Support to the realisation of the ocean energy implementation plan for the SET-Plan

Deliverable 5.1

Metrics for OE sector

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Executive Summary

OceanSET project was developed to support the Implementation Working Group (IWG) of the European Strategic Energy Technology Plan (SET Plan) for Ocean. The Implementation Plan created by the IWG focused on the key challenges for wave and tidal energy technologies. The group recognised that coperation and coordinated actions across member states can only be undertaken if there is a solid understanding of the different activities that are currently taking place across Europe.

Overall, a core focus of the OceanSET project is the completion of a total of three annual discovery exercises, with the objective of building up a detailed picture of the status of the ocean energy sector and its progress over the three years of the OceanSET project. The OceanSET project will build on the mapping exercise carried out in 2017 by the IWG to set an initial baseline and understand the Policy, Environmental, Technical and Financial activities that support the Ocean Sector in each Member State. Under the Ocean SET project, the plan is to complete this mapping exercise of the Member States supports and activities each year for the duration of the project, to identify any gaps in the MS activities and to provide guidance for local programme development in line with the Implementation Plan. This particular work package is tasked with developing metrics to monitor the progress of the funded projects in the OE sector. The baseline mapping analysis carried sought a total figure for funding available within each Member State for the development of the sector. This work package has sought to enable the Implementation Group to map data below that level and to seek metrics for each project funded at Member State, Agency and Developer level. The purpose of these metrics is to collect more granular data each year and to be able to compare, year on year the progress of projects and programmes in each Member State.

Project Summary

Call	H2020-LC-SC3-2018-2019-2020 submitted for H2020-LC-SC3-2018-Joint-Actions-2 / 11 Sep 2018
Topic	LC-SC3-JA-2-2018-2019 - Support to the realisation of the Implementation Plans of the SET Plan
Type of Action	CSA
Duration	36 Months
Project start date	16/03/2019
Project end date	15/03/2022
Project Officer	Matthijs Soede

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Project Objective

The OceanSET project was developed to support the Implementation Working Group (IWG) of the European Strategic Energy Technology Plan (SET Plan) for Ocean Energy. The Ocean Energy SET-Plan was adopted by the SET-Plan Steering Committee on the 21st of March 2018. An Implementation Plan has since been developed which will now be rolled out under OCEANSET.

The Implementation Plan focuses on the key challenges for wave and tidal energy technologies. Its ambition is to outline a structured approach that will enable wave and tidal technologies to follow a credible development path, with the ultimate destination of a commercially viable wave and tidal industry. The target timescale presented is 2025 for tidal technologies and 2030 for wave technologies to be commercially viable.

The overall project cost is €1.043M and the funding awarded is €0.99M. The project has been awarded by Horizon 2020. SEAI will be the Project Lead and will be tasked with the following:

- Co-ordinating management and administration of the project
- Co-ordination and management of the SET plan working group
- Data and information requests to Member States
- Data collation and Analyses

1.2 Deliverable 5.1

1.2.1 Purpose

This task focuses on ensuring the data collected during the annual mapping exercise (in particular for each of the technical projects funded) across each member state is comparable by defining and quantifying metrics to track the progression towards recognised ocean energy targets. Collected data from WP2 will be used to obtain estimates for the respective metrics. The monitoring methodology is being taking into consideration any methodology proposed by SETIS/SET-Plan SG and complemented with specific metrics of relevance to the development of ocean energy technologies. The metrics will be monitored annually. The monitoring results will feed into Tasks 5.2 (knowledge sharing workshop) and 5.3 (Review progress of the ocean energy sector).

1.2.2 Objectives

1. Develop a streamlined monitoring and analysis methodology (taking into consideration any methodology proposed by SETIS/SET-Plan SG), determining what will be monitored, defining key Metrics (performance indicators) and putting in place implementation support structures for analysis of monitoring data collected. These key metrics will be developed by WP5 participants, as discussed through e-mail, teleconference or face to face meeting in the first three months of the project (and presented in D5.1);
2. Embed the methodology and metrics in to the annual mapping and analysis each year;

3. Analyse raw information collected in WP2 to get the defined metrics and provide a report on the results to feed into Tasks 5.2 and 5.3;
4. Build on the accumulated information and complete an annual analysis of the feedback from the Member States, to review and upgrade the monitoring and analysis methodology annually, and if deemed necessary, and feed information about raw information requests into the WP2 in preparation for the mapping exercise the following year.

2. Monitoring Methodology

The SET-Plan IP specifies the need to monitor key operational actions at the MS and Region level, to track the progress of the ocean energy sector. Technology Development Actions have been specified in the ocean energy SET-Plan IP, including resources, targets, and ownership. These Technology Development Actions are divided into six Technical Actions, three Financial Actions and two Environmental Actions, with the overall objectives for each action summarised below.

- **Technical Actions**: ensure support for all TRLs, contributing to the development of tidal arrays and driving convergence in wave technologies.
- **Financial Actions**: ensure investment and insurance support funds are available to support the development of the sectors.
- **Environmental Actions**: promoting knowledge sharing on safety and environmental matters.

The Working Group carried out a high-level baseline mapping exercise of activities across 10 Member States in 2017 (see Appendix 1). This has served as an indication of the level of support available and the focus of the Member States activities. The mapping exercise requested any information available on four key aspects of local support:

1. POLICY:
    - Is there a specific Ocean Energy Policy in the Member State or Region?
    - If so, has it a specific owner and a responsible agency for implementation and oversight?
2. ENVIRONMENTAL
    - Identification as to whether the MS is focussing on specific local Environmental actions.
3. TECHNICAL
    - Identification as to whether the MS is focussing on specific local technical actions and
    - To determine which technologies are being supported.
4. FINANCIAL
    - An outline of the indicative budget available for the implementation for the sectoral development (for 2017 and 2018).

The overall result (see Appendix 1) was a high-level understanding regarding the national intent and a baseline of the plans for the next 3 years. This mapping exercise has helped in understanding the structure of the priorities at Member State level and has provided a foundation and baseline for OceanSET to continue to develop this data gathering methodology and enable more granular data to be collected in relation to the OE sector support, through defining and quantifying metrics to track the progression towards agreed ocean energy sectoral targets.

3. OceanSET Methodology

The OceanSET project will develop an annual questionnaire to gather data from member states on OE sector and this questionnaire will have sections pertaining to the Member State Support (Policy, Environmental and Financial), Agency Support (Environmental, Financial and Technical) and Developer/Project level (Technical and Financial). The overall questionnaire will be sent to each MS representatives as the designated contact point and to collate and to provide answers for Section 1, based on their analysis and on the information, they collect among several entities in their own MS. Section 2 is primarily for financing agencies (Agencies) with specific questions and metrics requested for projects supporting the development of ocean energy conversion devices (Developers and Agencies to answer), based on the awarded projects and technologies which under development and/or supported by the Member State.

The process flow for these questionnaires is describes below and outlined in figure 1:

1. OceanSET members will circulate the questionnaire to MS representatives.
2. Each MS representatives will answer SECTION 1 of the Questionnaire and sends SECTION 2 to their relevant Agencies.
3. It will be the responsibility of the Agencies to answer SECTION 2 and return it to MS representative
    a. If the Agencies identify developers or projects that are of a TRL7+ within question no. 8 of SECTION 2 they can send SECTION 2 to developers to gather this information
    b. If the Agencies can answer these questions themselves or have not identify developers or projects that are of a TRL7+, then they will return SECTION 2 directly to their MS representative.
4. It will be the responsibility of the MS to collate the Questionnaire (SECTION 1&2) before sending it back to the OceanSET point of contact.
5. Once all MS questionnaires are returned, OceanSET will carry out Mapping Analysis of the data collected. Any data gaps identified will be addressed within the next questionnaire sent to MS.
6. Findings will be published in the Annual Report and the new questionnaire prepared for sending to MS for the following year.

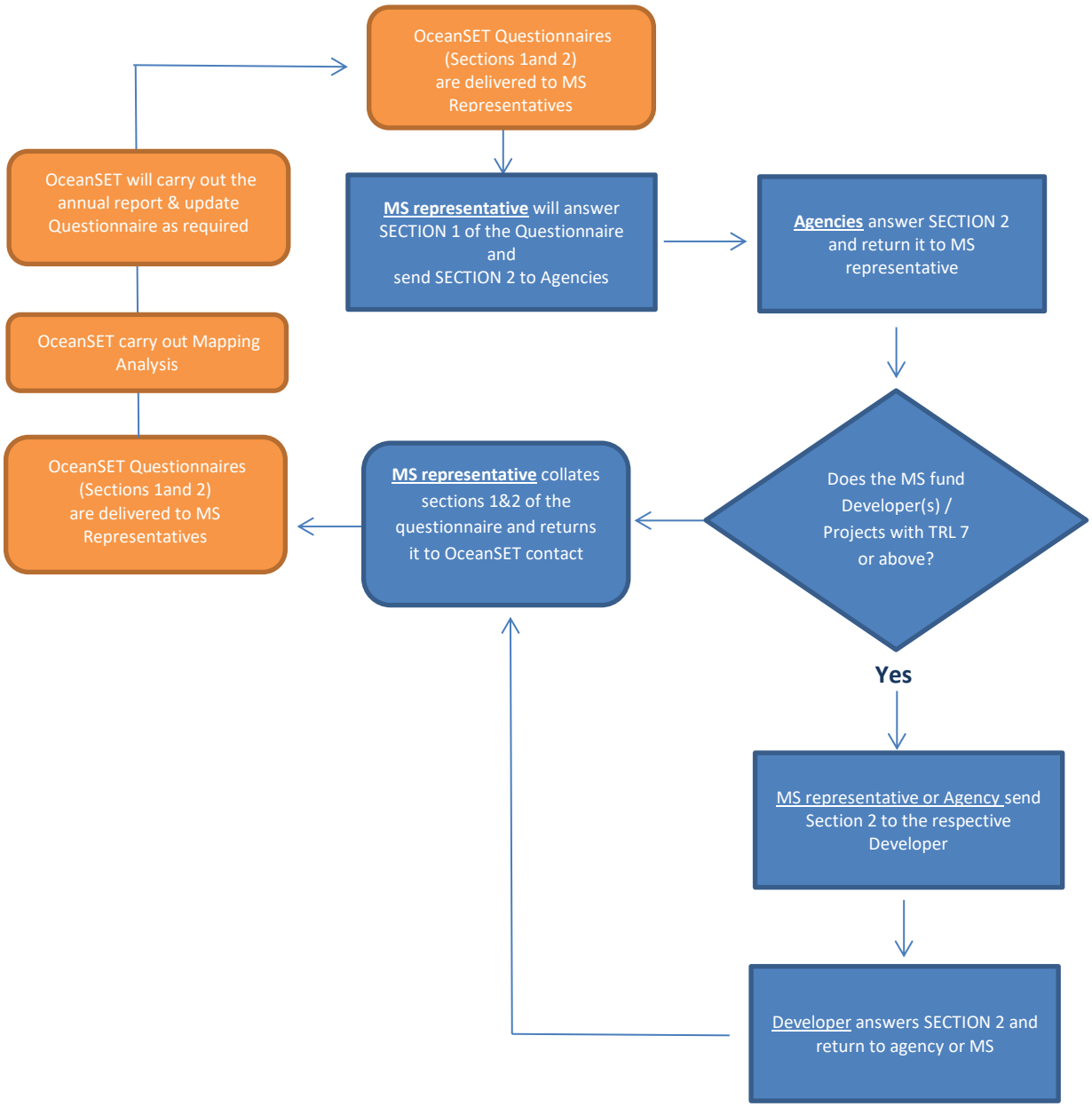

FIGURE 1: PROCESS FLOW FOR OCEANSET QUESTIONNAIRE

4. OceanSET metrics

In order to add value and a progressive stage of granularity to the annual Member State mapping exercise and also enable assess the progression of the sector a set of metrics have been established. These metrics will enable a like with like comparison between responses submitted by each MS responding to the Questionnaire.

The annual review of OCEANSET Questionnaire will involve the following:

1. A gap analysis of the data submitted across the 4 thematic areas (Policy, Environment, Technical and Financial) to determine if there are international gaps as well as recommendations for MS if national programmatic gaps are identified;
2. A review of each section of the questionnaire to determine in more granular questions are required for the following year;
3. A review of the metrics to determine if any updates are required for the following years questionnaire.

These metrics aim to create a yearly picture of the industry regarding its evolution towards the commercialization stage. Policy, regulatory and financing contexts are approached. However, the main focus is metrics that directly reflect the advancement of the sector into affordable and reliable energy, with some redundancy. Metrics such as weight of devices, mean time to install or mean time to repair could help characterize how the evolution is occurring but were excluded, to simplify. It is assumed that they end up incorporated in costs. Some further metrics are added concerning environment and the value chain, since these are enabling conditions also covered in the SET-Plan Actions. The key metrics proposed to assess the progression of the sector are as follows:

No.	Metrics
1	Total amount spent on OE
2	Percentage of budgeted amount spent
3	Total amount financed by Government
4	Total amount financed by EC
5	Total amount privately financed
6	Total amount financed by grants
7	Total amount financed by debt
8	Number of MS with an OE policy
9	Number of MS with a consistent environmental impact assessment for OE at Governmental level
10	Number of MS per supply chain development level
11	Total new installed capacity for OE conversion
12	Total OE installed capacity in the end of 2017
13	Total electrical OE injected in the grid
14	Total electrical OE generated in test sites and not injected in the grid
15	Total number of projects per development area
16	Number of projects by TRL
17	Number of projects by development stage
18	Number of projects by type of technology
19	Average power coefficient (tidal stream)/capture length (wave) in TRL 1-6 projects
20	Costs of manufacture, installation and maintenance (tidal, wave) in TRL 1-6 projects
21	Average mean time to failure in TRL 1-6 projects
22	Average capacity factor in TRL 7-9 projects
23	Average availability in TRL 7-9 projects

24	Average CAPEX in TRL 7-9 projects
25	Average OPEX in TRL 7-9 projects
26	Average lifetime in TRL 7-9 projects
27	Average LCOE in TRL 7-9 projects
28	Number of jobs created

These metrics will be determined from the information collected in the monitoring procedure, *i.e.* the responses to SECTIONs 1 and 2. Unless otherwise stated they refer to the previous year – which currently is 2018 – and wave and tidal stream technologies. For statistical purposes should be remembered that data is collected only among MS belonging to the SET-Plan IWG on ocean energy, which is a sub-group of European countries.

4.1 Monitoring metrics

A set of technical metrics have been developed by the working group which are designed to provide additional granularity and comparability across Member State responses. The metrics developed for the 2018/2019 Questionnaire are outlined in the next sections and included in the relevant questions.

4.1.1 MS Questionnaire SECTION 1

SECTION 1 is to be answered by MS representatives. Representatives may contact Governmental, or even private, entities related to MS statistics, energy, environment and the ocean, to obtain information about installed power capacity, energy produced, policies, regulation and consenting. Academic sources could also be of help, for example in the supply chain characterization.

The set of questions directed to MS representatives, SECTION 1, is as follows:

1. Is there a national Ocean Energy Policy outlined? If yes, please provide a link (identify good national policies that could be considered best practice in supporting the industry).
2. Is there an assigned Ministry/Department owner at Government Level?
3. What organisation(s) is/are responsible for operational ownership of the ocean energy programmes - operational level delivery programmes?
4. What amount (€M) was spent on ocean energy (wave, tidal) in the MS in 2018?
5. What is the budget planned for ocean energy (wave, tidal) in the MS in 2019?
6. What was the capacity (MW) from ocean energy (wave, tidal) installed in the MS at the end of 2017?
7. How much ocean energy (wave, tidal) capacity (MW) was installed in the MS during 2018?
8. How much energy (MWh) generated in the ocean by wave or tidal devices was injected in the grid in 2018?
9. How much energy was generated in test sites by wave or tidal devices but not injected in the grid in 2018?
10. Is there a mechanism for ocean energy to get revenue support that pay for every unit of electricity provided to the grid (*e.g*. contracts for difference or feed-in tariffs)?

	(Y/N)
Wave	
Tidal	

11. If yes, is such revenue supporting reinforced for ocean energy (please, tick the most appropriate)?

Yes	
No, ocean energy competes against all other renewable technologies	
No, ocean energy competes against only against other emerging renewable technologies such as offshore wind	
N/A	

12. If yes, is there a specific revenue support tariff for ocean energy? Please indicate.

	(€/MWh)
Wave	
Tidal stream	

13. How much revenue support was paid to ocean energy last year (€)?
14. How much ocean energy (MWh) from waves or tidal stream earned this revenue support in 2018?
15. What is the average licencing time in the MS?
16. Is there any consistent environmental impact assessment at Government level?
17. How would you classify in your MS the ocean energy (wave, tidal) supply chain (please, tick the most appropriate):

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

4.1.2 MS Questionnaire SECTION 2

SECTION 2 is better answered by financing entities in the MS, Agencies that award projects from either country level (MS) or European Commission (EC) funds. MS representatives are supposed to send SECTION 2 to those organizations and receive their responses in due time.

This SECTION concerns work in progress in projects and the developments expected. It should be answered in correspondence to each project: one SECTION 2 per project.

SECTION 2 applies to all sorts of projects about ocean energy: wave, tidal stream, devices, subsystems, resource, environment, etc. Question number 8 indicates the scope of the project.

If the project concerns the development of an energy conversion device (for example, when the option "Investigating novel devices before moving towards convergence of design" in question number 8 is selected), Agencies have a further course of action:

- Agencies should try to fulfil, as much as possible, questions 11 to 17;
- Should also send SECTION 2 to the respective Developer(s), as described in section 3.

Some Developers participate in several device development projects. It is advisable that MS representatives ask them to answer one SECTION 2 per each of their projects. It is also advisable to ask Developers to answer as much as possible all the questions.

SECTION 2 includes two measures of technical maturity – TRL (Question 10) and Stages (Question 11). Stages (also widely referred to as Phases) are a feature of Pre-Commercial Procurement programmes, combining prescribed stage activities with clearly defined success criteria and associated metrics.

Application of stages in the development process means that projects are assessed not only on the activities they complete (Stage Activities liked to TRLs), but also how successful those activities were (achievement of success criteria and high performance in the metrics).

Stages can be managed through a stage-gate process, like the Wave Energy Scotland Pre-Commercial Procurement programme, ensuring that projects progress to higher stages, funding values and TRLs only when they are ready and demonstrate sufficiently attractive techno-economic results.

The set of questions and metrics directed to Agencies and Developers, SECTION 2, is as follows:

One questionnaire per project (wave, tidal stream)

1. Project name
2. Coordinating entity
3. Project lifetime regarding the MS/EC funding – start date and end date
4. Estimated progress toward completion of the project (%)
5. Budget (€)
6. Financing breakdown (%)

Grant	Debt	Own equity

7. Which entities are financing (%)

MS	EC	Private

8. What development areas are addressed in the project?

Development areas (tick the area most appropriate)	
Developing novel concepts for improved power take-offs	
Increasing power take-off reliability	
Developing novel devices before moving towards convergence of design	
Increasing device reliability and survivability	
Development of electrical connection systems	
Development of electrical power conditioning and storage solutions	
Development of moorings, foundations and associated connection subsystems	
Investigating alternative materials and manufacturing processes for device structures	
Defining and enforcing standards for stage progression through scale testing	
Developing and implementing optimisation tools / Developing advanced control systems to optimise device and subsystem performance	
Investigating resource availability	
Developing environmental impact assessment methodologies and tools	

9. Which type of technology is the project addressing?

Type of energy conversion device (tick the most appropriate or specify)			
Wave		**Tidal stream**	
Attenuator		Horizontal axis turbine	
Overtopping/terminator device		Vertical or cross-axis turbine	
Oscillating water column		Oscillating hydrofoil	
Rotating mass		Enclosed tips (Venturi)	
Submerged pressure differential		Archimedes screw	
Point absorber		Tidal kite	
Oscillating wave surge converter		Other (please specify)	
Bulge wave			
Other (please specify)			

Installation type (tick the most appropriate or specify)			
Floating		**Fixed**	
Slack moored		Monopile	
Taut moored		Jacket structure	
Semi-taut moored		Gravity base	
Other (please specify)		Shoreline mounted	
		Other (please specify)	

10. Which TRLs is the project addressing? Please tick initial and expected final TRL.

TRL 1 – basic principles observed	
TRL 2 – technology concept formulated	
TRL 3 – experimental proof of concept	
TRL 4 – technology validated in lab	
TRL 5 – technology validated in relevant environment	
TRL 6 – technology demonstrated in relevant environment	
TRL 7 – system prototype demonstration in operational environment	
TRL 8 – system complete and qualified	
TRL 9 – actual system proven in operational environment	

Next questions are applicable only if the scope of the project is device development

11. Could you please indicate past and current development stages of the device?

Stage	Activity Summary	TRL alignment	Identify previously completed and current stages
Stage 0	Basic research. Principles postulated and observed but no experimental proof available	1	
Stage 1	Technology formulation. Concept and application have been formulated	2-3	

Stage 2	Testing of small scale (e.g. 1/30th - 1/20th scale) prototype in a laboratory environment. Numerical model complete	4	
Stage 3	Testing of large scale (e.g. half scale) prototype in representative environment	5-6	
Stage 4	Demonstration of full-scale prototype system in operational environment at pre-commercial stage	7	
Stage 5	Full commercial application, technology available for consumers	8-9	

12. In what specific innovation objectives is the project focused (cost reduction, demonstration of survivability over typical winter period, etc.)?
13. What capacity (MW) is to be installed during the project?

Already installed	Foreseen

14. Please present the performance of the project or technology, providing as many of the following metrics as possible at the current stage:

	Current performance	Level of detail used in evaluating the metrics (*)
Annual energy production (MWh)		
TRL 1-6		
Power coefficient (tidal)		
Capture length (wave, m)		
Cost of installation (€)		
Cost of manufacture (€)		
Cost of maintenance (€/year)		
Mean time to failure (h)		
TRL 7-9		
Capacity factor (%)		
Availability (h year)		
CAPEX (€/W) (**)		
OPEX (€/W year) (***)		
Lifetime (years)		
LCOE (€/MWh)		
Number of jobs created		

(*) Please use the following guide to identify the level of detail used in evaluating the metrics above:

	Detail	**Stages**	**Guide**
L	Early-stage – Low level of detail	0-1	High-level estimates or results of high-level numerical analysis
M	Mid-stage – Medium level of detail	2	Results from numerical modeling, rig/tank testing or medium-level operational planning and analysis
H	Late stage – High level of detail	3-5	Results from in-sea testing or detailed operational planning and analysis

(**) CAPEX – The capital expenditures involved in project development (all site related activities in advance of final investment decision), manufacturing of equipment (WEC/TEC structure and rotor/prime mover, foundations and moorings, power take-off, electrical systems and cabling, spares and refurbishment equipment), installation and commissioning of all necessary aspects of a project.
(***) OPEX – The operational expenditure includes all other annual costs such as operations & maintenance, fees & charges, insurance etc.

15. If you didn’t answer the previous question, please indicate why.
16. Could you describe major achievements/successes in the project?
17. Any other question suggested as relevant?

Appendix 1: Mapping outcome from IWG

MS	Ocean Energy Policy (Is there a national Ocean Energy Policy outlined?	IS there an assigned Ministry/ Department owner at Government Level?	is there operational responsibility for the delivery of the Ocean Energy programmes	National PRIORITY ACTIONS - TECHNICAL	PRIORITY ACTIONS - ENVIRON	PRIORITY ACTIONS - FINANCE	PRIORITY ACTIONS - OTHER	2016 - Amount (€M) spent on Ocean Energy by MS	2017 budget planned	Estimated Budget allocation from 2018-2020 (note this is not considered as commitment only an indicative estimate of possible allocation of budget to 2020)
IE	YES	YES	YES	YES	YES	YES	YES	€3.5M	€4M	Yes - Under the OREDP the Government committed €30M from 2014 up to 2020
BE	NO*	YES	NO				YES	0.6M		
CY		YES	NO	YES	YES	YES	YES	TBC	20M	
DE	YES	YES	YES					1.4M	2.3M	
ES	NO *	YES	YES	YES			YES	1M	TBC	
ES (Basque)	YES	YES	YES	YES		YES		2.5M	2.5M	Demonstration, Research and Innovation programme: €5M
ES (Cantabria Region)		YES	YES	YES			YES	6.0M		
FR	YES	YES	YES							
FR (Normandy)	YES	YES	YES	YES			YES			
PT	YES	YES	YES	YES	YES	YES	YES	0.6M	27M	€48M - Est
IT	YES	YES	YES	YES	YES	YES	YES	1M	0,5M	Yes - approximately €6M up to 2020 through competitive national projects
SE	No *	YES	YES	YES	YES	YES	YES	4.3M	2.7M	€3,9m allocated so far (from Swedish Energy Agency). NB. Most likely more funding will be allocated
UK (NI)	YES	YES	YES	YES	YES	YES	YES	No	No	N/A
UK (Wales)	YES	YES	YES	YES	YES	YES	YES	3M	8M	€45 million euro
UK (Scotland)	YES	YES	YES	YES	YES	YES	YES	15M	15M	45M
UK (BEIS)										

High level mapping of Ocean Energy activities in MS and Regions and indicative available support