The SET Plan IP does 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. The increase in the number of device concepts at high TRL is a promising development that goes some way towards addressing the concern expressed in previous analyses that the number of concepts active in the high TRL category was arguably insufficient 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.

1.5 Installation, logistics and infrastructure

While previous surveys indicated the provision of test infrastructure was generally considered adequate, shortcomings had been reported, particularly for testing mid-TRL technology and sub-systems (both laboratory and open-water testing) and some Member States and Regions had expressed a desire for establishing local test facilities that at first sight appeared to replicate existing provision in another Member State or Region.

The most recent survey has identified the establishment of further test infrastructure:

Spain: A new open sea test site primarily for wave energy technology was authorized in July 2020 in Galicia, located in Punta Langosteira, A Coruña. Expansion of the HarshLab facility, a material test facility installed at the BiMEP test site, is planned. Detailed design was completed in 2020 with installation and commissioning scheduled for the summer of 2021.

Sweden: A new materials test facility was established at the Kristineberg Marine Research and Innovation Center in Fiskebäckskil.

UK Wales: Development of the Marine Energy Test Area (META), the Pembrokeshire Demonstration Zone (PDZ) and the Morlais demonstration zone for tidal stream technology continues.

Investment in further test infrastructure in new regions enhances European capacity and supports the development of the local supply chains in these regions. Furthermore, a greater

diversity of test centres can increase the options available for early demonstration projects.

To complement the addition of further test infrastructure, enhanced support for cross-border access to existing test infrastructure is required. A network of existing facilities that previously collaborated in access programmes such as MARINET and MARINET2 have secured support from the European Strategy Forum on Research Infrastructures (ESFRI) to establish a distributed Research Infrastructure for the offshore renewable energy sector. The MARINERG-i consortium is comprised of 13 partners from 12 countries (Germany, Belgium, Denmark, Spain, France, the Netherlands, Ireland, Italy, Norway, Portugal, the United Kingdom and Sweden) bringing together every European country with significant testing capabilities in the offshore renewable energy sector. By consolidating expertise, investment and access to infrastructures, the MARINERG-i Research Infrastructure will foster innovation across a variety of offshore renewable energy technologies and stages of development.

Member States continue to report 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 are envisaged or underway largely driven by the expansion of offshore wind developments (notably Spain and UK Wales).

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 to support specific requirements of the ocean energy sector. Only one Region, one hosting an open-water test site, considered there to be a dedicated supply chain.

Several Member States are actively considering the supply chain requirements to support installation and logistics in the ocean energy sector (Spain, UK (Wales), UK (Scotland)), 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.

A less positive view was expressed concerning the electricity grid with some Member States noting the need for significant upgrades.

1.6 Standards and guidelines for evaluation of wave energy technologies

The IEA-OES's Evaluation and Guidance Framework for Ocean Energy Technology, published in January 2021, is the culmination of international activity under the auspices of the International Energy Agency Ocean Energy Systems' Task 12 group. The IEA-OES's framework is considered as directly addressing the objective of Action 1.6 as it has the potential to ensure future wave energy innovation programmes apply a consistent approach for evaluating a set of agreed metrics using data derived from recommended engineering activities.

The IEA-OES's framework represents a certain amount of international consensus, having been the subject of significant stakeholder engagement with the IEA-OES contracting parties and all key user groups (policy makers, public and private investors, technology developers and standards institutions).

In general, the framework has been viewed favourably with most Member States

indicating preparedness to adopt it, although some remained neutral and a minority were explicitly against adopting it. There is also evidence of early adoption in development programmes.

The IEA-OES recognises that further work is required to communicate the benefits such a framework provides to the key user groups and the Task 12 group is pursuing a three-year follow-on work programme with objectives that address this point.

Progress with this Action is supported by DTOceanPlus, a Horizon 2020 funded project, which published an open-source suite of software design tools that assists the development and deployment of the ocean energy technology. One part of the suite of tools is the Stage Gate design tool that defines a set of stages, metrics and engineering activities for subsystems, devices and arrays that mirrors those of the framework. Within this defined process, the Deployment and the Assessment design tools deliver design and development support for technical evaluation of the specified metrics.

Overall, progress with this action is in line with the expectation of the IP. The IEA-OES's follow-on work programme will communicate the content of framework effectively at both Member States and Regional levels to encourage its uptake. However, a potential gap exists in supporting the uptake of the DTOceanPlus tools. Following completion of the project in August 2021, the tools are only supported on an ad hoc basis. Coordinated support to maintain and continue the development of the tool would be a valuable contribution to the ocean energy sector.

6.2.2 Financial Actions

An assessment of the capacity gap is made for each of the financial actions in the SET Plan Ocean Energy IP.

2.1 Creation of an investment fund for ocean energy farms

The IP envisages establishing a fund to provide flexible capital (debt, equity, grant, etc) to support initial deployments of ocean energy technology combining EU and Member State funding to leverage further private capital. A feasibility study was anticipated, followed by the creation of a fund in 2019 (assuming a favourable outcome).

There is no evidence of progress towards the creation of a collaborative investment fund, combining EU and Member State funds, dedicated to supporting initial deployments of ocean energy technology. The Member State survey indicated Member States are hesitant to express support for such a fund without more detailed information. This highlights the need for a suitably defined feasibility study.

Investment funds at a Member State/Regional level do exist although none are currently dedicated to ocean energy technology.

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

The IP envisages establishing a fund to assist the underwriting of the technology risks associated with initial ocean energy projects. A feasibility study was anticipated in 2019, followed by the creation of a fund in 2020 (assuming a favourable outcome).

A feasibility study was commissioned as part of the OceanSET project to consider the benefits of such a fund and to develop potential structures for its practical implementation. Through desk studies and interviews with representatives of wave and tidal technology developers, project developers, technology certifiers, insurers, investors and lenders, the study concluded a fund of this nature would be of significant benefit to the sector and identified and recommended potential structures for implementation. The findings of the study, completed in June 2021, were validated through consultation with industry and public authorities.

Although delayed in relation to the IP's anticipated timing, progress has been made with this action. It remains to disseminate the findings of the study amongst relevant stakeholders and to identify and establish an appropriate grouping of stakeholders to select and implement a preferred structure for the fund.

2.3 Wave Energy Europe Pre Commercial Procurement (PCP) action for development of wave energy technology

The IP envisages establishing a technology development programme, based on the precommercial procurement (PCP) model of innovation procurement, to develop innovative solutions to the technical challenges facing the wave energy sector in key sub-systems, systems and devices progressing their development to TRL 8.

The inclusion of a call for the joint action "European Pre-Commercial Procurement Programme for Wave Energy Research & Development" in the Horizon 2020 Work Programme [LC-SC3-JA-3-2019] addresses this action directly. The call resulted in a single award to the EuropeWave project [17]. The grant agreement was signed in early December 2020

[17] https://www.europewave.eu/

with the project starting formally on 1 January 2021.

The EuropeWave PCP is a €19.6m 53-month long programme that will finance the development of several wave energy converter designs through three distinct phases, progressively selecting only the most promising designs at each phase transition. The final phase will see three wave energy converter designs deployed and tested at the open water facilities of BiMEP and EMEC between the spring of 2025 and early summer 2026.

The EuropeWave project is one instance of the type of programme anticipated in this IP action, an instance with a single technical challenge for which innovative solutions are sought, that of developing whole-system prototypes.

As EuropeWave's budget is commensurate with that anticipated in the IP (once coordination costs are included), it is presumed that the action anticipated a single programme. Therefore, it may be deemed that the action has been delivered, pending the successful completion of the EuropeWave PCP.

However, consideration should be given to establishing further PCP programmes to address the technology challenges associated with key sub-systems and systems.

7. Communication and exploitation of results

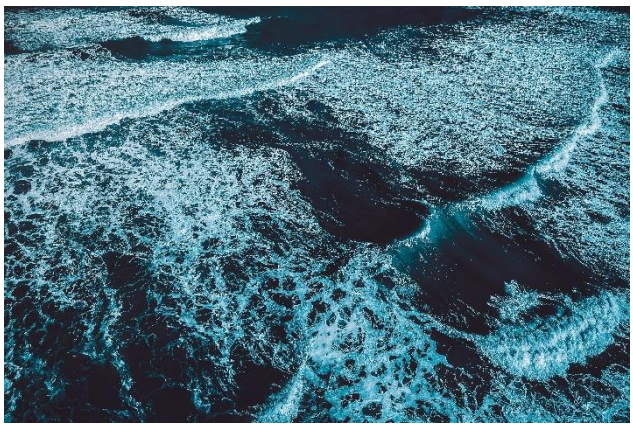
Culminating with the publication of the annual reports, dissemination and communication activities are a core part of the OceanSET project. They aim to promote project outputs and provide easily accessible information to key players in the European ocean energy field and beyond. The effectiveness of the communication and dissemination actions has been evaluated for each month using indicators defined at the beginning of the project.

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 third year of the project. The website is increasingly visited with an average of 212 monthly visits and 11 different public deliverables were downloaded every month. Posts on social networks showed a satisfactory rate of community engagement with 61 interactions generated per month. Two newsletters have been released on the OceanSET website and shared with all the partners for dissemination.

A video created for promoting the ocean energy IWG and the results of the OceanSET project has been showcased at several meetings including the 15th SET Plan Conference as well as on social media. E-workshops organised during this third year were successful, both in terms of the number of participants (121 for the dissemination workshop and 56 for the knowledge sharing workshop) and interest shown by the audience in the results of the mapping and analysis activities.

8. Review and Lessons Learned

As with the first and second OceanSET surveys, challenges remained in year three in obtaining accurate and comprehensive information regarding the activities and funding of ocean energy projects in Europe. While the quality of responses continues to improve, research can differ by timelines and prioritisation in each Member States making it difficult to carry out a like-with-like analysis of sector. This year's data collection process was improved by avoiding repetition of questions answered in previous years, and by asking instead if circumstances had changed since the previous survey. In addition, Member States were asked to update their Registry of Projects for 2020, rather than expecting the Member States to prepare their submission from the very beginning.



Again, the main challenge with the data gathered has been identifying annual funding provision. Member States have previously reported the total funding committed to projects which are frequently multi-annual projects. Further clarity was requested in year 3 with Member States requested to indicate the 2020 project cost, however, accompanying explanatory notes suggested that Member States are not always able to readily identify the per annum spend on individual projects. The cumulative Member State budget and spend for "Ocean Energy" in 2020 reported in Survey 1 of €28.7m and €30.9m are believed to underestimate the true total value of Member State support for the ocean energy sector.

Several Member States were not able to readily determine a specific ocean energy budget despite known support for the ocean energy sector (e.g., support is provided through general support instruments). Member States with an expressed interest in the ocean energy sector should be encouraged to establish mechanisms for recording and reporting their budget provision and actual spend.

Overall, there is evidence of widespread support for the ocean energy sector with 10 Member States mentioning national or regional programmes and calls for projects in 2020. However, 4 Member States represented on the IWG appear to have no coordinated programme to support the development of ocean energy sector, a situation that warrants further enquiry.

Of the 141 projects identified in the survey, 19 were European funded projects with a total project value of €158.1m and receiving €114.5m grant aid. These projects are typically cross-border collaborations involving the providers of testing infrastructure (laboratory and open-sea sites) providing subsidised access to their test facilities, cross-border collaborations involving multiple developers supporting pilot deployments of more than one technology. Only a minority of projects (2) were supporting the direct development of an individual technology.

14 projects were identified as being funded through the ocean energy ERA-NET cofund programme (OCEANERA-NET COFUND) with a total project value of €7.3m with grant aid of some €4.4m.

Both EU and ocean ERA-NET cofund projects indicate a capacity for collaboration in the ocean energy sector. Further efforts should be made to build on this capacity.

The overall funding of technical activity against the actions of the SET Plan Ocean Energy IP suggests that the sector continued to be appropriately supported in 2020. The investment committed to projects addressing Technical Actions active in 2020 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.

In the tidal energy subsector, several concepts are in active development. Six 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. The IP's ambition to deploy 3 full-scale device demonstrations in the period 2019-2022 appears to be on-track.

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.

As yet, there is no evidence of progress towards the creation of a collaborative investment fund, combining EU and Member State funds, dedicated to supporting initial deployments of ocean energy technology. Member States are hesitant to express support for such a fund without more detailed information. This highlights the need for a suitably scoped feasibility study into the viability of an appropriate form for a dedicated investment fund for ocean energy.

The publication of the IEA-OES Framework for the evaluation of ocean energy technology and the follow-on programme to promote it with key users maintains progress in the realisation and adoption of an EU-wide standard.

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	Complete
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	Complete
	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	Complete
	Deliverable 3.6	WES	Public/private financing ratio for each action, or bundle of actions, in the SET Plan IP	15/02/2022	Pending
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	Complete
	Deliverable 5.7	DGEG	3rd Annual monitoring and review report with recommendations	15/02/2022	Complete
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	Complete
	Deliverable 6.9	FEM	Report on 2nd Dissemination workshop	15/04/2021	Complete
	Deliverable 6.10	FEM	3rd Annual report on dissemination and communication activities	15/02/2022	Complete
	Deliverable 6.11	FEM	Publication and promotion of 3rd OceanSET Annual Report	15/03/2022	Complete
	Deliverable 6.12	SEAI	Report on project closure meeting	15/03/2022	Pending
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	Complete

Appendix B: Member States Survey – Questions

OceanSET sent a survey to all SET Plan Member States.

Question Number (* denotes mandatory question)	Question	Answer Format
Part 1 (General, National and Regional Policy information)		
1*	Please select the member state you are answering for?	Dropdown option
2	If you are only answering for a region in your Member State please let us know what region	Text answer
3*	What is the name of the organisation answering this survey?	Text answer
4*	Is there an assigned Ministry/Department owner at Government Level?	yes/no answer
5*	Compared to 2019, has your Member State updated existing, or created new, policies in 2020 which support the development and deployment of ocean energy technology?	yes/no If yes, please identify the policy or policies (policy name and URL).
6*	Did your Member State provide any funding for national/regional programme(s), in 2020 to support ocean energy?	yes/no If 'no' - skips to Q13
Part 2 (Financial Information)		
7*	What was the budget for ocean energy (wave,tidal) for your Member State in 2020 (€m)? Please see in the note above in summary of metrics that clarifies what to include in this answer	Text answer (€)

8*	What amount of public funding was actually spent on ocean energy (wave, tidal) in your Member State in 2020? (€M) Please exclude any private funding. This will help us understand the gap between your budget in 2020 and what was spent in 2020 for our gap analysis. Please ensure the amount here matches the amount you entered in column N 'Project spend in 2020 (€)' in the Registry of Projects excel sheet that accompanies this survey.	Text answer (€)
9	Identify national/regional funding programmes that were open during 2020 to support ocean energy technology development and demonstration projects (consider both programmes that exclusively targeted ocean energy technology and general technology programmes).	Please indicate the programme name, what TRL the fund is targeting, and a URL.
10*	Did your Member State provide revenue support (€/MWh) for ocean energy in 2020?	yes/no If 'no' - skips to Q13
11*	Which of the following best describes the revenue support mechanisms available to ocean energy technology in 2020 in your country	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
12	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.	Wave €/MWh: Tidal stream €/MWh:

Part 3 (Technical Information)		
13*	The IEA-OES published an internationally supported framework (URL) for the evaluation of ocean energy technology performance. In your opinion, is the framework suitable for adoption in your Member State's funding programmes?	yes/no tick box answer If you would like to comment on IEA_OES Task 12, please do so here.
14*	Have there been any changes to the test site facilities in your country for ocean energy (prototypes) in 2020 compared to 2019?	yes/no If 'no' - skips to Q18
15	Are there test site facilities in your country for ocean energy (prototypes)?	yes/no
16	Please tick the type(s) of testing infrastructure in your Member State. Multiple answers can be chosen.	Tank / Open Ocean Test Facility / None
17	Please indicate up to which TRL these test site facilitates	Free text box
18*	Do you believe there are sufficient testing facilities in your Member State to support the sector development?	yes/no answer If no please indicate where you believe the gaps are
19*	In 2019, port facilities and grid infrastructure to support the sector in the next ten years were generally considered good, as was the ocean energy (wave, tidal) supply chain in Member States. Is this still your view?	yes/no If you would like to comment on changes to these in 2020, please do so here.
20	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)	Free text box to provide link to studies
21*	Has your Member State undertaken any steps in 2020 to speed up consenting in or outside testing sites.	Yes, inside test sites No, inside test sites Yes, outside test sites No, outside test sites Please provide details
Part 4 (Environmental and European information)		
22*	Has your Member State developed a national Marine Spatial plan?	yes/no If yes, please provide details of the plan including a link.

23	If you answered yes to the question above, please let us know if your national Marine Spatial Plan included zones for ocean energy development.	yes/no Please provide further details here.
24*	Has your Member State created, or plans to create, an investment fund to support initial ocean energy farms?	Yes - a dedicated investment fund Yes - a general investment fund that would support initial ocean energy farms No Don't know If yes, please provide details.
25*	Would your Member State be willing to contribute to a dedicated European investment fund for ocean energy farms?	yes/no/don’t know If you would like to comment, please do so here
26	If you weren't able to answer these questions, please let us know why.	We do not have this data The questions were too detailed Other (please specify)

Appendix C: Developers Survey – Questions

This set of questions was distribued to Developers with ocean energy projects operational in 2020 and 2021 at pre-commercial stage (Stage 4 and 5 / TRL 7+)

Question Number (* denotes mandatory question)	Question	Answer Format
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.	Name of 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 in 2020 and/or 2021.	Start date - End date (mm/yyyy – mm/yyyy)
3*	Please confirm the technology development stage **at the start of the project.**	Dropdown Options 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)
4*	Please confirm the target technology development stage **on completion of the project.**	Dropdown Options 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

	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.	representative environment (TRL 5-6) Stage 4 - Commercial-scale demonstration (TRL 7-8) Stage 5 - Commercial-scale demonstration in a small array (TRL 9)
5*	How is the project being delivered (select one)?	Single entity; Consortium (partnership): single MS; Consortium (lead contractor / sub-contractor): single MS; Consortium (partnership): multi-MS; Consortium (lead contractor / sub-contractor): multi-MS. If this project is being led by another organisation, please provide their name
6	If the project is being delivered as a consortium, which type of organisations are involved in the consortium?	Multiple answers can be chosen Industrial R&D; Academic R&D; Manufacturing; Marine operations; Other (please specify)
7*	Does the project involve technology transfer from another technology sector into the wave or tidal sector?	Yes, please specify the technology sector / No
8*	What is the overall cost of the project (include all partners costs, in-kind costs, etc.)?	sliding range from €1m to €30m (€)
9	If you know the exact cost or would like to make a clarification, please provide it below	Text box
10	How is the project funded? Please provide the percentage split from the options below and ensure the sum of your responses equals 100%	dropdown options public sector funds % partners funds % debt % other % (please specify)

11	If you answered 'Other' to question 10 above, please specify.	Text box
12	Please select the type of public funding provided. Tick all that apply.	tick box: Member state funding EU funding Private funding Which public sector funding programmes provided the public sector funding?
13	If you have additional information to add on your funding model, please provide it here	Text box
14*	Please select your technology type (type of device) and installation type.	Dropdown options **Technology type:** 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 Other (please specify) **Installation types:** Floating - Slack moored Floating - Taut moored Floating - Semi-taut moored Fixed – Monopile

		Fixed - Jacket structure Fixed - Gravity base Fixed - Shoreline mounted Other (please specify) If other please specify here and indicate wave or tidal
15	Where the project is deploying devices, please provide the following information.	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).
16	Where capacity is being installed in phases, report each phase separately (e.g. phase 1: 0.25MW, 1 machine, June 2020, 36 months; Phase 2: 0.5MW, 2 machines, May 2021, 24 months).	Text box
17	For device deployment projects, how long did the complete consenting process take (i.e. from submission of application to receipt of licence)?	Text box
18*	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 (€/W) OPEX (€/W per annum) Average annual energy production (MWh per annum) Availability (%) Design life (years) *(See SurveyMonkey for ranges)*
19*	Please provide information on the target LCOE (€/MWh) in this project *All information provided will be anonymised and aggregated to ensure the respondent's privacy is protected.*	Text box
20	What further supports could your funding provider offer to enhance the outputs of your project?	Text box
21	Please provide information on the technical aspects of the project to help us understand the metrics that were **achieved**. Your answer will help the European Commission's design its future funding calls.	CAPEX (€/W) OPEX (€/W per annum) Average annual energy production (MWh per annum)

	All information provided will be anonymised and aggregated to ensure the respondents privacy is protected.	Availability (%) Design life (years) *See SurveyMonkey for ranges*
22	Please provide information on the **achieved** LCOE (€/MWh) in this project *All information provided will be anonymised and aggregated to ensure the respondent's privacy is protected.*	Text box
23	How much energy did this project export to the grid in 2020 (MWh)?	Text box
24*	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.	Dropdown options: • 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, • Development of novel wave energy devices, • 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,

		• Open-data repository for ocean energy, • Improvement of the environmental and socioeconomic impacts of ocean energy, • Standardisation and certification, • Other (please specify).
25	Technical specifications (i.e. draft technical standards) for ocean energy technology are in development. As a technology developer, are you engaged with the process of creating these specifications?	Yes, fully engaged Yes, somewhat engaged No
26	Do you feel technical specifications benefit the sector in its current state of development?	Yes No Neutral If you would like to comment, please do so here:
27	How do you carry out the performance certification of your device?	1st party application of relevant standards (developer) 2nd party application of relevant standards (client/investor) 3rd party application of relevant standards (accredited certification and test bodies) None of the above (please clarify)
28	What topics would you like to see included in upcoming Research and Innovation funding calls for the development of OE devices? (Please specify if your suggestion is for wave, tidal or both)	Text box
29	What other actions would you like to see the European Commission take to progress the OE sector? (please specify if your suggestion is for wave/tidal/both)	Text box
30	If you couldn't answer a question above (due to insufficient information, or not understanding the questions, etc.) please let us know which question and why.	Text box

Appendix D: Member States Survey Answers

Q1	Member State (MS)	**Germany**	**UK**	**UK**	**UK**	**Belgium**	**Denmark**	**Sweden**	**Portugal**	**Netherlands**	**Italy**	**Spain**	**Ireland**	**Norway**	**France**	**Cyprus**
Q2	If you are only answering for a region in your MS please let us know what region		Scotland	Wales	England	Flemish region						Madrid				ss
Q3	Name of the organisation answering this survey?	Fraunhofer IEE	Scottish Enterprise	MEW	Offshore Renewable Energy Catapult	Flemish government, department Economy, Science & Innovation	Energistyrelsen	Swedish Energy Agency	DGEG	Ministry of Economic Affairs and Climate Policy	ENEA	CDTI	SEAI	Ministry of Petroleum and Energy	ADEME (French Agency for Ecological Transition)	ss
Q4	Is there an assigned ministry/department owner for OE at government level?	No	Yes	No	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes
Q5	Compared to 2019, has your MS updated existing, or created new, policies in 2020 which	No	No	No	No	Yes	No	No	Yes	No	No	Yes	No	No	No	No

	support the development and deployment of OE tech?															
	If yes, please identify the policy or policies (policy name and URL).	Belgium: End 2017 the Flemish government approved the setup of the "Blue Cluster" to stimulate the active and sustainable innovation cooperation between companies, knowledge institutes, sector organisations, public actors, with focus on the "Blue economy" in the broadest sense (including innovation in Ocean Energy) and in view of competitiveness growth for a large group of Flemish companies. Portugal: NECP2030 https://ec.europa.eu/energy/sites/default/files/documents/staff_working_document_assessment_necp_portugal_en.pdf Spain: During 2020 the Spanish Government continued working in the Energy and Climate National Integrated Plan 2021-2030 (PNIEC), and the Energy Transition and Climate Change Law. Both documents fixes the framework to develop new energy infrastructures, the energy source targets for 2030 and new rules to boost renewable energy in general and, ocean energy specifically. The PNIEC, sets for ocean energy the target of reaching 25 MW of installed capacity for 2025 and 50 MW for 2030. The renewable energy contribution is expected to reach 42% in 2030. The Basque Government approved in 2016 its Energy Strategy for 2030, which included a specific initiative to speed up technology and commercial development for marine energy and set a target of 10 MW by 2030. In April 2020 the Ministry for the Ecological Transition opened a public consultation process of the Roadmap for the development of Offshore Wind and Ocean Energies in Spain. In a first step, the roadmap establishes the need of high TRL development support programs, to help the sector to reach a certain maturity prior to support. In a second step, the roadmap bid for demonstration projects. Regarding the use of marine space, the Government is writing the maritime space management plan. It is comprised by five management plans must be developed, one for each of the five marine areas established in Law 41/2010, on the protection of the marine environment. A first draft has been written and was under public consultation during 2020. It is currently being reviewed by the Ministry, together with the Autonomous Regions. The cartographic information contained in these documents can be consulted in the InfoMAR geographic viewer, Marine Environment Information System, also currently under construction http://infomar.cedex.es. Public consultation: https://www.miteco.gob.es/en/prensa/ultimas-noticias/El-MITECO-inicia-la-audiencia-e-informaci%C3%B3n-p%C3%BAblica-de-los-planes-de-ordenaci%C3%B3n-del-espacio-mar%C3%ADtimo-de-las-cinco-demarcaciones-marinas-espa%C3%B1olas-/tcm:38-527481 The Spanish Strategy of Science, Technology and Innovation 2021-2027 is developed within the scope of the national government through the multi-annual State Plan for Scientific and Technical Research and Innovation (PEICTI), which establishes its scientific-technical and social priorities. The first PEICTI covering the period 2021-2023 was worked during 2020 and approved by the Council of Ministers on 15th June 2021.														
Q6	Did your MS provide any funding for national/regional programme(s) in 2020 to support OE?	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No
Q7	What was the budget for ocean energy (wave, tidal) for your Member State in 2020 (€M)?	ongoing projects - not specified	€16m			no earmarked budget	0	€2.1M The budget for OE also covers osmotic power and temperatur	Not a specifc figure for ocean energy.		2259625	3,0	€3.5m		1.8	

								e gradient power.								
Q8	What amount of public funding was actually spent on ocean energy (wave, tidal) in your MS in 2020? (€M) excluding private funding.	ongoing projects - not specified	€16m			0,216 (IEA reported 2020 budget estimated)	2,3	€5.3M	Unsufficient data.		1.835.125	1,168	€2.316m		1.8	
Q9	Identify national\regional funding programmes that were open during 2020 to support OE tech dev and demonstration projects.	7. Energieforschungsprogramm der Bundesregierung	Wave Energy Scotland, Saltire Tidal Fund, Ocean ERANet			Spearhead Cluster programme	EUDP + Innovationsfonden	Marine Energy Conversion programme, Pilot and demonstration programme	EEA Grants Blue Growth Programme		POR(Regional Funding), Local Academic Funding	See comments below	none		Call for projects "Systèmes énergétiques, villes et territoires durables"	
	Comments	Spain: CDTI- R&D Programme based on a non-competitive call for R&D projects carried out by private companies. Open call to all technologies and throughout the year. R&I projects are approved provided that they meet internal assessment criteria. The Basque Energy Agency (EVE) launched a new call of its “Demonstration and validation of emerging marine renewable energy technologies” programme in 2020. As previous calls, the programme has a budget of 2,5 M€ for a maximum of 3-year duration projects. The AEI - State funding agency for research, launched during 2020 a specific call for research projects at low TRL whose evaluation results are still pending of publication. This call was launched in the last quarter. of 2020.														
	TRL	not specified	4-6, 6-7, 3-6			TRL 2-7	1-8	TRL 3-7, TRL 5-8	1-9		7-8	CDTI: TRL 5-7; EVE: TRL up to TRL7-8			5	
	URL	Link					EUDP Innovationsfonden	Marine Energy Conversion programme	Link			CDTI EVE			Link	

								Pilot and demonstration programme								
Q10	Did your MS provide revenue support (€/MWh) for OE in 2020?	Yes	Yes	No	Yes	No	No	Yes	No	Yes	No	Yes	No	No	No	Yes
Q11	Which of the following best describes the revenue support mechanisms available to OE tech in 2020 in your country.	OE tech has an exclusive revenue support mechanism.	OE tech competes against other emerging renewable technologies.		OE tech competes against all other renewable technologies.			OE tech competes against all other renewable technologies.		OE tech competes against all other renewable technologies.		OE tech competes against all other renewable technologies.				OE tech competes against other emerging renewable techs.
Q12	What is the value of the revenue support tariff available to OE tech (€/MWh)? Wave	3.47-12.4	281 (this is a strike price and therefore a maximum, actual value based on competitive process)		c150 to 200			Mean value 6.77 EUR (The revenue support varies a lot throughout the year (market-based system))		130/MWh		200 €/MWh (specific support tariff for MUTRIKU project)				
Survey Q12	What is the value of the revenue support tariff available to	3.47-12.4	225 (this is a strike price and therefore a maximum					Mean value 6.77 EUR (The revenue support varies a lot		130/MWh						

	OE tech (€/MWh)? Tidal		, actual value based on competitive process)					throughout the year (market-based system))								
Q13	In your opinion, is the IEA-OES framework for the evaluation of OE tech performance suitable for adoption in your MS funding programmes	No	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes
	If you would like to comment on the IEA-OES Task 12, please do so here.	UK (Scotland): Will be adopted in EuropeWave which was discussed in 2020 Belgium: I do not know Sweden: It could perhaps be, but would need to look into it more before saying yes or no to this question (this survey did not have an option for Don´t know). Netherlands: Please include salinity gradient and OTEC, as it is in line with the statement that "Future Task 12 activity will expand to incorporate other forms of ocean energy" Norway: Unfortunately, I couldn't access the document through this link so I can't assess whether this would be suitable fro adoption in any of our funding programmes. France: I do not know if the framework could be directly adopted within each organization and call for projects (our calls are not technology oriented), but the teams who analyze and follow ocean energy projects could definitely use the framework.													
Q14	Have there been any changes to the testing facilities in your country for ocean energy (prototypes) in 2020 compared to 2019?	No	Yes	Yes	No	No	No	Yes	No	Yes	No	Yes	No	No	No	Yes

Q15	Are there test site facilities in your MS for OE (prototypes)?		Yes	Yes				Yes		Yes		Yes				
Q16	Please tick the type(s) of testing infrastructure in your MS.		Open Ocean Test Facility (and tank – see below)	Open Ocean Test Facility				Open Ocean Test Facility (and tank – see below)		Tank (and Open Ocean Test Facility – see below)		Open Ocean Test Facility (and tank – see below)				
Q17	Please indicate up to which TRL these test sites facilitate.		Up to TRL8 (multiple choice unavailable, both tank and open sea available)	4-6				See comments below		1-9 (I wasn't able to tick both tank and open ocean test facility in question 13)		See comments below				
	Additional comments to Q17	Sweden: Tank (SSPA) TRL 3-5, Open Ocean Test Facility (Islandsberg, Uppsala University, part of Marinet 2)) TRL 5-8, Test Facility for stream power (in a river in Söderfors, Uppsala University) TRL 7-8. New test site facility: testbed for materials in marine environment has been inaugurated in 2020 (https://www.ri.se/en/test-demo/materials-in-marine-environment, RISE) Spain: In Spain, there are tanks and Open Ocean Test Facilities. (I cannot click multiple answers in question 16). A new open sea test site for MRE in Galicia was authorized in July 2020. The site is located in Punta Langosteira (Arteixo), close to the outer harbour of A Coruña. It provides a location for the temporary anchoring and the deployment of marine energy devices to test and validate them under real operating conditions in the open sea. The Galicia test site is an ocean research, demonstration and operation of marine energy converters under real conditions in open waters, mainly wave energy converters. The test site allows to validate designs, components and materials of the devices, and to assess the technical and economic feasibility of the energy converters. BiMEP is an open sea test area located off the coast of Armintza, in the province of Bizkaia. Operating since June 2015, BiMEP offers technology developers an offshore area with suitable wave and wind resources, thereby enabling the demonstration and validation of the technical and economic viability of different concepts of energy converters, equipment and materials prior to commercial development. HarshLab is an advanced floating laboratory for the evaluation of standardized probes and components in an offshore environment. It is suitable to test new materials and solutions against corrosion, ageing and fouling in real and monitored conditions. The first version of HarshLab was installed at BiMEP in September 2018. It can handle up to 125 samples in atmospheric zone, 320 in splash and 320 in immersion (765 probes in total). Since its commissioning in September 2018, HarshLab hosted														

		more than 500 samples coming from 19 industrial companies, including materials from H2020 projects, such MARINET2, NEWSKIN and NEMMO. Mutriku Wave Power Plant, the first multi-turbine wave energy facility in the world, has been integrated in BiMEP infrastructure, being now a second facility of BiMEP. The plant was connected to the grid in July 2011, reaching a record of cumulative energy from waves powered to the grid of more than 2 GWh, milestone that was reached in February 2020. PLOCAN offers a test site for marine energy converters among other uses. It includes an offshore multipurpose platform providing workshops, laboratories, classrooms, training rooms and open working areas around a test tank to facilitate sea trials and launching vehicle to the sea. In autumn 2020 WAVEPISTON deployed its first full scale device at PLOCAN.														
Q18	Do you believe there are sufficient testing facilities in your MS to support the sector development?	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
	If no, please indicate where you believe the gaps are	UK (Wales): These will improve when Morlais and Pembrokeshire Demo Zones come online - however the middle step will still need to be addressed via EMEC as META is not grid connected Spain: In general there are test infrastructures at high TRL (PLOCAN and BIMEP) and medium TRL (CEHIPAR, CEDEX, IHC,…). However, we consider that more infrastructures for medium TRLs could be needed (test sites in real condition but protected), and test infrastructure for tidal, current, salinity gradient and thermal gradient technologies would be needed. For validation of devices in arrays, we consider that test infrastructures could also be needed														
Q19	In 2019, port facilities and grid infrastructure to support the sector in the next ten years were generally considered good, as was the OE (wave, tidal) supply chain in MS. Is this still your view?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
	If you would you like to comment on	UK (Wales): These should be significantly improved with the progression of the floating wind opportunity in the Celtic Sea Netherlands: In 2019, it was stated that 'Part of a supply chain which is partially complemented by suppliers from other sectors' while this should be "Part of a supply chain which is well complemented by suppliers from other sectors"														

	changes to these in 2020, please do so here.	Spain: Related to the supply chain: We have good players in the offshore renewable energy sector: Navantia (jackets, mooring structures), Vicinay Marine (mooring, anchoring), Windar (wind tower); Navacell (shipyard in the Basque country region).														
Q20	Please identify any recent studies your Member State has done to review infrastructure and supply chain needs of the ocean energy sector (including grid/port/research/test facility/supply chain)	Germany: none UK (Scotland): reviews undertaken in relation to offshore wind, but not specifically ocean energy. Wales: WG has commissioned 2 studies into grid and ports in last 12 months - the findings/ recommendations are still awaited. ORE Catapult has produced a supply chain analysis report - however this centres around floating wind Belgium: the Blue Cluster is member of ELBE+ (European Leaders of Blue Energy). ELBE+ undertakes several activities, among which market analysis, supply chain analysis etc. Sweden: Nothing new to report since last OceanSET survey Portugal: No recent (2019-2020) studies at governmental level. Netherlands: No studies have been done on behalf of the government. Spain: The elaboration of the Roadmap for the development of Offshore Wind and Ocean Energies in Spain, that currently the Spanish government is carrying out, supposes itself a deep study on reviewing infrastructures and supply chain needs of the ocean energy sector. In the framework of the draft of the Roadmap for the development of Offshore Wind and Ocean Energies in Spain, it is foreseen the inclusion of the measure n.2.1 “Evaluation of port infrastructure for construction, assembly or export of components associated with marine renewable installations”, whose objective is to strengthen the country's logistics and port infrastructure capacities for the manufacture and assembly of offshore wind farms and marine energy devices. PROEXCA, launched in March 2020 a Study for the improvement of the competitiveness of Canary Islands companies in the Marine Renewable Energy sector. https://proexca.es/wp-content/uploads/2020/03/Estudio_cadena_de_valor_empresas_canarias_eolica_offshore_CMC-min.pdf Ireland: IWEA Position Paper on Offshore Grid Options https://windenergyireland.com/images/files/20191204iweaoffshoregridoptionspositionpaper.pdf ; Harnessing our potential - Investment and jobs in Ireland’s offshore wind industry : https://windenergyireland.com/images/files/final-harnessing-our-potential-report-may-2020.pdf														
Q21	Has your MS taken any steps in 2020 to speed up consenting in or outside test sites?			Yes, inside test sites					Yes, inside test sites							
		No, inside test sites	No, inside test sites		No, inside test sites		No, inside test sites	No, inside test sites		No, inside test sites		No, inside test sites	No, inside test sites	No, inside test sites	No, inside test sites	
									Yes, outside test sites							

		No, outside test sites	No, outside test sites	No, outside test sites	No, outside test sites	No, outside test sites	No, outside test sites	No, outside test sites		No, outside test sites	No, outside test sites	No, outside test sites	No, outside test sites	No, outside test sites	No, outside test sites	
	Please provide details of any changes.			META has been consented to facilitate early stage deployment testing and component and sub assembly testing		I do not know		not aware of any changes	There is an ongoing effort to simplify and speed up the consenting process.			See comments below				
		Spain: Regarding the regulatory framework, no dedicated consenting process exists for ocean energy technologies in Spain but there are several legal documents affecting ocean energy projects and in June 2020 a new one was approved to start the change to a new legal framework: Royal Decree-Law 23/2020, of June 23, which approves measures in the field of energy and in other areas for economic reactivation. In addition, the Royal Decree 960/2020, of November 3, regulates the economic regime of renewable energies for electricity production facilities														
Q22	Has your Member State developed a national Marine Spatial Plan?	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	
	If yes, please provide details of the plan including a link.	Germany: https://www.bsh.de/EN/TOPICS/Offshore/Maritime_spatial_planning/maritime_spatial_planning_node.html ; jsessionid=DAE14C8A6D93FFB0C6F2905B5A0633A2.live21323 UK (Scotland): https://www.gov.scot/policies/marine-planning/national-marine-planning/ UK (Wales): https://gov.wales/marine-planning UK (England): https://www.gov.uk/government/publications/the-south-west-marine-plans-documents														

		Belgium: https://www.health.belgium.be/en/marinespatialplan.be Denmark: https://www.dma.dk/Vaekst/Havplan/Pages/default.aspx Sweden: Sweden is developing three distinct marine spatial plans for its territorial waters and exclusive economic zone. In December 2019 the Swedish Agency for Marine and Water Management submitted the plan proposals to the Swedish government. The government shall adopt plans by March 2021 the latest. Portugal: https://www.dgrm.mm.gov.pt/en/web/guest/as-pem-psoem Netherlands: The National Water Plan provides a policy framework for MSP based on the Water Act and includes the Policy Document for the North Sea 2016-2021 as an appendix. The Policy Document includes the Netherlands' Maritime Spatial Plan and reflects the Dutch Government's policy choices for the North Sea. Every 6 years the plan is revised. The Netherlands is now in the 3rd cycle of MSP, preparing the programme for 2022-2027 which will be part of the new National Water Plan (NWP). The National Water Plan contains the North Sea Programme (the Program Noordzee 2022-2027) under which the MSP will be incorporated by the Dutch government. In addition, there is another process in the Netherlands that is of relevance to MSP in the Dutch EEZ: the North Sea Agreement that contains agreements between national government and stakeholders (including offshore wind industry, fishing industry, etc.) up to 2030. (Italy subsequently reported that it's MSP is pending: https://www.mit.gov.it/documentazione/pianificazione-dello-spazio-marittimo) Spain: Yes, the Spanish government has carried out an exercise over the last 2 years with the agents of the different sectors involved to define the Maritime Spatial Planning. Recently (June 2021) the documents have been opened to public consultation to complete the participation of stakeholders. The contributions received for the first consultation of the MEOPs are being reviewed in detail by MITECO. Finally, it should be noted that the second public consultation procedure for the Strategic Environmental Assessment the maritime spatial planning began in July 2021. Ireland: Published in 2021 - https://www.gov.ie/en/publication/60e57- national-marine-planning-framework/ France: In France, each seaboard has its own strategic plan. They have been elaborated in 2019 and are now accessible to the general public for a final feedback before being validated by the French State by the end of 2021/beginning of 2022: https://www.merlittoral2030.gouv.fr/donnez-votre-avis														
Q23	If you answered yes to Q22, please let us know if your national Marine Spatial Plan included zones for OE development.	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes		No	Yes		Yes	
	Please provide further details here.	Germany: While not explicitly mentioned in the MSP, ocean energy devices are theoretically included (no practical application so far) UK (Scotland): RENEWABLES 1: Proposals for commercial scale offshore wind and marine renewable energy development should be sited in the Plan Option areas identified through the Sectoral Marine Plan process [122] (Map 9). Plan Options are considered the preferred strategic locations for the sustainable development of offshore wind and marine renewables. This preference should be taken into account by marine planners and decision makers if alternative development or use of these areas is being considered. Proposals are subject to licensing and consenting processes. UK (Wales): However strategic resource areas and locational guidance for ocean energy are anticipated soon Belgium: Zones for renewable energy foreseen Denmark: The plan includes renewable energy and is not further specified. Sweden: It includes test sites for ocean energy Portugal: Renewable energy production is contemplated as a possible use and activity in the maritime space - in the water column and at the sea surface.														

		Netherlands: The MSP document Agenda voor het Waddengebied was published in December 2020 and offers space for experiments under certain conditions for wave and tidal energy in the Waddenzee and near the North Sea coastline (p.51). Any potential upscaling of these experiments will only be possible if amongst others, it offers a substantial contribution to the objective of the Wadden islands to become self-supporting in their energy needs. The MSP document North Sea 2016-2021 identified initiatives for both wave/tidal energy, which entail knowledge of these technologies being developed and pilot projects being carried out. To identify the potential of these and other technologies, research was to be commissioned by the government during the planning period of the Policy Document on the North Sea (p.43). Relevant activities include research into the potential of new technologies, encouraging tidal / wave energy and research into combined energy farms (p.114) Spain: No area is classified as Ocean Energy priority area. There is no restriction for R&D projects, but it recommends using stablished R&D sites for Ocean Energy Ireland: Zones to be developed under the Offshore Renewable Energy Plan by end of 2022. France: A zone dedicated to tidal energy is already included in the plan for Eastern Channel-North Sea, off Normandy's coastline. Other zones might exist but I don't know the details														
Q24	Has your MS created, or plans to create, an investment fund to support initial ocean energy farms?	No	Yes, a general investment fund that would support initial ocean energy farms	Don't know	No	No	No	No	Don't know	No	No	Don't know	No	Don't know	No	
	If yes, please provide details.	UK (Scotland): in 2020, Scotland has a Renewable Energy Investment Fund, now it is EIF https://www.gov.scot/policies/renewable-and-low-carbon-energy/energy-investment-fund/ Spain: I don´t have accurate information on this issue, but Spanish government is working on New Financing Schemes. It is estimated about 200 million euros of public budget in support of the technological development of marine renewable technologies in the period 2021-2023. France: At the moment, 2 tidal energy farms are requesting initial support and a feed in tariff (they submitted a project at the "Systèmes énergétiques, villes et territoires durables" call for project). These 2 projects are being analysed and the Government is working on its position on this topic.														
Q25	Would your MS be willing to contribute to a European investment fund for OE farms?	Don't know	No	Don't know	Yes	Don't know	Don't know	Don't know	Don't know	No	Don't know	Don't know	Don't know	Don't know	Don't know	
	Comments.		involvement would be dependan							Not according to the						

			t on Brexit rules							current state of play. Additional studies are needed first, then political support.						
Q26	If you weren't able to answer these questions, please let us know why		Other (please specify)	We do not have this data	We do not have this data	Other (please specify)							Other (please specify)	We do not have this data	We do not have this data	
			some limitations in questions/survey layout, but overall managed to answer most			combination of we do not have this data and questions too detailed							n/a			

Appendix E: Year-on-Year OceanSET data (2018, 2019, 2020)

Policy/Deployment	2018	2019	2020
number of MS answering the survey	11	10	13
Number of MS with an OE policy	6	9	8
Number of MS with an assigned Ministry/Department owner at governmental level for OE	9	9	8
Number of MS with consistent environmental impact assessment for OE at Governmental level (outside test site/inside test site)	9	8/6	8/6
Number of MS with test site facilities	10	10	11
Estimated total budget for OE (wave, tidal) (€M)	23*	42.7	28.7
Total amount spent on OE (€M)	26.3	44.8	30.9
Number of MS with revenue support for wave energy	6	5	6
Number of MS with revenue support for tidal energy	5	4	5
Estimated average consenting time (years) (outside test site/inside test site)	4.25*	2.7/ 1.3	2.7/ 1.3
Number of MS with self-sufficient/well complemented supply chain for OE	7	7	12
Number of MS who funded TRL 7+ projects	7	9-	11

* Metrics have been estimated because data was collected in terms of ranges. The methodology followed consisted in assigning a value by averaging the maximum value and the minimum value in the selected range; in the lowest range, the midpoint is considered; in the highest range the minimum of the range is considered.

TABLE 16: YEAR-ON-YEAR KEY METRICS COLLECTED FROM SURVEY SECTION 1 (2018, 2019, 2020)

Active TRL 7+ / Stage 4-5 projects – Target technology performance data	2018	2019	2020
number of projects answering the survey – wave and tidal	12	11	20
Number of projects – wave	7	7 **	13
Number of projects – tidal	5	4 **	7
Number of projects within a consortium – wave and tidal	6	3 **	11
Number of projects addressing environmental impact assessment (EIA) methodologies and tools	0	1 **	3
Number of projects addressing enforcement of stage progression standards through scale testing	1	4**	6
Total installed capacity (MW) – wave	0.6	4.4	4,6
Total installed capacity (MW) – tidal	4	5,25	3.5
Average installed capacity per project (MW) – wave	0.08	0.73	0,8
Average installed capacity per project (MW) – tidal	0.8	1,31	1,2
Total annual electricity production (MWh/year) – wave	n/a *	1825	2207
Total annual electricity production (MWh/year) – tidal	11500	13250	2933
Average annual electricity production per installed capacity (MWh/MW) – wave	n/a *	1468 ***	6826
Average annual electricity production per installed capacity (MWh/MW) – tidal	1762	2550 ***	1830
Average capacity factor (%) – wave	29	n/a *	n/a
Average capacity factor (%) – tidal	32	n/a *	n/a
Average annual availability (%) – wave	88	67 ***	78
Average annual availability (%) – tidal	74	67 ***	78

Average CAPEX (€/W) – wave and tidal	9.5	5,65	5.5
Average CAPEX (€/W) – wave	12.7	2.01 ***	6.4
Average CAPEX (€/W) – tidal	7.9	8.38 ***	3.4
Average OPEX (€/W/year) – wave and tidal	0.4	0.76	0,5
Average OPEX (€/W/year) – wave	0.7	0.32 ***	0.5
Average OPEX (€/W/year) – tidal	0.1	1.08 ***	0.5
Min./max. technical lifetime (years) – wave	3/25	5/20	20/30
Min./max. technical lifetime (years) – tidal	5/25	15/25	20/25
Average LCOE (€/MWh) – wave	n/a *	207	272
Average LCOE (€/MWh) – tidal	217	375	200
Number of jobs created – wave	121	n/a *	n/a
Number of jobs created – tidal	78	n/a *	n/a

* Metrics not included due to insufficient data. Data was considered insufficient when not available (n/a) at all or when the few data available would lead to a possible identification of the project(s) involved.
** Metrics based on 11 projects (the remaining are based on a universe of 10 projects).
*** Metrics have been estimated because data was collected in terms of ranges. The methodology followed consisted in assigning a value by averaging the maximum and the minimum in the range; in the lowest range the midpoint is considered, zero; in the highest range the minimum of the range is considered instead of an average.

TABLE 17: YEAR-ON-YEAR KEY METRICS FOR WHOLE-SYSTEM TRL 7-9 DEVICES, COLLECTED FROM TARGET DATAT IN SURVEY SECTION 2 (2018, 2019, 2020)

		TRL 1-6			TRL 7+			unknown	
	2018	2019	2020	2018	2019	2020	2018	2019	2020
Ocean	-	7	9	-	2	5	-	20	17
Sub-System	-	2	5	-	1	1	-	2	1
Support	-	5	4	-	1	4	-	18	16
Tidal	17	5	8	5	11	12	-	8	8
Sub-System	-	2	5	-	4	4	-	1	1
Support	-	1	1	-	2	2	-	4	4
Whole-System	-	2	2	-	5	6	-	3	3
Wave	50	46	40	7	12	17	-	16	25
Sub-System	-	18	17	-	5	6	-	3	13
Support	-	4	2	-	0	1	-	11	9
Whole-System	-	24	21	-	7	10	-	2	3
Grand Total	67	58	57	12	25	34	-	44	50

TABLE 18: YEAR-ON-YEAR NUMBER OF PROJECTS FUNDED BY OCEANSET REVIEW CATEGORIES (2018, 2019, 2020)

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