European Technology & Innovation Platform for Ocean Energy

# Deliverable 3.4:

# A study into the potential social value offered to Europe from the development and deployment of wave and tidal energy to 2050

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# Executive Summary

This report, Deliverable 3.4 Socioeconomic Study ('A study into the potential social value offered to Europe from the development and deployment of wave and tidal energy to 2050'), gathers evidence on the direct and indirect impacts, in terms of job creation, training needs and business opportunities along the value chain, to the European society and economy of the development of wave and tidal energy technologies in Europe and their deployment globally to 2050.

This study builds upon the study into the potential economic value of these technologies previously completed in the project (i.e. Deliverable 3.3 GVA Study) and identifies specific opportunities, quantitative social benefits and high-level policy recommendations. Furthermore, the socioeconomic study has a particular focus on the potential benefits that ocean energy technologies can have on coastal communities. To this respect, results, analyses and conclusions have been based on three case studies of the European regions with strongest capabilities and opportunities in ocean energy.

The global methodology involved four main steps as summarised below:

1. Based on the Gross Value Added (GVA) outputs, the socio-economic study gathered evidence on number and type of jobs along the value chain with a global perspective.
2. Parallel to this global job creation study, a survey was conducted among a number of key European coastal regions to assess the capabilities and socio-economic opportunities that ocean energy development can offer in these territories.
3. Three different regions were selected for the case studies. This included identification of key stakeholders in the local area, data gathering and workshop for the dissemination & validation of opportunities with stakeholders.
4. Finally, results and conclusions of the case studies were used to provide a series of recommendations for other EU regions with similar characteristics and objectives to maximise the impact of ocean energy in their territories.

With regard to the first step, two main deployment scenarios were selected for the job study based on the IEA ETP Faster Innovation Case (FIC), which assume the net zero carbon emissions target would be attained globally by 2050 due to a faster rate of technology innovation. These two scenarios lead to a lower and upper bound of the job creation potential for Europe if the right policies are implemented to deploy 60 GW and 100 GW by 2050 respectively. It is worthwhile mentioning that even if the job study estimates the direct, indirect and induced jobs, the results presented will mainly highlight the potential for direct and indirect jobs creation, as induced jobs are more difficult to interpret. This also facilitates comparison with other studies that have not considered induced jobs into their projections.

**Scenario 1 (FIC 60 HL) – Europe follows the global market**

This scenario is based on the achievements of the SET Plan targets but reaching net zero globally by 2050. 60 GW of ocean energy is deployed in Europe by 2050 and 293 GW globally, with the tidal/wave energy proportional split assumed to be 40%/60% in all regions for this deployed capacity. Following on from the assumption that Europe does not take a strong lead in ocean energy, the European supply chain is assumed to be less strong, with Europe as a market follower for ocean energy, retaining a lower proportion of the economic activity required for this deployment.

- Given the high leakage rates considered, this scenario would approximately create 205,000 new jobs (Direct and Indirect) for the European economy in 2050.
- Domestic deployments account for 62% of the European jobs. Deployment in the Rest of the World (RoW) provide 38% of European jobs.
    - This is because the ramp-up of annual installations happens faster in Europe than in the ROW, plateauing faster towards 2050. In the ROW, annual installations start later and slower than in Europe, but culminate significantly higher than European installations by 2050, due to the size of the ROW compared to Europe and its thus larger tidal/wave potential. This explains why 38% of European jobs in 2050 are coming from projects outside of Europe, despite the fact that the leakage rate for European installations is 30% and for ROW 95%, and thus fewer jobs are created from ROW projects.
- Wave energy technologies contribute to two thirds of the job creation.
- 2.1 jobs per MW can be created due to domestic deployments.
- The number of Direct and Indirect employment has the same order of magnitude.
- The results from this scenario are presented in Table 3.3 below.

*Table 0.1: High leakage job creation results for the FIC with medium proportion of global ocean deployment occurring in EU waters*

| Deployment Scope | Technology | 2050 Installed Capacity (GW) | Leakage Rate | Direct jobs in Europe 2050 | Indirect jobs in Europe 2050 | Total jobs in Europe 2050 | Jobs/ MW |
|---|---|---|---|---|---|---|---|
| Europe | Tidal | 24 | 30% | 16,460 | 15,095 | 31,555 | 1.31 |
| | Wave | 36 | 30% | 50,893 | 45,317 | 96,210 | 2.67 |
| **Europe total** | | **60** | **-** | **67,353** | **60,412** | **127,765** | **2.13** |
| Rest of World | Tidal | 93 | 95% | 19,551 | 17,645 | 37,196 | 0.40 |
| | Wave | 140 | 95% | 21,088 | 18,619 | 39,707 | 0.28 |
| **RoW total** | | **233** | **-** | **40,639** | **36,264** | **76,902** | **0.33** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Global | Tidal | 117 | - | 36,011 | 32,740 | 68,751 | 0.59 |
| | Wave | 176 | - | 71,981 | 63,936 | 135,917 | 0.77 |
| **Global total** | **Ocean** | **293** | **-** | **107,991** | **96,676** | **204,667** | **0.70** |

Figure 3.2: Workers annually employed in the Ocean Energy Sector under scenario FIC60.Figure 3.2 shows the trend in terms of people directly or indirectly employed in the ocean energy sector in Europe during the period spanning from 2031 to 2050. By the end of the period, wave energy is expected to provide a greater potential for job creation due to the larger capacity installed. In total, a cumulative 1.4 million jobs-years can be created in Europe during this period.

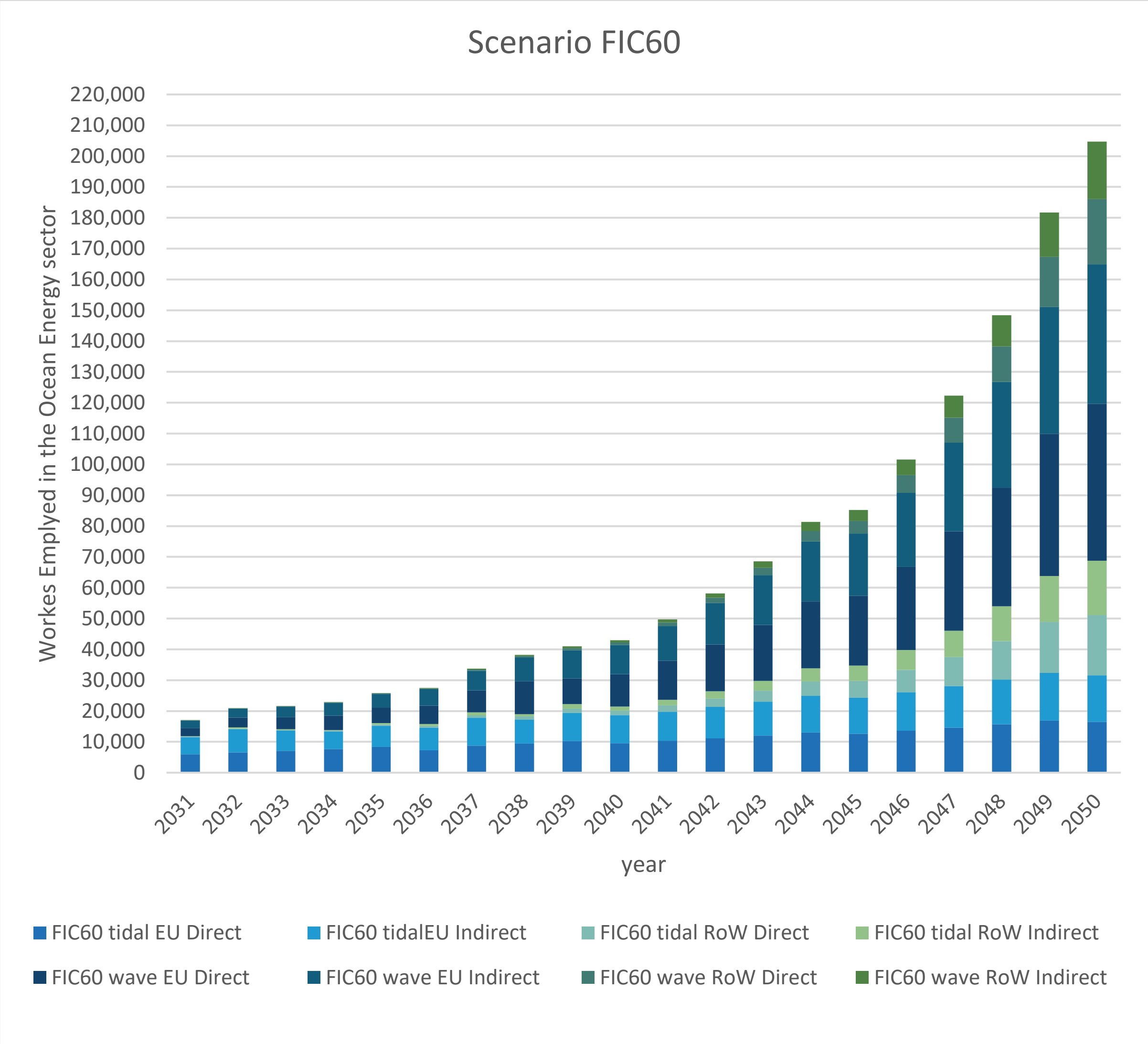


*Figure 0.1: Workers annually employed in the Ocean Energy Sector under scenario FIC60.*

**Scenario 2 (FIC 100 LL) – Europe leads the global market**

This scenario also assumes that net zero is reached globally by 2050 but has more ambitious European deployment, assuming that Europe leads the global market for ocean energy in this time. 100 GW of ocean energy is deployed in Europe by 2050 and 293 GW globally, with the tidal/wave energy proportional split assumed to be 40%/60% in all regions for this deployed capacity. Europe makes efforts to be a market leader for ocean energy, creating a strong European supply chain and retaining a high proportion of the economic activity required for this deployment.

- Given the low leakage rates considered, this scenario would approximately create 505,000 new jobs (Direct and Indirect) for the European economy in 2050.
- The share of jobs created in Europe due to global deployments (48%) almost equals the jobs created due to domestic deployments (52%).
    - This is because the ramp-up of annual installations happens faster in Europe than in the ROW, plateauing faster towards 2050. In the ROW, annual installations start later and slower than in Europe, but culminate significantly higher than European installations by 2050, due to the size of the ROW compared to Europe and its thus larger tidal/wave potential. This explains why 48% of European jobs in 2050 are coming from projects outside of Europe, despite the fact that the leakage rate for European installations is 10% and for ROW 75%, and thus fewer jobs are created from ROW projects.
- Wave energy technologies contribute to 72% of the job creation.
- 2.6 jobs per MW can be created due to domestic deployments.
- The number of Direct and Indirect employment has the same order of magnitude.
- The results from this scenario are presented in Table 3.4 below.

*Table 0.2: Low leakage job creation results for the FIC with high proportion of global ocean deployment occurring in EU waters*

| Deployment Scope | Technology | 2050 Installed Capacity (GW) | Leakage Rate | Direct jobs in Europe 2050 | Indirect jobs in Europe 2050 | Total jobs in Europe 2050 | Jobs/ MW |
|---|---|---|---|---|---|---|---|
| Europe | Tidal | 40 | 10% | 32,892 | 30,219 | 63,111 | 1.58 |
| | Wave | 60 | 10% | 105,859 | 94,338 | 200,197 | 3.34 |
| **Europe total** | | **100** | **-** | **138,751** | **124,557** | **263,308** | **2.63** |
| Rest of World | Tidal | 77 | 75% | 42,076 | 37,910 | 79,986 | 1.04 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Wave | 116 | 75% | 85,807 | 75,783 | 161,590 | 1.40 |
| **RoW total** | | **193** | **-** | **127,884** | **113,693** | **241,576** | **1.25** |
| Global | Tidal | 117 | - | 74,968 | 68,129 | 143,097 | 1.22 |
| | Wave | 176 | - | 191,666 | 170,121 | 361,787 | 2.06 |
| **Global total** | **Ocean** | **293** | **-** | **266,634** | **238,250** | **504,885** | **1.72** |

Figure 3.3 shows the trend in terms of people directly or indirectly employed in the ocean energy sector in Europe during the period spanning from 2031 to 2050. By the end of the period, wave energy is expected to provide a greater potential for job creation due to the larger capacity installed. In total, a cumulative 3.4 million jobs-years can be created in Europe during this period.

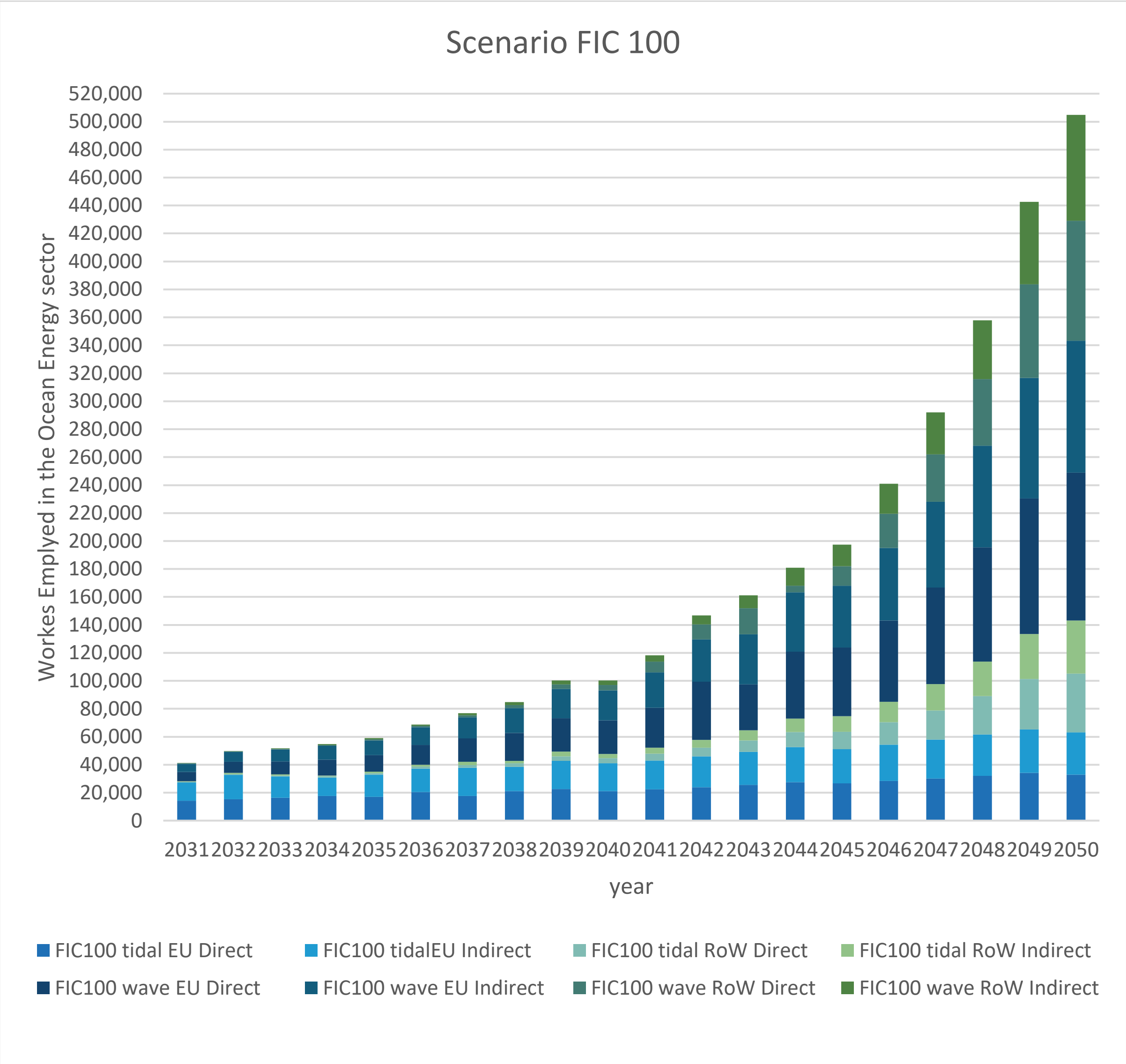


*Figure 0.2: Workers annually employed in the Ocean Energy Sector under scenario FIC100.*

**Case studies**

The study also gathered evidence on the direct and indirect impacts of ocean energy on the local communities and European regions. Furthermore, from the analysis of the case study results, a number of conclusions and actions can be extracted, and presented to other European regions in similar conditions, in order to promote the development of the ocean energy sector Europe-wide.

NUTS 2 regions have been chosen to perform this analysis as they are the fundamental groupings for the application of regional policies. This is because the range of population is limited and it is feasible to identify the key decisions makers that can directly influence local policies in this territory. At this geographical level, key stakeholders are easier to identify with the support of regional industrial associations, and the implementation of local policies could be more effective. Moreover, NUTS 2 regions guarantee greater homogeneity, which facilitates comparison among the geographical areas. NUTS 2 regions are considered homogeneous both in terms of superficial extension and population (typically they have a population of between 0.8 and 3 million inhabitants), with few exceptional cases including very large cities.

10 European coastal regions have been surveyed and classified in terms of the region's strengths (capabilities) and favourable external factors (opportunities). Two regions have been selected for the development of the case studies due to their long-standing experience in ocean energy and their positioning in the Strong quadrant of the Opportunity-Capability graph; these regions are the **Basque Country [ES]** and **Scotland [UK]**. A third region, **Brittany [FR]**, has been also identified as of a high interest and some conclusions have been extracted from a study performed by another European project[1].

The main findings from the case studies are grouped in four categories:

- Benefits
- Challenges
- Best practices
- Actions

These findings have been used to build a series of recommendations for other regions interested in ocean energy. A summary of the best practices and actions identified through the case studies is provided below. They are presented according to the capability and opportunity factors of the self-assessment. This helps regions to choose which factors they wish to improve.

[1] H2020 ELEMENT - Regional Impact Analysis Report

**Industry configuration**

- A regional association coordinating the emerging ocean energy value chain in the region.
- Development of a strong value chain: infrastructures (e.g. ports and harbours), supply chain (e.g. steel manufacturing), technology developers, test centres and researcher and technology organisations.
- Creation of a specific ocean energy brand to gain visibility beyond the region.
- Accredited entities to provide technology verification on marine energy converters and sub-systems.

**Technology development**

- Demonstrate that the technologies are developed to a level where its technological and financial reliability is guaranteed.
- Webinars and public reports to capture best practices and lessons learnt from deployments.
- Concentrate efforts on solving specific technology challenges to the sector.
- Monitor akin sectors for innovations that can be easily transferred. Diversification and transfer of skills from other sectors – such as oil and gas, and maritime.
- Participation in European and international networks and collaborative programmes.

**Human resources**

- Achieving a critical mass of researchers, workers and dedicated staff involved in the ocean energy sector
- Leading universities and research centres contributing to valuable research outputs.
- Promote training at all levels to have access to very specific knowledge in the sector. STEM graduates and early-stage professionals with technical experience and expertise will be increasingly necessary.

**Political factors**

- Existence of a regional ocean energy strategy, established targets and future planning requirements.
- Strong institutional support. Regional development agencies working in collaboration with the regional government, businesses and SMEs to support ocean energy projects.

- Innovation with respect to the support mechanisms for the ocean energy sector. Some examples of successful funding schemes include Wave Energy Scotland, the Marine Saltire Fund, and the OceanERANET cofund.
- Provide consistent funding for early stage technology developers (long term stability).
- Promotion of lighthouse projects (e.g. Mutriku wave power plant in the Basque Country or EMEC in Scotland) to develop practical expertise and build confidence.
- Development of standardised consenting and licensing processes for marine deployments, with accessible guidance and information.

**Economic factors**

- Efficient use of limited resources.
- Existence of market pull mechanism (e.g. a feed-in-tariff with contract for difference).

**Socio-environmental factors**

- Public engagement for existing projects, continued communication with local communities and other maritime users to raise awareness. Information boards may stimulate deployment sites as an attraction point for locals and tourists.
- Supporting jobs and economic growth, particularly in fragile coastal communities and islands
- Maximising local content within the supply chain needs means allowing these companies to increase in scale and production volumes.
- The creation of a Renewable Energy Community (REC) would result in extra positive socio-economic impacts (e.g. standard of living, educational change, social cohesion and perception of the sea as an ocean energy resource).

Regions interested in ocean energy are invited to make a self-assessment of their opportunities and capabilities to know the current positioning. The initial quadrant positioning should be considered to build the region's strategy to reap the desired socio-economic benefits and impacts. The strategy will set the right direction to reinforce the capabilities and maximise the opportunities and give an indication of the level of effort to achieve this.

The self-assessment questionnaire for regions is annexed to this report.

# Acronyms

| | |
|---|---|
| CAPEX | Capital Expenditure |
| EIS | European Innovation Scoreboard |
| EMP | Number of persons engaged |
| ETIP Ocean | European Technology and Innovation Platform for Ocean Energy |
| EMEC | European Marine Energy Centre |
| EU | European Union |
| FIC | Faster Innovation Case |
| GDP | Gross Domestic Product |
| GVA | Gross Value Added |
| HL | High Leakage |
| IEA-OES | International Energy Agency - Ocean Energy Systems |
| IO | Input Output |
| LL | Low Leakage |
| NPV | Net Present Value |
| NUTS | Nomenclature of territorial units for statistics |
| OPEX | Operational Expenditure |
| OPIN | Ocean Power Innovation Network |
| SEA | Socio-Economic Accounting |
| SET | Strategic Energy Technologies |
| STEM | Science, Technology, Engineering and Maths |
| R&D | Research & Development |
| REC | Renewable Energy Community |
| RoW | Rest of the World |
| VA | Gross value added at current basic prices |
| WIOD | World Input Output Database |
| WP | Work Package |

# List of Tables

# List of Figures

# Contents

# 1. Introduction

Achieving the targets of the EU strategy on offshore renewable energy by 2050 [1] will require identifying and using a large number of sites for ocean energy production and connection to the power transmission grid. Therefore, early involvement of all groups concerned is crucial to analyse the socioeconomic benefits and risks, ensuring coexistence with other activities and making sure the public accepts planned deployments. Socioeconomic studies are an essential step during the deployment of a new sector to show its benefit and to potentially attract attention from stakeholders, as well as support from investors.

The European Technology and Innovation Platform for Ocean Energy (ETIP Ocean) is an existing and established network of ocean energy professionals, stakeholders and experts that provides a hub for knowledge exchange and collaboration within the emerging ocean energy sector. The ETIP Ocean 2 project carries out a range of research, stakeholder engagement and knowledge sharing activities to fulfil its three strategic objectives:

- Ensure the optimal use of existing resources for the sector.
- Support and accelerate European and global deployment of ocean energy.
- Ensure that the potential benefits for European industry and society are maximised.

The present work fulfils the above objectives as it aims **to gather evidence on the direct and indirect socioeconomic impacts, in terms of job creation, training needs and business opportunities along the value chain of ocean energy in Europe**.

This document presents the results of this study, based on a combination of a top-level approach and a bottom-up perspective. The top-level approach builds upon the study into the potential economic value of these technologies led by the University of Edinburgh [2], whereas the bottom-up perspective provides more granularity in terms of the socio-economic benefits and opportunities through the analysis of specific case studies in three coastal regions.

This socioeconomic study sits within the WP3 Economics and Social Impact, which conducts macro- and micro-economic level analyses to identify the macro- and socio-economic fundamentals of the ocean energy sector.

## 2. Global Methodology

This study started with the definition of a global methodology to quantify and discuss the future value of the ocean energy sector in Europe in terms of its socio-economic benefits, for both wave and tidal energy technologies. The methodology was contrasted with the ETIP Ocean Steering Committee.

In the literature, two common approaches are adopted to conduct a socio-economic study, namely a top-down approach and a bottom-up one. The former begins with an analysis of high-level factors, then it zooms in focusing on particular aspects, while the latter moves on a reverse direction [3].

With regards to the top-down approach, the perspective is commonly associated with the word "macro" or macroeconomics, and in general looks at how systematic factors affect an outcome. In this type of analysis, the study starts accounting for inputs at large scale in order to learn punctual outcomes. This approach will be used to bridge the results of the Gross Value Added study with the estimation of jobs.

The bottom-up perspective provides more granularity in terms of the socio-economic benefits, training needs, business opportunities and risks. It allows gathering evidence on the direct and indirect impacts of ocean energy at the “micro” or regional level. Feedback from a few case studies will result into a generalisation of the socio-economic study results and conclusions in the form of recommended practices for the local communities.

The following graph summarises the global methodology of the socio-economic study.

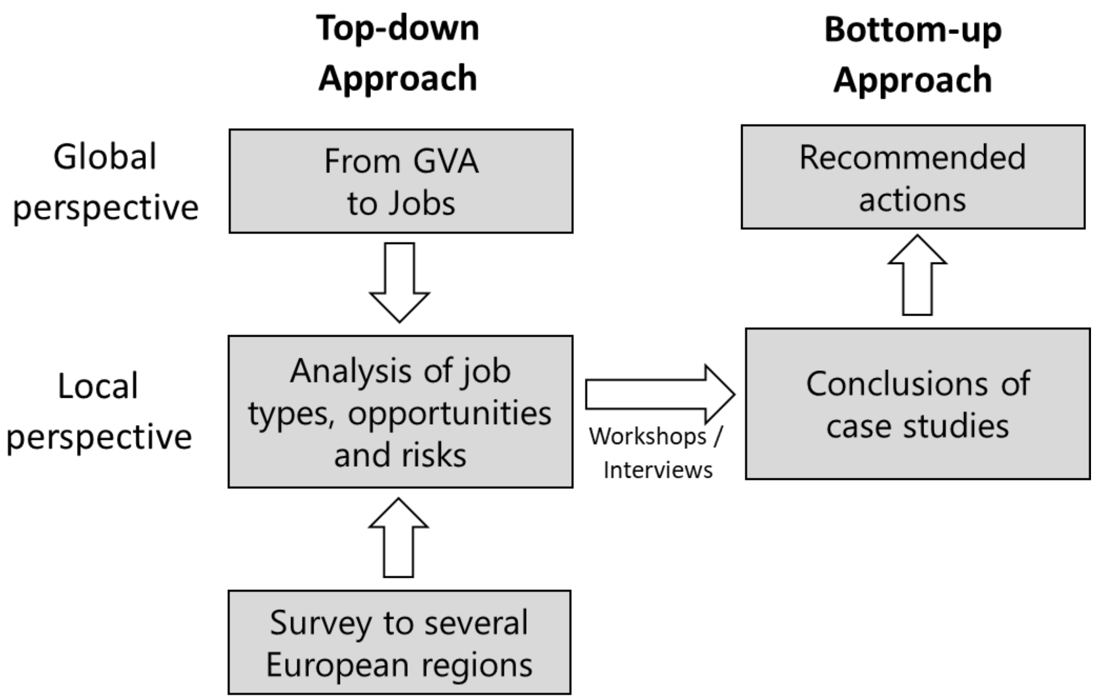

*Figure 2.1: Global methodology for the socioeconomic study*

This global methodology involved four main steps as summarised below:

1. Based on the Gross Value Added (GVA) outputs, the socio-economic study gathered evidence on number and type of jobs along the value chain with a global perspective. World Input Output Database Socio Economic Accounts [4] were used to transform GVA figures into estimation of job creation potential that ocean energy presents for Europe.
2. Parallel to this global job creation study, a survey was conducted among a number of key European coastal regions to assess the capabilities and socio-economic opportunities that ocean energy development can offer in these territories.
3. Three different regions were selected for the case studies. This included the identification of key stakeholders in the local area, data gathering and workshop for the dissemination & validation of opportunities with stakeholders.
4. Finally, results and conclusions of the case studies were used to provide a series of recommendations for other EU regions with similar characteristics and objectives to maximise the impact of ocean energy in their territories.

# 3. Estimation of job creation

## 3.1 Related studies

This work builds on a number of existing studies which have produced estimations of the job creation potential for ocean energy at national, European and international level.

Based on the projections for installed capacity for ocean energy, the following reports quote a wide range of job creation potential for the sector:

- In 2013, the Ecorys study [5] commissioned to support this impact assessment for the EU Action Plan on Blue Energy [6] estimated that 10,500‐26,500 permanent jobs in O&M and up to 14,000 temporary jobs in manufacture could be created by 2035 to deploy 10.5 GW.
- In 2017, the IEA-OES International Vision for Ocean Energy [7] stated that 300 GW could be deployed and 680,000 direct jobs created globally by 2050.
- In 2020, Ocean Energy Europe assessed a value of 400,000 jobs for the deployment of 100 GW by 2050 in Europe [8].
- Finally, IEA-OES has commissioned an Ocean Energy Jobs Creation study to update projections for the 2030/2050 horizons for various associated countries [9]. 2021 preliminary results of this ongoing task show a long-term job assessment by 2050 for European countries totalling 1,029,000 jobs (direct, indirect and induced) for a combined installed capacity of 60 GW.

Given the different scope of existing estimations and great diversity of assumptions for the quantification of job creation, a more structured and transparent approach is needed.

## 3.2 Approach and main hypotheses

The approach implemented for the estimation of job creation is built upon the output of the Gross Value Added (GVA) analysis for the ocean energy sector in Europe, carried out by the University of Edinburgh, which follows the top-down path described in section 2. The GVA study investigates the potential economic benefit to the European economy of the development of ocean energy electricity generation technologies in Europe and their deployment globally to 2050. Furthermore, the GVA study investigates the impact on the economic benefit of the overall domestic (European) supply chain strength for European and international deployments.

This top-down approach is also consistent with the recent *Ocean Energy Jobs Creation* study [9] commissioned by the Ocean Energy System group at the International Energy Agency (IEA-OES). This study aims at delivering a validated methodology for job assessment in the ocean energy sector and building up from the existing know-how developed on other renewable energies and other maritime sectors [10]. Despite the many analogies in the approach, the different deploying trajectories, cost reduction, underlying assumptions and geographical coverage make this study not fully comparable with ETIP Ocean results.

In ETIP Ocean, the GVA benefit has been calculated for various deployment scenarios based on and beyond the achievement of the Strategic Energy Technology Ocean Energy Implementation Plan (SET Plan) targets of €100/MWh for tidal and €150/MWh for wave by 2030[2]. GVA results are based on the following assumptions:

- Capital expenditure (CAPEX) and Operational expenditure (OPEX) values are derived from the cost to deploy associated with the SET Plan targets from 2030 to 2050 and the deployment modelling outputs.
- These expenditure values are split across individual technical cost breakdowns according to the BVG Associates and Ocean Power Innovation Network (OPIN) value chain study for Scottish Enterprise [11]. Different breakdowns for tidal stream and wave devices are employed to reflect not only the different technological requirements between the two, but also their varying stages of development.
- National share of spend is distributed according to data obtained from the World Bank using manufacturing share of Gross Domestic Product (GDP) as a proxy for CAPEX share [12]. Manufacturing is the majority cost centre to incur CAPEX. OPEX share is allocated in the same proportion as CAPEX.
- Direct, indirect and induced GVA effects are obtained through the Leontief inverse of IxI Input Output (IO) tables from the WIOD for each scenario [13]. The technical cost centres are assigned to economic sectors of the WIOD for the relevant GVA effects to be identified.
- The impact on the GVA results of the strength of the European supply chain was assessed through the application of variable leakage rates and the proportional global deployment occurring in Europe. Leakage rates are kept constant across the industries.
- Country results are aggregated for each sector to obtain the GVA per industry, summed across industries and coupled with the equivalent for the Rest of World to produce the global GVA result per scenario.
- To account for inflation, a constant discount rate of 3.5% is incorporated into the calculation to obtain the Net Present Value (NPV) of the annual GVA results across all years [14].

More details on the GVA methodology and underlying assumptions can be found in [2].

[2] SET Plan temporary working group for ocean energy, "*SET Plan Ocean Energy Implementation Plan*", 2018

The process implemented for the estimation of jobs leverages on the outcomes of this GVA analysis. A high-level flowchart illustrating the steps taken and inputs required to obtain the results presented in this report is shown in Figure 3.1.

In brief, input data is extracted from the WIOD Socio-Economic Accounting (SEA) dataset [4] per country and industry sector considered in the GVA analysis. In particular, the *Number of persons engaged* (EMP) and the *Gross value added at current basic prices* (VA) are collected for the EU27 and the UK. The Employment per GVA ratio (EMP/VA) defines the value of direct job creation per country and industry sector.

Employment effects associated with the development and deployment of each scenario are obtained through the Leontief inverse of IxI Input Output (IO) tables from the WIOD [13] following the same process as for the GVA analysis.

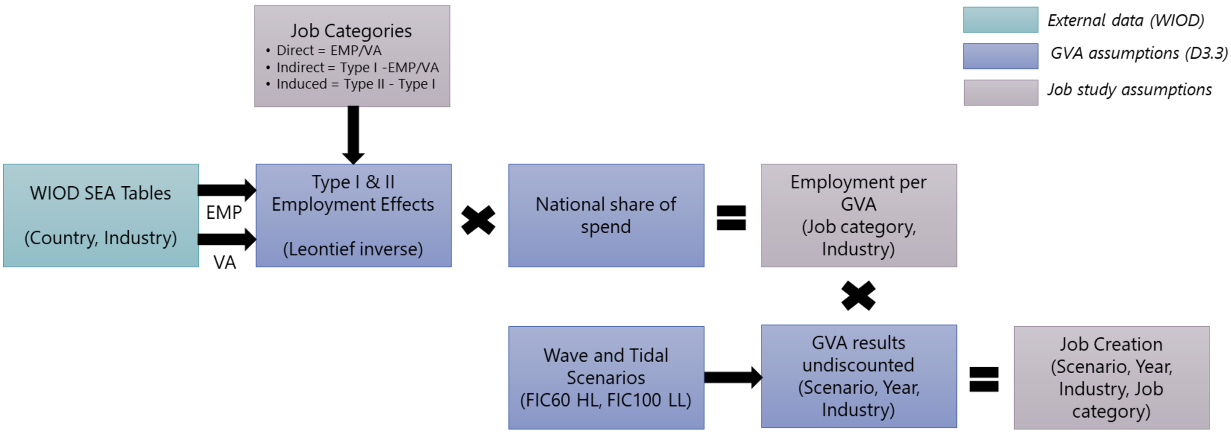


*Figure 3.1: Flowchart of the process implemented for the estimation of jobs in the ETIP Ocean project.*

The job categories (i.e. direct, indirect and induced) are then multiplied by the national share of spend to obtain the EMP/VA ratios for Europe, which are again multiplied by discounted GVA results. As a result, the final output is the number of Direct, Indirect and Induced jobs created in the 28 countries, annually from 2025 to 2050. Job creation potential for the European supply chain is quantified for both European and international deployments.

The two main deployment scenarios selected for the job study are based on the IEA ETP Faster Innovation Case (FIC), which assume the net zero carbon emissions target would be attained globally by 2050 due to a faster rate of technology innovation [15].

*Table 3.1: FIC's 293 GW 2050 global installed capacity*

| | *2050 Installed Capacity (GW)* | | | |
|---|---|---|---|---|
| | Scenario 1 – FIC 60 | | Scenario 2 – FIC 100 | |
| | Europe | RoW | Europe | RoW |
| *Tidal stream* | 24 | 93 | 40 | 72 |
| *Wave* | 36 | 140 | 60 | 116 |
| ***Ocean*** | **60** | **233** | **100** | **193** |

*Table 3.2: Rates of leakage from the European economy for domestic and international deployments*

| | *Low Leakage (LL)* | | *High Leakage (HL)* | |
|---|---|---|---|---|
| | Leakage (%) | Retention (%) | Leakage (%) | Retention (%) |
| *European deployments* | 10 | 90 | 30 | 70 |
| *Global deployments* | 75 | 25 | 95 | 5 |

**Scenario 1 (FIC 60 HL)** - **Europe follows the global market**

This scenario is based on the achievements of the SET Plan targets but reaching net zero globally by 2050. 60 GW of ocean energy is deployed in Europe by 2050 and 293 GW globally, with the tidal/wave energy proportional split assumed to be 40%/60% in all regions for this deployed capacity. Following on from the assumption that Europe does not take a strong lead in ocean energy, the European supply chain is assumed to be less strong, with Europe as a market follower for ocean energy, retaining a lower proportion of the economic activity required for this deployment.

**Scenario 2 (FIC 100 LL)** - **Europe leads the global market**

This scenario also assumes net zero is reached globally by 2050 and has more ambitious European deployment, assuming Europe leads the global market for ocean energy in this time. 100 GW of ocean energy is deployed in Europe by 2050 and 293 GW globally, with the tidal/wave energy proportional split assumed to be 40%/60% in all regions for this deployed capacity. Europe makes efforts to be a market leader for ocean energy, creating a strong European supply chain and retaining a high proportion of the economic activity required for this deployment.

These two scenarios lead to a lower and upper bound of the job creation potential for Europe if the right policies are implemented to deploy 60 GW and 100 GW by 2050 respectively.

It is worthwhile mentioning that even if the job study estimates the direct, indirect and induced jobs, the results presented will mainly highlight the potential for direct and indirect jobs creation, as induced jobs are more difficult to interpret. This also facilitates comparison with other studies that have not considered induced jobs into their projections.

## 3.3 Main Outcomes

The outcomes are shown for the two scenarios in terms of workers employed annually from 2031 to 2050, showing the numbers of persons engaged in the wave energy or in the tidal energy sectors, and subdivided between Direct and Indirect jobs.

### 3.3.1 FIC with 60 GW of 293 GW global deployment occurring in Europe and less favourable supply chain conditions ('Europe Follows the Market')

In this scenario, Europe's gross share of deployment is consistent with the SET Plan at 60 GW but only captures a relatively small proportion of the overall global deployment (293 GW) of the Faster Innovation Case (FIC). In essence, Europe has not taken sufficient proactive action to invest in ocean energy and integrate it into its energy mix. Likewise, Europe misses the opportunity to export ocean energy technologies to the global market. Thirdly, a high leakage rate means Europe relies on imports to service domestic deployments reducing its local content.

Main results for FIC with 60 GW of 293 GW global deployment occurring in Europe and less favourable supply chain conditions (FIC 60 HL) are as follows:

- Given the high leakage rates considered, this scenario would approximately create 205,000 new jobs (Direct and Indirect) for the European economy in 2050.
- Domestic deployments account for 62% of the European jobs. Deployment in the Rest of the World (RoW) provide 38% of European jobs.
    - This is because the ramp-up of annual installations happens faster in Europe than in the ROW, plateauing faster towards 2050. In the ROW, annual installations start later and slower than in Europe, but culminate significantly higher than European installations by 2050, due to the size of the ROW compared to Europe and its thus larger tidal/wave potential. This explains why 38% of European jobs in 2050 are coming from projects outside of Europe, despite the fact that the leakage rate for European installations is 30% and for ROW 95%, and thus fewer jobs are created from ROW projects.
- Wave energy technologies contribute to two thirds of the job creation.
- 2.1 jobs per MW can be created due to domestic deployments.
- The number of Direct and Indirect employment has the same order of magnitude.
- The results from this scenario are presented in Table 3.3 below.

*Table 3.3: High leakage job creation results for the FIC with medium proportion of global ocean deployment occurring in EU waters*

| Deployment Scope | Technology | 2050 Installed Capacity (GW) | Leakage Rate | Direct jobs in Europe 2050 | Indirect jobs in Europe 2050 | Total jobs in Europe 2050 | Jobs/ MW |
|---|---|---|---|---|---|---|---|
| Europe | Tidal | 24 | 30% | 16,460 | 15,095 | 31,555 | 1.31 |
| | Wave | 36 | 30% | 50,893 | 45,317 | 96,210 | 2.67 |
| **Europe total** | | **60** | **-** | **67,353** | **60,412** | **127,765** | **2.13** |
| Rest of World | Tidal | 93 | 95% | 19,551 | 17,645 | 37,196 | 0.40 |
| | Wave | 140 | 95% | 21,088 | 18,619 | 39,707 | 0.28 |
| **RoW total** | | **233** | **-** | **40,639** | **36,264** | **76,902** | **0.33** |
| Global | Tidal | 117 | - | 36,011 | 32,740 | 68,751 | 0.59 |
| | Wave | 176 | - | 71,981 | 63,936 | 135,917 | 0.77 |
| **Global total** | **Ocean** | **293** | **-** | **107,991** | **96,676** | **204,667** | **0.70** |

Figure 3.2 shows the trend in terms of people directly or indirectly employed in the ocean energy sector in Europe during the period spanning from 2031 to 2050. By the end of the period, wave energy is expected to provide a greater potential for job creation due to the larger capacity installed. In total, a cumulative 1.4 million jobs-years can be created in Europe during this period.

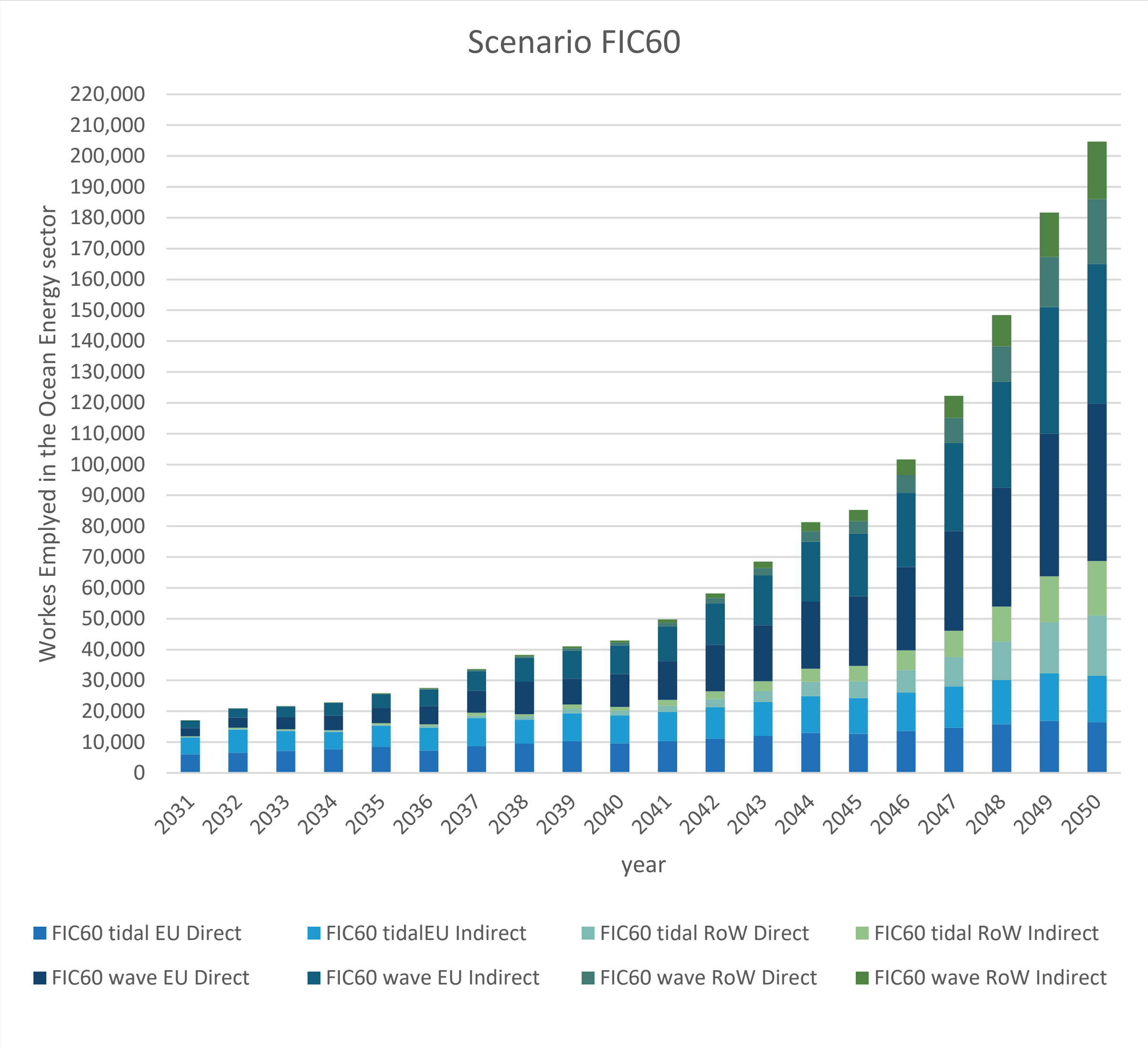


*Figure 3.2: Workers annually employed in the Ocean Energy Sector under scenario FIC60.*

### 3.3.2 FIC with 100 GW of 293 GW global deployment occurring in Europe and more favourable supply chain conditions ('Europe Leads the Market')

In this scenario, Europe invests in ocean energy to include it into energy mix and encourages a relatively higher proportion of global deployment to occur in Europe (100 GW). Europe makes itself an attractive place to deploy ocean energy technologies, capitalising on its blue economy opportunity and thereby stimulating developers to deploy in its waters. Taking advantage of global export market opportunities, Europe wins global contracts for projects deployed elsewhere in the world. The low leakage rate applied denotes Europe's prioritisation of local content for domestic deployments and the development of strong European supply chain.

Results for FIC with 100 GW of 293 GW global deployment occurring in Europe and more favourable supply chain conditions (FIC 100 LL) are as follows:

- Given the low leakage rates considered, this scenario would approximately create 505,000 new jobs (Direct and Indirect) for the European economy in 2050.
- The share of jobs created in Europe due to global deployments (48%) almost equals the jobs created due to domestic deployments (52%).
    - This is because the ramp-up of annual installations happens faster in Europe than in the ROW, plateauing faster towards 2050. In the ROW, annual installations start later and slower than in Europe, but culminate significantly higher than European installations by 2050, due to the size of the ROW compared to Europe and its thus larger tidal/wave potential. This explains why 48% of European jobs in 2050 are coming from projects outside of Europe, despite the fact that the leakage rate for European installations is 10% and for ROW 75%, and thus fewer jobs are created from ROW projects.
- Wave energy technologies contribute to 72% of the job creation.
- 2.6 jobs per MW can be created due to domestic deployments.
- The number of Direct and Indirect employment has the same order of magnitude.
- The results from this scenario are presented in Table 3.4 below.

*Table 3.4: Low leakage job creation results for the FIC with high proportion of global ocean deployment occurring in EU waters*

| Deployment Scope | Technology | 2050 Installed Capacity (GW) | Leakage Rate | Direct jobs in Europe 2050 | Indirect jobs in Europe 2050 | Total jobs in Europe 2050 | Jobs/ MW |
|---|---|---|---|---|---|---|---|
| Europe | Tidal | 40 | 10% | 32,892 | 30,219 | 63,111 | 1.58 |
| | Wave | 60 | 10% | 105,859 | 94,338 | 200,197 | 3.34 |
| **Europe total** | | **100** | **-** | **138,751** | **124,557** | **263,308** | **2.63** |
| Rest of World | Tidal | 77 | 75% | 42,076 | 37,910 | 79,986 | 1.04 |
| | Wave | 116 | 75% | 85,807 | 75,783 | 161,590 | 1.40 |
| **RoW total** | | **193** | **-** | **127,884** | **113,693** | **241,576** | **1.25** |
| Global | Tidal | 117 | - | 74,968 | 68,129 | 143,097 | 1.22 |
| | Wave | 176 | - | 191,666 | 170,121 | 361,787 | 2.06 |
| **Global total** | **Ocean** | **293** | **-** | **266,634** | **238,250** | **504,885** | **1.72** |

Figure 3.3 shows the trend in terms of people directly or indirectly employed in the ocean energy sector in Europe during the period spanning from 2031 to 2050. By the end of the period, wave energy is expected to provide a greater potential for job creation due to the

larger capacity installed. In total, a cumulative 3.4 million jobs-years can be created in Europe during this period.

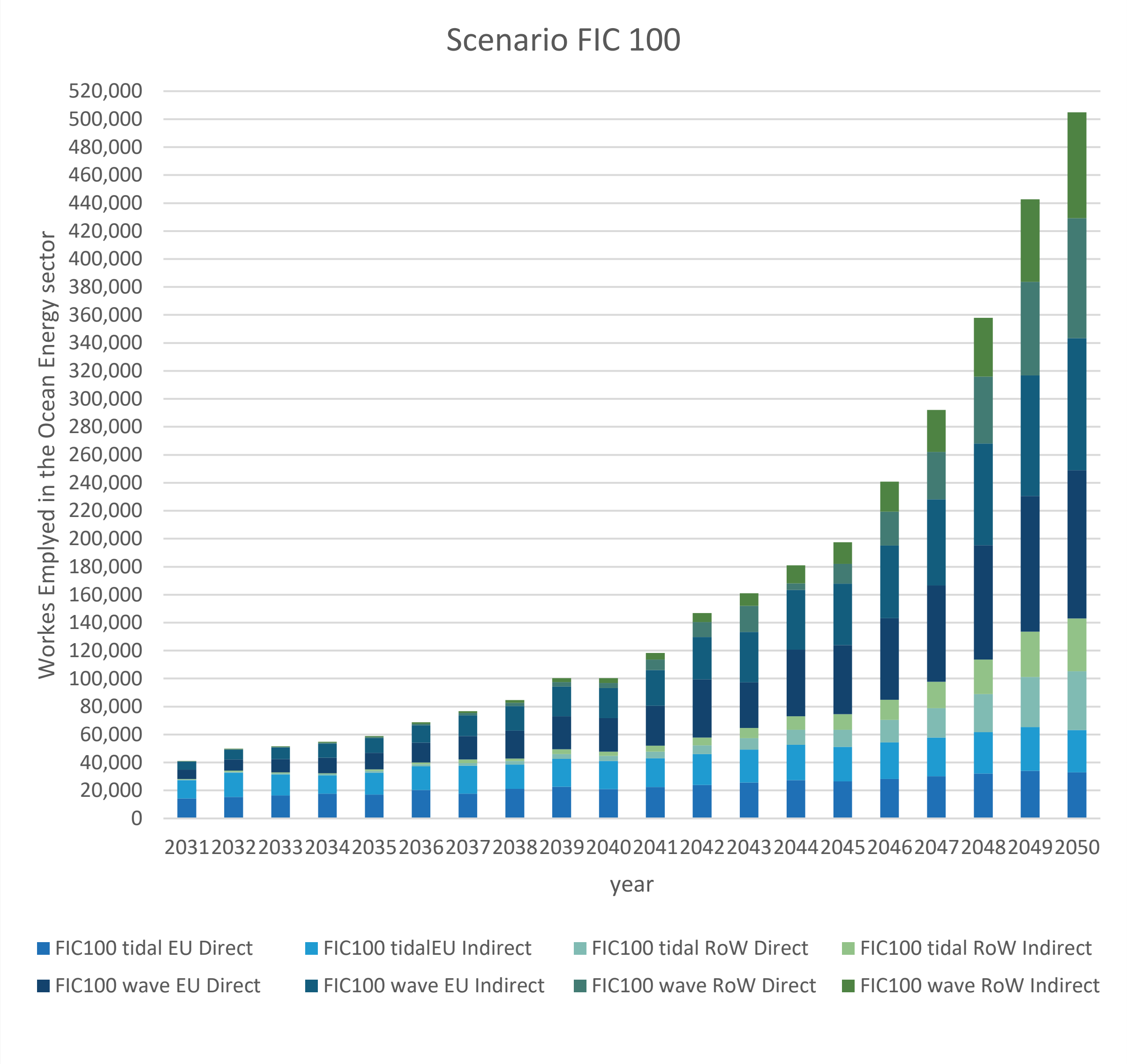


*Figure 3.3: Workers annually employed in the Ocean Energy Sector under scenario FIC100.*

### 3.3.3 Job creation for economic sectors

The technical cost centres have been assigned to economic sectors of the WIOD as shown in Table 3.5. It can be noted that the *manufacture of metal products* (C25) is allocated to both the generating device and the balance of plant cost centres. Similarly, the *management consultancy activities* (M69_70) are allocated to development and project management and installation.

*Table 3.5: Technical cost centres and WIOD industrial sectors*

| Technical Cost Centre | WIOD Sector Code | Sector |
|---|---|---|
| **Development and project management** | M69_70 | Legal and accounting services; activities of head offices; management consultancy activities |
| **Main structure / Generating device** | C25 | Manufacture of fabricated metal products, except machinery and equipment |
| | C27 | Manufacture of electrical equipment |
| | C26 | Manufacture of computer, electronic and optical products |
| **Balance of plant supply** | C25 | Manufacture of fabricated metal products, except machinery and equipment |
| | C33 | Repair and installation of machinery and equipment |
| **Installation** | H50 | Water transport |
| | M69_M70 | Legal and accounting services; activities of head offices; management consultancy activities |
| **Contingency** | K65 | Insurance, reinsurance and pension funding, except compulsory social security |

Since the leakage rates are constant across the industries, and the employment effects are constant across scenarios, the distribution profile of job creation by each national industry for the European economy is therefore constant for wave and for tidal across both scenarios.

The *manufacture of metal products* (C25) together with the *manufacture of electrical equipment* (C27) is expected to generate about two thirds of jobs. For tidal stream (see Figure 3.4), the *manufacture of metal products* generates the highest number of jobs (41%), followed by the *manufacture of electrical equipment* (22%). For wave (see Figure 3.5), the *manufacture of metal products* concentrates an even bigger number of jobs (55%). The *manufacture of electrical equipment* accounts for a lower share of jobs (11%).

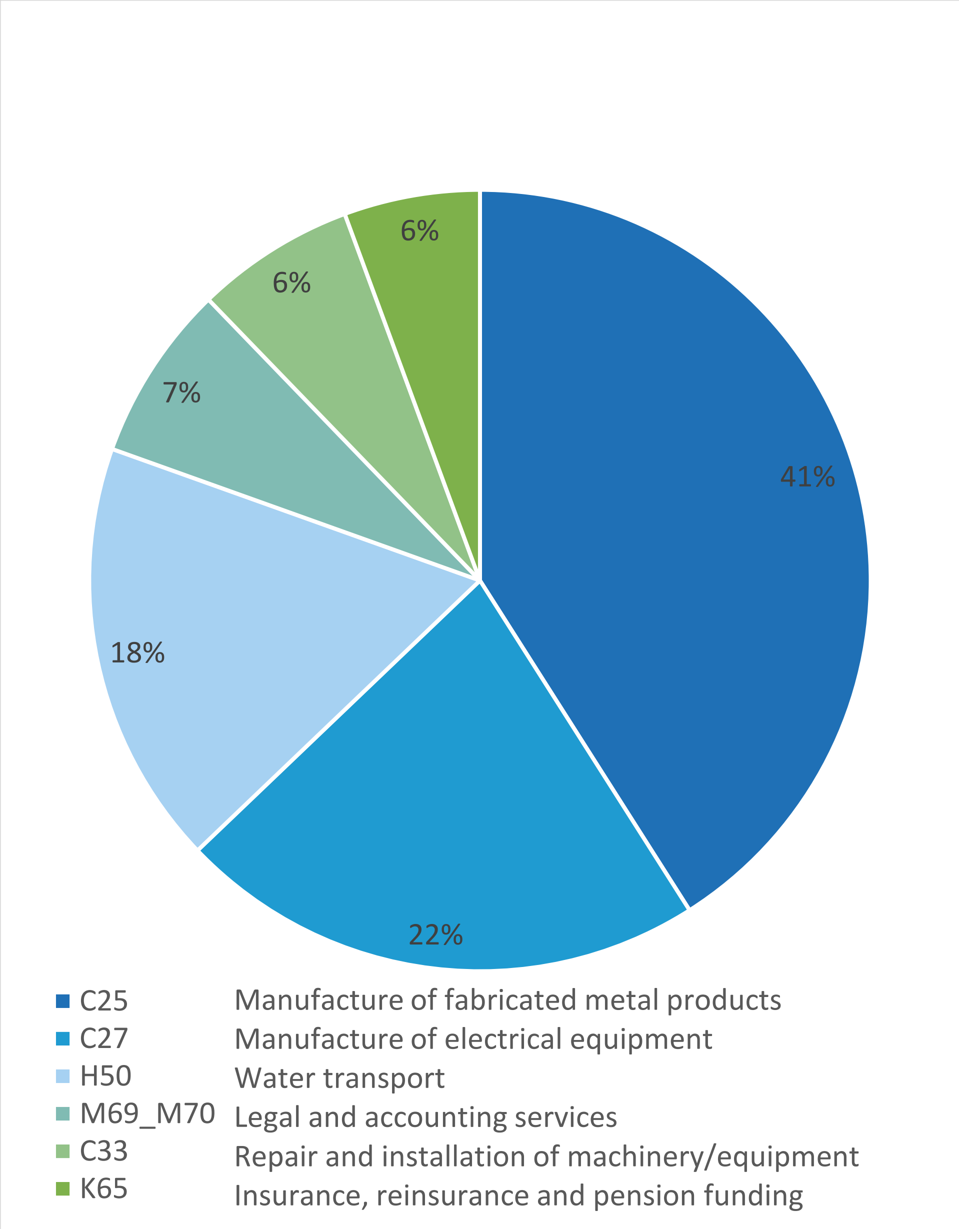


*Figure 3.4: Share of jobs generated by each relevant industrial sector for European tidal deployment*

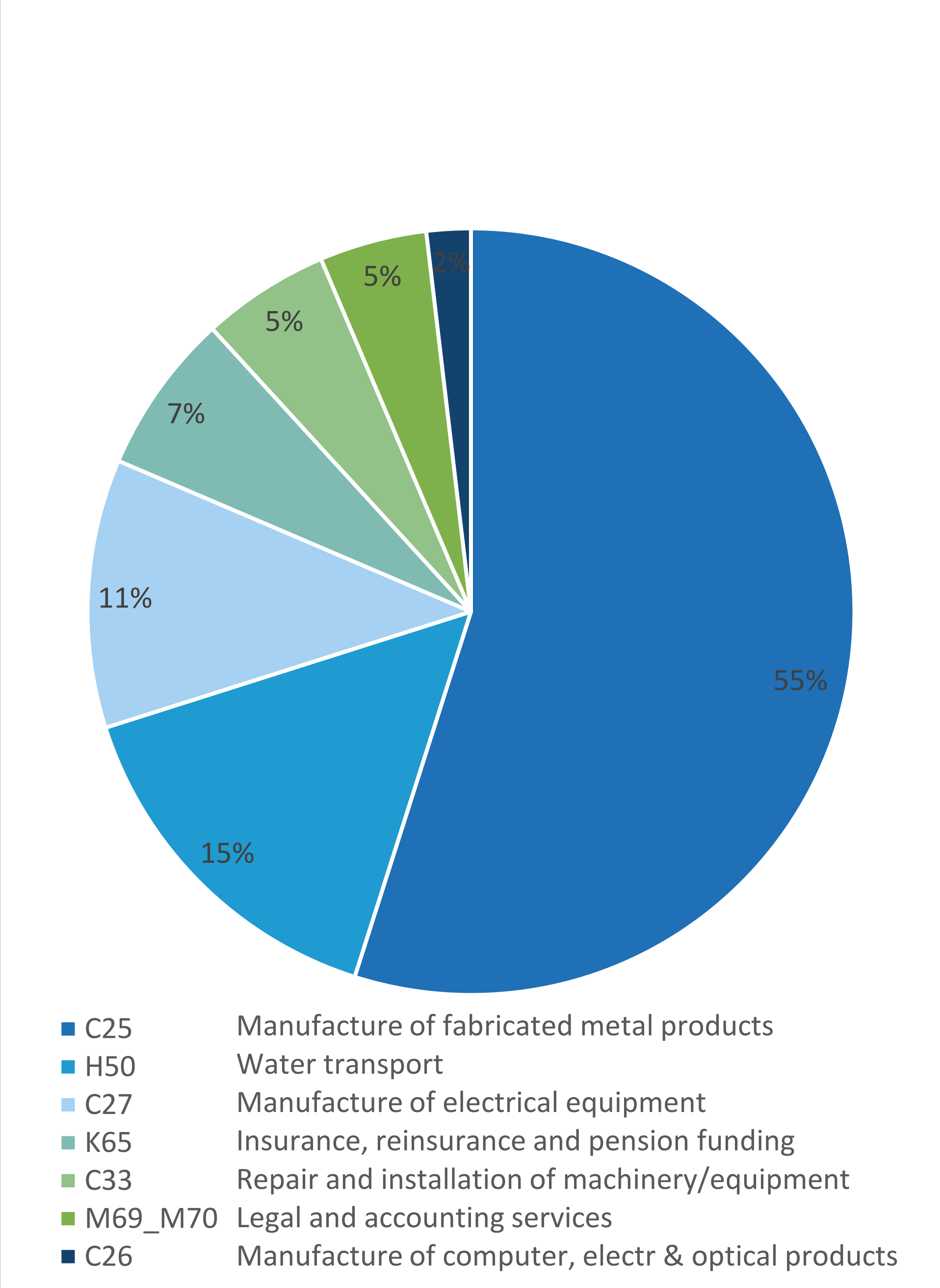


*Figure 3.5: Share of jobs generated by each relevant industrial sector for European wave deployment*

The GVA study assumes that the companies involved in upfront manufacturing activity will also be recruited in post-deployment activities such as repair and maintenance. Therefore, OPEX is allocated in the same proportion as CAPEX. Results from the GVA study show that OPEX contributes to 45% of the overall GVA. It is expected that a similar percentage of jobs can be created due to maintenance activities during the lifetime of the project (20 years). Furthermore, the jobs linked to maintenance work will be stable during the lifetime of the project compared with the development and production of devices, which only creates jobs before the farm starts operating.

### 3.3.4 Limitations of this study

As introduced before, the job creation potential is highly dependent on the level of deployment achieved in Europe (installation trajectory) and the development of a strong European supply chain (leakage). Particularly, forcing trajectories to achieve deployment targets by 2030 may distort the otherwise steadily growing contribution of ocean energy to job creation for Europe. In order to avoid this effect, the evolution of annual employment is presented in the period 2031-2050.

Cost reduction is not directly coupled to the different deployment trajectories of wave and tidal technologies in the GVA model. The distribution of national share of spend according to GDP allows to compute aggregated figures of employment. However, allocation of job creation to individual countries might be unrealistic since the level of deployment and strength of the supply chain need not be proportional to the GDP.

Employment related to the manufacturing of devices is assumed to happen in the same year the capacity is deployed. Depending on the size of the farms deployed this could require several years.

Comparability of results with related studies is limited either because approaches are dissimilar, or the assumptions are inconsistent and unknown. For instance, higher initial costs can offset by several years the deadlines when the sector is expected to grow.

# 4. Characterisation of regions

## 4.1 Why focus on NUTS2 regions

The first criterion to identify and compare the regions or local communities is the classification at the same rank according to the EU Nomenclature of Territorial Units for Statistics[3]. This hierarchical system is created and released by the European Commission and it is adopted for sub-dividing equal economical territories of the EU and the UK. The NUTS 2021 classification, that is valid for data transmissions to Eurostat from January 1st 2021, lists 104 regions at NUTS 1, 283 regions at NUTS 2 and 1345 regions at NUTS 3 level.

Specifically, NUTS 2 regions are the fundamental groupings for the application of regional policies. This is because the range of population is limited and it is feasible to identify the key decisions makers that can directly influence local policies in this territory. At this geographical level, it is easier to identify key stakeholders with the support of regional industrial associations, and also the implementation of local policies could be more effective.

Moreover, NUTS 2 regions guarantee greater homogeneity, which facilitates comparison among the geographical areas. NUTS 2 regions are considered homogeneous both in terms of superficial extension and population (typically they have a population of between 0.8 and 3 million inhabitants), with few exceptional cases including very large cities.

## 4.2 Factors to characterise regions

Regions are characterised by two sets of factors:

- **Capabilities**: factors that indicate how prepared the regions are to grasp the opportunities offered by ocean energy.
- **Opportunities**: factors external to the region that can be exploited.

Factors describing the size of the opportunity presented by the project need separate consideration from those that describe the competence of the region to address it. A fundamentally uninteresting opportunity should not be improved simply by the fact that is easy to do. Besides, the size of the opportunity is irrelevant if it requires competences that the region does not have. Thus, these two factors are roughly separate and independent considerations.

### 4.2.1 Capability factors

Capability factors are the region's strengths, internal to the region, and describe the outstanding features that separate this type of local community from the rest. Examples

[3] https://ec.europa.eu/eurostat/documents/345175/629341/NUTS2021.xlsx

of capability factors are industrial development, innovation index, technology providers, and R&D agents.

Capability factors of the regions have been organised in three categories:

1. Capabilities related to the industry configuration of the region.
2. Capabilities related to its technological development. This category refers to how technologically prepared the region is to meet the challenges of ocean energy.
3. Capabilities related to the human resources of the region and their education and skills level.

*Industry configuration*

Regarding the industry configuration of the regions the following four factors can be assessed:

a. Weight of the industry sector in the region's economy, measured as the GVA that manufacturing represents in relation to all economic activities in the region.
b. Infrastructures for the deployment of ocean energy (laboratories, demonstrations infrastructures)
c. Region's readiness to supply products or services for ocean energy: how ready would a potential value chain in the region be to provide products and services in the field of ocean energy.
d. Level of entrepreneurship in the region.

*Technological development*

In relation to the technological development category, the following four factors can be considered:

a. Region's gross domestic expenditure on R&D.
b. Region's innovation index.
c. Number of product or process innovators in the region.
d. Region's key technological know-how for the development of ocean energy considering the presence of universities, research centres or testing infrastructures working in the field of ocean energy.

*Human resources/Education level*

Finally, regarding the human resources of the regions and their skills and education level the following three factors can be considered.

a. Employment in medium and high-tech manufacturing and knowledge intensive services.
b. Workforce with STEM skills in the region.
c. Region's labour productivity.

### 4.2.2 Opportunity factors

Opportunity factors refer to favourable external factors that could give the local community a competitive advantage. Examples of opportunity factors are length of coastal line, wave/tidal resource, public support, permitting processes, and untapped potential.

The opportunities in the field of ocean energy that can be exploited, have been also organised in three categories:

1. Political factors.
2. Economic factors.
3. Societal-environmental factors.

*Political factors.*

The following political factors can be considered:

a. Presence of strategies to support the ocean energy deployment in the region.
b. Presence of labour policies to support the ocean energy deployment in the region.
c. Policies in place to support new businesses in the field of ocean energy.

*Economic factors.*

The economic factors to assess regions are the following three:

a. Presence of market pull funding mechanisms for the development of new ocean energy projects.
b. Share of renewable energy in gross final energy generation in the region.
c. Level of dependence on external energy sources: a high level of dependence on external energy sources is considered a major opportunity.

*Societal-environmental factors.*

Regarding the societal-environmental factors, the following three are assessed:

a. Social perception of ocean energy in the region.
b. Potential of the region's ocean resources for energy generation, primarily based on the length of its coastline.
c. Existence of any specific consenting process for ocean energy.

## 4.3 Assessment of capability and opportunity factors.

The next step in the characterisation of regions was assessing capability and opportunity factors. For that purpose, we have considered four scaling levels for each factor:

- 0 or low.
- 4 or low to medium.
- 8 or medium to high.

- 12 or high.

Scaling statements were defined for each factor to assign scaling levels to them. Scaling statements define the meaning of the factors and how to estimate them in relation to the dimensions of capability and opportunity that we want to measure.

Prior to assessing the factors, their actual values were obtained in two ways:

- Some values were retrieved from public databases such as Eurostat[4] or the EIS (European Innovation Scoreboard)[5].
- The values that were not publicly available were asked to the regions through a questionnaire.

The following table shows the list of capability and opportunity factors and the sources from which they have been obtained.

*Table 4.1: Capability factors and their sources.*

| CAPABILITY FACTORS | Source |
|---|---|
| **Industry configuration** | |
| Weight of the industry sector in the region's economy. | Eurostat |
| Infrastructures for the deployment of ocean energy. | Questionnaire |
| Region's readiness to supply products or services for ocean energy. | Questionnaire |
| Level of entrepreneurship in the region. | EIS |
| **Technological development** | |
| Region's gross domestic expenditure on R&D. | Eurostat |
| Region's innovation index. | EIS |
| Number of product or process innovators in the region. | EIS |
| Region's key technological know-how for the development of ocean energy. | Questionnaire |
| **Human resources** | |
| Employment in medium and high-tech manufacturing and knowledge intensive services. | EIS |
| Workforce with STEM skills. | Eurostat |
| Region's labour productivity. | Eurostat |

[4] https://ec.europa.eu/eurostat

[5] https://ec.europa.eu/info/research-and-innovation/statistics/performance-indicators/regional-innovation-scoreboard_en

*Table 4.2: Opportunity factors and their sources.*

| OPPORTUNITY FACTORS | Source |
|---|---|
| **Political factors** | |
| Presence of strategies to support the ocean energy deployment in the region. | Questionnaire |
| Presence of labour policies to support the ocean energy deployment in the region. | Questionnaire |
| Policies in place to support new businesses in the field of ocean energy. | Questionnaire |
| **Economic factors** | |
| Presence of market pull funding mechanisms for the development of new ocean energy projects. | Questionnaire |
| Share of renewable energy in gross final energy generation in the region. | Questionnaire |
| Level of dependence on external energy sources. | Questionnaire |
| **Societal-environmental factors** | |
| Social perception of ocean energy in the region. | Questionnaire |
| Potential of the region's ocean resources for energy generation. | Length of the coastline |
| Specific consenting process for ocean energy. | Questionnaire |

From the large group of NUTS 2 regions, a reduced number of potential European regions engaged in the ocean energy sector were selected and longlisted, basing on previous knowledge of the ETIPocean2 project partners. The longlist comprises 18 European regions from 6 different countries, evaluated either for their capabilities or for their opportunities, to potentially create a local emerging market.

The 18 shortlisted regions are shown in the table below:

| No. | NUTS2 Region | Country |
|---|---|---|
| 1 | Pays de la Loire | France |
| 2 | Brittany | France |
| 3 | Normandy | France |

| No. | NUTS2 Region | Country |
|---|---|---|
| 4 | Scotland | UK |
| 5 | Wales | UK |
| 6 | Basque Country | Spain |
| 7 | Canary Islands | Spain |
| 8 | Cantabria | Spain |
| 9 | Galicia | Spain |
| 10 | Asturias | Spain |
| 11 | Flanders | Belgium |
| 12 | Province of Zeeland | Netherlands |
| 13 | Province of Gelderland | Netherlands |
| 14 | Province of North Holland | Netherlands |
| 15 | Province of Fryslân | Netherlands |
| 16 | Province of South Holland | Netherlands |
| 17 | Province of Utrecht | Netherlands |
| 18 | Region Västra Götland | Sweden |

## 4.4 Results: classification of regions.

The following ten regions responded to the survey:

| No. | NUTS2 Region | Country |
|---|---|---|
| 1 | Pays de la Loire | France |
| 2 | Brittany | France |
| 3 | Scotland | UK |
| 4 | Wales | UK |
| 5 | Basque Country | Spain |
| 6 | Cantabria | Spain |
| 7 | Galicia | Spain |
| 8 | Asturias | Spain |
| 9 | Flanders | Belgium |
| 10 | Province of Gelderland | Netherlands |

With the results gathered from the survey for these ten regions together with the data collected from public data sources, the capability and opportunity factors were assessed for these regions.

For each region, two aggregate values were then calculated for its capability and opportunity, obtained as the average values of the region's capability and opportunity factors. Then, capability and opportunity aggregated factors for the ten regions were transferred to a X-Y diagram: opportunity values were plotted in abscissae and capability values in ordinates. This provided a clear picture of the current development status of each region assessed in relation to ocean energy harnessing.

The diagram is divided in four quadrants, each one showing the situation of the ocean energy sector in the different regions:

1. Strong quadrant: regions located in this quadrant have good opportunities for harnessing ocean energy and good capabilities to do so as well.
2. Promising quadrant: regions in this quadrant show good opportunities for harnessing ocean energy but limited capabilities to exploit them. An improvement in their capabilities may lead them to the strong quadrant.
3. Exporting quadrant: regions located in this quadrant show high capabilities to exploit ocean energy but limited opportunities to do so. Therefore, they can export their capabilities to other regions with greater opportunities.
4. Limited options quadrant: regions in this quadrant have both limited opportunities and capabilities for harnessing ocean energy.

The graphic below shows the Opportunity-Capability graph for the ten regions assessed. Only the selected regions for the case studies are identified by name.

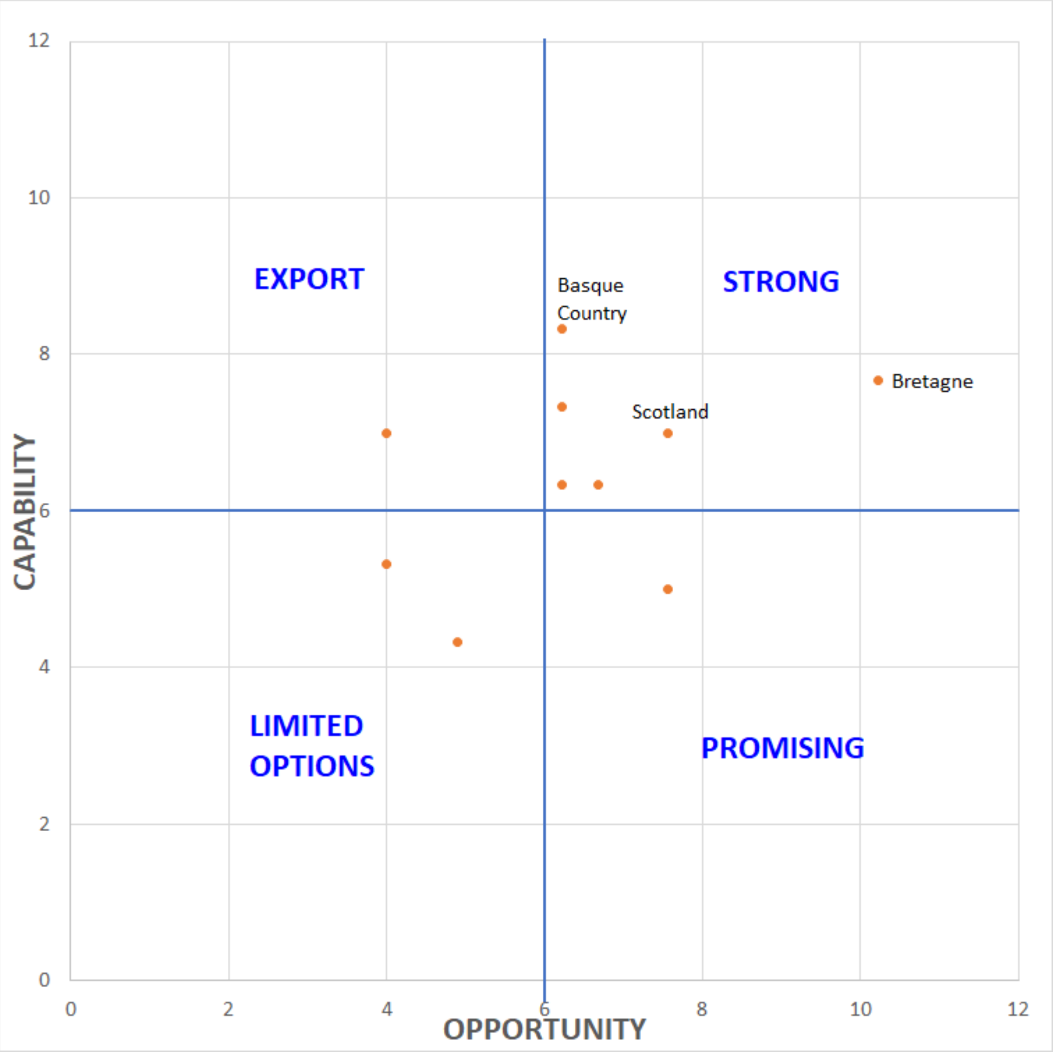


*Figure 4.1: Opportunity-Capability graph for the ten regions assessed.*

# 5. Case studies

Case studies are key to gather evidence on the direct and indirect impacts of ocean energy on the local communities and European regions. Furthermore, from the analysis of the case studies results, a number of conclusions and actions can be extracted, and presented to other European regions in similar conditions, in order to promote the development of the ocean energy sector Europe-wide.

## 5.1 Selection of Case Studies

Analysing the Opportunity-Capability graph seen in the previous chapter, we can see that the ten regions are distributed by quadrants as follows:

- Strong regions: 6
- Promising regions: 1
- Exporting regions: 1
- Regions with limited options: 2

Two regions have been selected for the development of the case studies due to their long-standing experience in ocean energy and their positioning in the Strong quadrant of the Opportunity-Capability graph; these regions are the **Basque Country [ES]** and **Scotland [UK]**. A third region, **Brittany [FR]**, has been also identified as of a high interest and some conclusions have been extracted from a study performed by the European project ELEMENT [16].

In relation to the dimensions in opportunity and capability factors described in the previous chapter, the selected regions are positioned as follows:

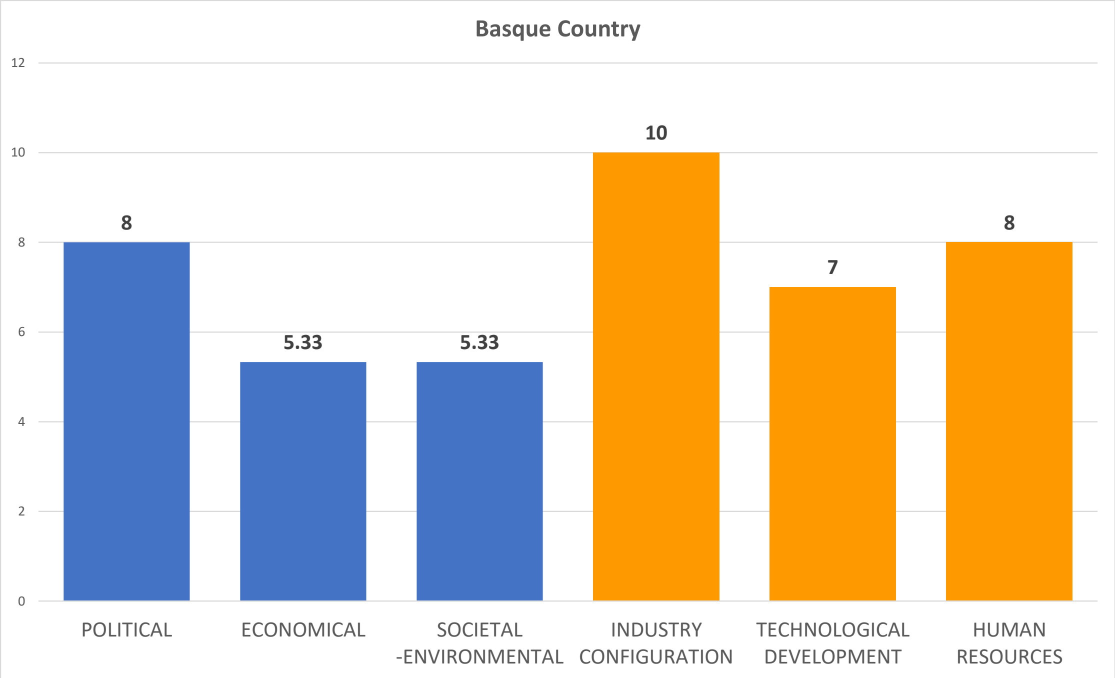


*Figure 5.1: Aggregate values of opportunity and capability dimensions for the Basque Country.*

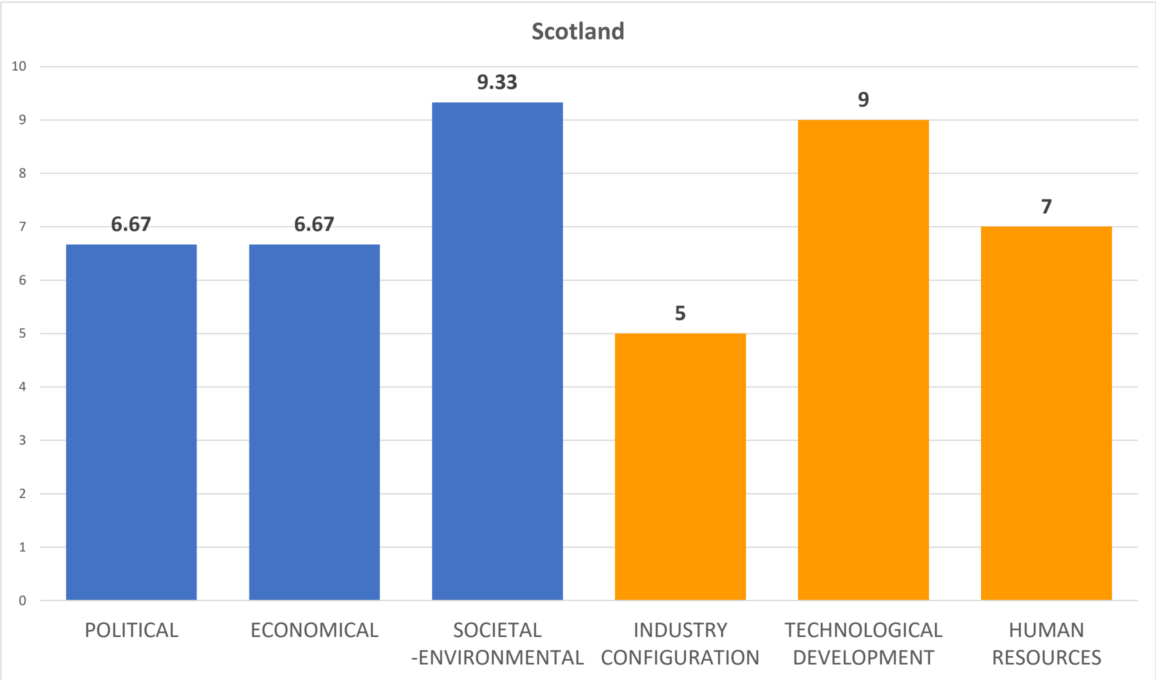


*Figure 5.2: Aggregate values of opportunity and capability dimensions for the Scotland.*

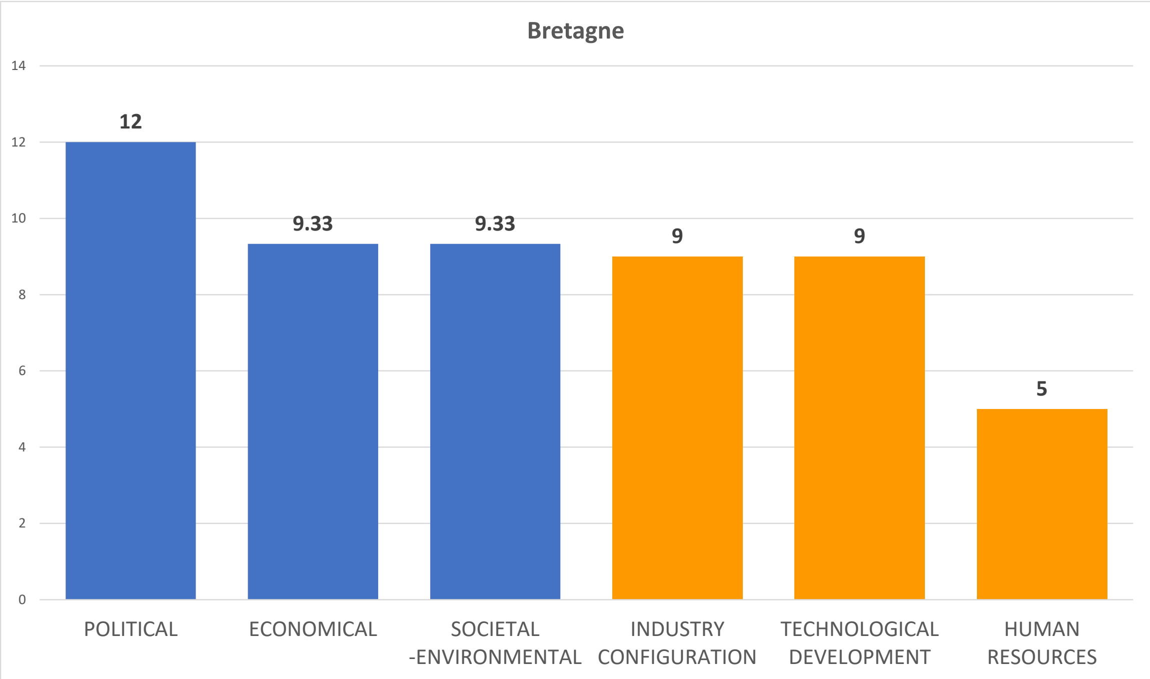


*Figure 5.3: Aggregate values of opportunity and capability dimensions for Bretagne.*

## 5.2 Case Study 1: Basque Country

### 5.2.1 Approach

The suggested approach for gathering information to prepare this case study consisted of holding a workshop with key stakeholders related to ocean energy from multiple profiles (e.g. universities, technology centres, public bodies, companies, business associations, etc.)

The aim of the workshop was gathering regional stakeholders' views on the possibilities and strategies needed for the development of ocean energy in the region. The workshop addressed the following issues related to the socio-economic impact of ocean energy on coastal communities:

- Potential benefits and risks that ocean energy technologies have on coastal communities (the first phase of the ETIP Ocean 2 project addressed the main barriers for the deployment of ocean energy).
- Steps that should be taken in the region to maximise the opportunities presented by ocean energy development and overcome the barriers that hinder it.

The workshop was structured in two parts:

1. The **first part** was devoted to stablishing the context of the discussion
   - Introduction of ETIP Ocean 2 project,
   - Main findings of the socio-economic study regarding job creation,
   - Methodology followed to assess the potential of European regions for the development of ocean energy and used for the selection of use cases,
   - Specific results of the assessment for the selected region as explained in the previous section.
2. The **second part** involved a discussion among participants with the aim of gathering inputs/insights/suggestions regarding the two aspects previously mentioned that will be posed as questions
   - Question 1: What are the potential benefits and risks that ocean energy technologies may have in your region?
   - Question 2: What steps could be taken in your region to maximise the opportunities presented by ocean energy development and overcome the barriers that hinder it? However, to incentivise the discussion, a secondary question was formulated: Do you know good practices in your region (or others) for promoting ocean energy?

During the second part, the participants were invited to consider 4 main topics for discussion:

- **Technology**: R&D, testing, sector-specific technological development, etc.
- **Supply chain**: everything around ocean energy technology that is essential to deploy projects: manufacturing, logistics, infrastructures such as ports, etc.
- **Financing**: focused more on the deployment of ocean energy farms than on technology development.
- **Social acceptance** including environmental issues, social awareness, permits…

Stakeholders participating in the workshop were selected to ensure a wide mix of ocean energy research, development, implementation, exploitation and impact. The stakeholders invited to the workshop in the Basque Country belonged to the following areas: academia, research and technology organisations, companies in the ocean energy value chain, industry associations related to ocean energy, public bodies and testing infrastructures.

The workshop was finally attended by 12 participants, representing the following profiles:

- Two participants from the Academia.
- Four participants from Research and technology organisations.
- Two participants from industrial companies.
- Two Industry associations: the Basque Energy Cluster (http://www.clusterenergia.com/) and the Basque Maritime Forum (http://www.foromaritimovasco.com/en/)
- One Public body: the Basque Energy Agency (https://www.eve.eus/)
- One Testing Infrastructure: Biscay Marine Energy Platform (https://www.bimep.com/)

The agenda was the following:

**First Part**: Current situation of ocean energy development in the Basque Country and presentation of the preliminary results of the ETIP Ocean2 project.

9:30 – 9:45: Current situation of ocean energy development in the Basque Country by the Energy Agency of the Basque Government (Olatz Ajuria)

9:45 – 10:00: The ETIP Ocean2 project and the main results of its socio-economic study by TECNALIA (José Luis Villate)

10:00 – 10:15: Methodology for assessing the potential of European regions for the development of ocean energy. Results for the assessment of Basque Country's potential for the development of ocean energies by TECNALIA (Xabier Uriarte)

**Second Part**: Group debate on the opportunities offered by ocean energy in the Basque Country.

10:15 – 11:00: Benefits and challenges posed by ocean energy technologies for the Basque Country – Group discussion.

11:00 – 11:15 Coffee break.

11:15 – 12:00 Good practices for making the most of ocean energy opportunities in the Basque Country and actions for a better use in the future – Group discussion

12:00 – 12:10 Conclusions, next steps and closing of the workshop by TECNALIA (Pablo Ruiz Minguela)

The sessions were held in Spanish in order to promote the richest and most detailed input possible. Participation in a language other than one's mother tongue may limit participants' input and may prevent the optimal level of detail from being achieved.

### 5.2.2 Main Findings

The first part of the workshop consisted of presentations about the current situation of ocean energy development in the Basque Country and the preliminary results of the project. The second part had a participatory approach for which the participants were divided into three groups of four persons each.

In this second part the groups addressed the following topics:

1. The benefits that they considered that ocean energy technologies might provide to the region and also the challenges posed by these technologies. Each group had 45 minutes to discuss about these issues and then, share their results in plenary.
2. Good practices related to the exploitation of ocean energy in the Basque Country and that could be exported to other regions. In addition, the groups discussed what actions would need to be implemented to make better use of the opportunities offered by ocean energy in the future. The time available was again 45 minutes both to discuss on these issues and then share the results in plenary.

Regarding the **benefits** that ocean energy technologies bring to the Basque Country the aggregate results of the discussion tables were as follows:

- These technologies help to **reduce the energy dependence** we have in the region.

- They help in the **diversification of existing industry**: on the one hand existing industry that has a certain entity and that can diversify to other sectors and, on the other hand, it is an opportunity for new companies that have higher technological capabilities. Due to the existing industrial fabric and the naval know-how, the Basque Country starts from a strong initial position in this process of recycling/adaptation of local industry.
- They also contribute to the **creation of valuable jobs and wealth**.
- They launch **synergies with other related sectors** as well as with other European regions.
- They promote the **training** of specialised personnel.
- They offer opportunities for **scientific and technological development**, i.e. technological independence.

In relation to the **challenges** facing the Basque Country in terms of harnessing ocean energy and its associated technologies, the discussion groups concluded the following:

- **Adequacy of support mechanisms for this sector**. Existing support mechanisms for other sectors are not valid for this one, therefore, it would be necessary to look for an innovation of these support mechanisms.
- **Coordination of the activities of** the different agents in the sector and public-private collaboration mechanisms. It is common for the different agents to participate in activities and forums of the sector in an uncoordinated manner, which makes it difficult for us to be identified as a sector.
- **Social acceptance and awareness raising** are probably the biggest challenges facing the sector. Political support depends to a large extent on how we are able to reduce the social conflicts that may arise.
    - Although it is understood that this is one of the renewable energy sources that can generate the least rejection because the visual impact is small, it is also true that the maritime space is not infinite and it will have to be shared with other sectors.
    - Once an ocean energy project is planned it will be very important to know how to communicate it so that it is socially accepted.
- **Technological reliability**: among different technology challenges, the participants agreed that reliability is probably one of the most important. Ocean energy technologies must be reliable in terms of energy production and maintenance needs to attract private support. The example of offshore wind was

mentioned which has attracted the interest of big players and investors after achieving enough technology maturity.

- **Keeping and promotion of key agents present** in the region such as BiMEP, Mutriku and the value chain, which is a benchmark and a singularity, but which must be maintained and promoted.
- **Lack of manufacturing industry** in certain components and services, for example specific vessels for some marine operations or some bespoke devices for ocean energy.
- **Possibility of managing own resources**: for example, areas for wave energy projects are usually under the control of the national government.
- **Actual business to attract customers**: opportunities make sense when there is a real business and devices are installed, if not, companies involved in ocean energy find difficulties to attract the interest of potential customers.
- **Training** at all levels is a challenge as it is necessary to have very specific knowledge in the sector, and it is not easy at the moment to recruit staff with this kind of knowledge.
- **Continuous public support** and commitment is essential because ocean energy requires large investments in the long term and with high risk. When SMEs invest in this type of technologies, they need to foresee continuity over time.

Regarding **best practices** for marine energy exploitation in the Basque Country, the discussion tables concluded the following ones:

- The **strong institutional support** and the Basque Government's initiative in this sector, not simply because there is a strategy, but also because it has embarked on specific projects that add high value, such as the Mutriku project. This has helped to build confidence in the sector.
- The **coordination of the ocean energy sector** carried out by the Basque Energy Cluster with the brand.
- A **good positioning** of all the agents in the sector: academia, research, administration, companies, producers, facilities and also the cluster, which has done a great job in this grouping and support, has helped in its identification.
- The **efficiency of the results achieved** in terms of return on investment: good return on what has been achieved to date versus what has been invested.

Finally, concluded the following **actions** for future better use of the opportunities offered by ocean energy:

- It seems the right time to create a **regional strategy** for wave energy, following European and national strategies.
- Continuation of supporting the sector with **"lighthouse" projects**. The next step could be an array of wave energy devices. It could help to align efforts and get everyone pushing in the same direction.
- To achieve a **good critical mass** of researchers, workers and dedicated staff involved in this sector.
- **Sustainability over time**: keep up institutional support, coordination, etc. and support coordination between University, Technology Centres and Industry.


*Figure 5.4: Pictures of the workshop held in the Basque Country: wallpapers and working groups.*

## 5.3 Case Study 2: Scotland

### 5.3.1 Approach

The results for case study 2 come from a number of individual interviews with ocean energy stakeholders in Scotland, who fall under a number of categories:

- Academia
- Industry (both technology developers and supply chain)
- Regional development agencies

### 5.3.2 Main Findings

Regarding the **benefits** that ocean energy technologies bring to Scotland, the aggregate results were as follows:

- Scotland has an established ocean energy sector due to strengths in wave and tidal resource, infrastructure (e.g. ports and harbours), supply chain (e.g. steel manufacturing), technology developers, test centres and academic researchers.
- Scotland has a high penetration of renewables within its current energy mix, dominated by wind energy. As ocean energy can provide electricity which is available at times of low wind resource, ocean energy can result in more consistent renewable energy output and security of supply.
- Furthermore, technology development programmes and grants from the Scottish Government and development agencies have supported the wider sector as a whole, with over £50M committed so far for ocean energy projects in Scotland. These funding schemes include Wave Energy Scotland, the Marine Saltire Fund, and the OceanERANET cofund.
- This strong base in resource, skills, and funding has resulted in the following benefits:
    - Accelerated technology development and deployment, providing Scotland with strong ocean energy industrial expertise and supply chain development
    - Diversification and transfer of skills from other sectors – such as oil and gas, and maritime
    - Supporting jobs and economic growth, particularly in fragile coastal communities and islands
    - Development of academic and research expertise, with academics from world leading universities contributing to valuable research outputs

- Development of testing expertise, facilitating testing of devices e.g. the European Marine Energy Centre on Orkney, the FloWave facility at the University of Edinburgh

In relation to the **challenges** facing Scotland in terms of harnessing ocean energy and its associated technologies, the results were as follows:

- While technology push has been well supported to date in Scotland, market pull is not devolved and the UK market mechanism (a feed-in-tariff with contract for difference) is challenging to access for ocean energy, as it has to compete with more established technologies[6].
- A key future challenge will be to maintain a suitable balance between technology push and market pull, and provide consistent funding for early stage technology developers. Funding currently comes from a number of sources, which are regional, national and European, and is not coordinated.
- Further to this, private investor funding is also difficult to obtain without clear long-term market signals for ocean energy.
- Public acceptance has not yet been a great challenge, with good public engagement for existing projects. This could be more challenging as the sector continues to scale up in Scotland, as there is a need for continued communication with local communities and other maritime users.
- Due to the early stage of ocean energy technologies, it is challenging to fund and deploy large- and full-scale demonstration projects. As projects move to array scale it could be a challenge to retain a high proportion of local content within the supply chain. Scottish technology developers are currently actively utilising local supply chains, but may not be able to continue with the same suppliers without focused support to allow these companies to increase in scale and production volumes.
- Transmission infrastructure is limited at sites with high ocean energy resource in the North and West of Scotland. Furthermore, Transmission Network Use of System (TNUoS) charges are disproportionately high in areas with high ocean energy resource.
- Insurance costs and finance costs are high compared with other renewable technologies, and will continue to be so until more long term demonstration has been undertaken to prove the reliability of ocean energy technologies.

[6] Since the interviews took place, the UK has put in place a contract for difference for tidal energy projects.

- Ensuring the workforce has skills and training specific to ocean energy technologies and deployments will continue to be a challenge for future projects. STEM graduates and early-stage professionals with technical experience and expertise will be increasingly necessary.
- Ideally, lessons learned from technology development and deployment would be freely shared to maximise learning by interaction. However, Intellectual Property (IP) issues can prevent developers from publicly sharing all of the information available.

Regarding **best practices** for marine energy exploitation in Scotland, the results were as follows:

- In terms of technology development, a number of deployments have taken place in Scotland, at a device scale for wave energy and array scale for tidal stream. Where possible, best practises and lessons learnt from these deployments have been shared, through both webinars [17] and reports [18], and learnings captures through the WES programme.
- In terms of testing, the European Marine Energy Centre (EMEC) operates to relevant test laboratory standards (ISO17025) enabling the Centre to provide independently-verified performance assessments. They are also accredited to ISO/IEC 17020 offering technology verification on marine energy converters and sub-systems.
- In terms of technology development funding, the Wave Energy Scotland Programme utilises a pre-commercial procurement process with stage gates, to ensure that the technology solutions with the highest performance can be taken forward to future funding rounds. Individual sub-systems and full wave energy device concepts are developed simultaneously through these funding calls.
- In terms of sector collaboration with policy-makers, the Scottish Government has established a Marine Energy Working Group, to allow the ocean energy industry to work with policy-makers to ensure that Scotland maintains its competitive advantage in the sector, as well as contributing to the global development of the ocean energy industry.
- Regional development agencies Scottish Enterprise and Highlands and Islands Enterprise work in collaboration with the Scottish Government, Scottish businesses and SMEs to support ocean energy projects.
- Scotland plays an active role in knowledge sharing and research-industry collaborative programmes – e.g. ETIP Ocean, the European Energy Research Alliance (EERA), and the International Energy Agency (IEA). The Energy Technology

Partnership (ETP) scheme also acts as a direct mechanism to link academia and industry.

- Marine Scotland have developed standardised consenting and licensing processes for marine deployments, with accessible guidance and information.
- Crown Estate Scotland's seabed leasing programme supports seabed leasing for offshore renewable energy projects in Scotland, supporting the sustainable growth of maritime industries.

Finally, concluded the following **actions** for future better use of the opportunities offered by ocean energy in Scotland:

- As many key policies and market signals are not devolved to the Scottish Government, a key future action to support the Scottish ocean energy industry would be the development of a UK marine energy strategy by the UK Government. This should be developed in collaboration with EU member states to meet the wider European target of 1GW deployed capacity of ocean energy by 2030.
- The UK already has targets for offshore wind energy through the Offshore Wind Sector Deal, of 40 GW offshore wind and 1 GW floating offshore wind by 2030. Any strategy for ocean energy should be taken in collaboration with the offshore wind sector, optimising the use of planning, seabed leasing, workforce skills and shared balance of plant infrastructure.
- Any deployment targets within a UK marine energy strategy should be supported by a balance of technology push and market pull mechanisms to facilitate said deployment. These dedicated support mechanisms will be necessary to meet future targets.
- Within this strategy, support should also be provided for infrastructure requirements, both hard infrastructure e.g. ports and harbours, fabrication facilities and soft infrastructure, e.g. skills and training.
- With a UK marine energy strategy in place, future planning requirements and leasing rounds can be placed at a UK and regional level to support future deployments.
- With a UK marine energy strategy in place, devolved governments such as the Scottish Government can then take strategic actions to support the Scottish ocean energy sector and future Scottish deployments.

## 5.4 Case Study 3: Brittany

### 5.4.1 Approach

The assessment of capability and opportunity factors in ETIP Ocean 2 resulted in three strong regions that could provide significant experience for the identification of direct and indirect socio-economic impacts of ocean energy. However, due to limited resources, the project could only complete the primary research corresponding to the two full case studies specified in the description of work, namely the Basque Country and Scotland.

As an alternative approach, secondary sources were used to gather evidence in Brittany with a view to accounting for all available socio-economic information at regional level. Specifically, the ELEMENT project, also funded under the H2020 programme, has published a regional assessment of the effects of tidal energy in the area around Etel estuary communities in Brittany [16].

### 5.4.2 Main Findings

Although restricted to tidal energy, the study analysed the following list of socio-economic issues:

- Demographics
- Standard of living / housing conditions / vulnerable groups
- Educational change
- Social cohesion
- Perception of the sea as a tidal energy resource
- Recreational and tourism activities
- Employment and business
- Industrial strategy and rural regeneration
- Commercial shipping and navigation
- Effects on the regulatory framework

All issues found positive effects with a major positive impact on employment and business. In addition, should a tidal energy fed Renewable Energy Community (REC) be created, this would result in extra positive impacts in the standard of living, educational change, social cohesion and perception of the sea as a tidal energy resource.

The main findings are summarised below for each of the topic areas analysed.

*Table 5.1: Main socio-economic effects in Brittany*

| Topic area | Findings |
|---|---|
| Demographics | Potential to increase the offer of new skilled local jobs. |

| Topic area | Findings |
|---|---|
| Standard of living / housing conditions / vulnerable groups | Reduction of tidal energy cost to or below current market prices would foster the consumption power of local communities.<br>Increase in the standard of living can benefit housing conditions.<br>The creation of a REC can help provide tidal energy at an attractive price to vulnerable groups. |
| Educational change | Children, students and households can receive lessons, coaching and participate in site visits to increase consciousness in energy and ecology issues. |
| Social cohesion | The Renewable Energy Community (REC) model will enhance community spirit and act together towards a greener world.<br>Green-energy providers like Enercoop Bretagne have a potential for social cohesion because these associations are led by citizens. |
| Perception of the sea as a tidal energy resource | Local community engagement activities to raise awareness that estuaries, as well as coastal and river waterways, can generate energy by harnessing the tide and water speed. |
| Recreational and tourism activities | Tidal turbines can be placed underwater and therefore have no visual impact and noise problems for local residents.<br>Information boards may stimulate the site as an attraction point for locals and tourists. |
| Employment and business | Employment can be promoted by sharing the related job opportunities available in the tidal business as well as in the supply chain. This is particularly relevant in local communities with a high unemployment rate.<br>Engineering activities related to the development, testing and manufacture of components, repair and installation or water transport are expected to have a major positive effect on employment and businesses. A wider number of business activities may indirectly benefit. |
| Industrial strategy and rural regeneration | The direct engagement of CHBS in the ELEMENT project is increasing their network as well as supporting their future business needs.<br>Brittany, with an important deficit in terms of energy production and a high tidal current resource potential, has a real interest in developing decentralized units of marine renewable energy. |
| Commercial shipping and navigation | Tidal technologies to be installed in Etel must be placed in an area that will not interfere with navigation. |

| Topic area | Findings |
|---|---|
| Effects on the regulatory framework | The Brittany coasts are considered to have high currents and be great prospects for tidal energy. However current speed data is not readily available for estuaries and rivers.<br>R&D projects on estuary and run-of-river sites will be instrumental to gather experience in order to promote even further tidal energy and reap the previously mentioned benefits to local communities.<br>The Etel estuary has already received regulatory consent for tidal projects in the past. |

# 6. Conclusions

## 6.1 Top-down approach: transforming GVA into jobs

The job study has found that between 205,000 and 505,000 new jobs can be created for the European economy in 2050 depending on the market share of global deployment that can be retained in Europe and the conditions for the development of the European supply chain. Domestic deployments alone could range between 128,000 and 263,000 jobs. The results reinforce the conclusions from the GVA study [2].

Building a policy framework that supports faster innovation to reach net zero by 2050, European leadership in the global market and a strong supply chain is critical for maximising the socio-economic benefit. Indeed, a 66% increase in the proportion of global deployment retained in Europe (from 60 GW to 100 GW) can have a multiplier effect, raising the number of jobs by 147%. On average, 16 jobs can be created by MEUR of GVA generated for the European economy and 2.1-2.6 jobs per MW of domestic deployments.

Domestic deployments are a significant part of the job creation potential (in the range of 52-62%) and a facilitator of a greater share of the global market. Support to the European and national industrial activity will promote Europe's independence from foreign supply and prioritise local content in the supply chain. Moreover, a strong local content would enable great wider benefits at the community level.

Wave energy is expected to contribute to a 75% share of total jobs in domestic deployments. This is because wave energy accounts for 60% of the total capacity installed and it also retains greater value per MW (around 125% of tidal). In the rest of the world, wave and tidal stream technologies retain a similar value per MW for Europe.

## 6.2 Bottom-up approach: recommendations from the case studies

Regions interested in ocean energy are invited to make a self-assessment of their opportunities and capabilities to know the current positioning.

1. Strong quadrant: regions located in this quadrant have good opportunities for harnessing ocean energy and have good capabilities to do so as well.
2. Promising quadrant: regions in this quadrant show good opportunities for harnessing ocean energy but limited capabilities to exploit them. An improvement in their capabilities may lead them to the strong quadrant.
3. Exporting quadrant: regions located in this quadrant show high capabilities to exploit ocean energy but limited opportunities to do so. They can therefore export their capabilities to other regions with greater opportunities.

4. Limited options quadrant: regions in this quadrant have both limited opportunities and capabilities for harnessing ocean energy.

The initial quadrant positioning should be considered to build the region's strategy to reap the desired socio-economic benefits and impacts. The strategy will set the right direction to reinforce the capabilities and maximise the opportunities and give an indication of the level of effort to achieve this.

A summary of the best practices and actions identified through the case studies is provided below. They are presented according to the capability and opportunity factors of the self-assessment. This helps regions to choose which factors they wish to improve.

**Industry configuration**

- A regional association coordinating the emerging ocean energy value chain in the region.
- Development of a strong value chain: infrastructures (e.g. ports and harbours), supply chain (e.g. steel manufacturing), technology developers, test centres and researcher and technology organisations.
- Creation of a specific ocean energy brand to gain visibility beyond the region.
- Accredited entities to provide technology verification on marine energy converters and sub-systems.

**Technology development**

- Demonstrate that the technologies are developed to a level where its technological and financial reliability is guaranteed.
- Webinars and reports to capture best practices and lessons learnt from deployments.
- Concentrate efforts on solving specific technology challenges to the sector.
- Monitor akin sectors for innovations that can be easily transferred. Diversification and transfer of skills from other sectors – such as oil and gas or maritime.
- Participation in European and international networks and collaborative programmes.

**Human resources**

- Achieving a critical mass of researchers, workers and dedicated staff involved in ocean energy.
- Leading universities and research centres contributing to valuable research outputs.

- Promote training at all levels to have access to very specific knowledge in the sector. STEM graduates and early-stage professionals with technical experience and expertise will be increasingly necessary.

**Political factors**

- Definition of a regional strategy specific for ocean energy, established targets and future planning requirements.
- Strong institutional support. Regional development agencies working in collaboration with the regional government and companies (including SMEs) to support ocean energy projects.
- Innovation with respect to the support mechanisms for ocean energy. Some examples of successful funding schemes include Wave Energy Scotland, the Marine Saltire Fund, and the OceanERANET cofund.
- Provide consistent funding for early stage technology developers (long term stability).
- Promotion of lighthouse projects to develop practical expertise, build confidence and align efforts.
- Development of standardised consenting and licensing processes for marine deployments, with accessible guidance and information.

**Economic factors**

- Efficient use of limited resources.
- Existence of market pull mechanism (e.g. a feed-in-tariff with contract for difference).

**Socio-environmental factors**

- Public engagement for existing projects, continued communication with local communities and other maritime users to raise awareness. Information boards may stimulate deployment sites as an attraction point for locals and tourists.
- Supporting jobs and economic growth, particularly in fragile coastal communities and islands
- Maximising local content within the supply chain needs means allowing these companies to increase in scale and production volumes.
- The creation of a Renewable Energy Community (REC) would result in extra positive socio-economic impacts (e.g. standard of living, educational change, social cohesion and perception of the sea as an ocean energy resource).

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# Annex: Self-assessment tool for regions.

The aim of this assessment tool is to provide regions with a mechanism to analyse their capacities and opportunities for harnessing ocean energy.

The tool provides regions with an estimate of two dimensions:

- Capability: the level of readiness of the region to take advantage of the opportunities offered by ocean energy.
- Opportunity: external factors related to the region's ocean energy harnessing potential.

Regions wishing to use this tool must obtain the value of 20 factors. 11 of which are capability factors and 9 are opportunity factors. Nine of these values can be obtained from public data sources while the remaining eleven values are obtained by answering questions in a questionnaire.

The following two sections describe the following:

1. How to obtain the values of the factors that can be searched in public databases.
2. The questionnaire to be answered by the region in order to obtain the values of the factors that are not available in public databases.

## Values gathered from publicly available data.

There are 9 values of factors that can be collected from publicly available information, 1 corresponds to an opportunity factor and 8 to capability factors.

These values can be obtained as follows:

**Societal-environmental opportunity factor:**

1. Potential of the region's ocean resources for energy generation:
    a. It is measured as a function of coastline length (Societal-environmental opportunity factor)

**Industry configuration capability factors:**

2. Relative weight of the industry in the regional economy (capability factor):
    a. This value is calculated as the percentage that NACE industry activities (B to E) represent in relation to total NACE activities.
    b. The value is taken from the Eurostat[7] dataset: "Gross Value Added at basic prices by NUTS 3 regions".

[7] https://ec.europa.eu/eurostat

3. Regional Entrepreneurship Development Index[8] that is a measure of regional entrepreneurship.

**Technological development capability factors:**

4. Region's gross domestic expenditure on R&D:
    a. This value is calculated as the average regional gross expenditure on R&D in the last 5 years as a percentage of the average GDP of those 5 years.
    b. These values can be found in Eurostat[9].
5. Regional innovation index[10] that shows the region innovation profile over time.
6. Number of product of process innovators in the region[11].

**Human resources/Education level capability factors:**

7. Employment in medium and high tech manufacturing & Knowledge intensive services in the region, taken from the Regional Innovation Scoreboard[12].
8. Percentage of the workforce with STEM skills, taken from the Eurostat dataset HRST by category and NUTS 2 regions[13].
9. Labour productivity in the region, taken from the Eurostat dataset Labour productivity per person employed and hour worked[14].

## Values gathered through a questionnaire.

The questionnaire consists of the following eleven questions, eight of which correspond to opportunities and three to capabilities:

**Opportunities: political factors.**

1. Is there any strategy to support the Ocean Energy deployment applicable in your region? *[options]*
    a. No, there is no regional energy strategy.
    b. There is a strategy that supports renewable energies in general.
    c. There is an Ocean Energy strategy under development.
    d. There is an Ocean Energy strategy in place.
2. Is there any employment policy in place to support the Ocean Energy deployment? *[options]*

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[8] https://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/regional_entrepreneurship_development_index.pdf
[9] https://ec.europa.eu/eurostat/databrowser/view/NAMA_10R_3GVA__custom_942519/default/table?lang=en
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[12] https://ec.europa.eu/research-and-innovation/en/statistics/performance-indicators/european-innovation-scoreboard/eis
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[14] https://ec.europa.eu/eurostat/web/products-datasets/-/tesem160

   a. No, there are no labour policies at all.
   b. Yes, there are policies to stimulate job creation in general.
   c. Yes, there are policies to stimulate job creation in renewables.
   d. Yes, there are policies to stimulate job creation in Ocean Energy.
3. Is there any policy in place to support new businesses in the field of Ocean Energy? *[options]*
   a. No, there are no policies at all.
   b. There are policies to support entrepreneurship and new businesses in general.
   c. Yes, there are policies to support entrepreneurship and new businesses in renewables.
   d. Yes, there are policies to stimulate job creation in Ocean Energy.

**Opportunities: economic, societal and environmental factors.**

4. Are there market pull funding mechanisms for the development of new Ocean Energy projects (e.g. export banks, government investment agencies, …)? *[options]*
   a. There is no market pull funding mechanism at all.
   b. Market pull funding mechanisms are available for innovation projects.
   c. Market pull funding mechanisms are available for renewable energy projects.
   d. Market pull funding mechanisms are available for Ocean Energy projects.
5. What is the approximate share of renewable energy (%) in gross final energy generation in the region?
6. What is the region's level of dependence on external energy sources? *[options]*
   a. More than 75% of energy is generated in the region.
   b. Between 50% and 75% of energy is generated in the region.
   c. Between 25% and 50% of energy is generated in the region.
   d. Less than 25% of energy is generated in the region.
7. What is the social perception of Ocean Energy in the region? *[options]*
   a. Negative perception of all renewables.
   b. Undecided, but sensitive to ecological and environmental issues.
   c. Positive attitude towards renewables in general.
   d. Acceptance of ocean energy is greater than other renewables.
8. Is there a specific consenting process for Ocean Energy? *[options]*
   a. There are some ad-hoc processes per project.
   b. There are some generic processes for renewable energy projects.
   c. There is a specific consenting process for Offshore Renewables that includes Ocean Energy.

d. There is a specific consenting process and a single point of contact for Ocean Energy

**Ocean Energy capabilities**

9. Does the region have any infrastructure for the deployment of ocean energy? *[options]*
    a. There is no infrastructure for this.
    b. There are small-scale laboratory infrastructures.
    c. There are large-scale laboratory infrastructures.
    d. There are offshore demonstration infrastructures.
10. Is the region prepared to supply products and/or services for Ocean Energy? *[options]*
    a. No specific component of the Ocean Energy value chain is present.
    b. There are some companies with interest in the region.
    c. Some companies in the region have participated in pilot projects on Ocean Energy.
    d. There is an association promoting the Ocean Energy supply chain development.
11. Does the region have key technological know-how for the development of Ocean Energy? *[options]*
    a. There are no specific technology development capabilities but some know-how in universities, research institutions and companies that can be applied in Ocean Energy.
    b. There are universities that carry out basic research on Ocean Energy.
    c. There are applied research centres and small-scale laboratories in Ocean Energy.
    d. The region has access to an important national network of universities, technology centres and offshore test infrastructures.

## Scoring of factors.

The next step is to score each of the factors. The tool considers four scaling levels for each factor:

- 0 or low.
- 4 or low to medium.
- 8 or medium to high.
- 12 or high.

Factor scores are calculated as follows:

1. For values obtained from public data sources:

The thresholds in relative performance of each regional factor are the same as those used in the European Innovation Scoreboard:

a) The low value (0) is assigned to those factors with values below 50% of the EU average.
b) The low to medium value (4) is assigned to those factors with values between 50% and 90% of the EU average.
c) The medium to high value (8) is assigned to those factors with values between 90% and 120% of the EU average.
d) The high value (12) is assigned to those factors with values above 120% of the EU average.

2. For values gathered through the questionnaire:

For multiple choice questions:

a) Option a. indicates score 0 (low)
b) Option b. indicates score 4 (low to medium)
c) Option c. indicates score 8 (medium to high)
d) Option d. indicates score 12 (high)

For the numerical answer about the share of renewable energy in gross final energy generation in the region the European average of 19.7%[15] is taken as a reference so that the following thresholds are considered:

a) Value 0 for shares below 9.9%.
b) Value 4 for shares between 9.9% and 17.7%.
c) Value 8 for shares between 17.7% and 23.6%.
d) Vale 12 for shares above 23.6%.

## Calculation of the aggregate values of capability and opportunity.

Once the scores for all factors have been obtained, the aggregate values of capability and opportunity for the region are calculated as follows:

$$Aggregated\ capability = \frac{Avg\ capability\ categ.1 + Avg.capability\ categ.2 + Avg.capability\ categ.3}{3}$$

Where:

- Categ. 1 refers to Industry configuration category.
- Categ. 2 refers to Technological development category.
- Categ. 3 refers to Human resources/Education level category.

[15] https://ec.europa.eu/eurostat/databrowser/view/NRG_IND_REN/default/table?lang=en

$$Aggregated\ opportunity = \frac{Avg\ opportunity\ categ.1 + Avg.opportunity\ categ.2 + Avg.opportunity\ categ.3}{3}$$

Where:

- Categ. 1 refers to Political factors category.
- Categ. 2 refers to Economic factors category.
- Categ. 3 refers to Societal-environmental factors category.

These aggregated values can be plotted on an Opportunity-Capability graph that provides an estimate of the region's positioning in relation to ocean energy harnessing. An example of this graph can be found in Figure 4.1 of this document.