Version 1.2

WP3	Deliverable D3.1

MUSES Project

Title: Case study methodology
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MUSES PROJECT

CASE STUDY METHODOLOGY

v. 1.2

MUSES DELIVERABLE:
D3.1: CASE STUDY METHODOLOGY

31 May 2017

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1 INTRODUCTION

1.1 *Purpose*

The purpose of this document is to establish a common methodology for the analysis of Multi-Use (MU) at case study level, within work-package 3 (WP3). This methodology will provide case study leaders with a common approach to examine practical experience related to MU in their local contexts. Aiming at maximizing the degree of commonality between the two scales of analysis considered in MUSES project (Sea Basin scale and local scale), this methodology incorporates some of the elements defined in the Analytical Framework (Analyzing Multi-Use MU in the European Sea Basins) developed under work-package 2 (WP2) - Overview of Multi-Use (D2.1).

The methodology described in this document is aimed at guiding the process of information and data gathering and stakeholder engagement, providing the needed degree of homogeneity to the cross-cutting analysis of the seven case studies considered by the project. The methodology should be interpreted as a flexible tool to be adapted in its details in order to meet the needs of the single case study.

1.2 *Project goals*

The overall goal of the MUSES project is to develop an Action Plan (AP) under WP4 which will facilitate implementation of Multi-Use in European Seas, based on innovation and Blue Growth potential.

Activities under WP3 are ultimately aimed at informing the Action Plan development with relevant issue for MU promotion, emerging from local contexts, experiences and perceptions.

As a first, fundamental step towards this goal, a definition of Multi-Use has been identified as follows:

In the realm of marine resource utilisation Multi-Use should be understood as the joint use of resources in close geographic proximity. This can involve either a single user or multiple users. It is an umbrella term that covers a multitude of use combinations in the marine realm and represents a radical change from the concept of exclusive resource rights to the inclusive sharing of resources by one or more users.

A **user** in this context is defined as the individual, group or entity that intentionally benefits from a given resource. If a business creates a separate legal entity to exploit an additional resource, this entity is then considered another user.

A **use** in this context is understood as a distinct and intentional activity through which a direct (e.g. profit) or indirect (e.g. nature conservation) benefit is drawn by one or more users. For the purpose of this definition, a clear distinction is made between different types of uses.

A **resource** in this context is a good or service that represents a value to one or more users. Such a resource can be biotic (e.g. fish stocks) or abiotic (e.g. ocean space) and can be exploited through either direct (e.g. fishing) or indirect (e.g. nature conservation) uses.

As defined in Deliverable 2.1 "Analytical Framework (AF) - Analysing Multi-Use (MU) in the European Sea Basins", prepared under WP2, MUSES will predominantly investigate **two MU scenarios**:

– Multi-use of geographical, human, biological resources. The multi-use of marine resources refers mainly to the geographical connection of resource uses to create added value for society to society as a whole and to each sector involved in MU individually. Examples of

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such a multi-use are the combination of offshore wind and tourism through offshore wind farm viewing boat tours.

– Multi-use of technical resources (marine infrastructure & platforms). In some cases an even closer (functionally & geographically) integration of uses is possible to create even more added value than a side by side scenario. This closer integration looks for synergies in integrating the operations and implementation of offshore activities and can start by e.g. the simple sharing of the use of offshore supply vessels to reduce individual operations costs. The synergistic integration of activities culminates in multi-use platforms. MU offshore platforms are engineering solutions, designed to incorporate modules of other compatible activities (e.g. TROPOS Project - www.troposplatfom.eu). Fully integrated multi-component and multi-purpose offshore platform serves as a main infrastructure shared by two or more ocean uses (e.g. H2Ocean project designed a platform coupling renewable energy harvesting + hydrogen generation + aquaculture + environmental monitoring) (Stuiver et al. 2016).

The Action Plan WP4 will report on the capacity of ocean space to accommodate Multi-Use, highlight where benefits can be realised, draw attention to barriers that can be overcome and provide recommendations on what actions are needed in order to enable this. The Action Plan will be fed into EU macro-regional and sea basin strategies (e.g. EU Strategy for the Baltic Sea region - EUSBSR, EU Strategy for the Adriatic-Ionian Region - EUSAIR, the Atlantic Action Plan, the forthcoming maritime strategy in the Western Mediterranean), on-going activities of Regional Seas Conventions, network roadmaps (e.g. SUBMARINER Roadmap), industry forums (e.g. Ocean Energy Forum) and national and EU maritime spatial planning policy processes.

Activities of WP2 (Overview of Multi-Use) and WP3 (Case Studies) provide knowledge and stakeholder perception and experience on MU at Sea Basins and local scale respectively.

1.3 WP3 objectives

Specific objectives of WP3 activity are:

- to analyze a comprehensive set of case studies according to real (existing) and/or potential MU, in order to provide a complete spectrum of advantages in combining different uses of the sea
- to identify barriers and opportunities of MU of the marine space to be addressed by the Action Plan and possible local actions
- to create local stakeholders platforms discussing (also beyond the project) MU potentiality, opportunities and limitations
- to concretely contribute to the advancement of MU in the context of each specific case study.

1.4 List of case studies

Seven case studies are defined for the MUSES project and will be analysed under WP3. They are indicated in Table 1-1and represented in Figure 1-1. Detailed description is provided in chapter 3.

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Table 1-1 - Case studies to be considered under MUSES WP3 activities.

Case study 1	Offshore wind energy developments coexistence with commercial fisheries / Tidal energy development & environmental interactions
Location	North Sea - North Coast of Scotland, East Coast of Scotland and Southern North Sea (German Bight)
Case study responsible partner	MS
Other participants partners	AWI
Case study 2	Marine Renewables & Aquaculture MU including the use of marine renewable energy near the point of generation
Location	Northern Atlantic Sea - West Coast of Scotland
Case study responsible partner	UNIVDUN
Other participants partners	-
Case study 3	Development of tourism and fishing in the Southern Atlantic Sea
Location	Southern Atlantic Sea: South Coast of mainland Portugal and Azores archipelago
Case study responsible partner	FGF
Other participants partners	-
Case study 4	Global resource area optimization, focused on energy, food supply and environment in Swedish waters
Location	Baltic Sea: Island of Gotland (Sweden)
Case study responsible partner	SUBM
Other participants partners	-
Case study 5	Offshore wind production & marine biomass production & environmental remediation in Danish waters
Location	Baltic Sea: Southeast Denmark
Case study responsible partner	SUBM
Other participants partners	-
Case study 6	Coastal and Maritime Tourism as a driver/booster for potential multi-use
Location	Mediterranean Sea: Northern Adriatic Sea
Case study responsible partner	ISMAR
Other participants partners	THETIS
Case study 7	Tourism & fisheries & energy production in the Aegean Sea
Location	Mediterranean Sea: Aegean Sea / Cyclades
Case study responsible partner	HCMR
Other participants partners	-

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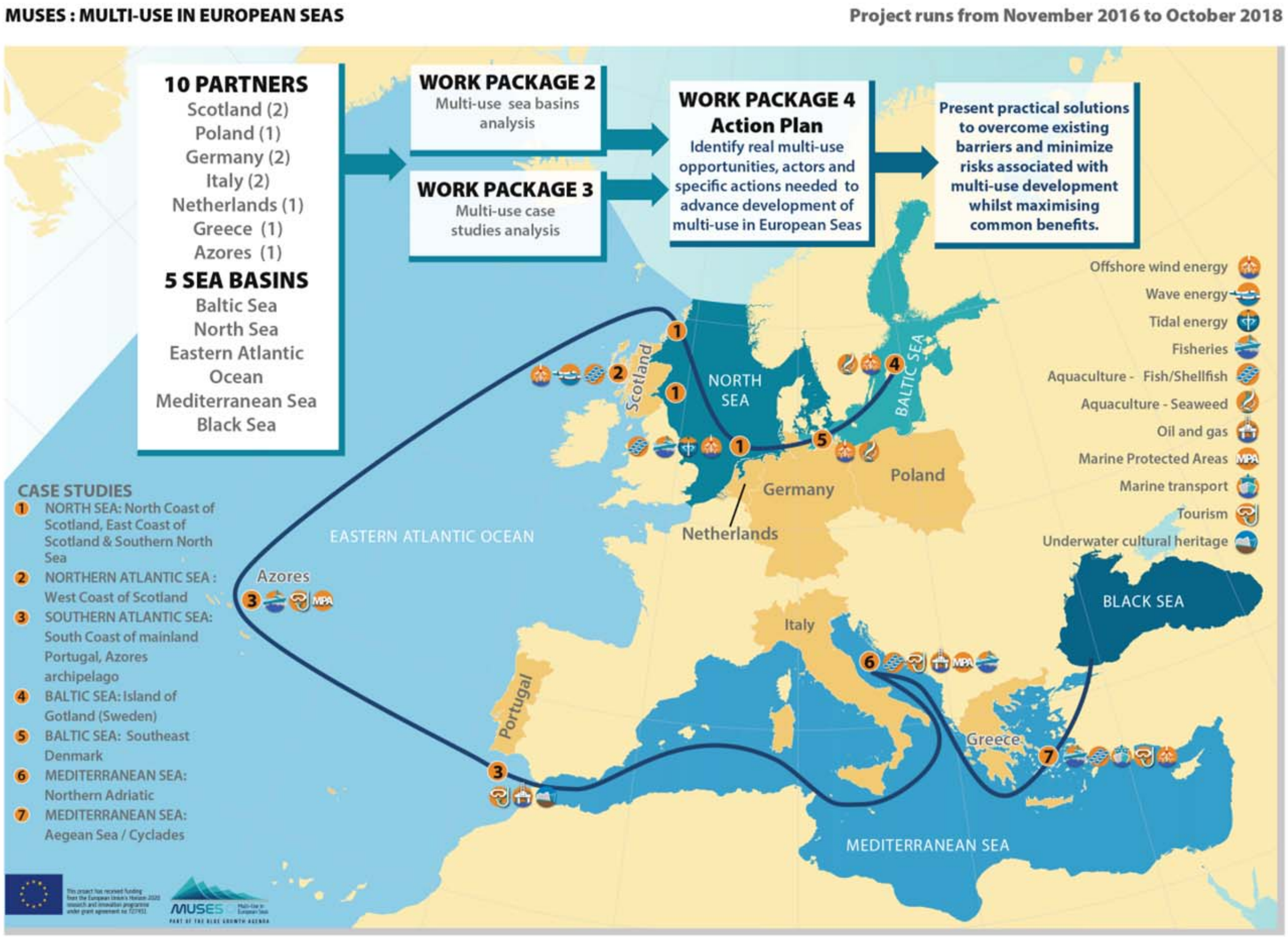

Figure 1-1 Case studies of MUSES project.

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1.5 Definition of spatial domain and scales

At case study level the analysis will consider Member States (MS) territorial waters as defined in Directive 2014/89/EU. If needed, due to the specific characteristics of the case study, marine waters of non-EU Member States and/or high seas may be considered, where relevant for Multi-Uses in the EU marine waters or when multi-uses have well defined present or future potentials.

Future potentials will be evaluated on the basis of:

a) existing legal, policy, strategic and planning documents covering MU at case study level
b) the literature findings and the experience of the completed and ongoing international projects
c) stakeholder involvement
d) other available information.

1.6 MU related projects

With the aim of providing some background to case study leaders in the starting phase of analysis, a description of the most relevant MU-related projects and studies have been prepared and are provided in Annex 1. The analysis considered examples of previous case studies derived from projects dealing with an EU scale and/or sea basin geographic scope. The analysis also included some national scale projects, but it shouldn't be considered exhaustive in this sense, and a detailed desk research on relevant studies at national level has to be carried out by every MUSES case study, to provide a complete background.

Descriptions given in Annex 1 cover concrete applications of the MU concept in geographical areas matching with MUSES case-studies and possibly focus on the same sectors. The overall scope of this work is to highlight what it is already available as background information.

The examined projects belong to three different categories. The first one includes projects or studies specifically proposing multi-use design concepts, the second one includes technology oriented projects especially concerning Ocean energy, the third one includes projects concerning Marine Spatial Planning issues in relation to MU.

All projects were examined and those of major relevance to the MUSES project (i.e. specifically concerning marine Multi-Use approach) are briefly described.

In addition, a breakdown of the available information for each case study into elements of Drivers, Barriers, Added Values and Impacts (DABI) is provided.

Finally, the main combinations of uses, resulted from all case-studies analysed according to the categorization of uses proposed in the Analytical Framework (Deliverable 2.1). DABI elements, are therefore re-organised for combinations of uses, independently from the specific location and sea-basin. Consequently, all the DABI elements concerning the same combination of uses have been put together.

1.7 WP3 activities: approach to case studies analysis

The objective of this analysis is to assess potential synergies for Multi-Use as well as the challenges encountered through a series of case studies with different thematic, geographic and focus areas dimension, and engage local stakeholders to identify barriers, opportunities, limitations and needs. **The ultimate goal of this analysis is to provide input from a local level scale for the development of an Action Plan for MU under WP4**.

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Case studies will be developed both through desk activities of review and analysis and stakeholder involvement. Desk analysis and stakeholder engagement activities will be combined but the process will be in a large part stakeholder-oriented: stakeholder knowledge, experience and perception will constitute the most relevant part of the analysis. Stakeholder identification and engagement will be carried out according to the methods described in deliverable D3.2.

Desk activities will examine legislative and administrative documents at national/local level, plans, projects, studies, scientific papers etc. Results will inform stakeholder engagement activities.

Stakeholders at a local level will be engaged with the scope of discussing views, options and opinions on MU development or re-enforcement at local scale.

Desk activities and interactions with stakeholders will be carried out according to an integrated approach, described in chapter 2.

Stakeholder engagement will be implemented according to the specific characteristics and needs of each case study. Nevertheless, in order to ensure comparability, all case studies will implement some of the following engagement methods:

a) **Interviews** for collecting stakeholder input on MU potential, MU possible combinations, evaluation of drivers/barriers to MU and added value/impact of MU.
b) **Expert panel(s)** (5-10 persons) for identification and assessment of proposed MUs. The panel(s) will identify opportunities, validate proposals, create synergies, highlight drivers/barriers to MU, discuss added values/impacts of MU, propose policy recommendations to overcome such barriers.
c) **Local workshop(s)** (15-25 persons) for consultation with local stakeholders and administrative authorities. The workshop(s) will be organized to identify potential conflicts both among sectors and between proposed activities and local planning, to explore proper integration of proposed co-location activities to local economic structure, to prepare recommendations by local stakeholders and administrative authorities for coping with conflicts. Drivers/barriers and added values/impacts of MUs will be also evaluated.
d) **Consensus conference(s)** (10-30 persons) for consultation with local society. The conference(s) will address discussion after presentation from the case study group to open the whole process to inhabitants, in order to widen dissemination of information and to prepare recommendations for local community groups on the proposed co-location of sea activities. Drivers/barriers and added values/impacts of MUs will be also discussed.
e) Others to be specified.

Detailed description of stakeholder engagement methods for each of the case studies is reported in deliverable D3.2 (Stakeholder identification and engagement process).

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2 CASE STUDY METHODOLOGY

This Work-package (WP3) maintains a consistency with the WP2 Analytical Framework and the whole MUSES approach, in this methodology the following definitions are considered:

- DRIVERS = factors promoting MU
  They are defined as those factors supporting / facilitating / strengthening MU development.
- ADDED VALUES = positive effects/impacts of establishing or strengthening MU
  They are defined as the positive effects of establishing / strengthening MU.
- BARRIERS = factors hindering MU
  They are defined as those factors preventing /negatively affecting MU.
- IMPACTS (NEGATIVE IMPACTS) = negative effects of establishing / strengthening MU.
  They are defined as the cons or the negative effects of implementing / strengthening MU).
- MU POTENTIAL is defined as the degree of opportunity the study area has to develop or strengthen MU.
- MU EFFECT is defined as the overall result or balance of pros and cons of developing MU in the study area.

The methodological approach to case studies under WP3 takes up essential elements of the WP2 Analytical framework, by selecting the necessary elements for evaluation of MU at a local scale. **For each case study a fiche will be prepared, summarising the findings from desk analysis and stakeholder engagement, in a common, structured way**. Case Study fiches will be prepared by compiling the templates presented in chapter 4. In addition, each case study will prepare an extended report with considerations, comments, recommendations to be exploited by the Action Plan (see chapter 2.4 for a description of this report contents).

As described in Figure 2-1, the methodology for case study analysis consists of two phases:

- Phase A. Case study Implementation (Task 3.2)[1]
- Phase B. Comparative analysis (Task 3.3).

In **"Phase A - Case study Implementation"** five steps can be identified, as follows:

1. MU overview & identification of potentials
2. Identification of MU drivers, barriers, added value, impacts
3. Analysis of MU potentials
4. Evaluation of overall MU net effect
5. Analysis by Focus Areas (see chapter 2.1.5 for specifications).

Detailed description of actions to be undertaken under each of these steps is provided in chapters 2.1 and 2.2. In addition, for each step, a template sheet has been designed to guide MUSES data collection along the analytical process (chapter 4). The entire process has been detailed in order to guarantee homogeneity of approach and comparability of results. Nevertheless **these methodological elements are provided as guidelines and are to be interpreted with a necessary degree of flexibility**, in order to be adapted to the heterogeneity of the case studies.

For **case studies** (Case Study 1, Case Study 3) that are made up of more than one study area, activities under Phase A will be undertaken for each of the sub-cases that make up that case study.

In **"Phase B - Comparative analysis"** three themes will be considered:

[1] ref. Annex 1 to the Grant Agreement

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1. analysis of overall MU potentials and effects
2. analysis by Focus Areas
3. paired case study analysis.

Both Phase A and Phase B will generate outputs which are also illustrated in Figure 2-1 and described in chapter 2.4

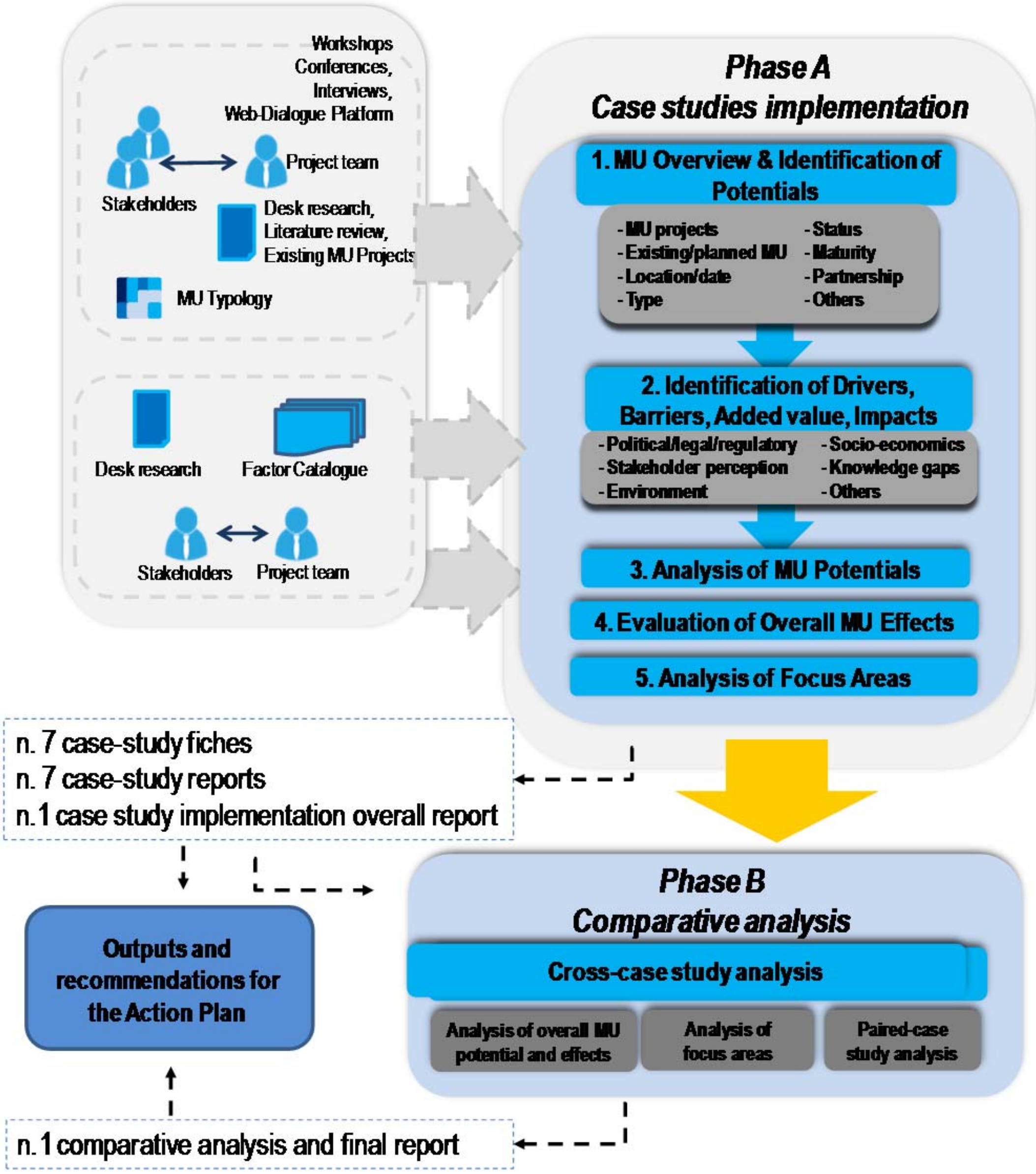

Figure 2-1 Graphical flow chart of the case study methodology and expected outputs.

2.1 Case study methodology: Phase A - Case study implementation

The steps to be carried out for case study implementation are as follows:

2.1.1 Step 1: MU overview & identification of potentials

This step refers to the MU potentials identification, considering existing/potential MU, type of MU (see the scenarios identified in WP2 Analytical Framework and presented in chapter 1.2 above), MU

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combinations (see catalogue of combinations provided in chapter 2.2 of WP2 Analytical Framework), and the collection of basic information for the further characterization of the MU type (location, date, legal basis, maturity, MU combinations, MU cooperation, advantages, possible extensions, etc). MU scenarios, combination and cooperation modes will be considered when preparing the case study fiches. Feasibility will be judged by expert knowledge in terms of likelihood, time horizon of possible appearance and spatial prevalence/scope.

This step will provide a general background on real / potential MU opportunities in the Case study area. Based on this background, **one (or, eventually, more) specific MU combination(s) - in place or potential - will be selected for each of the case study (or sub-case study) to be analysed in a greater detail through Step 2, Step 3, Step 4** . In this step it will be examined if and to what extent the idea of MUs has been framed so far in legal, policy, strategic and planning documents at national and local level, and what is the perception of decision makers and local stakeholders. Experiences of MU at national and / or local level will be summarised. Stakeholder views about MU will be collected; possible stakeholder roles in MU development will be investigated, their opinions on what kind of actions may have to be developed to strengthen any benefits or lessen any barriers/risks will be compiled.

Methods: Desk research (literature review, existing projects overview); stakeholder involvement (applied method will depend on each specific case study as illustrated in Deliverable D3.2).

Reference Templates (see chapter 4): Sheet 1, Sheet 2 (to be completed with reference to the Case study specifically selected MU scenario and combination).

Outputs: MU overview, MU combinations and MU type characterization.

2.1.2 Step 2: Identification of MU Drivers, Barriers, Added value, Impacts (MU DABI)

Drivers/barriers/added value/impacts to MU will be identified in this step. They will be categorized by considering key issues for MU development, such as policies, administrative/legal aspects, environmental and socio-economic constrains, technical capacity, and knowledge gaps (technology, environmental impacts, health and security issues etc.). A specific part of the analysis will be dedicated to the analysis of real vs perceived barriers, by comparing results from desk analysis with stakeholder perception. For definitions of real and perceived barriers and for the understanding of the scope of this analysis case study leaders should consider chapter 3.2 of the WP2 Analytical Framework.

Methods: Desk research will be used to identify a catalogue of factors which will be verified and weighted with stakeholder consultation. Consultation methods will be defined for each specific case study as illustrated in Deliverable D3.2). Detailed methodology for DABI identification is given in paragraph 2.2.

Reference Templates (see chapter 4): Sheet 3, Sheet 4, Sheet 5, Sheet 6.

Output: Catalogue of DABI. Structured information on stakeholder opinion about perceived and real barriers.

2.1.3 Step 3: Analysis of MU potentials

This step analyses the drivers and barriers for MU development identified in Step 2 by applying a scoring system. **Drivers and barriers will be scored by stakeholders** according to their knowledge and experience. **The relative balance between drivers and barriers will identify the potentials for MU development in the study area.** During this phase stakeholders will be also asked to consider

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and eventually integrate the catalogue of listed drivers/barriers, based on their experience. Desk analysis will also be considered in this phase: collection of data and information and then quasi-quantitative analysis will constitute the background to analyse MU potentials. Results will be discussed with stakeholders.

Methods: Desk analysis and stakeholder engagement. Stakeholder consultation methods will be defined for each specific case study as illustrated in Deliverable D3.2). Detailed methodology for drivers/barriers scoring and MU potential evaluation is given in chapter 2.2.

Reference Templates (see chapter 4): Sheet 9, Sheet 10.

Outputs: MU potentials look-up table.

2.1.4 Step 4: Evaluation of overall MU effects

This step analyses the added value (positive effects) and the impacts (negative effects) related to MU development and identified in Step 2 by applying a scoring system. **Added values and impacts will be scored by stakeholders** according to their knowledge. **The relative balance between added value and impacts will identify the overall MU net effect in the study area.** During this step stakeholders will be also asked to consider and eventually integrate the catalogue of listed added values/impacts based on their experience. Desk analysis will also be considered in this phase: collection of data and information and their quasi-quantitative analysis will constitute the background to analyse MU effects. Results will be discussed with stakeholders.

Methods: Desk analysis and stakeholder engagement. Consultation methods will be defined for each specific case study as illustrated in Deliverable D3.2). Detailed methodology for added values/impacts scoring and MU effect evaluation is given in chapter 2.2

Reference Templates (see chapter 4): Sheet 11, Sheet 12

Outputs: MU effects look-up table.

2.1.5 Step 5: Analysis of Focus Areas

In addition to the analysis carried out in the previous steps, case studies will be further evaluated, focusing on some characterizing elements. This is expected to be an open and flexible analysis, providing Case study leaders with the needed degrees of freedom to collect their results.

The ultimate aim of the Focus Areas analysis is evaluating case studies according to common conceptual categories.

All case studies will be analysed considering the specific thematic contents of all the Focus Areas.

Focus Areas analysis will therefore provide additional elements to case studies, in order to:

- Identify the need for developing MU(s)
- Identify impacts (both negative and positive, cumulative), socio-economic and environmental
- Identify barriers and enablers
- Identify actions to overcome barriers and max synergies.

The following three focus areas will be considered:

- **Focus-Area-1 "Addressing Multi-Use"**: this Focus Area analyses MUs development potentialities. It will be applied both to cases where MUs of the sea are not developed yet and to cases where MUs are already in place, but actions are needed in order to fully exploit MU potential. Within this Focus Area the main objective is to identify and evaluate

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possibilities for (additional) MU development, ways to overcome barriers, to minimise limitations and maximise synergies. Stakeholders involvement is aimed at: 1) exploring the possibility that existing or potential MU becomes a driver to identify and address potential planning scenarios through a participatory process; 2) highlighting most relevant perceived barriers and conflicts and identifying recommendations to overcome them. Relevant stakeholders are, for example, investors, sector operators, legal, planning and licensing authorities, other actors directly or indirectly impacted by MU.

- **Focus-Area-2 "Boosting Blue Maritime Economy"**: this Focus Area analyses those aspects of MUs strictly linked to the development of maritime economy. Main objectives here are: to highlight economic added-value of co-use of resources (infrastructures, services, personnel); to identify strategies reducing risks associated with economic development of combined uses; to promote local entrepreneurship and create context to favour job creation, broader social aspects and promote economic recovery. Possibility to include reference to MU in sector-specific national policy statements will be explored. Potentiality of implementation of MU networks in case studies areas, through planning & market & stakeholder interest analysis will be analysed. Assessment of stakeholders involvement is aimed at attracting investors and demonstrating social and economic benefits of MU. Relevant stakeholders are investors, public authorities (as possible providers of funds), local representatives of economic sectors, local communities.
- **Focus-Area-3 "Improving environmental compatibility"**: this Focus Area analyses those aspects of MUs linked to the protection of the marine environment and/or minimization of existing impacts. Main objectives here are (different objectives may suit to different case studies): to identify solutions to concentrate marine activities in order to minimize the use of sea space; to identify positive and negative impacts of MU; to identify technical solutions to minimize environmental impacts; to identify win-win solutions triggering both socio-economic development and environmental protection (e.g. sustainable tourism and MPAs or small scale fishery/aquaculture and MPAs).
  The licensing aspect of MU represents a key element to be analysed. Since Environmental Impact Assessment (EIA/SEA) is a statutory requirement for marine projects, analysing the EIAs of the selected case studies would provide fundamental insight into how MU is addressed / promoted within EIA - a foremost tool for shaping the design and decision-making of the projects. This is critical as planning frameworks rely on EIA for the integration of environmental and sustainability goals into decisions. Implications of MU on the Environmental Impact Assessment Directive could also be considered.
  Stakeholder involvement here is addressed at identifying conflicts and finding appropriate technological and procedural solutions. Relevant stakeholders are public authorities, in particular environmental protection institutions, NGOs, local communities, scientists, sector operators.

The analysis considering Focus Areas will be implemented by providing answers to a set of Key Evaluation Questions (KEQs). ALL case studies will answer to KEQs defined under ALL Focus Areas. KEQs have been identified to be answered throughout case studies implementation (see below).

Answers to KEQs represent an overall outcome of the overall CS analysis, resulting from both desk analysis and stakeholder involvement. KEQs are not to be interpreted as a draft template for interviews but as a list of issues to be answered by CS leaders as result of the entire CS process (including stakeholder engagement)

Draft answers will be prepared by case study leaders based on knowledge and information collected during the desk phase of the research.

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Questions and draft answers will be proposed to local stakeholder for verification / modification / integration during workshops and/or interviews.

Introductory statements on MU and DABI will be required when approaching stakeholders in the survey part of the work, in order to make sure that the offset for the survey is comparable.

Based on stakeholder feedback the final version of the answers will be prepared by CS leaders considering outcomes from all interviews and/or integrating results of workshop discussion.

The scheme of Figure 2-2 illustrates the approach to FA analysis.

	FA1: Addressing-MU	**FA2: Boosting Blue-Growth potential**	**FA3: Improving environmental compatibility**
Case-Study 1			
Case-Study 2	***FA1 Key Evaluation Questions***	***FA2 Key Evaluation Questions***	***FA3 Key Evaluation Questions***
Case-Study 3			
Case-Study 4			
Case-Study 5			
Case-Study 6			
Case-Study 7			

Figure 2-2 Approach to FA analysis.

Key Evaluation Questions

The following KEQs are identified for the Focus Areas. **During case study implementation additional relevant and specific questions will probably arise** as a result of the desk analysis and, particularly, of stakeholder engagement. **These new case study specific KEQs will be added** to the set of the common KEQs indicated below.

KEQs for Focus-Area-1 "Addressing Multi-Use"

1. Is it possible to establish / widen / strengthen MU in the case study area? (Y/N)
   For which MU combination in particular?
   What needs would MU satisfy?
2. Is space availability an issue for MU development / strengthening in the case study area at present? (Y/N)
   Will space availability become an issue for your area in the future? (Y/N)
   For what elements space availability is / could become an issue?
3. Are there MUs combinations and potentials that will share the same resources but in different times (e.g. reuse of an infrastructure after the end of its first life and original scope)? (Y/N)
   What are they?
4. What would be the most important resources to be shared between uses (infrastructures, services, personnel, etc)?

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5. Are existing and/or potential MUs taken into account within the existing or under development Maritime Spatial Plans? (Y/N)
6. How are MUs connected or related to land-based activities?
7. Is the needed knowledge and technology for MU development/strengthening in the case study area already available? (Y/N)
   What is the level of maturity of available knowledge?
   What is the level of readiness of available technology?
   Are there still research needs? (Y/N)
8. What action(s) would you recommend to develop / widen / strengthen MU in the case study area?
   What actor(s) do you see particularly important to develop / widen / strengthen MU in the case study area?
   (answers should be detailed enough to possibly allow undertaking actions finalized at MU promotion, at local case study level)

KEQs for Focus-Area-2 "Boosting Maritime Blue Economy"

1. Do you see added values for society and economy at large and/or for local communities of developing / widening / strengthening MU in the case study area? (Y/N).
   What are the most important ones?
2. Is it possible to quantify the socio-economic benefits related to MUs and how they (could) contribute to the sea economy at local and regional/national scale? (Y/N)
   What tools, knowledge, experiences are available?
3. Would MU development / strengthening be an opportunity for job creation and / or job requalification in your area? (Y/N)
4. Do you see possible elements of attractiveness for investors in developing / widening / strengthening MU in the case study area? (Y/N)
   What are these elements?
5. What are possible investors interested in developing / widening / strengthening MU in the case study area?
6. Is there sufficient dialogue between the stakeholder sectors for developing / widening / strengthening MU? (Y/N)
   Would dialogue facilitation be an asset? (Y/N)
7. In order to promote MU development / strengthening in the case study area,
   - would the availability of a *vision/strategy* (e.g. at national or sub-regional level) be helpful? (Y/N)
   - would a *feasibility study including evaluation of alternative scenarios* be helpful? (Y/N)
   - would *detailed projects* on already identified simulations be useful? (Y/N)
   - do you see *other enablers*?

KEQs for Focus-Area-3 "Improving environmental compatibility"

1. What are / would be the environmental added values (= positive environmental impacts) of developing / widening / strengthening MU in the case study area?

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2. Which tools (conceptual, operational) are used or should be further developed and used to better estimate environmental impacts and benefits of MU?
3. Is saving free sea space for nature conservation a driver for MU the case study area? (Y/N)
   Are there evidences about the present and future benefits of reserving free sea space? (Y/N)
   What are they?
4. What practical actions would you undertake to link MU development / widening / strengthening to improved environmental compatibility of maritime activities?
5. Are there win-win solutions triggering both socio-economic development and environmental protection already available for the case study area that MU should take up? (Y/N)
   What are they?
6. Is the environmentally friendly knowledge / technology for MU development/strengthening in the case study area available? (Y/N)
   Which is the level of readiness of available solutions?
   Are there still research needs on blue/green technologies for MU? (Y/N)
7. Would it be possible to promote MU through SEA/EIA procedures? (Y/N)
   What modifications would you suggest at your national / local level to promote MU through SEA/EIA procedures?

2.2 Details on the analysis of drivers/barriers/added value/impacts (DABI approach)

This methodology will be used to evaluate drivers/barriers and added value/impacts of MU in the context of the seven Case study analysis (Steps 2, 3 and 4 of Phase A). The methodology will be applied both to case-studies where MU is already developed (to boost potential) and to case studies where MU is not developed yet.

The analysis will consider the following four themes, defining what we call the **DABI approach**:

- **DRIVERS** = factors promoting MU
- **ADDED VALUES** = positive effects of establishing or strengthening MU
- **BARRIERS** = factors hindering MU
- **IMPACTS** = negative effects of establishing or strengthening MU

The application of the methodology to Case study analysis is aimed at providing:

- **an evaluation of the potential to develop or strengthen MU at Case study level**
  A comparative evaluation of drivers and barriers is carried out, providing an estimation of MU potential
- **an evaluation of the effect of MU development / strengthening at Case study level**
  The overall effect of MU is evaluated by comparing added values with impacts.

The methodology is illustrated in the diagram given in Figure 2-3. It consists of desk analysis, followed by a stakeholder engagement. The methodology is adapted from the framework applied by Kyriazi et al. (2016) and it is applied in coherence with MUSES WP2.

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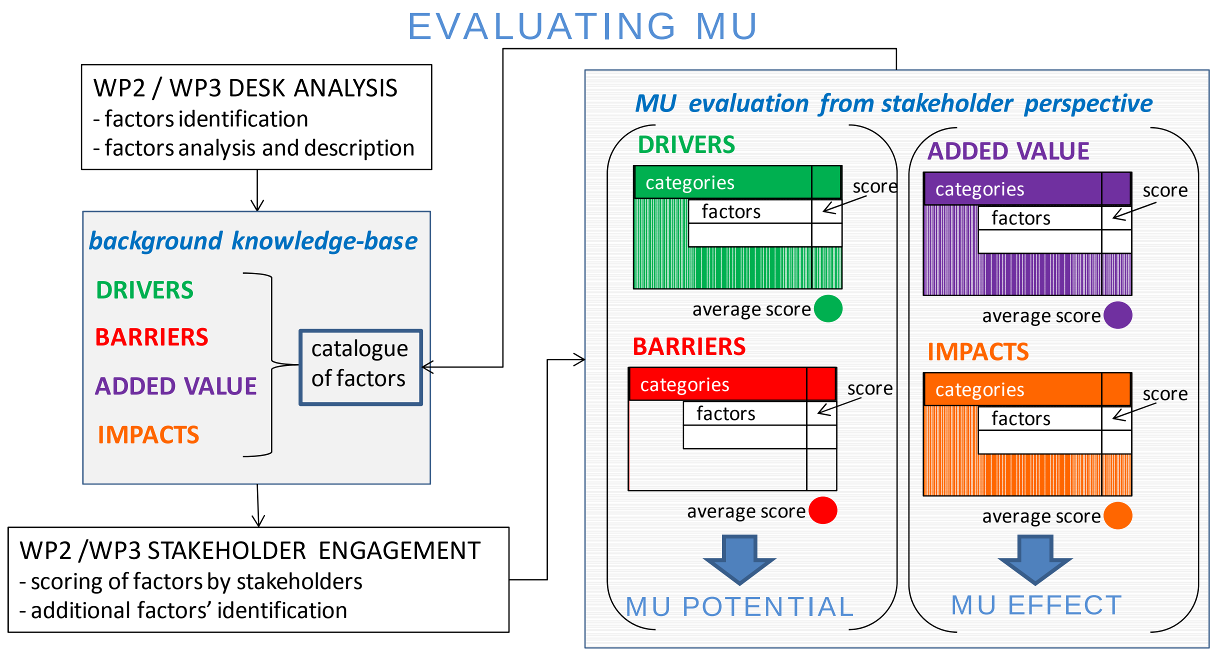

Figure 2-3 Diagram of the evaluation methodology of MU in Sea Basins and Case-Studies.

Source: own elaboration by THETIS

2.2.1 Desk analysis

MU related documents and literature will be screened: policies, strategies, laws, regulations, administrative procedures, plans, strategic environmental assessment (SEA), environmental impact assessments (EIAs), studies, projects, etc. A number of **relevant factors will be identified** with reference to the four themes. These factors will be analysed and described by the case study leader, providing motivation for their selection and a qualitative evaluation of their importance as drivers / barriers / added values / impacts of MU in the study area. The **catalogue of factors** and their related descriptions will provide a background knowledge-base for interacting with the stakeholders. This phase of analysis is also key for identifying factors that act as real barriers, i.e. barriers that are actually occurring, normally in a written form, and might not result from stakeholders' perceptions (see MUSES definition of real barriers in chapter 3.2 of deliverable D2.1 Analytical Framework). In addition, this background knowledge-base is relevant to critically evaluate, *ex post*, the results on stakeholder knowledge / perception and, eventually, to fill gaps in stakeholder consultation results where no answers are provided or there are unclear responses provided by stakeholders.

2.2.2 Stakeholder engagement

The factors identified during the desk phase will be **evaluated and scored by stakeholders** during interviews, workshops or any of the other consultation methods implemented in WP3. Stakeholder scores will provide a picture of perceived drivers/barriers/added value/impacts of MU. In addition, experts and stakeholders will be asked to identify additional factors according to their knowledge/experience.

2.2.3 Categories of factors

As a result of the desk analysis and stakeholder responses differences in factors (DABI) between studies will most probably be recorded. Comparability, within the four themes (DABI) will be achieved by **clustering the factors in categories**. A preliminary list of categories is provided in Table

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2-1 and Table 2-2. Additional categories may be identified in the desk phase and/or the stakeholder consultation phase.

Table 2-1 - Preliminary list of categories to be used to cluster the identified factors acting as DRIVERS and BARRIERS.

CATEGORIES FOR DRIVERS = factors promoting MU	CATEGORIES FOR BARRIER = factors hindering MU
Category D.1 – policy drivers (e.g. marine renewable policy) Factor D.1.1 .... Factor D.1.2 .... Factor D.1.n ...	***Category B.1 – legal barriers*** (e.g. lack of legislation to undertake MU) Factor B.1.1 .... Factor B.1.2 .... Factor B.1.n ...
Category D.2 – interactions with other uses (e.g. other use(s) present already in the area) Factor D.2.1 .... Factor D.2.2 .... Factor D.2.n ...	***Category B.2 – administrative barriers*** (e.g. specific administrative obstacles in allowing MU) Factor B.2.1 .... Factor B.2.2 .... Factor B.2.n ...
Category D.3 – economic drivers (e.g. availability of funds promoting MU) Factor D.3.1 .... Factor D.3.2 .... Factor D.3.n ...	***Category B.3 – financial barriers / risk*** (e.g. lack of full understanding of economic benefits of MUs – i.e. no investors) Factor B.3.1 .... Factor B.3.2 .... Factor B.3.n ...
Category D.4 – societal drivers (e.g. social or political promotion of MU) Factor D.4.1 .... Factor D.4.2 .... Factor D.4.n ...	***Category B.4 – barriers related to technical capacity*** (e.g. specific technical problems affecting combination of some uses) Factor B.4.1 .... Factor B.4.2 .... Factor B.4.n ...
other categories to be eventually identified	***Category B.5 – barriers related to social factors*** (e.g. social acceptance of MU) Factor B.5.1 .... Factor B.5.2 .... Factor B.5.n ...
	Category B.6 – barriers related to environmental factors (e.g. achievement of natural conservation targets) Factor B.6.1 .... Factor B.6.2 .... Factor B.6.n ...
other categories to be eventually identified	other categories to be eventually identified

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Table 2-2 **VALUES and IMPACTS.**

CATEGORIES FOR ADDED VALUES = positive effects of establishing or strengthening MU	**CATEGORIES FOR IMPACTS** = negative effects of establishing or strengthening MU
Category V.1 – economic added value (e.g. reduction of overall costs) Factor V.1.1 .... Factor V.1.2 .... Factor V.1.n ...	***Category I.1 – economic impacts*** (e.g. increased competition with other sectors not included in MU) Factor I.1.1 .... Factor I.1.2 .... Factor I.1.n ...
Category V.2 – societal added value (e.g. conservation of traditional sea uses) Factor V.2.1 .... Factor V.2.2 .... Factor V.2.n ...	***Category I.2 – societal impacts*** (e.g. increased societal non-acceptance of maritime activities) Factor I.2.1 .... Factor I.2.2 .... Factor I.2.n ...
Category V.3 – environmental added value (e.g. reduction of overall environmental impact) Factor V.3.1 .... Factor V.3.2 .... Factor V.3.n ...	***Category I.3 – environmental impacts*** (e.g. increased cumulative impacts on marine benthic ecosystem) Factor I.3.1 .... Factor I.3.2 .... Factor I.3.n ...
Category V.4 – better insurance policies and risk management (e.g. share risk management and related costs among different operators) Factor V.4.1 .... Factor V.4.2 .... Factor V.4.n ...	***Category I.4 - technical impacts*** (e.g. technical problems to infrastructures or services due to the combined use by two or more users) Factor I.4.1 .... Factor I.4.2 .... Factor I.4.n ...
Category V.5 - technical added values (e.g. improvements to infrastructures or services due to the combined use by two or more users) Factor V.4.1 .... Factor V.4.2 .... Factor V.4.n ...	
other categories to be eventually identified	other categories to be eventually identified

2.2.4 Scoring system and evaluation method

Identified factors (drivers, barriers, added value and impacts) will be **scored by the stakeholders**. Results of scoring will be aggregated into synthetic indexes. The scoring system and the evaluation method for MU potential and overall MU effect are described in Table 2-3 and Table 2-4 respectively.

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Table 2-3 - Method for evaluation of MU potential.

<table>
<tr><td colspan="2">In order to evaluate MU potential the following steps will be undertaken:
• scoring of drivers by stakeholders
• calculation of the average drivers score (average scores by categories can be also computed to complement the analysis)
• scoring of barriers by stakeholder
• calculation of the average barriers score (average scores by categories can also be computed to complement the analysis)
• MU potential estimation (see below for the description on this point).</td></tr>
<tr><td>Scoring of drivers (factors supporting / facilitating MU development / strengthening): to factors supporting MU a positive sign is attributed and the following scoring scale is applied:
• high priority score = +3
• medium priority score = +2
• low priority score = +1
• not relevant[2] score = 0
• absent[3] score = 0
• I do not know[4] no score is given</td><td>Scoring of barriers (factors preventing /negatively affecting MU): to factors negatively affecting MU a negative sign is attributed and the following scoring scale is applied:
• high obstacle score = -3
• medium obstacle score = -2
• low obstacle score = -1
• not relevant[2] score = 0
• absent[3] score = 0
• I do not know[4] no score is given</td></tr>
<tr><td colspan="2">MU potential will be evaluated by averaging the average drivers' score and the average barriers' score. MU potential can assume values in the interval [-1.5, 1.5][5] where -1.5 reflects totally negative MU potential and 1.5 totally positive MU potential. The list of negatively and positively scored factors should be attached to this analysis as well. The case of MU potential = 0 can occur where there is a balance between factors promoting MU development and factors hindering it. The development / strengthening of MU will therefore depend upon which of them will prevail. The knowledge of positive and negative factors is very useful to address actions aimed at facilitating MU development.</td></tr>
</table>

[2] It means that the factor is present, but it has no influence on MU potentials or MU effects.

[3] It means that the factor is not present.

[4] It means that there is no knowledge about the factor

[5] The negative extreme -1.5, is calculated by applying a score of -3 to all barriers (B) and a score of 0 to all drivers (D), calculating their averages (respectively average of B = -3 and average of D = 0) and finally calculating the average of these averages which is -1,5. The reversed process is applied for the positive extreme +1,5 where all drivers got 3 and all barriers 0 and the average of the sum of their averages is +1.5. Kyriazi et al. (2016).

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Table 2-4 - Method for evaluation of overall MU effect.

<table>
<tr><td colspan="2">In order to evaluate MU net effect the following steps will be undertaken:
• scoring of added values
• calculation of average added values score (average scores by categories can be also computed to complement the analysis)
• scoring of impacts
• calculation of average impacts score (average scores by categories can be also computed to complement the analysis)
• MU overall net effect estimation (see below for the description on this point).</td></tr>
<tr><td>Scoring of added values (positive effects of implementing / strengthening MU): to factors representing benefits of developing or reinforcing MU a positive sign is attributed and the following scoring scale is applied:
• high added value score = +3
• medium added value score = +2
• low added value score = +1
• not relevant[6] score = 0
• absent[7] score = 0
• I do not know[8] no score is given</td><td>Scoring of impacts (negative effects of implementing / strengthening MU): to factors representing negative effects of developing or expanding MU a negative sign is attributed and the following scoring scale is applied:
• high impact score = -3
• medium impact score = -2
• low impact score = -1
• not relevant[6] score = 0
• absent[7] score = 0
• I do not know[8] no score is given</td></tr>
<tr><td colspan="2">The overall MU effect will be evaluated by averaging the average added value's score and the average impacts' score. MU effect can assume values the interval [-1.5, 1.5][9] where -1.5 reflects a totally negative effect of MU in the area and 1.5 a totally positive effect. The case of MU effect = 0 can occur where there is a balance between pros and cons of MU development. The knowledge of positive and negative factors is very useful to address actions aimed at maximising added value of MU.</td></tr>
</table>

2.3 *Case study methodology: Phase B - Comparative analysis*

Comparative analysis will be carried out to provide relevant evidence from case studies to feed into WP4 Action Plan development. Comparative analysis will consider:

1) results from DABI analysis and estimation of MU potential and MU effect
2) results from real vs. perceived barriers analysis
3) results from Focus Areas analysis
4) pair analysis will be carried out on two contrasting case studies, aiming at highlighting elements of difference e.g. different development stages, differences in scale of the

6 It means that the factor is present, but it has no influence on MU potentials or MU effects.
7 It means that the factor is not present.
8 It means that there is no knowledge about the factor
9 The negative extreme -1.5, is calculated by applying a score of -3 to all impacts (I) and a score of 0 to all added values (A), calculating their averages (respectively average of I = -3 and average of A = 0) and finally calculating the average of these averages which is -1.5. The reversed process is applied for the positive extreme +1.5 where all added value got 3 and all impacts 0 and the average of the sum of their averages is +1.5 (Kyriazi et al. 2016).

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industry, space or infrastructure share. Based on the knowledge available at present on the case studies the following pairs are identified: Case study 2 versus Case study 5 and Case study 3 (area 1) versus Case study 6. This proposed selection will be verified and eventually revised when the results from case study implementation will be available.

Comparative analysis will also look into elements such as Sea Basin or Sub-Sea basin MU commonalities, near shore vs. off-shore MU related elements, "soft" vs. "hard" sea uses in terms of MU Drivers / Barriers / Added Value / Impact.

The analysis will finally provide a set of key conclusions and recommendation to feed into the Action Plan under WP4.

2.4 WP3 outputs to be produced

Case study reports

Each case study will produce a specific report with the contents described below. The indicated contents are expected in order to guarantee some homogeneity across the case studies, also to allow cross-case study analysis under Phase B Comparative analysis. Nevertheless such contents should not be interpreted as a rigid structure, but can be adapted and complemented with a given degree of flexibility, to be able to capture the specific characteristics of the different cases. If needed, annexes can be used to document specific aspects in detail.

These reports are expected to provide the results of the analysis carried out through Steps 1-5 Phase A, together with comments, considerations and any other concept the case study leaders will consider as a relevant outcome from their work.

1. Geographic description and geographical scope of the analysis
2. Current characteristics and trends in the use of the sea
3. MU overview
   Results from Phase A - Step 1 will be described and commented here. General background on real or potential MU in the area will be provided. National and or local projects and experiences will be described. Specific MU typology and combination to be further analysed in Steps 2, Step 3 and Step 4 will be identified.
4. Drivers, barriers, added value, impacts to MU
   Results from Phase A - Step 2 will be described and commented here. Final version of the catalogue of DABI relevant for the case study will be provided (finalized after validation from stakeholders). Results of the analysis on real vs perceived barriers will be also included. Comments and considerations are provided.
5. Analysis of MU potential
   Results from Phase A - Step 3 will be described and commented here. Results from stakeholder scoring of MU Drivers and Barriers and related estimation of MU potential will be given and commented. Other relevant comments and considerations on MU potential are provided. Annexes can be used if needed.
6. Analysis of MU effect
   Results from Phase A - Step 4 will be described and commented here. Results from stakeholder scoring of MU Added Value and Impact and related estimation of MU effect will be given and commented. Other relevant comments and considerations on MU effect (positive and negative) are provided. Annexes can be used if needed.
7. Focus areas analysis

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Results from Phase A - Step 5 will be described and commented here. Final list of KEQs (common and, eventually, case study specific) and related answers will be provided and commented.

8. Stakeholder engagement. Detailed description of activities carried out to engage stakeholders are given. Description of workshops, interviews and other engagement methods are provided. Annexes are provided including additional materials such as: lists of stakeholders involved, questionnaires, agendas of workshops, presentations, minutes etc.
9. Conclusions and recommendation from the Case study to the Action Plan to be developed under WP4

As Annex to the case study report, a Case Study Fiche will be included, consisting of the collection of completed sheets provided in chapter 4 of this document.

For case studies made up of more than one study (Case Study 1 and Case Study 3) the contents illustrated above will be provided for each of the sub-cases and three separated Case study Fiches will be prepared.

Case -study reports will be prepared by Case study leaders and provided to Thetis as WP3 coordinator.

Case study implementation overall report

Thetis as WP3 coordinator will collect, review and coordinate the seven reports from the case studies and prepare the deliverable D3.3 "Case study implementation" due in month 13 and the related Infographics due in month 14.

Comparative analysis and final report

A cross-case study report will be prepared. Results from Phase B - Comparative analysis will be described and commented. Cross-case study relevant materials will be specifically prepared like comprehensive Drivers / Barriers/ Added Value/ Impact catalogue, comprehensive MU potential and MU effect Look-up Tables, etc. Results from comparative analysis will be discussed between WP3 leader and case study leaders.

The following minimum contents will be provided:

1) overall results from drivers/barriers, added values/impacts analysis and estimation of MU potential and MU effect
2) overall results from real vs. perceived barriers analysis
3) results from Focus Areas analysis
4) in-depth analysis on paired case studies
5) Conclusions and recommendation from WP3 for the Action Plan to be developed under WP4.

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3 DESCRIPTION OF THE CASE STUDIES

The seven case studies that will be considered by the MUSES project under WP3 activities described in the following look-up tables.

3.1 Case study 1: Offshore wind developments coexistence with commercial fisheries / Tidal energy development & environmental interactions

This case study considers three sub-cases, referring to different geographical areas and MU combinations. They are:

- sub-case study 1-a: Multi-Use of sea between commercial fisheries and offshore wind farms in Scotland (East coast of Scotland)
- sub-case study 1-b: Tidal Energy Development and Environmental Interactions (North coast of Scotland)
- sub-case study 1-c: Multi-use of offshore wind farm (OWF) areas with (A) fisheries and (B) aquaculture (C) and restoration efforts (Southern North Sea, German Bight)

The sub-cases are described hereafter.

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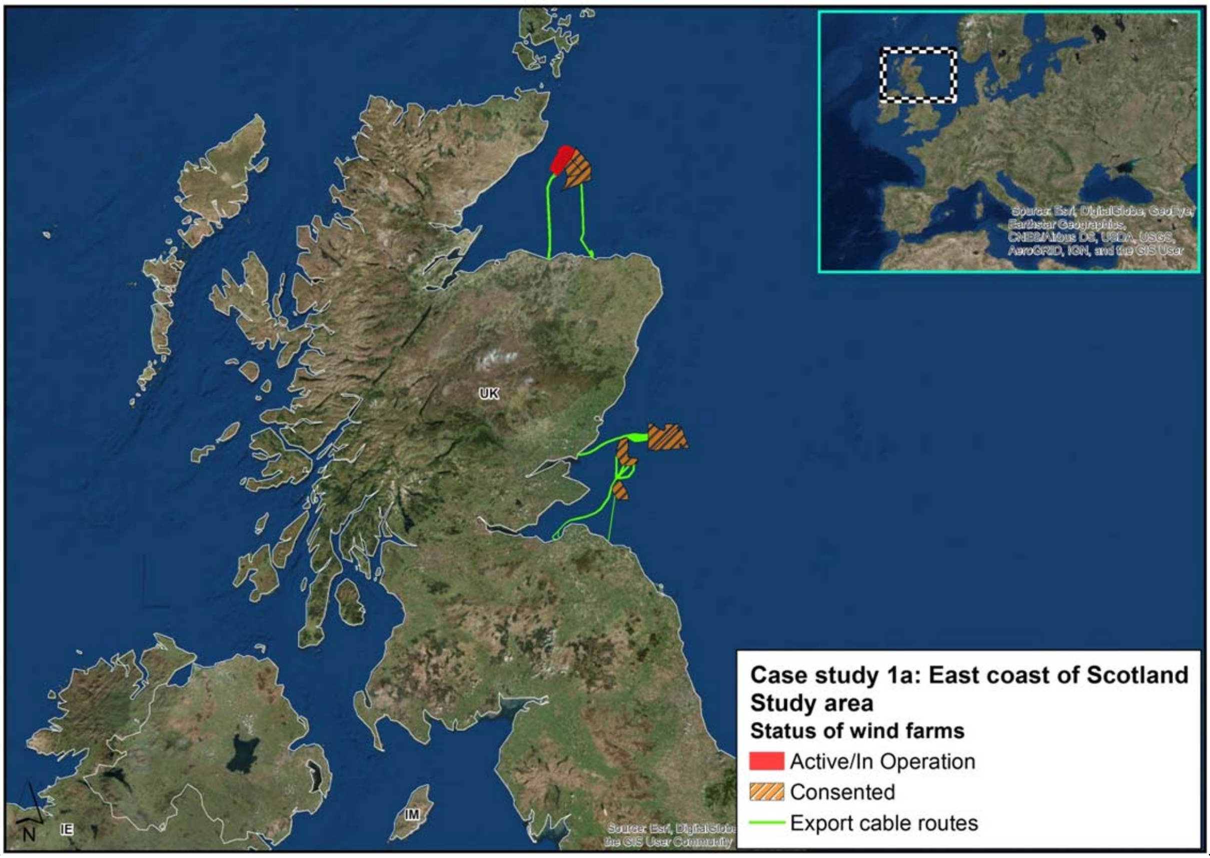
1. Case study n. 1-a
2. Regional Sea: North Sea
3. Location: East Coast of Scotland
4. Title: Multi-use space between commercial fisheries and offshore wind farms in Scotland
5. Case study area:



6. Current characteristics and trends in the use of the sea in the area:
Scotland's seas host a variety of marine uses with an increasing demand for ocean space. Amongst others, a major traditional marine user with a widespread distribution is commercial fisheries. Commercial fisheries have been historically vital to Scottish seas both economically and culturally. Scotland has one of Europe's largest fishing fleets with 2,046 working vessels; around 4,800 fishers; and landings which totalled ca. £466 million in 2012.
Besides traditional users, there are increasing plans for emerging activities in Scottish waters including marine renewable energy (i.e. offshore wind, wave and tidal stream energy) and marine conservation. Ambitious renewable energy targets include meeting 100% of Scotland's electricity needs from green sources including marine energy.
Consented and proposed offshore wind farms are found mainly in the East coast of Scotland, while wave and tidal developments are distributed primarily in the West coast and around Pentland Firth and Orkney region respectively. Whilst ocean energy has not reached commercial array deployment stage yet, offshore wind has achieved tremendous progress over the last years. A total of five major offshore wind projects in the East coast have been granted all necessary marine licenses and consents and will act as the main focus for this study.

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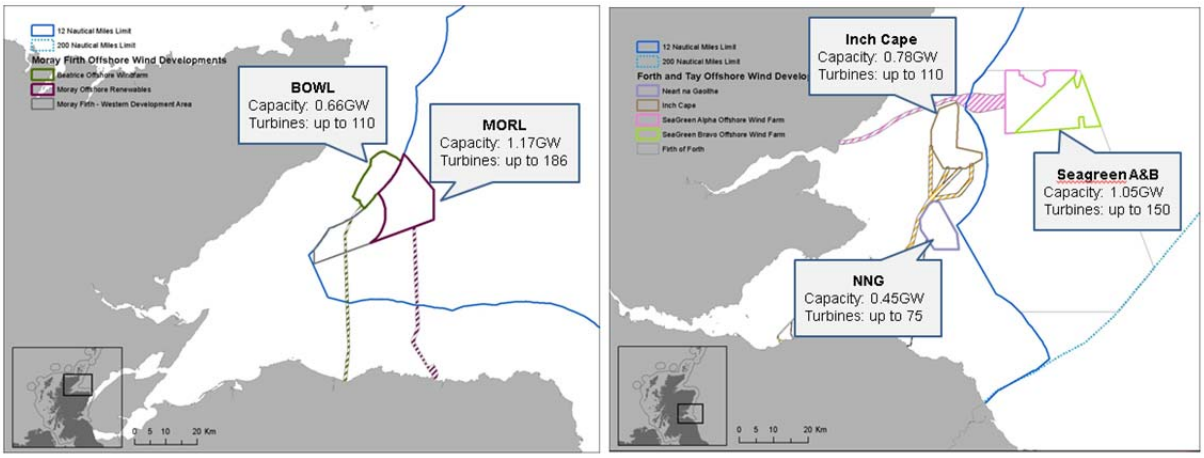

Figure 1: Major offshore wind farms in the Moray FIrth (left) and Forth & Tay (Right) regions

This case study will document the necessary steps taken by all stakeholders involved, in order to ensure effective coexistence between the two industries.

7. Existing Multi-use:

Despite significant benefits from emerging marine uses (e.g. greenhouse gas emission reduction from renewable energy sources), they raise important spatial concerns to traditional users (e.g. commercial fisheries), who often find themselves primarily concerned about the issue of exclusion. However, more space for one user group should not always be directly translated as less for others. Peaceful co-existence is often possible. However agreeing on space allocation and associated regulatory content requires each industry to represent their ocean space use effectively, reach a better understanding of the interactions between activities, and work towards negotiation and cooperation.

Spatial overlap between two human activities often generates interactions. One activity may have both beneficial and adverse effects on the other and vice versa. In the case of commercial fisheries and offshore wind, there is a range of potential interactions, including multi-use of geographical resources (spatial overlap), multi-use of human resources (e.g. vessel and other technical staff sharing), and multi-use of technical resources (e.g. sharing of upgrading port facilities).

8. Potential Multi-use:

This study documents a case of ‘existing’ multi-use, therefore this is section is not applicable.

9. Key issues to be analysed and discussed:

This case study will focus on:

- Policy and industry drivers for facilitating coexistence between the two industries
- Potential sources of conflicts between offshore wind farm developments and commercial fisheries, also referred to as barriers. For example, these include loss of access to fishing grounds, displacement of the fishing activity to alternative fishing locations etc.

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• Potential economic, environmental, and social consequences of conflicts, also known as impacts (negative effects). For example, loss of earnings, overfishing, loss of local knowledge etc. • Management interventions taken/ further needed to mitigate impacts (negative effects), and • Resulting synergies and added value from Multi-use
10. Information sources: • Scotland's National Marine Plan and other key national policy documents • National and European directives, e.g. MSP Directive • National stakeholder forums, e.g. UK Working Group on Fisheries Liaison with Offshore Wind and Wet Renewables Group (FLOWW). • Scientific and grey literature • Past European projects, e.g. CO-EXISTENCE
12. Expected results and impacts: This case study will document policy and industry drivers for facilitating coexistence between the two industries, sources and consequences of conflicts between offshore wind farm developments and commercial fisheries, management interventions taken to mitigate impacts , as well as resulting synergies and added value from Multi-use as emerged from existing information sources. Stakeholder involvement is aimed at highlighting most relevant existing perceived barriers and conflicts and identifying recommendations to overcome them.

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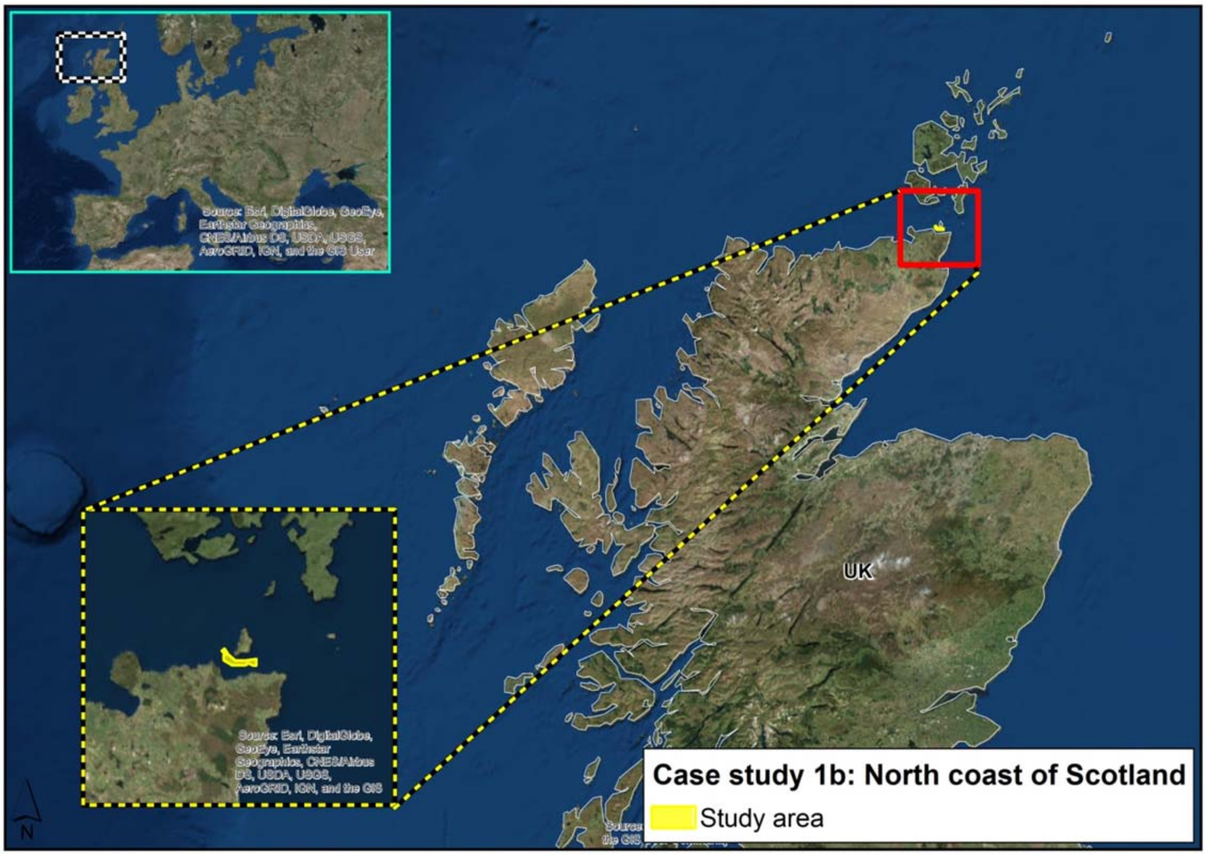
1. Case study n. 1-b
2. Regional Sea: North Sea
3. Location: North Coast of Scotland / Inner Sound of the Pentland Firth
4. Title: Tidal Energy Development and Environmental Interactions
5. Case study area:



The Inner Sound of the Pentland Firth is off the north coast of Scotland between Caithness on the Scottish mainland and the island of Stroma. The Inner Sound is recognized as a highly active site in terms of tidal flow and high wave frequency with maximum current speeds of up to 5 metres per second. The site also has good access to the grid, and suitable water depth for tidal turbines. The majority of the seabed in the Inner Sound is comprised of scoured bedrock exhibiting a 'saw tooth' profile. Rocks that form the seabed consist of folded and tilted sedimentary sandstone, flagstone and siltstone.

6. Current characteristics and trends in the use of the sea in the area:

This is a highly active area that has some of the best resources for marine renewable energy generation and has great potential for tidal energy generation. There is an Orkney-based European Marine Energy Centre (EMEC) facility for sea trials and testing for marine renewables as well as a commercial project, undertaken by MeyGen, which was licensed and consented in January 2014. MeyGen deployed their fourth tidal turbine at the Inner Sound site in the early part of 2017 and plan construction for the next 6MW phase to commence in 2018. Sustainable growth of marine renewable energy and the potential for coexistence with other marine users is a key objective of the Pilot Pentland Firth & Orkney Water Marine Spatial Plan which was published in March 2016.

The Pentland Firth is an important area for marine transport, including shipping transiting through the Firth as well as ferry traffic, recreational vessels and commercial fishing activity. The area is also important to a variety of species in the area including marine mammals, fish and birds.

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7. Existing Multi-use:

Existing multi-use is at the early stages in the Pentland Firth but would fall under the category 'Multi-use of geographical, human, biological' reference at chapter 2.1 of the WP2 Analytical Framework. The multi-use relates to the sustainable development of marine renewable energy and the coexistence with the marine environment and other marine users.

The focus of the case study will be on tidal energy generation and the marine environment. We anticipate that the main environmental factors considered in combination with tidal energy will be Marine Mammals and migratory fish, however, there may be other combinations also considered, for example birds, sea fish and benthic species.

North Sea – Pentland Firth combinations:

Combinations - Main Focus

- Tidal Energy – Environment (Marine Mammals)
- Tidal Energy – Environment (Migratory fish/Salmon)

Combinations – Possible secondary Focus

- Tidal Energy – Environment (Birds)
- Tidal Energy – Environment (sea fish)
- Tidal Energy – Environment (Benthic species)

8. Potential Multi-use:

This case study will focus on the potential for the sustainable development of tidal energy and coexistence with the marine environment. This coexistence is important to allow Scotland to unlock the considerable potential for offshore renewable energy developments. Estimates indicate that Scotland has up to 25% of Europe's potential tidal energy resource.

Scotland could lead the world in the development and deployment of offshore renewable energy technologies. The potential is enormous and there is opportunity to consider how to further harness this vast resource, in a sustainable manner, to provide power for homes, businesses and fulfil Scotland's ambition for a low carbon economy.

In order to realise this potential it is important to maximise the contribution that offshore renewable energy makes to renewable energy generation in Scotland; maximise opportunities for economic development, investment and employment; and at the same time minimise adverse effects on people, other sectors and the environment. The Scottish Government seeks to promote economically and socially beneficial activity while minimising adverse effects on the environment, human health and other users of the sea.

The tidal energy project in the Pentland Firth is in its initial phase with four turbines deployed and with deployment of further turbines planned using a phased approach. As part of the consenting process for Phase 1, the developers carried out an Environmental Impact Assessment (EIA). The EIA process identifies the areas of the project where significant environmental effects may occur, and outlines mitigation measures or management techniques aimed at reducing or offsetting these effects.

This project is therefore leading the way for this type of technology and provides an excellent opportunity to consider the sustainable development of tidal renewable energy and coexistence with the marine environment.

9. Key issues to be analysed and discussed:

Scotland has a third of the UK's tidal stream resources and two thirds of its wave potential and has the potential to generate more electricity than it currently needs from the waters around the Scottish coast. The Scottish Government is committed to supporting the future development of marine energy in Scotland by demonstrating to the investment community the strong industrial

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potential of marine energy and to press for continued UK Government support, continuing to offer support through the Renewable Energy Investment Fund and other financial mechanisms, and supporting innovation and cost-reduction through continued funding of Wave Energy Scotland.
25% of Europe's offshore wind resource can be found around Scotland's coastline. Offshore wind is a large-scale technology with the potential to play a pivotal role in our energy system over the coming decades. Innovation in offshore wind, and especially in technologies like floating wind, which offer scope for development in deeper water, will play a significant role in positioning Scotland as a world centre for energy innovation.
In 2015, 59.4% of Scotland's electricity consumption came from renewable sources, exceeding the 2015 interim target of 50%, and installed capacity continues to grow towards the 2020 target of 100%.
Scotland's draft Energy Strategy, published in January 2017, proposes a new 2030 'all-energy' renewables target to deliver the equivalent of 50% of Scotland's heat, transport and electricity consumption from renewable sources. Setting this ambitious but achievable target demonstrates the Scottish Government's commitment to a renewable future, and to the continued growth of a successful renewable energy sector in Scotland.
Offshore wind and marine renewable energy developments may have a wide range of environmental impacts throughout their project life-cycle. Effects could vary on a case-by-case basis and will depend upon the specific location, technology, the timing and the approach to activities and pressures from other forms of activity.
The Scottish Government recognises that improvements can be made to the mechanisms used to address these uncertainties and have developed a 'Scottish Offshore Renewables Research Framework' (SpORRAn) with a supporting research strategy. This framework will provide a mechanism for understanding, collaborating and co-ordinating research priorities across a range of topic areas. It will also provide a mechanism for new knowledge to feed into updates to the Sectoral Marine Plans and support Marine Scotland's risk based licensing and consenting approach.
Strategic Environmental Assessment, Habitats Regulations Appraisal and Environmental Impact Assessment assess key environmental risks which will be taken into account in plan and project development and consenting procedures. A strategic approach to mitigating potential impacts and cumulative impacts on the marine environment forms an integral part of marine planning and decision making.
This case study will consider Tidal Energy generation off the North Coast of Scotland, interactions with the environment including marine mammals and wild salmon and the identification of technical solutions to minimise environmental impact. In particular, it will need to take account of an ongoing collaborative Demonstration Project at the site which aims to understand the interaction between marine mammals and operational turbines. Consideration of the benefits and drivers for the co-existence of the activity will also be an important aspect of the case study.
The case study will also consider Survey Deploy and Monitor Licensing Policy Guidance and adaptive management measures which intend to provide regulators, and developers, with an efficient risk-based approach for taking forward tidal and wave energy proposals, whilst gaining a better understanding of the actual environmental impacts. Similarly the H2020 RICORE project considered establishing a risk-based approach to consenting where the level of survey requirement is based on the environmental sensitivity of the site, the risk profile of the technology and the scale of the proposed project.

10. Information sources:

There are a number of sources of information for this particular case study.

1. Documents can be accessed from the Tidal Energy Company's website including the Environmental Impact Assessment (EIA). There are also links to the to the Marine licensing papers held on the Marine Scotland Licensing Operations Team 'Current projects' pages of their website.

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http://marine.gov.scot/datafiles/lot/Meygen/Environmental_statement/Complete%20ES.pdf
http://www.gov.scot/Topics/marine/Licensing/marine/scoping/MeyGen

2. The pilot Pentland Firth and Orkney Waters Marine Spatial Plan (PFOW MSP) sets out an integrated planning policy framework to guide marine development, activities and management decisions, whilst ensuring the quality of the marine environment is protected. This document will therefore be a helpful source of information.
http://www.gov.scot/Publications/2016/03/3696

3. Scotland's National Marine Plan is a document that provides a comprehensive overarching framework for all marine activity in Scottish waters.

4. Strategic Environmental Assessments have also been developed for marine renewable energy in Scottish Waters. The Draft Sectoral Marine Plan for Wave and Tidal Energy and associated strategic environmental assessments and regional locational guidance documents provide a broad range of relevant information in relation to this region.
http://www.gov.scot/Publications/2013/07/8702

5. Historically, a 2007 SEA for marine renewables was also undertaken to support an early Pentland Firth and Orkney Waters leasing round for these technologies. Further information is detailed below.
http://www.gov.scot/Topics/marine/marineenergy/wave/WaveTidalSEA

6. The Scottish Government Demonstration Strategy: Trialling methods for tracking the fine-scale underwater movements of marine mammals in areas of marine renewable energy development sets out technical solutions for monitoring marine mammal behaviour around operating turbines and will therefore be a key source of information for the case study. We will liaise with colleagues within our science division to identify any additional potential scientific/academic papers which may inform the case study, particularly the identification of technical solutions to minimise environmental impact.
http://www.gov.scot/Topics/marine/Publications/stats/Science/SMFS/2016/0714

7. Survey, Deploy & Monitor Licensing guidance Policy - provides regulators, and developers, with an efficient risk-based approach for taking forward wave and tidal energy proposals. It is designed to enable novel technologies whose potential effects are poorly understood to be deployed in a manner that will simultaneously reduce scientific uncertainty over time whilst enabling a level of activity that is proportionate to the risks. It distinguishes between those proposed developments for which there are sufficient grounds to seek determination on a consent application based on a lesser amount of wildlife survey effort and analysis to develop site characterisation pre-application, and those where the combination site sensitivities, technology risk and project scale make a greater level of site characterisation appropriate. It then highlights how those developments will be deployed and monitored.
http://www.gov.scot/Topics/marine/Licensing/marine/Applications/SDM

8. The RiCORE project aimed to establish a risk-based approach to consenting where the level of survey requirement is based on the environmental sensitivity of the site, the risk profile of the technology and the scale of the proposed project. The project, which received funding from the European Union's Horizon 2020 research and innovation programme, ran between January 1st 2015 and June 30th 2016.
The impact of the project was to improve, in line with the requirements of the Renewable Energy Directive, consenting processes to ensure cost efficient delivery of the necessary surveys, clear and transparent reasoning for work undertaken, improving knowledge sharing and reducing the non-technical barriers to the development of the Offshore Renewable Energy sector so it can deliver clean, secure energy.
http://ricore-project.eu/

9. Draft Scottish Energy Strategy - http://www.gov.scot/Publications/2017/01/3414

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11. Expected results and impacts:

We aim to explore the multi-use /combination of tidal Energy generation and the Environment (particularly marine mammals and wild salmon) off the North Coast of Scotland. We will identify the main drivers, added values, barriers and negative impacts related to this combination. We will attempt to explore how any barriers can be reduced or eliminated and how the drivers/added value can be maximised. This will be achieved through a combination of desk study work and through engagement with relevant stakeholders.

The work will be undertaken under Work package 3 and will contribute towards the deliverables under that work package, including the 'case study implementation' and the ' WP3 – Comparative analysis & Final Report'. The case study will report on the findings from both the desk study and stakeholder engagement. The main aims will be to identify technical solutions to minimise environmental impacts, and establish how to maximise benefits and minimise impacts.

The case study will also feed into the work undertaken for work package 4 and in particular will help inform the Action Plan. This will therefore help form part of the key recommendations for real opportunities in Multi-use including recommendations to support Blue Growth, and how best to reduce/eliminate impacts.

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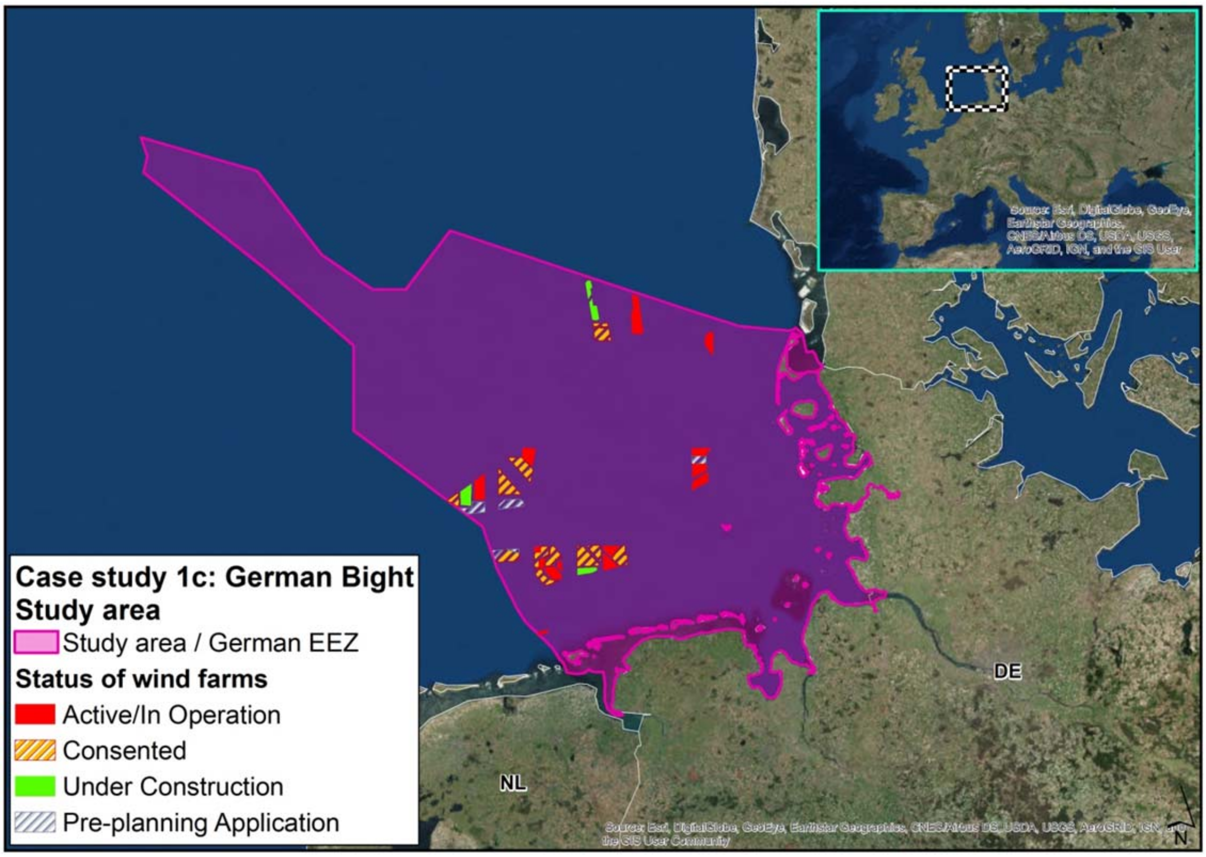
1. Case study n. 1-c
2. Regional Sea: North Sea
3. Location: Southern North Sea, German Bight / German EEZ
4. Title: Multi-use of offshore wind farm (OWF) areas with (A) fisheries and (B) aquaculture (C) and restoration efforts
5. Case study area:



The North Sea is a relatively young and shallow shelf sea system that is characterized by extremes. The southern mud flats of the Wadden Sea are shared by the Netherlands, Germany and Denmark and are, in large parts, protected conservation areas and declared as UNESCO World Natural Heritage. The area beyond territorial waters is characterized as a high energy environment with high wave heights and strong currents, posing unique technical challenges to any industry operating under these conditions.

Case study n.1.3 will focus on possible multi-use combinations of offshore wind farms in the German Bight in the Southern North Sea (see map). Several multi-use sites were already investigated, however, within this study the concrete location of the multi-use combinations has yet to be decided. The locations of OWFs can be obtained using the link at the end of this paragraph.

6. Current characteristics and trends in the use of the sea in the area:

The German Bight is characterized by a multitude of users all vying for very limited ocean space (see Figure 2). Which user claims which sites in the offshore realm was clearly organised by Germanys MSP conducted by the BSH[10], which was conducted for 5 years and finished in 2006 following EU regulations. After defining the actual state priorities of different user were ascertained, which were finally set by following national and international dependencies and contracts and subdivided into priority areas, reservation areas, and suitable areas. The outcome of it was a list of priorities, which

[10] Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency)

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is as follows:
(1) High priorities:
→ Safety and efficiency of shipping
→ National and international contracts [e.g. pipelines, cables]
→ Protection of the marine environment
→ National/Alliance defence
(2) Other priorities:
→ Resources
→ Scientific research
→ Wind farming

Currently, the main uses, not in order of importance or prevalence are as follows:

- **Marine traffic:** The German EEZ is part of major marine traffic transit ways going north and west as well as a route for inbound traffic serving the major ports of Hamburg, Bremerhaven, Cuxhaven and Wilhelmshaven. These dedicated shipping lanes are the most frequently used offshore waterways worldwide and constitute a major use of space causing many conflicts due to high demands for navigational security (s. Figure 2).
- **Offshore Wind Energy:** The offshore wind energy sector is a relatively new sector in the German EEZ but is poised to become one of the major sectors vying for space due to its exponential expansion in the recent decade. Though few offshore wind farms (OWFs) are in operation as of yet, the number as well as the applications for new OWFs are increasing (s. Figure 1). OWFs often adhere to strict safety regulations and, for the most part, constitute forbidden zones to other users.
- **Fisheries:** Fisheries are the traditional and oldest users in the case of the North Sea and still produce considerable percentages of the entire catch in EU waters. Increasing nature protection efforts and marine traffic volume as well as the new offshore wind energy sectors expansion constitute conflicts about ocean space for this sector.
- **Nature conservation:** Marine protected areas (MPAs) constitute a major use of marine space in the German EEZ. Interests of conservationists often clash with interests of different stakeholder groups. At this point, in addition to simple nature conservation efforts, restoration projects are also being carried out to strengthen the population of or reintroduce native species.
- **Aquaculture:** As of 2017 there is no marine aquaculture sector in the German EEZ yet. Though there has been a wealth of studies and projects investigating the suitability of candidate species and necessary engineering solutions, going as far back as the year 2000. These provide stakeholders with a solid knowledge and technology base for future expansions in this area.

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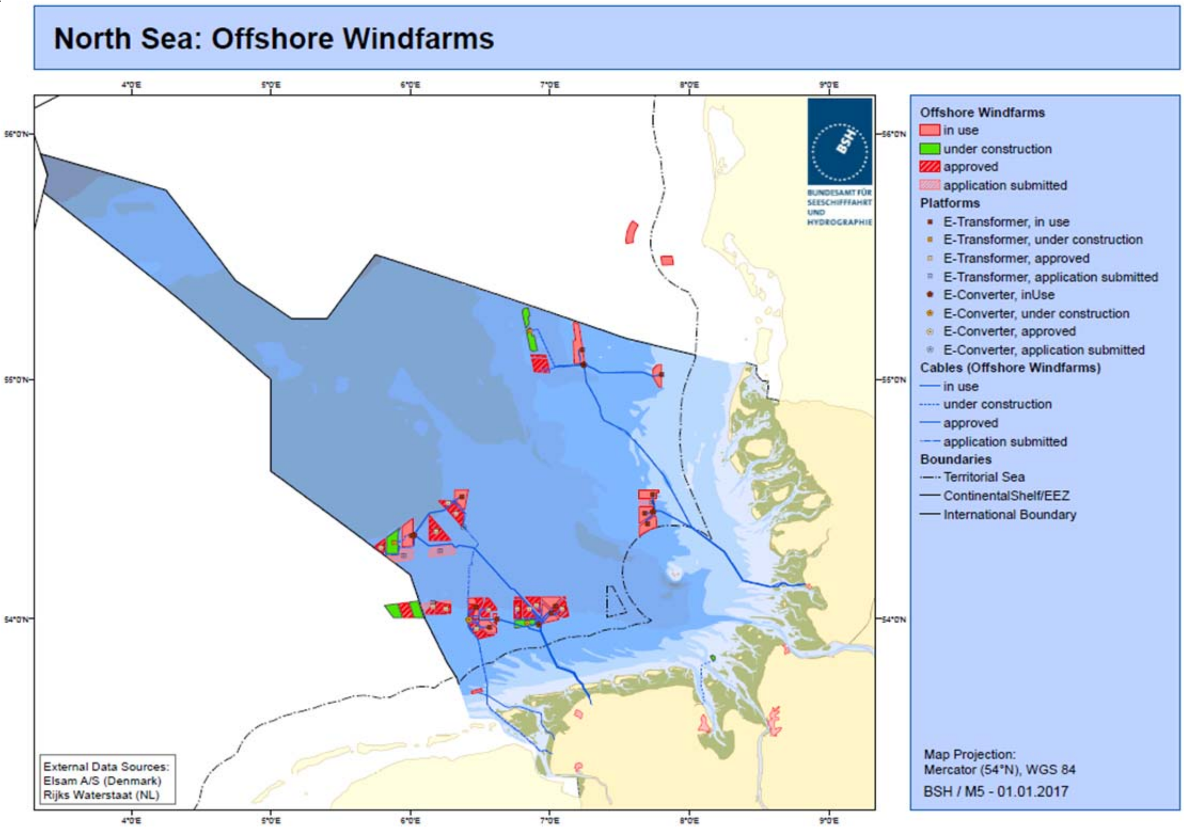

Figure 1 – Location of all Offshore Wind Farms (OWF) in use, under construction, approved or submitted in the German EEZ. Source: BSH – CONTIS Information System.

7. Existing Multi-use:

As showcased in Figure 2, the German EEZ is host to a wide variety of uses in a very limited geographical area. Very few of those uses come close to constituting a true multi-use per definition (s. Analytical Framework – MUSES Project).

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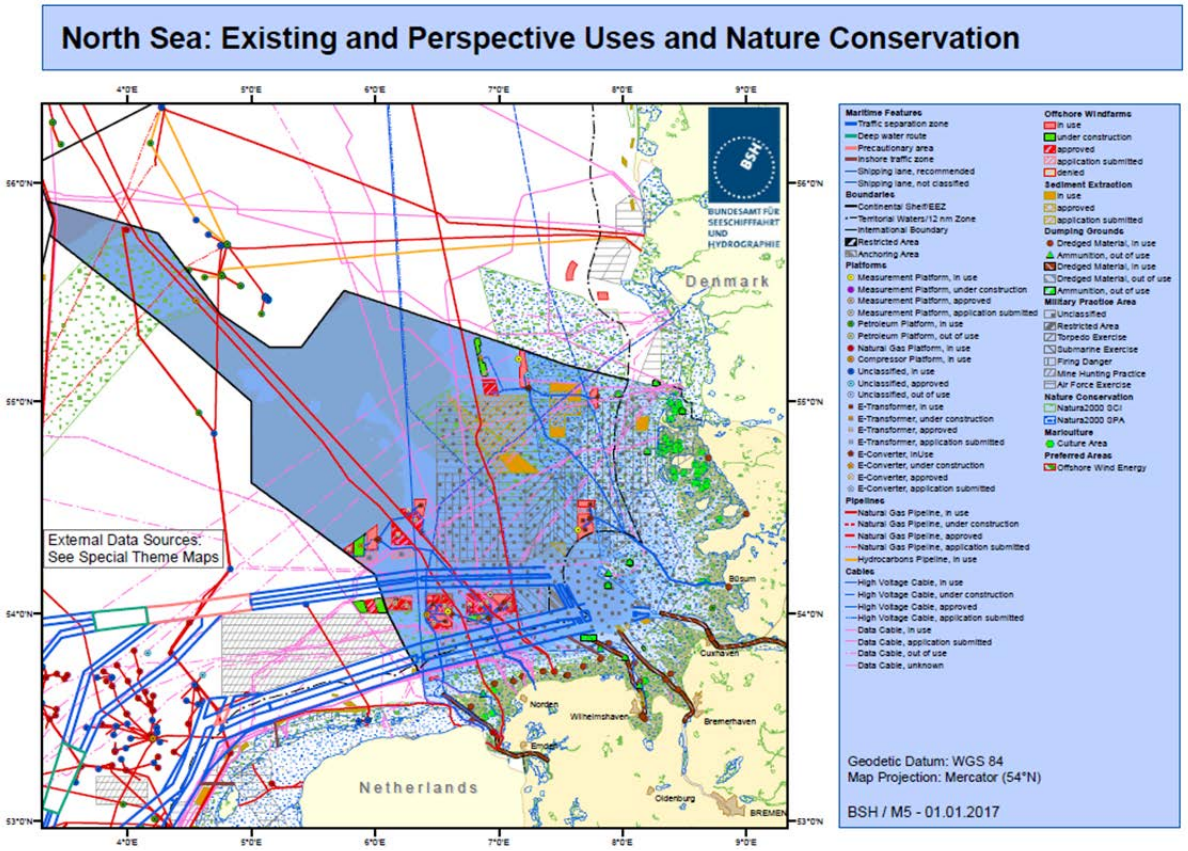

Figure 2 – Complete map of uses in the German EEZ. Source: BSH – CONTIS Information System.

8. Potential Multi-use:

The potential multi-use combinations that offer the most promise and will be investigated in this sub-case study are (A) OWF-Fisheries, (B) OWF-Aquaculture (fish and/or sea weed and mussels) and possibly (C) OWF-Environmental Protection (restoration efforts). The multi-use elements of the combinations are as follows:

(A) OWF-Fisheries:
Multi-use of geographical resources, i.e. ocean space

(B) OWF-Aquaculture:
Multi-use of geographical resources (i.e. ocean space) as well as possible multi-use of technical resources (i.e. marine infrastructure and platforms)

(C) OWF-Environmental Protection (restoration efforts).
Multi-use of geographical resources, i.e. ocean space

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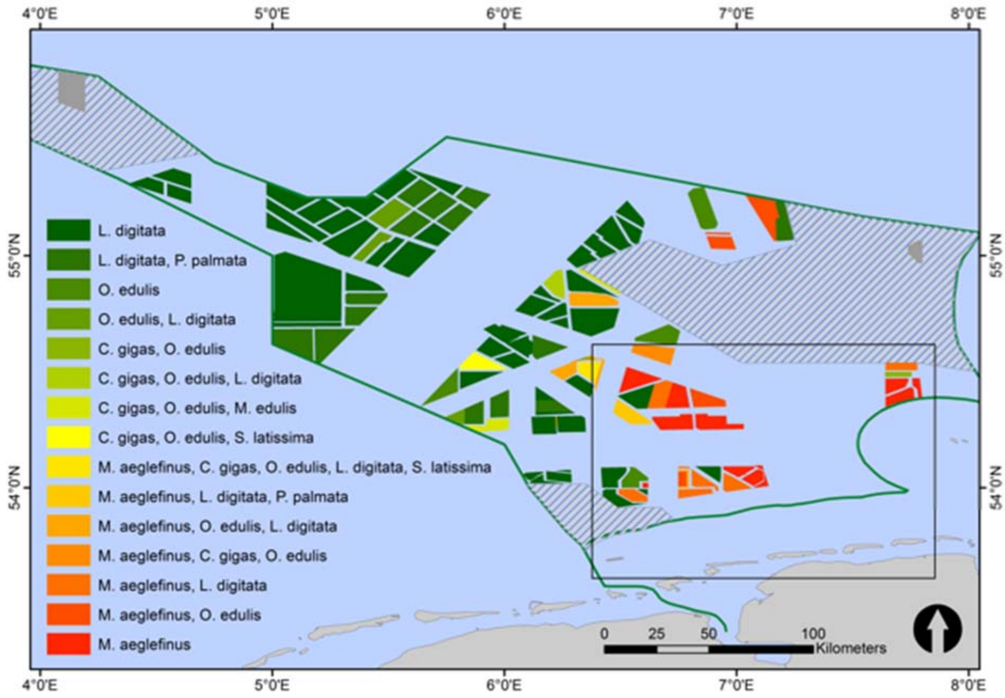

Figure 3 - Suitability of a range of aquaculture target organisms for OWFs the German EEZ. Stelzenmüller et al. 2017.

9. Key issues to be analysed and discussed:

The possible multi-use combinations that will be investigated in this sub-case study share many of the same issues. For an exhaustive but not final compilation of these issues see Table 1. Two of the major barriers to be discussed when dealing with the multi-use of space in the vicinity of offshore wind farms, are the governing regulatory framework as well as the inherent safety, liability and insurance concerns of the users.

	Drivers	Barriers
	Strengths	**Weaknesses**
internal	Development of a flexible, collective transportation scheme	Little to no interest in joint planning process
	Sharing of high-priced facilities	Little willingness to engage into new fields of activity
	Rationalization of operating processes	Ambiguous assignment of rights and duties
	Shortening of adaptive learning process for any offshore works by making use of available experience and knowledge	Problems of interfering operations
		Lack of motivating force due to doubtful mutual cost benefit
	Added values	**Impacts**
	Opportunities	**Threats**
External	Available working days coincide	Unfavourable accessibility of wind farm location inhibits joint O&M

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	Transportation and lifting devices are indispensable	Lack of regulatory framework supporting co-management arrangements
	Availability of a wide range of expertise (hard and soft skills)	No access rights within wind farm area for second party
	Lack of legislation in EEZ favours implementation of innovative concepts	Unsolvable problems of liability
		Dissimilar lease tenures

Table 3-1 – SWOT-Analysis modified after Buck and Langan (2017)

10. Information sources:

The case study will draw from the published and unpublished results of a long list of national and international scale projects on offshore co-existence and multi-use. The list has been compiled by AWI and has been previously provided to MUSES partners.

Other sources of information for the case study are analyses of the relevant bodies of law from international treaties down to the national and local German level as well as detailed analyses of administrative approval procedures for offshore activities.

Going beyond the already compiled research on multi-use, this case study will also engage relevant stakeholder groups and key stakeholders in the region to identify relevant drivers, barriers as well as added value and impacts of the investigated multi-use scenarios.

11. Expected results and impacts:

This case study will build on the previous investigations about the drivers, added values, barriers and impacts of the proposed multi-use combinations in the German EEZ by assessing this foundation of knowledge and engaging key stakeholders to extract new insights. A special focus area will be the barriers and how to address them going forward. The generated insights from review of the existing knowledge base and stakeholder engagement will be directly fed into MUSES regional, national and international analyses and thereby support the creation of stakeholder specific roadmaps for future actions. In addition, close interaction with stakeholders will further promote the concept of multi-use with those stakeholders.

References

Buck, B.H. and Langan, R. (Eds.) (2017). Aquaculture Perspective of Multi-Use Sites in the Open Ocean – The Untapped Potential for Marine Resources in the Anthropocene. Springer International Publishing.

Stelzenmüller, V. Gimpel, A., Gopnik, M. & Gee, K. (2017). Aquaculture Site-Selection and Marine Spatial Planning: The Roles of GIS-Based Tools and Models. In: Buck, B.H. and Langan, R. (Eds.) (2017). Aquaculture Perspective of Multi-Use Sites in the Open Ocean – The Untapped Potential for Marine Resources in the Anthropocene. Springer International Publishing.

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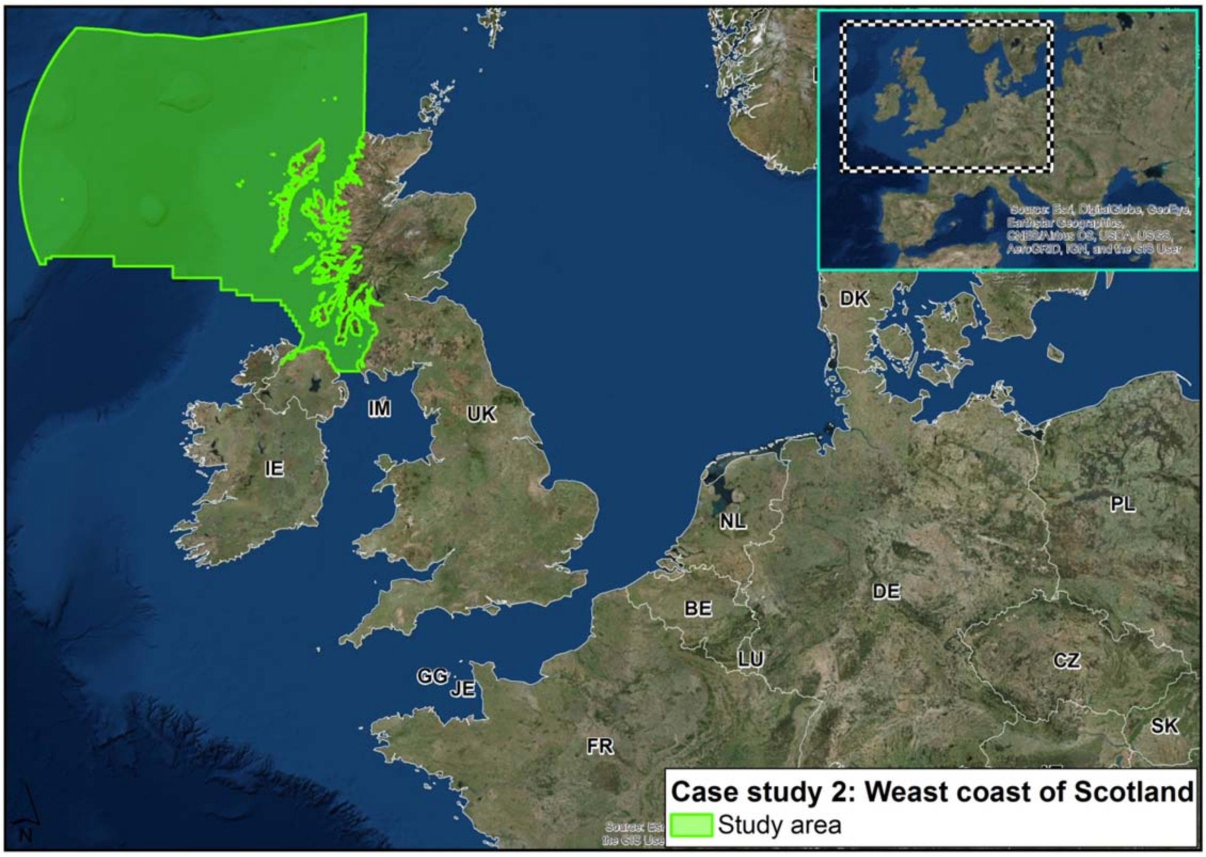
3.2 Case study 2: Marine renewables & Aquaculture MU including the use of marine renewable energy near the point of generation

1. Case study n. 2
2. Regional Sea: Atlantic Sea
3. Location: Northern Atlantic Sea - West Coast of Scotland
4. Title: Marine Renewables & Aquaculture MU including the use of marine renewable energy near the point of generation
5. Study area:



The North Atlantic is largely determined by large-scale wind currents and air masses emanating from North America, creating a high-pressure area and generating prevailing westerly winds across Western Europe. The continental embankments range from several hundred km in the North, with depths of the external region of the continental shelves ranging from 100 to 500m in width. A characteristic feature of the Atlantic Ocean is the powerful system of warm currents—the so-called Gulf Stream system — from the western and northern peripheries of the northern anticyclonal cycle.

Two geographical areas are of interest:

- the near shore and off-shore of the North Atlantic off Scotland, for analysing current MU eg wave Energy generation and salmon fish-farms as renewable wave energy is being used to replace traditional diesel generated power for fish-farming processes on the West Coast of Scotland.
- Further off shore, away from traditional sheltered sites to explore future and potential MU in the more exposed offshore waters.

This exact sites will become evident as soon as we engage the stakeholders.

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6. Current characteristics and trends in the use of the sea in the area:

The great north-south extent of the Northern Atlantic has relatively broad areas of continental shelf with a proliferation of plant (i.e., algae) and animal species.

Algae of commercial value include the kelp genus Laminaria, a source of iodine, potassium, and algin; Irish moss (*Chondrus crispus*), from which carrageenan is derived; including large communities of crustaceans and fish normally associated with coastal regions and which are the spawning grounds for the American and European freshwater eels of the genus Anguilla. Fishing activities e.g. driven by the demand for shellfish in Europe (Stornoway, Lerwick and Oban) resulted in large areas being overfished and many species depleted by the early 1990s.

The EU's Common Fisheries Policy restrictions on the total tonnage of catch that can be landed, allowable times for fishing, and on fishing gear that can be deployed, which have so far not succeeded in restocking.

Large scale decrease in employment in the fishing industry was due initially to the sacrifice of national fishing rights to the EEC on the UK's accession to the Common Market in the 1970s. We now have historically low abundances of commercially valuable fish in the North Sea and parts of the North Atlantic; which has been followed by commercial fish farms – especially in salmon, in the rivers and lochs of the north and west of Scotland.

Seaweed harvesting is a small-scale industry in the Outer Hebrides and Orkney islands, processes over 5,500 tonnes per annum, mainly *Ascophyllum nodosum* (manual and mechanical methods).

In terms of commerce and shipping, the North Atlantic Ocean is one of the world's busiest shipping lanes; with commerce between the Mediterranean Sea and the NE Atlantic Ocean having been initiated by the Carthaginians in the 7th cent. A.D.

Government policy is a key driver for the blue economy, where fisheries, tourism, and now energy regeneration, seem to be main economic drivers in the region.

Reports also state that the area could have more than double the amount of oil and gas reserves currently predicted, of extensive untapped reserves of oil and gas which could be underestimated by 100%. Major basins in the area are filled with geological conditions that support the formation of 'supermassive' oil reserves and the West Coast alone could provide oil and gas for at least 100 years with an estimated value of more than £1 trillion. Yet the area – off the west coast of Scotland and Outer Hebrides and Shetland –has remained largely untapped due to deep waters and difficult geological conditions.

Around 10% of Europe's total wave resource flows in the seas surrounding the Highlands and Islands of Scotland. Reports to the Scottish Government estimate that up to 14 gigawatts of recoverable energy lie off the area's western and northern flanks. This potential resource has drawn world leading wave energy device developers to the area. The Scottish Government has set ambitious targets for electricity generation from wave and tidal resources to contribute to its target of securing 100% of Scotland's electricity requirements from renewable sources by 2020.

The Atlantic ocean off Cornwall and the west coast of Scotland show the greatest promise for generating electricity from the waves that crash around the British Isles, according to research. Some of the highest waves, in the Rockall Trough to the west of Scotland, measure up to 29m from crest to trough. Rows of wave "farms" up to 1,000km long facing the Atlantic could generate around 11% of the UK's current power generation, the Carbon Trust analysis suggests. While the theoretical resource is as high as 18GW, around 10GW of capacity is more realistic given practical and economic constraints, it said.

The only barrier was the current lack of test drilling and technology.

7. Existing Multi-use:

Existing multi-uses for case study 3 are mainly integrated in "Multi-use of geographical, human, biological resources", as no platforms exist for now in the geographical areas of this case study. The shared marine resource in this context is mainly geographical (e.g. ocean space), physical (e.g.

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infrastructure or energy), and biological (e.g. fish stocks). There is no clear potential foreseen for other MU outside the scope of "Multi-use of geographical, human, biological resources" for the near future.

3.1 – West Coast of Scotland

- Commercial and touristic fishing
- Salmon Farming – Energy
- Tourism – Fish farming

3.2 – North Coast of Scotland

- MPAs – *Scientific research*
- MPAs – Tourism
- Wave Energy – aquaculture
- Tidal energy - fisheries

8. Potential Multi-use:

We expect that during WP2 and WP3 analysis, namely during stakeholders engagement, other potential multi-uses will be identified for these case study sites. For now, potential multi-uses identified for case study 3 are also mainly integrated in "Multi-use of geographical, human, biological resources".

- MPAs – Blue biotechnology
- Wave Energy – aquaculture
- Tidal energy – fisheries

Multi-use of technical resources (marine infrastructure & platforms) remains a future possibility, especially integrating the operations and implementation of offshore activities and can start e.g. by the simple sharing of the use of offshore supply vessels to reduce individual operations costs.

9. Key issues to be analysed and discussed:

We think main key issues to be analysed in the case study are similar to the key issues for WP2. Besides identifying multi-uses in these sites, identify main drivers, added values, barriers and negative impacts to existing multi-uses or to implementation of potential multi-uses, in order to contribute to WP4 and the definition of the Action Plan.

Licensing system in seems to be a significant barrier to multi-uses, and maritime activities in general, including technological feasibility as well as financial risks and commercial viability in terms of scaling. The financing and accessibility of modern infrastructure e.g. appropriate "green grids" bring additional barriers and concerns to the implementation of alternative maritime activities, for example, scaled up wave and tidal energy.

Profiles and of order of development (see 2.2) and location of MU (if applicable – location of existing uses (e.g. offshore wind) that could potentially be combined with upcoming one, or the potential location where two uses could develop jointly one day) will also be analysed.

Key drivers for the (potential) MU have been the Scottish Government push for Marine Renewables / Aquaculture / Power supply, within a political and socio-economic agenda with environmental benefits (implications).

10. Information sources:

National and regional laws will be analysed, as Regional Plans and Spatial Plans for Scotland and the relevant Scottish regions, as well as sectoral laws for the multi-use e.g. fisheries-tourism. and fisheries-energy generation.

EIA and SEA reports as well as planning and consenting consultation comments will be key documents for analysing how aspects of multi-use are characterised, discussed, presented, and addressed, if at all. Analysis of existing legal reports and cases, if any, may also be useful in highlighting aspects of Multi-use, especially conflictual ones.

Both scientific and media news will also be analysed, on actual and potential multi-uses, including perceptions of key stakeholders. Studies available from similar locations, if any, will also be analysed

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as starting points.
11. Expected results and impacts: We aim to identify multi-uses in the west-North coast of mainland Scotland relevant to the North Atlantic, as well as main drivers, added values, barriers and negative impacts related to those multi-uses (existing or potential). This will be achieved through desk research, but mainly through stakeholders' engagement and interviews. The results will contribute to develop WP3 deliverables, namely comparative analysis and case studies report. Results from case study 3 will also contribute to WP4 and the definition of the Action Plan that will include key recommendations. We also expect that results from this case study, similarly to Action Plan from WP4, can be used as basis to develop key recommendations for the EU, UK and Scottish Governments, at sliding scales depending on mandate and competency, to overcome identified barriers and negative impacts, as well as promote existing drivers and added values.

Additional in-sights on how Focus Areas Analysis will be addressed in case study 2

Broadly, the three main issues will particularly be analysed in the case study, with a sharper focus on key aspects emerging as we identify multi-uses in these sites. This will cover the main drivers, added values, barriers and negative impacts to existing multi-uses or to implementation of potential multi-uses, in order to contribute to WP4 and the definition of the Action Plan.

The actual knowledge and science of actual impacts of multi-use in the area seems very poorly developed.

Whilst the licensing system including how social and environmental aspects influence decisions and are traded off seems to be a significant barrier to multi-uses; aspects of financial risk and technological viability will also be analysed. The role of perceived community acceptance relating to the implementation of alternative maritime activities, for example, aquaculture or offshore energy, will also be included in the analysis.

The research aspects of our case study n.2 will be aligned to the above FA focus areas of analysis as shown below.

1	Addressing co-existence	For case studies where MUs already in place, explore how better management can overcome barriers and conflicts. 1. Identify potential for further smart economic-environmental combinations that can be implemented from the beginning of the MU development process, e.g. planning phase, mitigation of financial risk, building lead-infrastructure to facilitate/anticipate future MU; • highlight economic advantages of co-use; • identify strategies reducing risks associated with economic development of combined uses; • how to promote local entrepreneurship and create context to favour job creation and economic recovery; • potentiality of implementation of MU platforms, through planning & market & stakeholder interest analysis; • strategies for attracting investors, public authorities, and local communities and demonstrating social benefits of MU; • explore and analyse potentials for shared platforms, especially where co-generation of energy is concerned.
2	Boosting Blue	For case studies where MU is not yet in place, but there is evidence of a

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	Growth potential	high potentiality. 1. Smart economic-environmental combinations identified and implemented from the beginning of the MU development process. • highlight economic advantages of co-use; • identify strategies for reducing risks associated with economic development of combined uses; • explore how to promote local entrepreneurship and create context to favour job creation and economic recovery; • explore potentiality of implementation of MU platforms in case studies areas, through planning & market & stakeholder interest analysis; • analyse how to attract investors and demonstrate social benefits of MU from case study; • explore and analyse potentials for shared platforms, especially where co-generation of energy is concerned.
3	Improving environmental compatibility	For all case studies 1. Explore the overarching principle of Marine Spatial Planning: protection of the marine environment and/or minimization of existing impacts are relevant issues. • identify solutions to concentrate marine activities in order to minimize the use of sea space; • identify technical solutions to minimize environmental impacts; • identify win-win solutions triggering both socio-economic development and environmental protection (e.g. sustainable tourism and MPAs or small scale fishery/aquaculture and MPAs). Analyse how Environmental Assessment (EIA/SEA) for MSPs and marine projects, or selected case studies, addressed MU issues; and shaped the design and decision-making for MU, if at; • to what extent did EIA/SEA process promote/facilitate stakeholder discussion of MU issues? • What language or concerns over MU can be associated to various stakeholders (public authorities, environmental protection institutions, NGOs, local communities, scientists, sector operators, private business?). • explore and analyse potentials for shared platforms, especially where co-generation of energy is concerned. ➢ Potential alternative green energy generation solutions to replace diesel fed auxiliary generators used by ships berthed in port. ➢ The potential of co-locating high energy industries to where offshore wind/Marine Renewable electricity is generated. ➢ The linkage of energy generation and use at the same location for added benefits to the local community, including employment, supply chain and generally bringing money into the local community.

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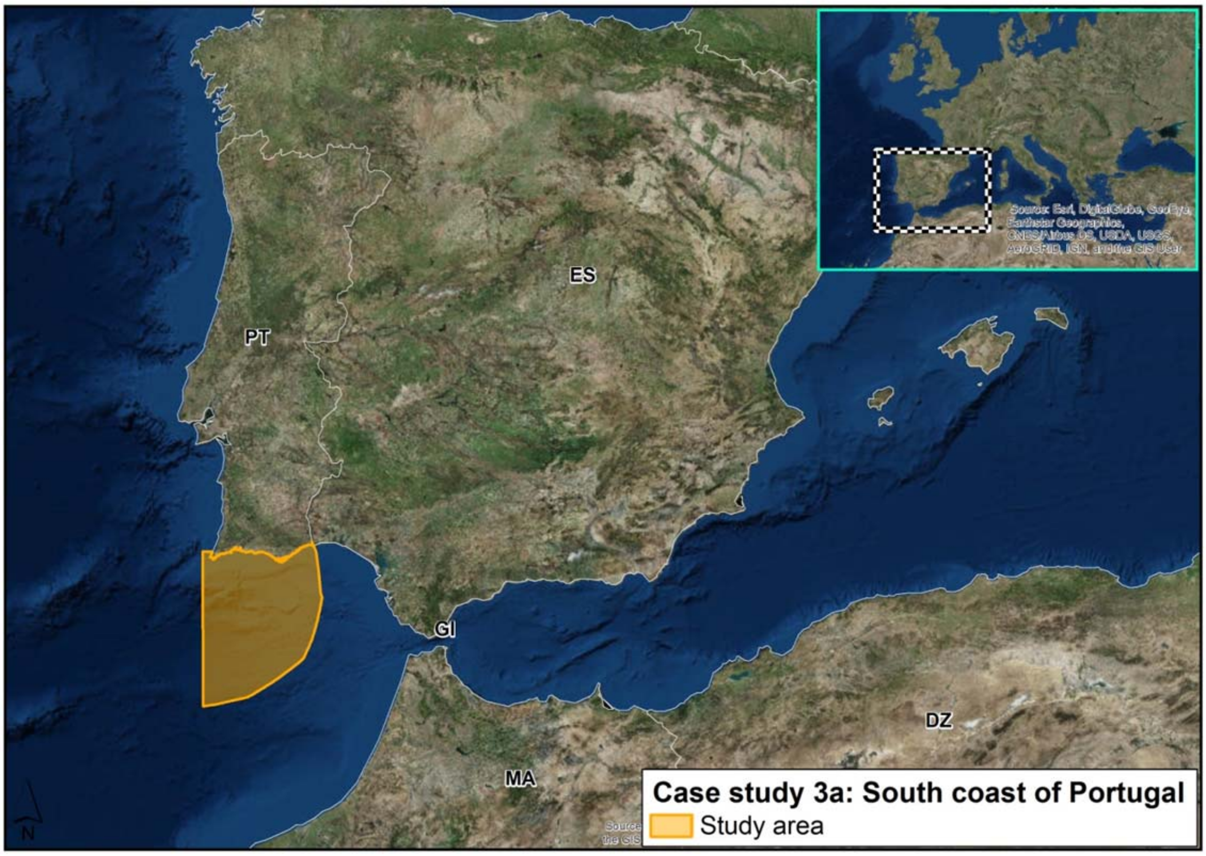
3.3 Case study 3: Development of tourism and fishing in the Southern Atlantic Sea

1. Case study n. 3
2. Regional Sea: Atlantic Sea
3. Location: Southern Atlantic Sea: South Coast of mainland Portugal and Azores archipelago
4. Title: Development of tourism and fishing in the Southern Atlantic Sea
5. Study area:



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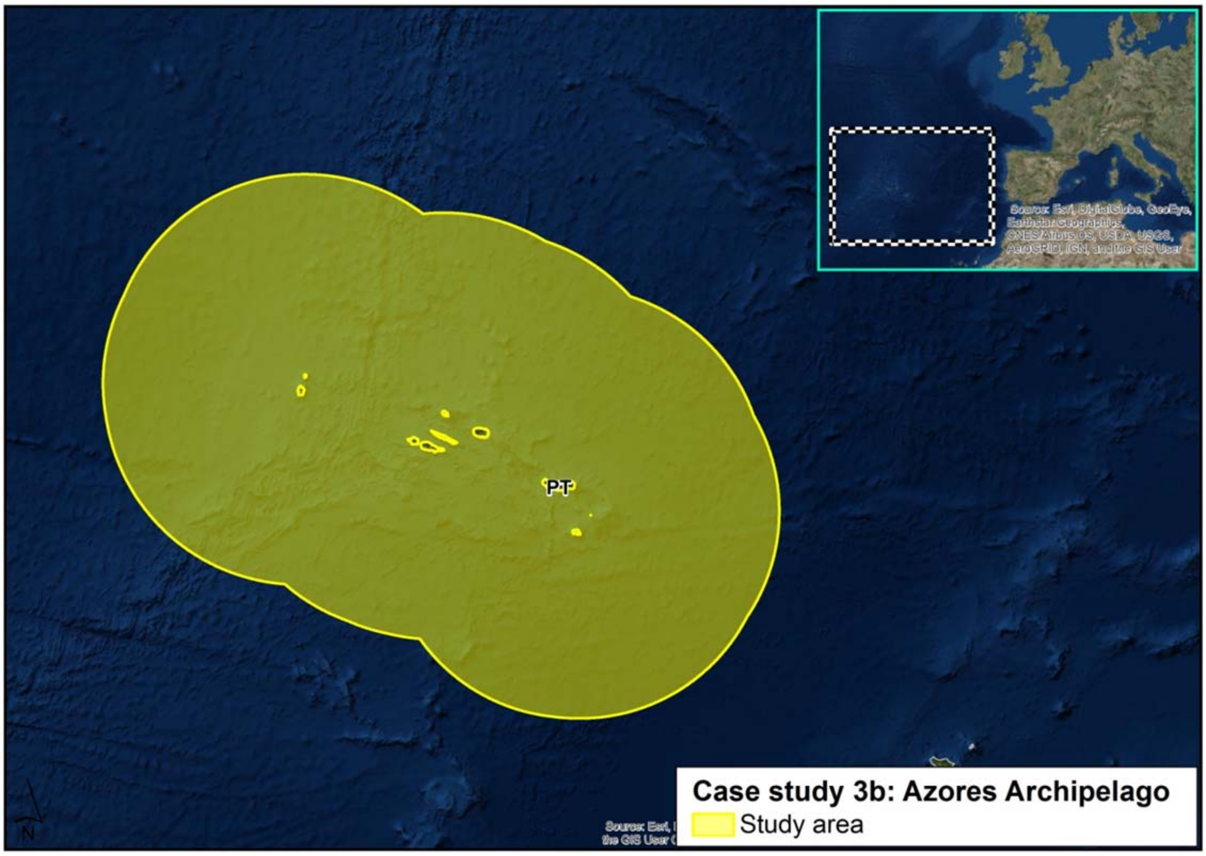

This case study is divided in two sub-regions (3.a – South Coast of mainland Portugal and 3.b – Azores archipelago) that have to be represented separately, due to geographical distance between areas and due to scale representation. South coast of Portugal mainland is about 150 km long in a straight line, while the Azores archipelago is located in the North Atlantic, approximately 1500km from the Portuguese mainland, composed of nine islands distributed along 600 km.

Considering the territorial extension of this case study, we will only know the geographical area of interest during the analysis of MU, because we will know their location during stakeholders' interviews.

6. Current characteristics and trends in the use of the sea in the area:

The South Coast of mainland Portugal is integrated in the Algarve region, which has 220 km of coast line, characterized by distinct ecological and geomorphological units with great variety and scenic value. One of the main uses of the sea has been related to transportation, with a heavy maritime traffic, as Algarve is located near the Strait of Gibraltar, the maritime entrance in the Mediterranean Sea. This maritime region hosts important fishery resources that have been important sources of wealth. Algarve has also been one of the most important regions, in Portugal, for maritime tourism, due to its location and weather conditions. This resulted in intense use of the shoreline for tourism and for the development of coastal maritime activities. Expected trend to this scenario is the continuity of this transport route and the continuity of the development of touristic activities, possibly with an increase in the diversity of offered activities. Recently, there has been the possibility to develop Oil and Gas Industry, but the process has been stopped by the Portuguese Government which prevented licensing. Activities related to underwater cultural heritage seem to be able to increase. Tourism seems to be the main economic drive in the region, for now.

The Azores archipelago is composed of nine islands, geographically distributed in three groups (Western: Flores and Corvo; Central: Graciosa, São Jorge, Faial, Pico and Terceira; and Eastern: São Miguel and Santa Maria) distributed along 600 km. The Azorean islands present about 1170 km of

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total coast line with great geomorphologic variety. The Azores has always been a strategic crossing point in the Atlantic. Nowadays it continues to be a crossing point for maritime traffic, either commercial, cruises or even yachting. Due to its location in the middle of the North Atlantic Ocean, transportation has long been one of the main uses of the Azorean seas, as well as fisheries. Tourism and maritime touristic activities have been increasing in recent years and the Azorean Government is committed to continue to encourage and support tourism development in the Azores. This also includes activities developed in the sea. Scientific research and the creation of maritime protected areas have also increased in recent years. The Azorean Government also seems to be encouraging activities for the blue economy, but no specific measures have been announced. Fisheries and tourism seem to the main economic drivers in the region, for now.

7. Existing Multi-use:

Existing multi-uses for case study 3 are mainly integrated in "Multi-use of geographical, human, biological resources", as no platforms exist for now in the geographical areas of this case study.
There is no potential foreseen for other MU outside the scope of "Multi-use of geographical, human, biological resources" for the near future.

3.1 – South Coast of mainland Portugal

- Tuna Farming – Tourism
- Tourism – Underwater cultural heritage

3.2 – Azores archipelago

- Fisheries – Tourism
- Tourism – Underwater cultural heritage
- MPAs – *Scientific research*
- MPAs – Tourism

8. Potential Multi-use:

We expect that during WP2 and WP3 analysis, namely during stakeholders engagement, other potential multi-uses will be identified for these case study sites. For now, potential multi-uses identified for case study 3 are also mainly integrated in "Multi-use of geographical, human, biological resources".

- Military defense – Scientific research
- MPAs – Blue biotechnology

9. Key issues to be analysed and discussed:

We think main key issues to be analysed in the case study are similar to the key issues for WP2. Besides identifying multi-uses in these sites, identify main drivers, added values, barriers and negative impacts to existing multi-uses or to implementation of potential multi-uses, in order to contribute to WP4 and the definition of the Action Plan.
Licencing system in Portugal seems to be a significant barrier to multi-uses, and maritime activities in general, for mainland Portugal. In the Azores, geographical location in the middle of the Atlantic brings additional barriers and concerns to the implementation of alternative maritime activities, for example, aquaculture or offshore energy.

10. Information sources:

National and regional laws will be analysed, as Regional Plans /Spatial Plans for Algarve and the Azores, as well as sectoral laws, as the Portuguese legislation for the multi-use fisheries-tourism. Considering that Algarve and the Azores lack studies and specific information on multi-uses, news and media on potential multi-uses will also be analysed. Studies available from similar locations, if any, will also be analysed as starting points.

11. Expected results and impacts:

We aim to identify multi-uses in south coast of mainland Portugal and in the Azores archipelago, as well as main drivers, added values, barriers and negative impacts related to those multi-uses

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(existing or potential). This will be achieved through desk research, but mainly through stakeholders' engagement and interviews. The results will contribute to develop WP3 deliverables, namely comparative analysis and case studies report. Results from case study 3 will also contribute to WP4 and the definition of the Action Plan that will include key recommendations. We also expect that results from this case study, similarly to Action Plan from WP4, can be used as basis to develop key recommendations for the Portuguese and Azorean Governments to overcome identified barriers and negative impacts, as well as promote existing drivers and added values.

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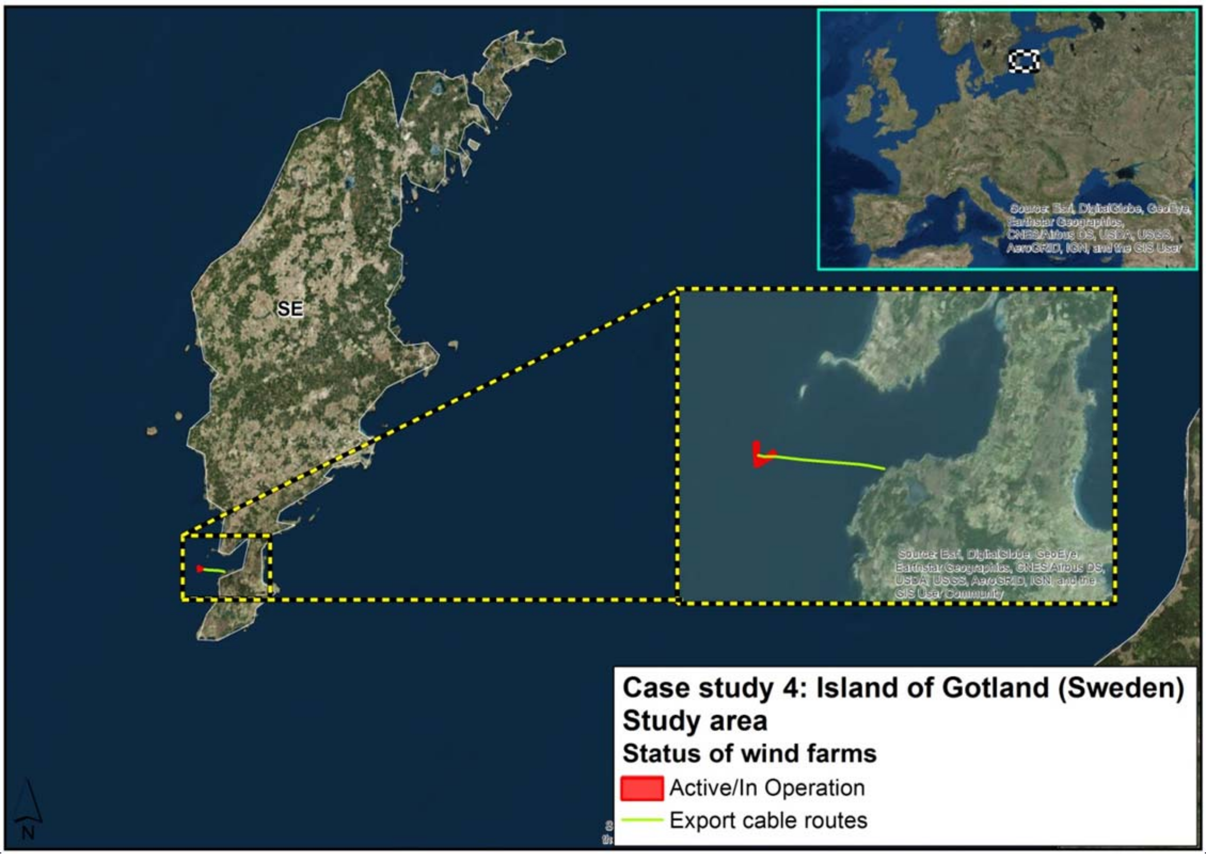
3.4 Case study 4: Global resource area optimization, focused on energy, food supply and environment in Swedish waters

1. Case study n. 4
2. Regional Sea: Baltic Sea
3. Location: Baltic Sea: Island of Gotland (Sweden)
4. Title: Global resource area optimization, focused on energy, food supply and environment in Swedish waters
5. Study area:



6. Current characteristics and trends in the use of the sea in the area:
Gotland, Sweden's largest island located in the Baltic Sea, is well suited for wind power production. Wind power has been put to use on Gotland for many years and at one time over 500 traditional windmills provided milling power for the island's communities. Gotland has already witnessed a significant wind power development, both onshore and offshore, while the proposed new projects will lead to an increase in the numbers of wind turbines. The first Swedish offshore wind farm Bockstigen near Gotland has been constructed successfully and is operating since March 1998. The Bockstigen project is located 3km off the island of Gotland and is nearing the end of its profitable life and plans are being made for the extensions. Built between 1996 and 1997, Bockstigen features five Wind World 550kW turbines. Its distance to the coast is about 4 km and the water depth app. 6 m. The site has the main advantages of:

- low water depth in relative large distance to land;
- suitable soil conditions for drilling and monopile foundation;
- harbour for installation and maintenance within reasonable distance.

Gotland is one of Sweden's most noted tourist destinations. Since 2010 the island has become a more versatile vacation spot visited by people from all over the world, in all manner of ways. In

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2012, the ferries between Gotland and mainland Sweden had 1,590,271 passengers. The main port of call on Gotland is Visbyand is visited by around 70 cruise ships every year. Round Gotland Race sailing event ("ÅF Offshore Race") starting at Stockholm, around the island of Gotland and back. Fishing is available all year round since the coastal waters don't freeze in winter. Fish that are most commonly fished around the island are pike (all year) and sea trout (October - May). Common fishing methods are spinning in shallow waters and fly fishing. Fishing license is not required when fishing takes place in the state waters.
7. Existing Multi-use: No existing Multi-Use in the area.
8. Potential Multi-use: Driving economic sector in Gotland is offshore wind energy production. The potential multi-use of the Swedish case will concern that of "geographical, human, biological resources" nature and in the form of staggered development of uses, due to the long established offshore wind parks in the area. Following combinations with offshore wind parks are considered potential multi use: 1. offshore wind and organised tourism (boats and fishing, seaweed gathering, diving tours, etc). 2. offshore wind and seaweed farming 3. offshore wind and mussel farming 4. offshore wind and combined marine biomass cultivation (seaweed, shellfish, starfish) as bio-compounds, fertiliser or feed with remediation of Baltic Sea nutrients as a driver
9. Key issues to be analysed and discussed: Due to the high levels of eutrophication in the Baltic Sea, the Swedish case study is focused on the combined use of offshore wind parks with mariculture (shellfish and/or seaweed) as a means to reduce nutrient levels (nitrogen, phosphorus, carbon dioxide) and improve overall environmental quality of the Baltic Sea water. The harvested biomass has great potential as nutrient and protein-rich animal feed as well as a resource for human food. The keys issues that will be analysed through desk study and more importantly, stakeholder involvement, will consider the following: • Barriers and drivers concerning co-localisation; lack of tradition for cooperation between the different sectors, conflict of interests, motivation for collaboration, identification of remediation sites vs wind sites • Barriers concerning legal licences, permits and insurance • Drivers for reducing eutrophication; nutrient remediation and positive environmental added value, potentials for a local blue bio-economy • Barriers and drivers for relevant stakeholder involvement The following aspects will be examined: • Logistics: The sea farms require infrastructure and harvesting technology that may be in conflict with the maintenance personnel and vessels that need to be able to access the turbines for service. How could this be combined in a good way? • Layout: The farm layout is today optimized on flow interaction between turbines in combination with wind statistics, cable costs and foundation costs. The result of that optimization does to a large degree depend on the turbine manufacturer where the trend is that the turbine becomes larger with time to decrease the cost for each kilowatt being produced. That also results in larger distances between turbines. This changes the possibility and/or limitations of how to establish sea farms inside the farm. • Regulations and guidelines: The aim with the case is to evaluate if it is realistic with full-scale

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projects by guidelines. The existing regulations and their application that is different for different countries also need to be investigated.

- The selection of suitable species of algae or mussels that may be cultivated.
- Influence of sea depth and distance to cost for optimal energy and aquaculture harvest.
- Use of algae, mussel in a more sustainable way for animal feed as well as a resource for human food.
- Sustainability analysis (for example including LCA, CBA and EROI methods),
- How are directives interpreted locally?
- What are the real and perceived challenges?
- To what extend is MSP in reality driven by the principle of „spatial efficency“, i.e. the promotion of co-uses in one place as much as possible in order to keep as much „space“ unused for future developments?

10. Information sources:

National, regional and local documents will be consulted. Some of the sources will include:

- Current Status 2014: National planning in Sweden's territorial waters and EEZ
- Swedish Maritime Strategy
- Swedish MSP Roadmap
- Proposal for the direction of MSP and scope of the Environmental Assessment
- Stakeholders in Swedish Marine Planning
- Transnational Cooperation and Dialogue in the Pomeranian Bight/Arkona Basin
- Handbook on multi-level consultations in MSP
- Maritime Strategy for Västra Götaland
- Maritime Clusters in Västra Götaland
- Transboundary MSP pilot in the Bothnian Sea
- Pilot MSP for the Middle Bank
- Assessment of how climate change will influence the ecosystem in the Baltic Sea and its uses

11. Expected results and impacts:

Case study will provide clear understanding of real and perceived barriers in relation to multi-use in the study area. Study will pinpoint specific issues and responsible actors, which will serve as a base for formulation of actions in support of multi-use in the area. Namely, with this case study, we hope to open the dialogue between the sectors that can potentially benefit from a geographical and biological multi-use of an existing offshore wind farm and identify how to overcome the barriers that are hindering what, potentially, could be part of the basis for a new blue bio-economy on Gotland Island and a significant reduction of environmental impacts in the surrounding Baltic Sea.

As these barriers are not limited to Gotland Island, findings will therefore presumably apply to the rest of Sweden, we are aiming to highlight those areas of local, regional and national legislation which need to be addressed in order to facilitate a wider establishment of mariculture in Swedesh waters and specifically in combination with offshore wind parks.

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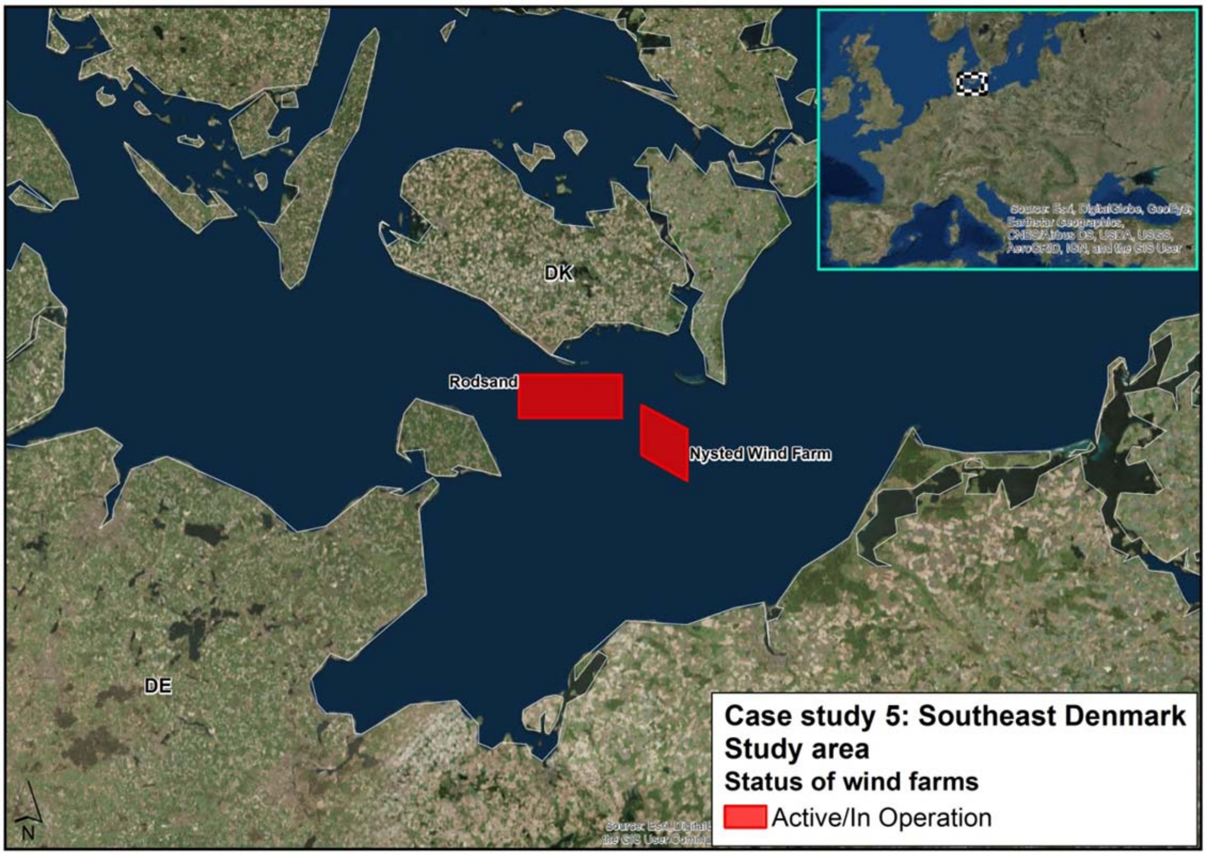
3.5 Case study 5: Offshore wind production & marine biomass production & environmental remediation in Danish waters

1. Case study n. 5
2. Regional Sea: Baltic Sea
3. Location: South Baltic Sea – South Coast of Lolland-Falster - Rødsand
4. Title: Offshore wind and mariculture; potentials for multi-use and nutrient remediation in Rødsand 2
5. Study area:



This case is based on the offshore wind park of Rødsand 2, which is located in the Baltic Sea off the south coast of Lolland and covers an area of 34 km^2.

6. Current characteristics and trends in the use of the sea in the area:
The main driving economic sectors concerning the water surrounding the islands of Lolland-Falster are maritime transport, wind energy and tourism. The waters off the southern coast of the islands in south-east Denmark have always been part of complex and busy transport axis; east-west (long-haul maritime transport between the North Sea, the Baltic and Russia) and north-south (ferry and private maritime activities between Denmark and Germany). Since the first offshore wind park was established at Vindeby, the wind turbine industry has had a major, if not somewhat turbulent, presence in the industrial port town of Nakskov on Lolland. Between 2003 and 2007, two major offshore wind parks, Rødsand 1 and Rødsand 2 were established 10 km off the south coast of Lolland; Rødsand 1, in 2003, owned by DONG Energy (80%) and E.ON Sweden (20%) and Rødsand 2, established in 2007 and owned by SEAS-NVE (80%) and E.ON (20%). Together they have the capacity to produce 380,6 MW of electricity (about 3% of total Danish electricity consumption). The 600km of coastline and gentle gradient of the sandy shores, low salinity and shallow, warm waters have contributed to an increasingly important income from, amongst others, water-based tourism, which

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is forecast to increase in the coming decades. There are large protected areas near the coastline, due to the presence of rare biological species, including the white-tailed sea eagle. The largest colony of harbour and gray seals in the Baltic can be found at Redsand National ParkThe two wind parks can clearly be seen from the tourist village of Nysted (Lolland) and the ferry terminal towns of Rødby (Lolland) and Gedser (Falster). Tourism is the largest land-based economic sector in the region, with popular beach resorts and sea-based activities accounting for most of this. Fishing tourism has been identified as a growing sector and active holidays including sea-kayaking, sailing, kite-surfing, wind-surfing are increasingly popular in this area of Denmark. Lolland Municipality has earlier branded itself on its focus on renewable energy and in this respect there has been a reasonably well established clean-tech tourism, which also involved the possibility of visiting the offshore wind parks by boat from Nysted. Lolland Municipality is currently making a "Plan of Potentials 2030" for tourism development, including increase coastal tourism as part of its strategy.

The infrastructural plans concerning the building of the Femern Belt connection are already being implemented on Lolland, although the finalisation and acceptance of the construction plans from the German side is creating a big delay and uncertainty. The new, high-speed rail transport between Copenhagen and Rødby is expected to increase the number of tourists to Lolland and to attract commuters to buy property in the area. Fishing is currently the only form of aquaculture in this geographical area.

The main driving economic sectors concerning the water surrounding the islands of Lolland-Falster are maritime transport, wind energy and tourism. The waters off the southern coast of the islands in south-east Denmark have always been part of complex and busy transport axis; east-west (long-haul maritime transport between the North Sea, the Baltic and Russia) and north-south (ferry and private maritime activities between Denmark and Germany). Since the first offshore wind park was established at Vindeby, the wind turbine industry has had a major, if not somewhat turbulent, presence in the industrial port town of Nakskov on Lolland. Between 2003 and 2007, two major offshore wind parks, Rødsand 1 and Rødsand 2 were established 10 km off the south coast of Lolland; Rødsand 1, in 2003, owned by DONG Energy (80%) and E.ON Sweden (20%) and Rødsand 2, established in 2007 and owned by SEAS-NVE (80%) and E.ON (20%). Together they have the capacity to produce 380,6 MW of electricity (about 3% of total Danish electricity consumption). The 600km of coastline and gentle gradient of the sandy shores, low salinity and shallow, warm waters have contributed to an increasingly important income from, amongst others, water-based tourism, which is forecast to increase in the coming decades. There are large protected areas near the coastline, due to the presence of rare biological species, including the white-tailed sea eagle. The largest colony of harbour and gray seals in the Baltic can be found at Redsand National ParkThe two wind parks can clearly be seen from the tourist village of Nysted (Lolland) and the ferry terminal towns of Rødby (Lolland) and Gedser (Falster). Tourism is the largest land-based economic sector in the region, with popular beach resorts and sea-based activities accounting for most of this. Fishing tourism has been identified as a growing sector and active holidays including sea-kayaking, sailing, kite-surfing, wind-surfing are increasingly popular in this area of Denmark. Lolland Municipality has earlier branded itself on its focus on renewable energy and in this respect there has been a reasonably well established clean-tech tourism, which also involved the possibility of visiting the offshore wind parks by boat from Nysted. Lolland Municipality is currently making a "Plan of Potentials 2030" for tourism development, including increase coastal tourism as part of its strategy.

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7. Existing Multi-use:
At present, there is no coordinated or conscious multi-use (here referring to "geographical, human, biological resources") between the offshore wind parks, maritime activities, tourism or aquaculture, although it is, however, possible to charter a private boat from the ports of Nysted and Gedser and to sail out and view the offshore wind parks at closer hand.
Existing elements: Offshore wind parks, water-based tourism

8. Potential Multi-use:
The potential multi-use of the Danish case will concern that of "geographical, human, biological resources" nature and in the form of a staggered development of uses, due to the long-established offshore wind parks in the area.

1. offshore wind and organised tourism (boats and fishing, seaweed gathering, diving tours, etc).
2. offshore wind and seaweed farming
3. offshore wind and mussel farming
4. offshore wind and combined marine biomass cultivation (seaweed, shellfish, starfish) as bio-compounds, fertiliser or feed with remediation of Baltic Sea nutrients as a drive

9. Key issues to be analysed and discussed:
Due to the high levels of eutrophication in the Baltic Sea, the Danish case study is focused on the combined use
of offshore wind parks with mariculture (shellfish and/or seaweed) as a means to reduce nutrient levels (nitrogen,
phosphorus, carbon dioxide) and improve overall environmental quality of the Baltic Sea water. The harvested biomass has great potential as nutrient and protein-rich animal feed or as a fertilizer and while the potential of combining uses for nutrient removal is clear, the Danish pilot study from 2012 revealed a number of challenges and perspectives which will be addressed in this case study.
The keys issues that we are intending to analyse through desk study and more importantly, stakeholder involvement, will consider the following:

- Barriers and drivers concerning co-localisation; lack of tradition for cooperation between the different sectors, conflict of interests, motivation for collaboration, identification of remediation sites vs wind sites
- Barriers concerning establishment of mariculture; Danish Water Framework Directive – state of play concerning aquaculture: limitations, definitions, environmental considerations
- Barriers concerning legal licences, permits and insurance
- Drivers for reducing eutrophication; nutrient remediation and positive environmental added value, potentials for a local blue bio-economy
- Barriers and drivers for relevant stakeholder involvement – (where/how, for example do you

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find a willing seaweed farmer?)
10. Information sources: National, regional and local documents will be consulted, such as the Danish EEZ, Danish Water Framework Directive, regional and local development strategies and national experts consulted, such as Danish Energy Authority, Danish Agriculture and Food Council, Danish Aquaculture, Ministry for Environment and Food – Innovation Committee, as well as involving local stakeholders, such as local government and business and tourism authorities, fishermen and site-specific actors.
11. Expected results and impacts: With this case study, we hope to open the dialogue between the sectors that can potentially benefit from a geographical and biological multi-use of an existing offshore wind park (in this case, Rødsand 2) and identify how to overcome the barriers that are hindering what, potentially, could be part of the basis for a new blue bio-economy on Lolland-Falster and a significant reduction of environmental impacts in the surrounding Baltic Sea. As these barriers are not limited to Rødsand 2 and Lolland and will therefore presumably apply to the rest of Denmark, we are aiming to highlight those areas of local, regional and national legislation which need to be addressed in order to facilitate a wider establishment of mariculture in Danish waters and specifically in combination with offshore wind parks.

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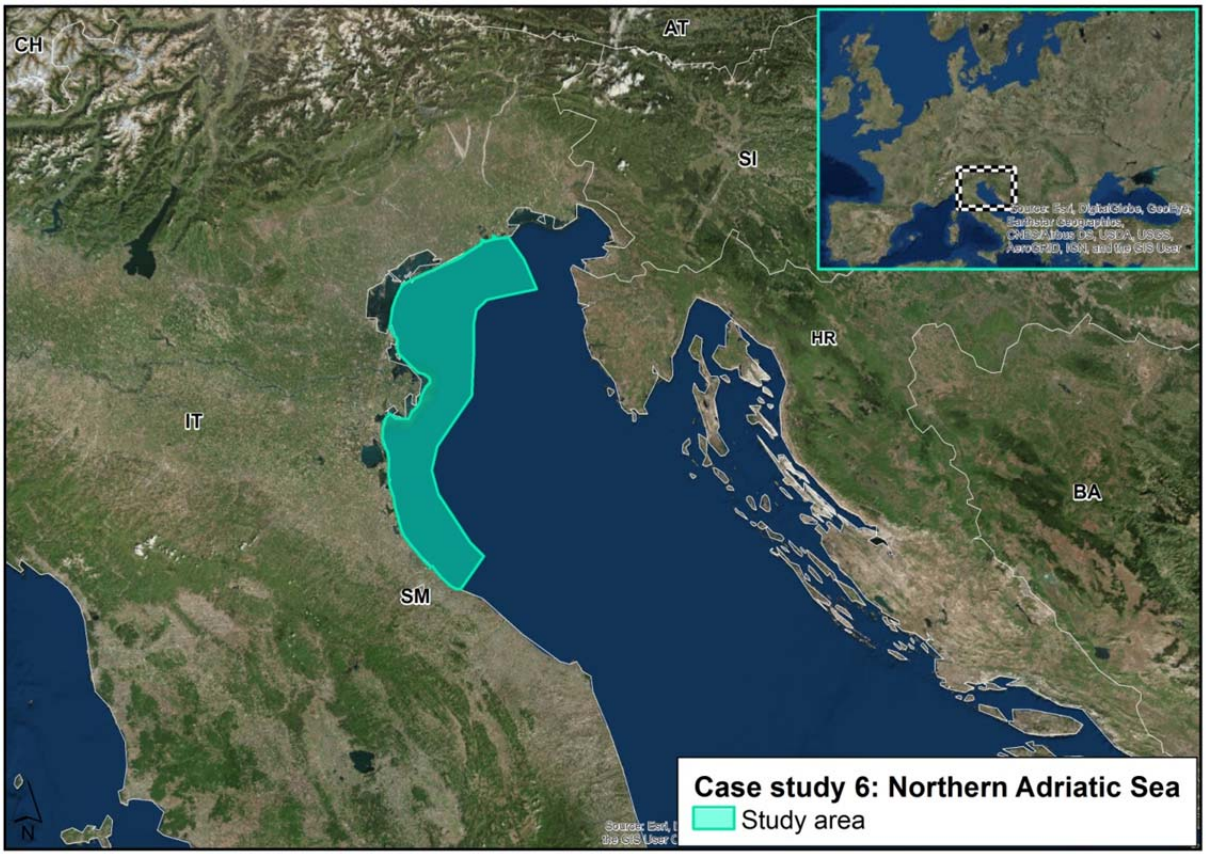
3.6 Case study 6: Coastal and Maritime Tourism as a driver/booster for potential multi-use

1. Case study n. 6
2. Regional Sea: Mediterranean Sea
3. Location: Mediterranean Sea: Northern Adriatic Sea
4. Title: Coastal and Maritime Tourism as a driver/booster for potential multi-use
5. Study area:



The Adriatic Sea is a semi-enclosed basin that communicates with the Ionian Sea through the Otranto Strait. Its northern part is the largest shelf area of the entire Mediterranean, while the southern part is characterized by the presence of a circular pit (South Adriatic Pit) having the maximum depth of 1200 m.

The geographical area of interest is identified in the northern Adriatic Sea, along the Italian coast from Emilia Romagna to Veneto Region, where deltas and narrow coastal plains, generally occupied by wetlands, lagoons and sandy coasts, define the most relevant landscape.

6. Current characteristics and trends in the use of the sea in the area:

The Adriatic Sea area is currently intensively crowded by uses (coastal and maritime tourism, transport of goods and passengers, fisheries, aquaculture, oil and gas, energy and communication cables, military uses, sand extraction, cultural heritage, protected areas) expected to grow over the next years. In the area of analysis the interactions among uses are particularly intense and coastal and maritime tourism represents the main socio-economic driver with great potential for the future.

The Emilia-Romagna region possesses a significant number of installed gas/oil extraction platforms with 80% located within the 12 miles limit from the coast, which is the marine area under the jurisdiction of the Emilia-Romagna region. Furthermore, the region has been one of the first Italian regions to identify beach nourishment as the best method to defend beaches from erosion and the use of sand extraction for beach nourishment is expected to increase in a significant way.

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Apart from the installation of hydrocarbon platforms (both on- and offshore) and sand extraction activities, tourism, maritime transport and fishing are the main maritime activities in the Emilia-Romagna region that have been modifying the natural balance of the coastal–marine system.

Emilia-Romagna's fishing sector is characterised by a diversification of the fishing activities towards alternative and integrative forms of income, such as tourist-fishing. Nevertheless, the sector remains important to Emilia-Romagna's economy. Moreover, since the mid-70s, mariculture in Italy has developed considerably.

Furthermore, the Emilia-Romagna region is composed of 13 ports of small-medium size and the port of Ravenna which is important at the national level as well. The regional port system has become particularly important, especially after the growth of the tourism sector and the economic fishing activity.

The Veneto region's marine area is intensively used. Especially in the Venice lagoon many activities are taking place. Shipping from and towards the port of Venice is significant.

Fishing is another important contributor to maritime activities in the Veneto region, in the lagoon, the territorial sea as well as in the high seas. However, fishing activity has decreased over time as fish stocks are in decline due to overfishing and pollution. Mariculture, both inside the lagoon and in the sea is another increasing activity in the area.

Competition between fishing in the Adriatic and preservation of the environment is primarily experienced around the so called 'rocky outcrops' (Tegnúe), which are important biodiversity hotspots. These outcrops are used by fish to spawn and, consequently, are attractive fishing areas; they have beep protected since 2002 through a 'nautical zone' in order to prohibit fishing.

Coastal tourism is also substantial in the Veneto region, with environmental effects related to water quality. Beach nourishment and sand extraction are other activities influencing environmentally and economically the use of the sea space in the region.

7. Existing Multi-use:

Existing multi-uses for case study 6 are related to the scenario "Multi-use of geographical. Human, biological resources", where some uses are present and connected in a common geographical area created a combined added value. In particular, the most identifiable multi-use in the area is the combination of small scale fishery and tourism.

No existing MU for "Multi-use of technical resources (marine infrastructure & platforms)" is currently present in the area.

8. Potential Multi-use:

The case study aims to be an example of "soft/distributed MUs", focusing on the scenario "Multi-use of geographical. Human, biological resources", maximizing coexistence and synergies among the uses that can contribute to sustainable tourism development as the main economic driver in the area.

A particular focus on the aquaculture sector as an important activity for the Blue Growth of the area will also be developed. The case study elaboration will be carried out by analysing the conflicts of tourism with aquaculture and other uses and building alternative scenarios where both identifying new suitable sites for the potential development of aquaculture in coexistence and in mutual benefit with tourism, and re-allocating existing aquaculture sites in order to minimize conflicts/barriers and maximize synergies with tourism, boosting the Blue Growth of the area.

A possible driver for "Multi-use of technical resources (marine infrastructure & platforms)" could be the possibility of future decommissioning of some of the oil and gas platforms in the area. This could stimulate multi-use activities with other uses, namely aquaculture, fisheries, tourism, renewable energies.

Another potentially interesting area of analysis is the co-presence of protected areas (e.g. artificial

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reefs) where environmental tourism (e.g. diving) could be promoted.
9. Key issues to be analysed and discussed: The key issues to be analysed in this case study will include the driving factors and the barriers related to multi-use development as well as the added value and potential negative impact of its establishment, in order to contribute to WP4 and the definition of the Action Plan. A desk research study will be performed to set the baseline information, followed by interviews with stakeholders and a workshop to discuss preliminary results. Technical aspects (e.g. methods and tools for data analysis) are also essential for the implementation of the MU. The involvement and an active discussion with key stakeholders will be fundamental for a concrete and shared vision towards MU in the area, starting from a re-analysis of the multi-use potential in the area, to confirm or correct/integrate the preliminary vision.
10. Information sources: A desk study will be performed were national and regional laws will be analysed together with regional plans dealing with sectoral domains as coastal erosion, fisheries, energy. Mainly regional documentation related to procedures, plans, studies, reports will be used to start the analysis, together with relevant EU projects related with multi-use, collected during the preparation of the WP2 Analytical Framework.
12. Expected results and impacts: With this case study we want to discuss and agree on a definition of multi-use in the north Adriatic Sea and engage stakeholders in an active discussion on drivers and barriers related to multi-use in the area; the exercise will produce a concrete identification of areas where MU is more likely to have the maximum positive effect, as well as proposals on how to promote blue economy in the area and discussion on added values and negative impacts concerning environmental, socio-economic and technical aspects of multi-uses in the case study. These activities will be useful to also increase awareness of the issue of multi-use in the sea and its added value and positive effects among stakeholders. Based on the case study results, scenarios for concrete MU will be developed and reviewed through the stakeholder engagement strategy. Finally, the case study will provide elements and ideas for the development of the Action Plans (WP4) and can be used as initial step for the application of similar methodologies

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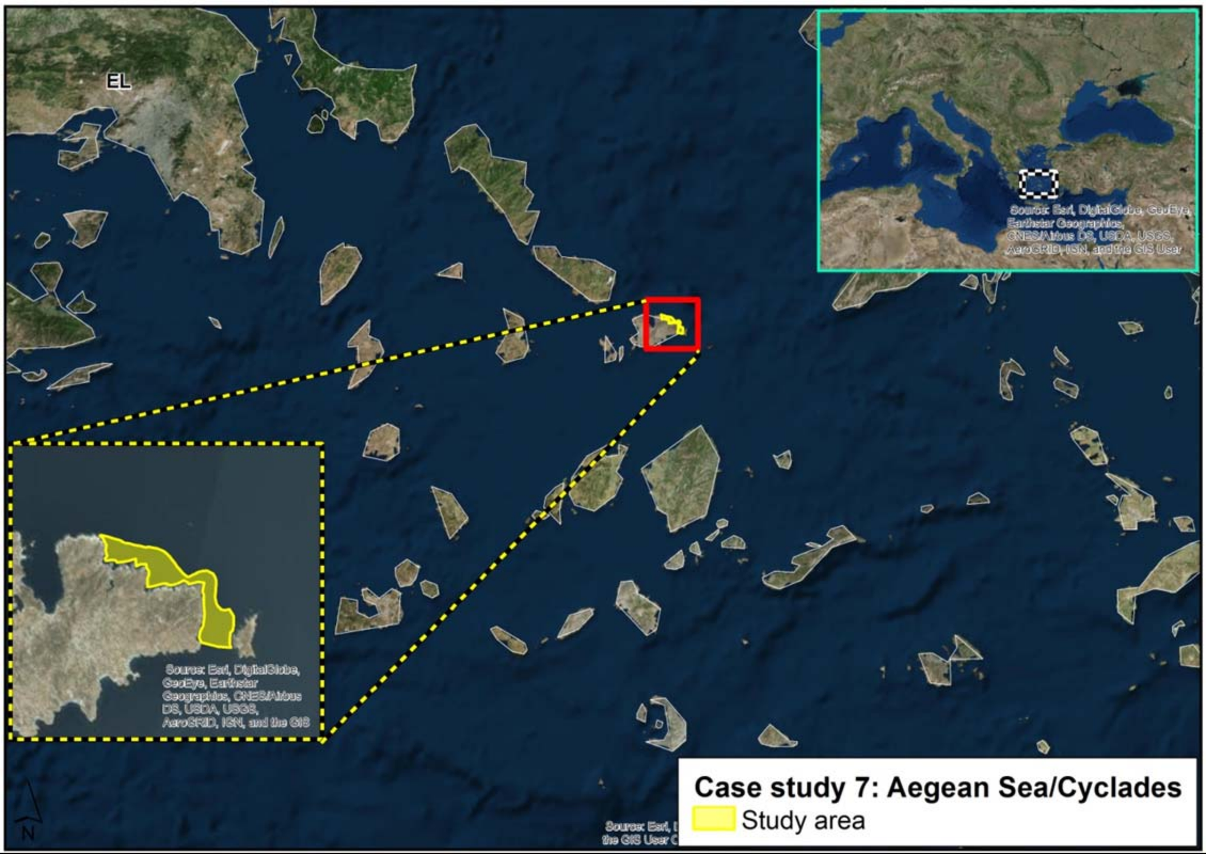
3.7 Case study 7: Tourism & fisheries & energy production in the Aegean Sea

1. Case study n. 7
2. Regional Sea: Mediterranean Sea
3. Location: Mediterranean Sea: Aegean Sea / Cyclades
4. Title: Tourism & fisheries & energy production in the Aegean Sea
5. Study area:



6. Current characteristics and trends in the use of the sea in the area:
The study area is located off the northern part of the Mykonos Island (Cyclades plateau). Mykonos is one of the top tourist destinations in the Mediterranean and hence enjoys a fully developed tourism industry with associated marine activities such as organized scuba-diving activities, since Mykonos has underwater geological formations and lively ecosystems, wrecks, etc., and there is also dense maritime transport. Moreover the broader Cyclades plateau is considered an important fishing ground for trawl fisheries, with important smallscale fisheries also operating there.

The driving economic sector is tourism. Since the 1950s, Mykonos has been one of the most popular tourist islands in the Mediterranean receiving almost 1 million tourists annually. Due to the extensive development of the tourism sector, 90% of the island's economic activity is linked either directly or indirectly to tourism, that peaks on the island from May to October. During the latter period water and *energy demand* increase dramatically; as an example, in summer water demand exceeds 8.000 m^3 whereas the municipal desalination facility can barely provide a maximum of 2.300 m^3 daily. A solution to the above issues may be renewable energy power supply and *energy-*powered *desalination,* as *Greece's renewable* energy sector has enormous potential. Indeed, there are ideal conditions for both the *wind* and the *solar* sector, which is also the case for the Aegean Sea islands. However, local communities that are heavily involved in the tourism industry are not

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particularly keen to accommodate energy installations, e.g. wind parks, on their islands, and this is particularly true for Mykonians. A discussion with local authorities in Mykonos, also known as the *Isle of the winds*, revealed their concern to explore the potential introduction of offshore wind farms (OWFs) off the northeastern part, which attracts the least interest for touristic development on the island. In parallel, renewable energy sources appear to be candidate power supplies for sea water desalination facilities. Hence a multi-use (MU) arrangement that may satisfy electricity and freshwater demands could be an option that could make the island both water and energy sustainably independent. However, the selection of the optimal MU system is a difficult task because it depends strongly on many factors and thus the key question for this case study is whether renewable energy and desalination facilities, when used in a conjoint manner, constitute the type of MU that may contribute to tourism sustainability in Mykonos, or the desk study and the stakeholder survey that will be conducted will reveal a different combination of more appropriate uses that should be considered for development .

Candidate area for the potential development of OWF at the north-eastern part of Mykonos

7. Existing Multi-use:

No Multi-use is in place

8. Potential Multi-use:

The type of potential MU that has been proposed to be investigated within the Greek case Study belongs to the category *Multi-use of technical resources (marine infrastructure & platforms)*.

Greece has made substantial progress in promoting and supporting renewables, having commissioned the first commercial wind park in Europe built in 1983 on the Cycladic island of Kythnos. In Mykonos there is increased energy demand particularly during the touristic season, but considering the fact that placing energy installations on the island is not an option, exploring potential alternative solutions such as OWFs constitutes a major challenge. Then, as water supply is crucial for the sustainability of islands, the importance of desalination plants is also underlined; recent studies have shown that there is high potential in moving these plants offshore which minimizes also their aesthetic impacts, another major issue for a highly touristic island. What is more, to make use of the seascape in a smarter, more sustainable and less disruptive manner by combining different activities on the same location, e.g. through innovative MU offshore platforms, would create less disturbance across the natural environment which is a prerequisite for the case of Mykonos. Hence, this case study will initially investigate the potential of MUs combining OWFs and water desalination, but considering also the inclusion of mari-culture. Indeed, offshore aquaculture and wind farms seem to be compatible uses of the marine environment, with offshore aquaculture activities highlighted under the Blue Growth strategy as one of the areas where further development is possible for several European basins. With fish stocks of the Mediterranean

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declining, **aquaculture** seems to be an efficient and environmentally sustainable way of meeting the increasing demand for seafood. However, a point that should be underlined for this case study is that since no prior MUs, *sensu stricto*, exist in the Greek Seas, it is worth exploring through the desk analysis and the stakeholder survey the priorities and needs existing specifically on the local scale (i.e. in Mykonos). The latter will devise possibly on options of alternative MUs considering also that under the current economic conditions in Greece, financing of offshore projects may prove difficult given the offshore technology and *investment costs, as well as risks stemming from high operation costs.*
9. Key issues to be analysed and discussed: Based on literature review and stakeholder input we will identify potential MUs discussing also the scenario that has been initially proposed. In particular, literature review based on available socio-economic and environmental information, policies and strategies as well as taking paradigms mainly from projects exploring MU potential in the Basin (e.g., MERMAID, TROPOS) will create the baseline information for investigating existing options for the proposed MU but also for identifying alternative MUs. This input will also initiate discussions with stakeholders for selecting the most appropriate type(s) of MUs for the area under study. Stakeholder engagement aside from identifying potential MU, will devise also on possible drivers/barriers and other factors. More importantly the fact that no prior MUs exist offers the opportunity to create a common vision of such a potential based on specific shared goals according to stakeholders' preferences and aspirations.
10. Information sources: *Needs further engagement with issues related to the development of the case study to identify sources of information but definitely national/local laws, administrative procedures, plans, studies (including EIAs), information on existing MU activities or infrastructures will be considered...*
11. Expected results and impacts: For the implementation of the case study a participatory method will be applied which will be linked with cooperative game theoretic (CGT)allocation techniques and conflict resolution processes for addressing issues related to the achievement of consensus and mutually beneficial agreements related to MUs. Using CGT techniques will provide an added value while investigating barriers and opportunities for the establishment of MU platforms in the Greek Seas. Outcomes will build knowledge on potential advantages in combining different uses through identifying multi-use potentiality, opportunities and limitations which is the project's key objective. More precisely, durable impacts will be for instance the capacity building of those who are involved in marine spatial decision making, the potential production and adoption of formalized processes of marine spatial decision making that especially addresses the issue of MU, enhancing the awareness of the local community regarding the benefits of MU, while attracting the interest of potential investors and entrepreneurs.

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4 TEMPLATES FOR PREPARATATION OF CASE STUDY FICHES

The aim of these templates is to prepare Case study fiche, compiling data and information from desk analysis and collecting stakeholder knowledge and opinion.

The template follows the stepwise approach described in chapter 2. The design of the template was kept open in order to be applicable for desk research, stakeholder interviews and combined analysis. A specific template sheet was designed for each step (Table 4-1) and to provide input information for stakeholder analysis matrix (Table 4).

Table 4-1. Methodological steps for Case Study analysis with respective sheets and outputs.

Phase	Step	SHEET
Phase A	Step 1. MU Overview and Identification of MU Potentials	1, 2
	Step 2. Identification of drivers, barriers, added values and impacts.	3, 4, 5, 6
	Step 3. Analysis of Overall MU Potentials	7, 8, 9, 10
	Step 4. Evaluation of Overall MU Effects	11, 12
	Step 5. Focus areas	13

Table 4-2. Sheets of the template providing input data for the stakeholder analysis matrix and consequently the action planning process in WP4.

Stakeholder analysis matrix	SHEET
Interview general information	7, 8

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Step 1. MU Overview and Identification of MU Potentials

Method: Literature review including:

- past and ongoing MU related projects outputs (sheet 1),
- peer reviewed literature,
- grey literature including relevant industry reports, industry web pages, news articles, etc.

Literature review will be all encompassing with no cut offs in order to capture the most up-to-date information.

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SHEET 1	
1.1. Overview of existing/potential MU projects/sites	
Describe existing/potential MU projects/sites	…
Project/source aim	…
Project/source name	…
Partners involved	…
contact/info details	…
Type of resources shared (as defined under 2.1)	a) biological b) human resources c) physical d) geographical e) other_______
Order of development (as defined under WP2 Analytical framework chapter 2.1):	a) joint b) staggered
Location	
	Provide the location of the existing MU or
	Provide the location of the existing use and the potential combined use (s)
MU commencement (date)	
Legal basis of MU – administrative obligation/private contract/research project	Administrative/obligation ☐ Private contract ☐ Research project ☐
level of maturity of MU	Planned ☐ Design phase ☐ Full implementation ☐ Commercial use ☐ *Provide date/ time period of maturity level*:

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Technology Readiness Levels (TRL) (*if applicable*)	**TRL1.** basic principles observed ☐ **TRL2.** technology concept formulated ☐ **TRL3.** experimental proof of concept ☐ **TRL4.** technology validated in lab ☐ **TRL5.** technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies) ☐	**TRL6.** technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies) ☐ **TRL7.** system prototype demonstration in operational environment ☐ **TRL8.** system complete and qualified ☐ **TRL9.** actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space) ☐ ☐
Is MU cooperation subsidized	International ☐ National ☐	EU level ☐ Regional ☐
Advantages from MU (*from desk research and then crossreferenced with SHEET 5-Added Value*)	*What are the advantages from MU?* *1.* ___ *2.* ___ *3.*___ *4.*___ *5.* ___	
Possibility of extension	*What are the possibilities of extension of MU?* *Where?* ___ *What?* ___ *Who?* ___ *What are the conditions for extension?* ___	
Key private/public actors for MU development	*Who are the key actors involved?* ___ ___ ___ ___	
Others ?		
Reference documentation & notes • … • … • …		

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SHEET 2			
1.2. Define MU combinations *Instruction: Define the MU by selecting USE 1 combined with USE 2 as described in D3.2 AF chapter 2.2.*			
USE 1		**USE 2**	
Offshore wind (fixed & floating)	☐	Offshore wind (fixed & floating)	☐
Offshore wave	☐	Offshore wave	☐
Tidal energy	☐	Tidal energy	☐
Hydrogen generation	☐	Hydrogen generation	☐
Desalination	☐	Desalination	☐
Commercial Fishery	☐	Commercial Fishery	☐
Environmental Protection	☐	Environmental Protection	☐
Environmental Monitoring	☐	Environmental Monitoring	☐
Floating Shipping terminal	☐	Floating Shipping terminal	☐
Tourism	☐	Tourism	☐
Aquaculture fish	☐	Aquaculture fish	☐
Aquaculture seaweed and mussels	☐	Aquaculture seaweed and mussels	☐
Cultural Heritage	☐	Cultural Heritage	☐
Oil&Gas	☐	Oil&Gas	☐
Other: _______________	☐	Other:____________________	☐
IF 3 or more use combinations, please specify: • … • … • …			
Reference documentation & notes • … • … • …			
USE 1		**USE 2**	
Offshore wind (fixed & floating)	☐	Offshore wind (fixed & floating)	☐
Offshore wave	☐	Offshore wave	☐
Tidal energy	☐	Tidal energy	☐
Hydrogen generation	☐	Hydrogen generation	☐
Desalination	☐	Desalination	☐
Commercial Fishery	☐	Commercial Fishery	☐
Environmental Protection	☐	Environmental Protection	☐
Environmental Monitoring	☐	Environmental Monitoring	☐
Floating Shipping terminal	☐	Floating Shipping terminal	☐
Tourism	☐	Tourism	☐
Aquaculture fish	☐	Aquaculture fish	☐
Aquaculture seaweed and mussels	☐	Aquaculture seaweed and mussels	☐
Cultural Heritage	☐	Cultural Heritage	☐

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Oil&Gas	☐	Oil&Gas	☐
Other: _______________	☐	Other:____________________	☐

IF 3 or more use combinations, please specify:

- …
- …
- …

Reference documentation & notes

- …
- …
- …

USE 1	☐	**USE 2**	☐
Offshore wind (fixed & floating)	☐	Offshore wind (fixed & floating)	☐
Offshore wave	☐	Offshore wave	☐
Tidal energy	☐	Tidal energy	☐
Hydrogen generation	☐	Hydrogen generation	☐
Desalination	☐	Desalination	☐
Commercial Fishery	☐	Commercial Fishery	☐
Environmental Protection	☐	Environmental Protection	☐
Environmental Monitoring	☐	Environmental Monitoring	☐
Floating Shipping terminal	☐	Floating Shipping terminal	☐
Tourism	☐	Tourism	☐
Aquaculture fish	☐	Aquaculture fish	☐
Aquaculture seaweed and mussels	☐	Aquaculture seaweed and mussels	☐
Cultural Heritage	☐	Cultural Heritage	☐
Oil&Gas	☐	Oil&Gas	☐
Other: _______________	☐	Other:____________________	☐

IF 3 or more use combinations, please specify:

- …
- …
- …

Reference documentation & notes

- …
- …
- …

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Step 2. Identification of drivers, barriers, added values and impacts.

Method: Mainly desk research complemented with stakeholder consultation through interviews, workshops or other methods. Consultation methods will be defined for each specific case study.

This part will identify the categories for driver/barriers/added value/impact, their detailed description, the definition of factors determining them and will provide basic information for the classification of perceived versus real barriers (see chapter 3.2. of D2.1 Analytical Framework),

This section is the back bone for the scoring of MU potentials and MU overall effects. As an example, these sheets provide basic categories common to all sea-basins, which will be further complemented through desk research and where required stakeholder consultation.

Sheet 3, 4. 5 and 6 will provide the scope conditions for the desk research on identification of drivers, barriers, added value and impacts. Particular attention will be given to the MU combinations (see chapter 2.2 of D2.1 Analytical Framework), the type of resources shared, the order of development and the location (as defined under chapter 2.1 of D2.1 Analytical Framework).

Key information concerned is:

- Type of MU combination in line with figure 2 and table 1 of the WP2 AF;
- Type of resources shared (as defined under chapter 2.2 of the WP2 AF);
- Order of development (as defined under chapter 2.2 of the WP2 AF);
- Location (if applicable – location of existing uses (e.g. offshore wind) that could potentially be combined with upcoming one, or the potential location where two uses could develop jointly one day)

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SHEET 3			
	2.1. DRIVERS = Factors promoting MU ***Identification and description of DRIVERS categories & factors***		
Category definition	**Description**	**Factor definition**	**At what scale factor occurs/is relevant? (internat., EU, seabasin, National..)**
D.1. **Policy drivers**	…	Factor D.1.1… Factor D.1.2… Factor D.1.3… Etc	
D.2.**Relation with other uses**	…	Factor D.2.1… Factor D.2.2… Factor D.2.3… Etc…	
D.3. **Economic drivers**	…	Factor D.3.1… Factor D.2.2… Factor D.2.3… Etc…	
D.4. **Societal drivers**	…	Factor D.4.1… Factor D.4.2… Factor D.4.3… Etc	
D.5…	…	Factor D.5.1… Factor D.5.2… Factor D.5.3… Etc	
Etc…	…	Etc…	
	References • **…**		

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SHEET 4			
	2.2. BARRIERS= Factors hindering MU ***Identification and description of BARRIERS categories & factors***		
Category definition	**Description**	**Factor definition**	**At what scale factor occurs/is relevant? (internat.,EU, seabasin, National..)**
B.1. **Legal barriers**	…	Factor B.1.1… Factor B.1.2… Factor B.1.3… Etc…	
B.2. **Administrative barriers**	…	Factor B.2.1… Factor B.2.2… Factor B.2.3… Etc…	
B.3. **Barriers related with economic availability / risk**	…	Factor B.3.1… Factor B.2.2… Factor B.2.3… Etc…	
B.4. **Barriers related with technical capacity**	…	Factor B.4.1… Factor B.4.2… Factor B.4.3… Etc…	
B.5. **Barriers related with social factors**	…	Factor B.5.1… Factor B.5.2… Factor B.5.3… Etc…	
B.6. **Barriers related with environmental factors**	…	Etc…	
	References • …		

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SHEET 5			
	2.3. ADDED VALUE = Positive effects of establishing or strengthening MU *Identification and description of ADDED VALUE categories & factors*		
Category definition	**Description**	**Factor definition**	**At what scale factor occurs/is relevant? (internat.,EU, seabasin, National..)**
V.1…	…	Factor V.1.1… Factor V.1.2… Factor V.1.3… Etc…	
V.2…	…	Factor V.2.1… Factor V.2.2… Factor V.2.3… Etc…	
V.3…	…	Factor B.3.1… Factor B.2.2… Factor B.2.3… Etc…	
V.4…	…	Factor V.4.1… Factor V.4.2… Factor V.4.3… Etc…	
V.5…	…	Factor V.5.1… Factor V.5.2… Factor V.5.3… Etc…	
Etc…	…	Etc…	
	References • …		

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SHEET 6			
	2.4. IMPACTS = Negative effects of establishing or strengthening MU ***Identification and description of IMPACTS categories & factors***		
Category definition	**Description**	**Factor definition**	**At what scale factor occurs/is relevant? (internat.,EU, seabasin, National..)**
I.1…	…	Factor I.1.1… Factor I.1.2… Factor I.1.3… Etc…	
I.2…	…	Factor I.2.1… Factor I.2.2… Factor I.2.3… Etc…	
I.3…	…	Factor I.3.1… Factor I.2.2… Factor I.2.3… Etc…	
I.4…	…	Factor I.4.1… Factor I.4.2… Factor I.4.3… Etc…	
I.5…	…	Factor I.5.1… Factor I.5.2… Factor I.5.3… Etc…	
Etc…	…	Etc…	
	References • …		

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Step 3. Analysis of MU Potentials

Method: Desk analysis and stakeholder engagement. Collection of data and information and they qualitative-quantitative analysis will constitute the background to analyse MU potentials. Results of desk analysis will be discussed with stakeholders. Stakeholder consultation methods will be defined for each case study, based on the specific context (interviews, seminar with selected experts, etc.). Stakeholders will be asked to score the factors but also to add additional categories and/or factors that have not been previously identified through desk research.

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SHEET 7				
General interviewee (stakeholder) information				
Name Surname				
Organization				
Title/Position				
Contact	Tel:_______________________________		Email:	
Sea basin	Atlantic	☐	North & Baltic Sea	☐
	Baltic Sea	☐	North Sea	☐
	Black Sea	☐	North Sea & Atlantic	☐
	Med Sea	☐	ALL Sea-basins	☐
Scale	International	☐	National	☐
	EU level	☐	Regional	☐
	Basin	☐	Local	☐
	Sub-basin	☐	MUSES Case Study: _________	
Country	Belgium	☐	Lithuania	☐
	Bulgaria	☐	Malta	☐
	Croatia	☐	Netherlands	☐
	Cyprus	☐	Northern Ireland	☐
	Denmark	☐	Norway	☐
	England	☐	Poland	☐
	Estonia	☐	Portugal (Azores)	☐
	Finland	☐	Portugal (Mainland)	☐
	France	☐	Rumania	☐
	Germany (Baltic Sea)	☐	Scotland	☐
	Germany (North Sea)	☐	Slovenia	☐
	Greece	☐	Spain	☐
	Ireland	☐	Sweden	☐
	Italy	☐	Wales	☐
	Latvia	☐	Other country: ______________________________	
Sector	Aggregates	☐	Offshore Wind Energy	☐
	Government	☐	Oil & Gas	☐
	Commercial fisheries	☐	Recreational Fisheries	☐
	Defence	☐	Shipping	☐
	Environmental	☐	Statutory bodies	☐
	Aquaculture fish	☐	Submarine Cables	☐
	Aquaculture seaweed and mussels	☐	Tourism & Recreation	☐
	Marine Renew. Energy-Tidal	☐	Other	☐

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	Marine Renew. Energy Wave ☐	☐
Type	Academic/Research Institute ☐ Advisor ☐ Classification body ☐ Consultants ☐ Decision maker ☐ Investor ☐ Lobby group ☐ Media ☐	Planner - Marine ☐ Planner – Terrestrial ☐ Policy maker ☐ Private Company ☐ Regulator ☐ Sectorial Group/Forum/Network ☐ Statutory body ☐ Statutory consultee ☐
Other?		

SHEET 8 **Data collection method**	
Method of engagement/modes of data collection	Questionnaire ☐ In person Interview ☐ Phone/Skype Interview ☐ Workshop ☐ Other ________________ ☐

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SHEET 9		
2.3.1. Category Drivers (D) *Instructions: Compile the scores according to stakeholder judgment using definitions provided in chapter 2.2. If necessary, extend categories and factor list according to step 2 (chapter 2.1.2).* *Scoring instructions:* • *high priority score = +3* • *medium priority score = +2* • *low priority score = +1* • *absent = 0 (*the factor is not present*)* • *not relevant = 0(*the factor is present, but it has no influence on MU potentials or MU effects*)* • *I do not know = NK (*there is no knowledge on the factor*)*		
Category D.1 - policy drivers (e.g. marine renewable policy)	**Factor list**	**Score**
	Factor D.1.1_____________________________	
	Factor D.1.2_____________________________	
	Factor D.1.n_____________________________	
Category D.2 - relation with other uses (e.g. other use(s) present already in the area)	**Factor list**	**Score**
	Factor D.2.1_____________________________	
	Factor D.2.2_____________________________	
	Factor D.2.n_____________________________	
Category D.3 - economic drivers (e.g. availability of funds promoting MU)	**Factor list**	**Score**
	Factor D.3.1_____________________________	
	Factor D.3.2_____________________________	
	Factor D.3.n_____________________________	
Category D.4 - societal drivers (e.g. social or political promotion of MU)	**Factor list**	**Score**
	Factor D.4.1_____________________________	
	Factor D.4.2_____________________________	
	Factor D.4.n_____________________________	
Others	**Factor list**	**Score**
	Factor D.n.1_____________________________	
	Factor D.n.2_____________________________	
	Factor D.n.n_____________________________	
Reference documentation & notes • … • … • …		

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SHEET 10		

2.3.2. Category Barriers (B)

Instructions: Compile the scores according to stakeholder judgment using definitions provided in chapter 2.2. If necessary, extend categories and factor list according to step 2 (chapter 2.1.2).

Scoring instructions:

- *high priority score = +3*
- *medium priority score = +2*
- *low priority score = +1*
- *absent = 0 (*the factor is not present*)*
- *not relevant = 0(*the factor is present, but it has no influence on MU potentials or MU effects*)*
- *I do not know = NK (*there is no knowledge on the factor*)*

Category	Factor list	Score
Category B.1 – legal barriers (e.g. marine renewable policy)	Factor B.1.1_____________________________	
	Factor B.1.2_____________________________	
	Factor B.1.n_____________________________	
Category B.2 – administrative barriers (e.g. specific administrative obstacles in allowing MU)	Factor B.2.1_____________________________	
	Factor B.2.2_____________________________	
	Factor B.2.n_____________________________	
Category B.3 – barriers related with economic availability / risk (e.g. lack of full understanding of economic benefits of MUs – i.e. no investors)	Factor B.3.1_____________________________	
	Factor B.3.2_____________________________	
	Factor B.3.n_____________________________	
Category B.4 – barriers related with technical capacity (e.g. specific technical problems affecting combination of some uses)	Factor B.4.1_____________________________	
	Factor B.4.2_____________________________	
	Factor B.4.n_____________________________	
Category B.5 – barriers related with social factors (e.g. social acceptance of MU)	Factor B.5.1_____________________________	
	Factor B.5.2_____________________________	
	Factor B.5.n_____________________________	
Category B.6 - barriers related with environmental factors (e.g. achievement of natural conservation targets)	Factor B.6.1_____________________________	
	Factor B.6.2_____________________________	
	Factor B.6.n_____________________________	
Others	Factor B.n.1_____________________________	
	Factor B.n.2_____________________________	
	Factor B.n.n_____________________________	

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Step 4. Evaluation of Overall MU Effects

SHEET 11

2.3.3. Category Added Values (V)

Instructions: Compile the scores according to stakeholder judgment using definitions provided in chapter 2.2. If necessary, extend categories and factor list according to step 2 (chapter 2.1.2).

Scoring instructions:

- *high priority score = +3*
- *medium priority score = +2*
- *low priority score = +1*
- *absent = 0 (*the factor is not present*)*
- *not relevant = 0(*the factor is present, but it has no influence on MU potentials or MU effects*)*
- *I do not know = NK (*there is no knowledge on the factor*)*

Category	Factor list	Score
Category V.1 - economic added value (e.g. reduction of overall costs)	Factor V.1.1________________________________	
	Factor V.1.2________________________________	
	Factor V.1.n________________________________	
Category V.2 - societal added value (e.g. conservation of traditional sea uses)	Factor V.2.1________________________________	
	Factor V.2.2________________________________	
	Factor V.2.n________________________________	
Category V.3 - environmental added value (e.g. reduction of overall environmental impact)	Factor V.3.1________________________________	
	Factor V.3.2________________________________	
	Factor V.3.n________________________________	
Category V.4 - better insurance and risk management (e.g. share risk management among different operators)	Factor V.4.1________________________________	
	Factor V.4.2________________________________	
	Factor V.4.n________________________________	
Others	Factor V.n.1________________________________	
	Factor V.n.2________________________________	
	Factor V.n.n________________________________	

Reference documentation & notes

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SHEET 12		
2.3.4. Category Impacts (I) *Instructions: Compile the scores according to stakeholder judgment using definitions provided in chapter 2.2. If necessary, extend categories and factor list according to step 2 (chapter 2.1.2).* *Scoring instructions:* • *high priority score = +3* • *medium priority score = +2* • *low priority score = +1* • *absent = 0 (*the factor is not present*)* • *not relevant = 0(*the factor is present, but it has no influence on MU potentials or MU effects*)* • *I do not know = NK (*there is no knowledge on the factor*)*		
Category I.1 - economic impacts (e.g. increased competition with other sectors not included in MU)	**Factor list**	**Score**
	Factor I.1.1_____________________________	
	Factor I.1.2_____________________________	
	Factor I.1.n_____________________________	
Category I.2 - societal impacts (e.g. increased societal non-acceptance of maritime activities)	**Factor list**	**Score**
	Factor I.2.1_____________________________	
	Factor I.2.2_____________________________	
	Factor I.2.n_____________________________	
Category I.3 - environmental impacts (e.g. increased cumulative impacts on marine benthic ecosystem)	**Factor list**	**Score**
	Factor I.3.1_____________________________	
	Factor I.3.2_____________________________	
	Factor I.3.n_____________________________	
Others	**Factor list**	**Score**
	Factor I.n.1_____________________________	
	Factor I.n.2_____________________________	
	Factor I.n.n_____________________________	

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Step 5. Analysis of Focus Areas

SHEET 13	
2.3.5. Focus areas The following KEQs are identified for the Focus Areas. During case study implementation additional relevant and more specific questions will probably arise as result of the desk analysis and, particularly, of stakeholder engagement. These new case study specific KEQs will be added to the set of the common KEQs indicated below.	
Focus-Area-1 "Addressing Multi-Use"	1. Is it possible to establish / widen / strengthen MU in the case study area? (Y/N) For which MU combination in particular? What needs would MU satisfy? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	2. Is space availability an issue for MU development / strengthening in the case study area at present? (Y/N). Will space availability become an issue for your area in the future? (Y/N). For what elements space availability is / could become an issue? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	3. Are there MUs combinations and potentials that will share the same resources but in different times (e.g. reuse of an infrastructure after the end of its first life and original scope)? What are they? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	4. What would be the most important resources to be shared between uses (infrastructures, services, personnel, etc)? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	5. Are existing and/or potential MUs taken into account and valorised within the existing or under development maritime spatial plans? (Y/N) Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:

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SHEET 13	
2.3.5. Focus areas The following KEQs are identified for the Focus Areas. During case study implementation additional relevant and more specific questions will probably arise as result of the desk analysis and, particularly, of stakeholder engagement. These new case study specific KEQs will be added to the set of the common KEQs indicated below.	
	6. How are MUs connected or related to land-based activities? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	7. Is the needed knowledge and technology for MU development/strengthening in the case study area already available? (Y/N). What is the level of maturity of available knowledge? What is the level of readiness of available technology? Are there still research needs? (Y/N) Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	8. What action(s) would you recommend to develop / widen / strengthen MU in the case study area? What actor(s) do you see particularly important to develop / widen / strengthen MU in the case study area? *(answers should be detailed enough to possibly allow undertaking actions finalized at MU promotion, at local case study level)* Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
Focus-Area-2 "Boosting Blue Maritime Economy"	1. Do you see added values for society and economy at large and/or for local communities of developing / widening / strengthening MU in the case study area? (Y/N). What are the most important ones? What are the most important ones? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	2. Is it possible to quantify the socio-economic benefits related to MUs and how they (could) contribute to the sea economy at local and regional/national scale? What tools, knowledge, experiences are available?

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SHEET 13	
2.3.5. Focus areas The following KEQs are identified for the Focus Areas. During case study implementation additional relevant and more specific questions will probably arise as result of the desk analysis and, particularly, of stakeholder engagement. These new case study specific KEQs will be added to the set of the common KEQs indicated below.	
	Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	3. Would MU development / strengthening be an opportunity for job creation and / or job requalification in your area? (Y/N) Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	4. Do you see possible elements of attractiveness for investors in developing / widening / strengthening MU in the case study area? (Y/N). What are these elements? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	5. What are possible investors interested in developing / widening / strengthening MU in the case study area? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	6. Is there sufficient dialogue between the stakeholder sectors for developing / widening / strengthening MU? (Y/N). Would dialogue facilitation be an asset? (Y/N) Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	7. In order to promote MU development / strengthening in the case study area, - *would the availability of a vision/strategy (e.g. at national or sub-regional level) be helpful? (Y/N)* - *would a feasibility study including evaluation of alternative scenarios be helpful? (Y/N)* - *would detailed projects on already identified simulations be useful? (Y/N)*

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SHEET 13	
2.3.5. Focus areas The following KEQs are identified for the Focus Areas. During case study implementation additional relevant and more specific questions will probably arise as result of the desk analysis and, particularly, of stakeholder engagement. These new case study specific KEQs will be added to the set of the common KEQs indicated below.	
	- do you see other enablers? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
Focus-Area-3 "Improving environmental compatibility"	1. What are / would be the environmental added values (= positive environmental impacts) of developing / widening / strengthening MU in the case study area? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	2. Which tools (conceptual, operational) are used or should be further developed and used to better estimate environmental impacts and benefits of MU? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	3. Is saving free sea space for nature conservation a driver for MU the case study area? (Y/N). Are there evidences about the present and future benefits of reserving free sea space? (Y/N). What are they? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	4. What practical actions would you undertake to link MU development / widening / strengthening to improved environmental compatibility of maritime activities? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	5. Are there win-win solutions triggering both socio-economic development and environmental protection already available for the case study area that MU should take up? (Y/N). What are they? Answer formulated by CS leaders after desk analysis and

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SHEET 13	
2.3.5. Focus areas The following KEQs are identified for the Focus Areas. During case study implementation additional relevant and more specific questions will probably arise as result of the desk analysis and, particularly, of stakeholder engagement. These new case study specific KEQs will be added to the set of the common KEQs indicated below.	
	consultation with the stakeholders:
	6. Is the environmentally friendly knowledge / technology for MU development/strengthening in the case study area available? (Y/N). Which is the level of readiness of available solutions? Are there still research needs on blue/green technologies for MU? (Y/N) Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:
	7. Would it be possible to promote MU through SEA/EIA procedures? (Y/N). What modifications would you suggest at your national / local level to promote MU through SEA/EIA procedures? Answer formulated by CS leaders after desk analysis and consultation with the stakeholders:

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5 ANNEX 1: BACKGROUND ANALYSIS OF MU RELATED PROJECTS RELEVANT FOR CASE STUDIES

1) PREFACE

In this document we describe the most relevant MU-related projects and studies, in order to individuate concrete applications of the MU concept in geographical areas matching with MUSES case-studies and possibly focussing on the same sectors.

The overall scope is to provide background information and context to MUSES case studies, highlighting what is already available as background information from previous studies.

A preliminary list of possible relevant projects has been provided in the Project deliverable D.2.1 (Analytical framework). The examined projects belong to three different categories. The first one includes projects or studies specifically proposing multi-use design concepts, the second one includes technology oriented projects especially concerning Ocean energy, the third one include projects concerning Marine Spatial Planning issues.

All projects have been examined and those of major relevance for MUSES aims (i.e. specifically concerning maritime multi-use approach with case-studies) are briefly described (chapter 2)). Particular attention has been paid to case-studies identification and description. It is important to highlight that a special focus was given to international projects with case-studies in Europe and in particular to European wide projects, with different case-studies in different European Sea basins.

In addition some national projects (chapter 0) suggested by project partners, based on their expertise, have also been included that is by no means an exhaustive list of them, but forms a first informative base of MU applications in several countries. Furthermore, some of the national projects are particularly relevant because they have a sea basin perspective, or because they consider multiple case-studies in different EU areas.

Marine Spatial Planning (MSP) oriented projects without a proper application of the multi-use concept as defined in the MUSES project, are not included in this document. However, when such projects analyse possible conflicts and synergies among different sea uses, they can be relevant as background information for further developing or implementing potential combination of different uses at sea. The COEXIST European project, with case-studies in all the European basins, is a prime example and is described in chapter 4.

The location of all the examined case-studies is mapped (chapter 5) to assist in the identification of case-studies with a spatial correspondence to the MUSES case-studies areas. A second selection is then operated in order to individuate case-studies matching with MUSES sectors of interest for each sea-basin, recalled in Table 5-2.

Furthermore, a first application of the methodology described in the Project Deliverable 2.1 (Analytical Framework) has been attempted in this document, trying to breakdown the available information of each case-study into elements of Drivers, Barriers, Added Values and Impacts (DABI, see Table 5-1).

It may not be possible to identify all these categories for each case study, this depends on the information availability on each examined project. Furthermore, though several environmental negative effects of the proposed multiuse platforms or multiuse combinations have often been stressed in the various project documents (e.g. organic enrichment, noise disturbance, habitat alteration etc.), they haven't always been included as "Impacts" as defined in the MUSES analytical

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framework. In several cases, such negative effects cannot be assessed as impacts effectively derived from the combination of uses, but rather as impacts that would also occur if the proposed uses were independently developed. Another element of uncertainty relates to the difference between the concept of “barrier/driver” (a factor that hinders or promotes the multiuse approach) and the concept of “impact/added value” (the negative/positive effect of multiuse). In some cases, the attribution to the correct element is not immediate and a certain degree of subjectivity can occur in the interpretation of the consulted documentation. Just to give an example, the factor “increased risk for navigation” due to an installation of a new MU platform can be considered a “barrier” if we consider the concept design but also an impact, if we consider the platform already in operation.

The findings of this activity are reported in a single DABI (Drivers/Added Values/Barriers/Impacts) table attached to this document as Appendix, containing the list of all case-studies with all detected elements of the DABI.

In a second step, the main combinations of uses, resulting from the analysis of all case-studies are then analysed (chapter 6), according to the categorization of uses proposed in the Analytical Framework (Deliverable 2.1). DABI elements, previously collected for each case-study, are therefore re-organised for combinations of uses, independently from the specific location and sea-basin. Consequently, all the DABI elements concerning the same combination of uses have been put together, converging information coming from all previously mapped MU case studies or initiatives. The elements of DABI for each combination of uses are reported in the afore-mentioned DABI table (Appendix).

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Table 5-1 Categorization of Drivers, Barrier, Added values and Impacts, as defined in Deliverable 2.1 (Analytical Framework).

ELEMENT		CATEGORY
MU POTENTIAL	DRIVERS Factors promoting MU	Category D.1 - Policy drivers *(e.g. marine renewable policy)*
		Category D.2 - Interaction with other uses *(e.g. other use(s) already present in the area)*
		Category D.3 - Economic drivers *(e.g. availability of funds promoting MU)*
		Category D.4 - Societal drivers (e.g. social or political promotion of MU)
		Other
	BARRIERS Factors hindering MU	Category B.1 - Legal barriers *(e.g. lack of legislation to undertake MU)*
		Category B.2 - Administrative barriers *(e.g. specific administrative obstacles in allowing MU)*
		Category B.3 – Financial barriers / risk *(e.g. lack of full understanding of economic benefits of MUs – i.e. no investors)*
		Category B.4 - Barriers related to technical capacity *(e.g. specific technical problems affecting combination of some uses)*
		Category B.5 - Barriers related to social factors *(e.g. social acceptance of MU)*
		Category B.6 - Barriers related to environmental factors *(e.g. achievement of natural conservation targets)*
		Other
MU EFFECTS	ADDED VALUES Positive effects of establishing or strengthening MU	Category V.1 - Economic added value *(e.g. reduction of overall costs)*
		Category V.2 Societal added value *(e.g. conservation of traditional sea uses)*
		Category V.3 Environmental added value *(e.g. reduction of overall environmental impact)*
		Category V.4 - Better insurance policies and risk management *(e.g. share risk management and related costs among different operators)*
		Category V.5 – Technical added value *(e.g. improvements to infrastructures or services due to the combined uses by two or more users)*
		Others
	IMPACTS Negative effects of establishing or strengthening MU	Category I.1 - Economic impacts *(e.g. increased competition with other sectors not included in MU)*
		Category I.2 - Societal impacts *(e.g. increased societal non-acceptance of maritime activities)*
		Category I.3 - Environmental impacts *(e.g. increased cumulative impacts on marine benthic ecosystem)* *Imp*
		Category I.5 – Technical impacts *(e.g. Technical problems to infrastructures or services due to the combined use by two or more users)*
		Other

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Table 5-2 MUSES case studies and relevant sectors.

Case Study		Explored Sectors
Code	**Name**	
1	North Sea	Aquaculture- Fish— Aquaculture – Shellfish Commercial Fisheries Offshore Tidal Energy Offshore Wind Energy
2	Northern Atlantic Sea	Aquaculture- Fish— Aquaculture – Shellfish Wave Energy Wind Energy
3	Southern Atlantic Sea	Commercial Fisheries Cultural Heritage MPA Oil and Gas Tourism
4	Baltic Sea (Sweden)	Aquaculture-Seaweed Wind energy
5	Baltic Sea (Denmark)	Aquaculture-Seaweed Wind energy
6	Mediterranean Sea - Northern Adriatic	Aquaculture- Fish Aquaculture-Shellfish Commercial Fisheries MPA Oil and Gas Tourism
7	Mediterranean Sea – Aegean/Cyclades	Aquaculture-Fish Aquaculture-Shellfish Commercial Fisheries Shipping terminal Tourism Wind Energy

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2) DESCRIPTION OF INTERNATIONAL MULTI-USE PROJECTS AND STUDIES

a. MERMAID

The MERMAID project (Innovative Multi-purpose off-shore platforms: planning, design and operation, www.mermaidproject.eu) was funded by the European Commission under the 7th Framework Programme for Research and Development. MERMAID is one of three projects (together with the after mentioned projects TROPOS and H2OCEAN) funded by FP7-OCEAN.2011-1 “Multi-use offshore platforms”.

The MERMAID project ran from 2012 till 2016 and had a cost of 7,4 million euro. The European Union has granted a financial contribution of 5,5 million euro.

The MERMAID consortium consisted of 29 European partners bringing together expertise from both science and industry.

The Project developed concepts for next-generation offshore platforms for multi-use of ocean space for energy extraction, aquaculture and platform-related transport. The project did not envisage building new platforms, but aimed at examining different concepts, such as a combination of structures or completely new structures on representative sites under different conditions.

The project considered 4 offshore study sites for multi-use offshore platforms: Atlantic, North Sea, Baltic Sea and Mediterranean Sea, see Table 5-3. Site-specific designs, with combinations of **wind** turbine, **aquaculture** and **wave** energies, were developed based on an extensive stakeholder consultation process and the environmental characteristics of each site.

A brief description of the 4 case-studies of the MERMAID Project is provided in the following text, extracted from the MERMAID booklets (Pirlet et al., 2014, Calberg et al., 2015) and from the Project report D.2.4 (Platform Solutions) downloaded from the MERMAID website. Another useful source is the paper of Stuiver et al (2016), where policy, economic, social, technical, environmental and legal factors (the so called PESTEL approach) are explored for the four MERMAID case-studies. Major features of each site, deduced by the analysis of the above mentioned documents, are summarized in Table 5-4.

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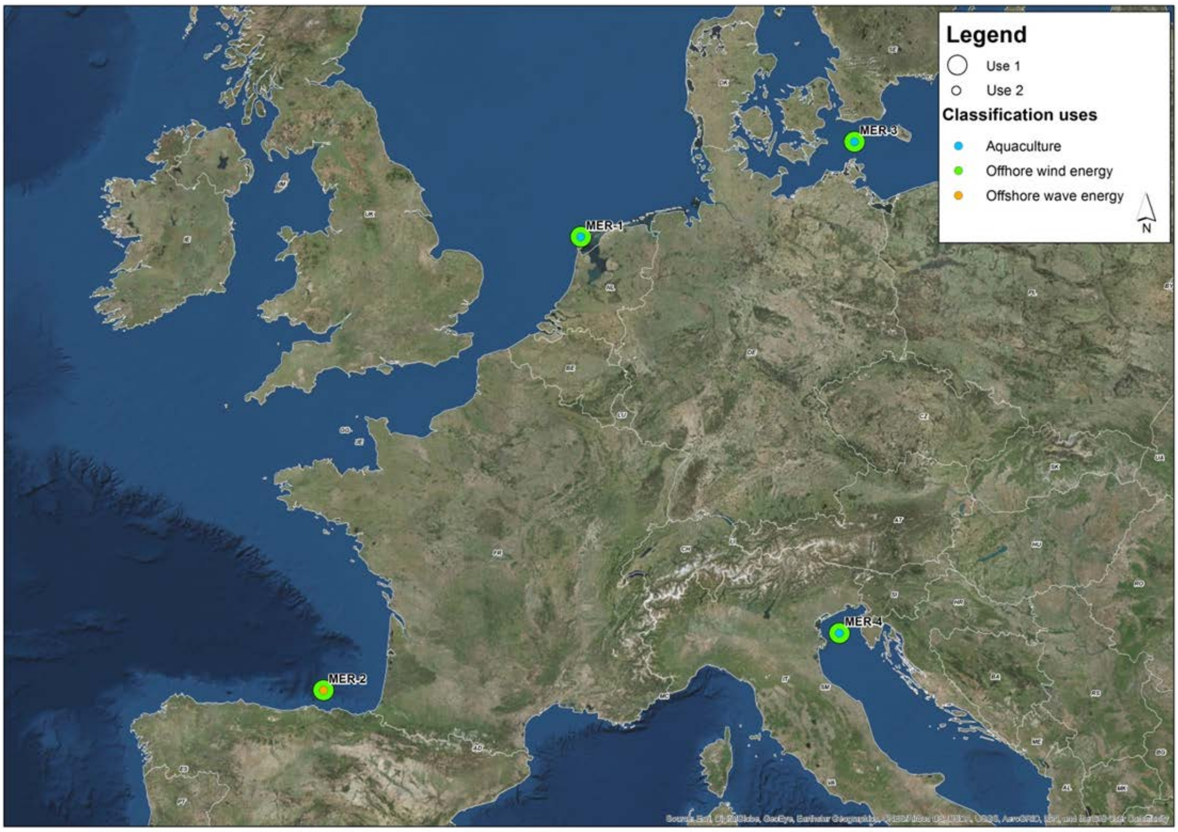

Table 5-3 Location of Case Studies of MERMAID Project and proposed combinations of uses.

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Table 5-4 MERMAID Project: summary of case-studies.

Sea Basin	Case Study Location	Case-study code	Environmental characteristics/Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2
North Sea	Gemini wind farm	MER-1	High wind energy potential. Optimal conditions for seaweed. North and Wadden Sea sediment exchange	Gravity-based foundations. Wind turbines. Extensive aquaculture	Staggered development site-specific concept design	Offshore wind energy	Aquaculture-seaweed Aquaculture-shellfish
Atlantic	Cantabrian Offshore Site	MER-2	Narrow continental shelf combined with open sea conditions. Very high wind and wave energy potential The high energy content makes the site very attractive for developing multi-use offshore platforms.	Semi-submersible floating platform composed of wind turbines wave energy converters	Joint development site-specific concept design	Offshore wind energy	Offshore wave energy
Baltic	Kriegers Flak	MER-3	High wind energy potential. Estuarine site. Optimal condition for temperate fish. Baltic and North Sea flow exchange	Gravity based foundations. Wind turbines. Extensive mariculture	Joint development site-specific concept design	Offshore wind energy	Aquaculture-fish Aquaculture-seaweed
Mediterranean	Northern Adriatic Sea	MER-4	Mild wind and wave energy potential. Good conditions for mussels and fish. Lowest potential for marine renewable energy in the Mediterranean	Gravity-based foundations Wind turbines Fish farming	Joint development site-specific concept design	Offshore wind energy	Aquaculture-Fish

Gemini Wind Park (Dutch North Sea)

The North Sea site is an area with typical active morphology. The test study area lies above the Wadden See Islands in the North of the Netherlands (Southern North Sea). In this area the Dutch authorities awarded 3 permits for larger offshore wind farms, the so-called Gemini project.

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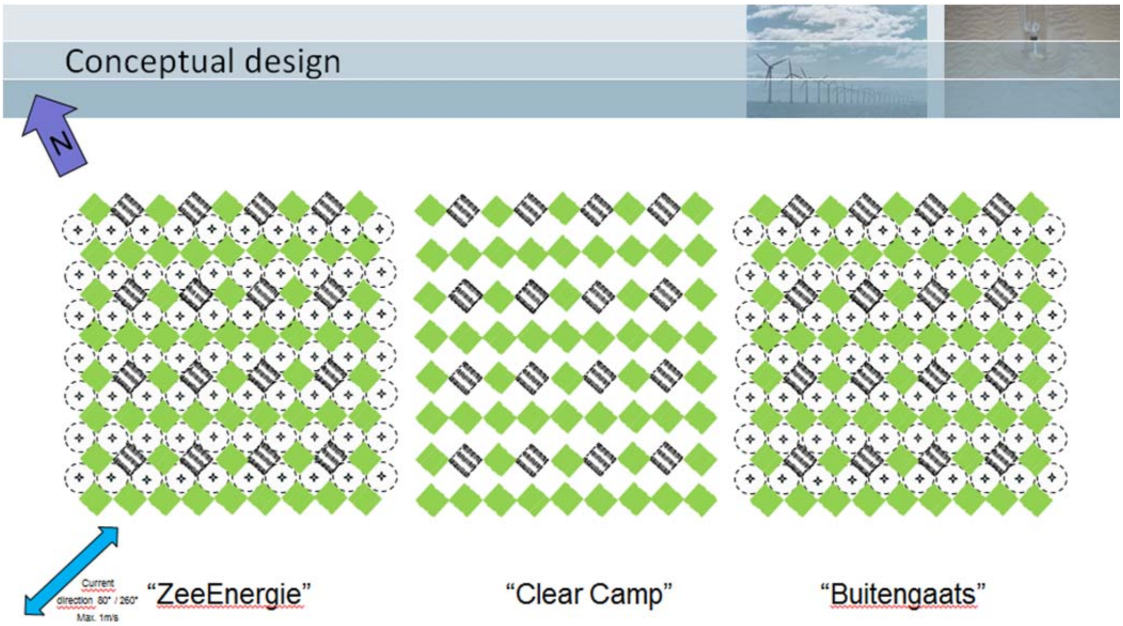
The North Sea case study focused on the future **wind** park location Gemini: although these offshore wind farms only have licenses for single use, more stakeholders in the Netherlands are starting to discuss multiuse possibilities, such as regional fishermen, entrepreneurs for aquaculture and tourism. In collaboration with the identified stakeholders, offshore wind farms combined with **seaweed** and **mussel** aquaculture, which elevated the importance to a most promising conceptual multi-use design.

Fish aquaculture was excluded from the design due to relatively high water temperature peaks during the summer. Currently, no native fish species are expected to survive under these circumstances given the relatively shallow cultivated environment in the North Sea. Wave energy convertors were initially considered, however due to the low efficiency in combination together with the limited availability of wave energy in the North Sea, it was concluded that this function is currently not feasible

A modular approach has been proposed for the structures for combined seaweed and shellfish cultivation, enabling an easy extension of the activities. These structures could be located inside and outside the offshore wind farm and should not be connected to the turbines. An alternation of seaweed and shellfish structures is envisaged (Table 5-5).



Green diamonds illustrates seaweed, round circles are the offshore wind turbines and black and white diamonds are the areas with mussel aquaculture.

Table 5-5 Conceptual design of the multi use offshore wind farm at the North Sea site. Source: MERMAID Project Deliverable D7.3 "Site Specific design conditions".

In the future the multi-use platform may be extended to other user functions such as facilities for **energy storage**, **tourism** (recreational fisheries and diving trips) and **fisheries** (passive fishing gear). Some of the key challenges that deserve further study are: the design of the seaweed/mussel farming system within the offshore wind farm (integration of the two types of aquaculture, design of harvesting equipment, etc.), the ecological challenges linked to aquaculture activities (e.g. risk assessment of environmental impact and the mitigation of diseases) and evaluation of the environmental and socio-economic benefits of this multi-use platform.

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The operational challenges of this study site include the relatively high distance to the nearest main port (85 km) and the extreme wave heights which may occur during storms. Other challenges have been linked to the complexity of the integration of the two types of aquaculture, as well as the issue of the environmental impact and socio-economic benefits of the platform.

Factors hampering the MU platform concepts and design in the North Sea are legal and policy factors (lack of MU platform regulatory framework), social obstacles (including trust of potential users), technical obstacles (harsh condition of the North Sea, lack of experience in offshore aquaculture) and environmental obstacles (environmental impact).

Cantabrian Offshore Site (Atlantic)

The study area is the Cantabrian Offshore site, located off the region of Cantabria (Spain), between the Biscay Gulf at the East and Galicia at the Western part of the Iberian Peninsula. A narrow continental shelf combined with open sea conditions exposed to north-western storms provides a severe ocean environment. It is characterized by very rough wind and wave conditions.

The envisaged localisation of the Multi Use Platform is a site characterized by a wide range of water depths ranging between 40 and 200 meters where floating structures are the most suitable technology for ocean energy harvesting.

Based on the available resources and the characteristics of the Atlantic Site, a combination of **offshore wind** and **wave energy** extraction was opted for.

The Atlantic case study was mainly technology driven and focused on Multi-Use Platform (MUP) engineering simulating scenarios (wind and wave conditions). The proposed scenario consists of an array of 5 MW wave energy converters and 2.5 MW wind turbines. The design consists of a semi-submersible floating platform formed by three oscillating water column (OWC) wave energy converters and one horizontal wind turbine (Table 5-6

Due to the water depth in the study site, only floating devices have been taken into consideration, and will be of particular interest for countries with a narrow continental shelf. In the future, other user functions such as leisure and maritime transport may be integrated in the platform. The design of this multi-use offshore platform was assessed especially challenging due to the very rough wave and wind conditions in the Atlantic Site. Furthermore, the environmental impact of the converters, structures and foundations can be an element of possible concern.

According to the analysis performed by Stuvier et al., 2016 on the MERMAID case-studies, there are no plans by the national Spanish government to pursue at this time, MU platforms in the Atlantic Ocean, which are solely driven by the European Union-funded research. The analysis of obstacles to the development of MU platforms (Stuvier et al., 2016) revealed legal and policy obstacles (lack of cooperation among different regions and exclusive economic zones, complex permitting procedure) social obstacles (conflicts with fishing communities), technical and economic obstacles (the combination of high wave and depth makes it difficult to design secure systems) and environmental obstacles (legislation of protected areas).

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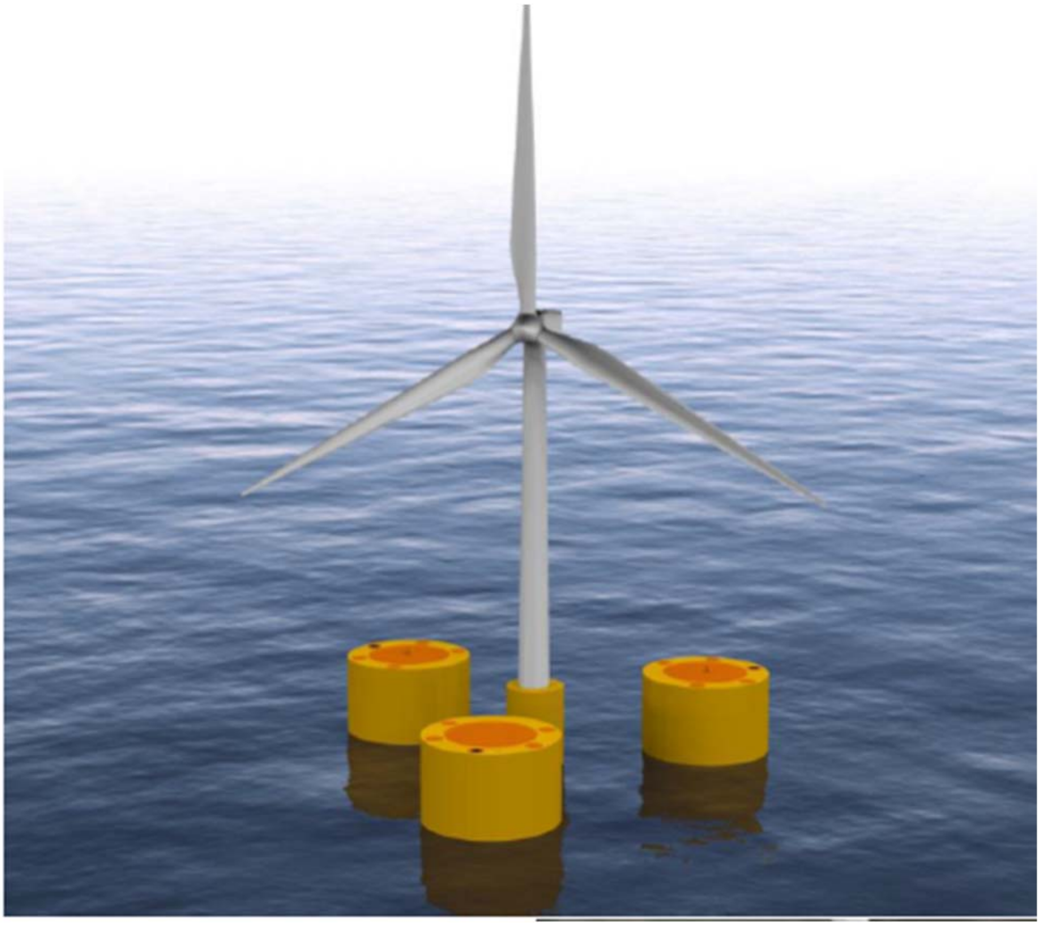

Table 5-6 Wind and wave energy converter concept for Atlantic case-study (Source: MERMAID Project Deliverable D7.3 "Site Specific design conditions").

Kriegers Flak (Baltic Sea)

The study area is the Kriegers Flak, a large sandy shoal with a sand layer thickness of up to 8 m located in the Danish territory of the Western Baltic Sea, between Denmark, Sweden and Germany. Dedicated areas (about 20 km^2) within the Danish territory are extensively used for sand extraction.

An offshore **wind** farm (75 turbines with a total capacity of 600 MW) is already scheduled to be in operation in 2020 in this study site. The MERMAID project explored the theoretical possibility to combine this wind farm with additional **aquaculture** activities, such as **fish** (rainbow trout or Atlantic salmon) and **seaweed** farming (*Furcellaria sp*.).

The research focused on possible combinations of various aquaculture potential with offshore wind. Analyses indicate that fish farms with an annual production at 10,000 tons of salmon or trout will be feasible. The fish farming is planned as two separate facilities located between the two clusters of turbines to gain some physical protection from the foundations and the wind turbines.

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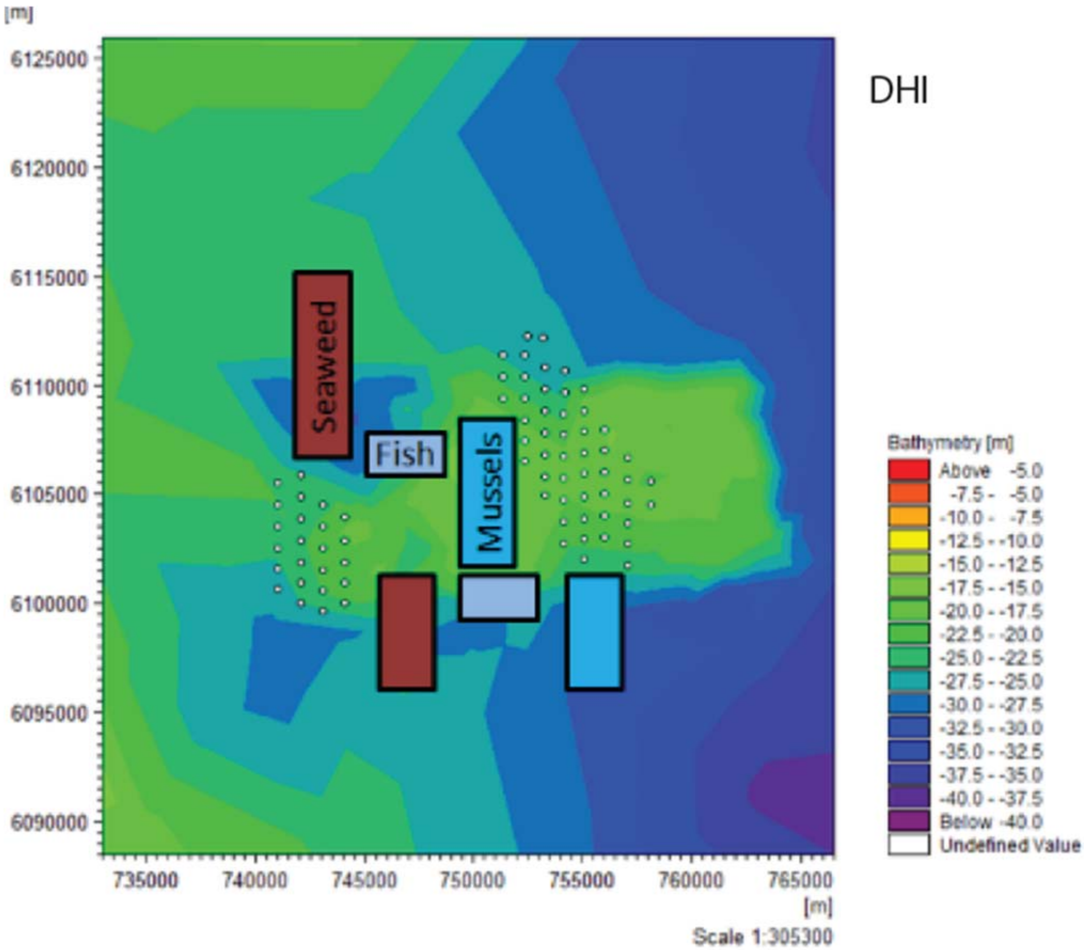

Table 5-7 Spatial layout of multi-use platform with wind energy plant and fish farming for the Baltic Sea - case-study (Source: MERMAID Project Deliverable D7.3 "Site Specific design conditions").

One of the challenges of this study site is the significant distance to the nearest port. The combination of aquaculture and offshore wind energy will therefore provide significant benefits in terms of transportation and housing. Still, the operational difficulties when combining different users should be taken into account. The main obstacle to large-scale fish farming could be the environmental impact caused by the release of nutrients. In this regard, a study was conducted to examine the potential of sessile filter feeders living on the turbine foundation to sequester aquaculture waste. Future use of macro-algal cultures for wave damping will require both innovation and small-scale field testing.

The idea of MU Platforms in the Baltic area is mainly supported at the European level by the European Commission, while no public stakeholders in the Baltic Sea have decided to realize MU Platforms at local or regional levels (Stuvier et al., 2016).

A series of obstacles to the development of maritime activities in MU platforms have been identified in the Baltic Sea (Stuvier et al., 2016), such as legal and policy obstacles (wind and aquaculture are governed by different authorities and regulations), technical obstacles (requiring risk assessment for the combination of the two sectors), environmental obsatcles (effects on habitats and living marine environment, euthropicationand release of antibiotics).

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Northern Adriatic Sea (Mediterranean)

The study area is the northern Adriatic Sea, in a sheltered deep water site. The initial site suggested for multi-use was the research platform Acqua Alta, about 12 km off the coast of Venice. Later the designers changed the MUP location from 12 km to ca 27 km offshore, because of visibility issues of wind turbines raised by the stakeholders involved.

The assessment of the available resources at the site in terms of wave, wind, and aquaculture potential led to an economically ineffective single purpose, both because of the limited available energy and due to the significant distance from the shore as a result of the flat sea bottom. The selected MUOP includes **wind turbines** and **fish farming**. In the developed concept, the occupied space is a square shaped area of 0.64 km^2 where the wind turbines are placed at the corners and the fish farm in the middle. This configuration allows sufficient spacing around the cages for water circulation and sailing.

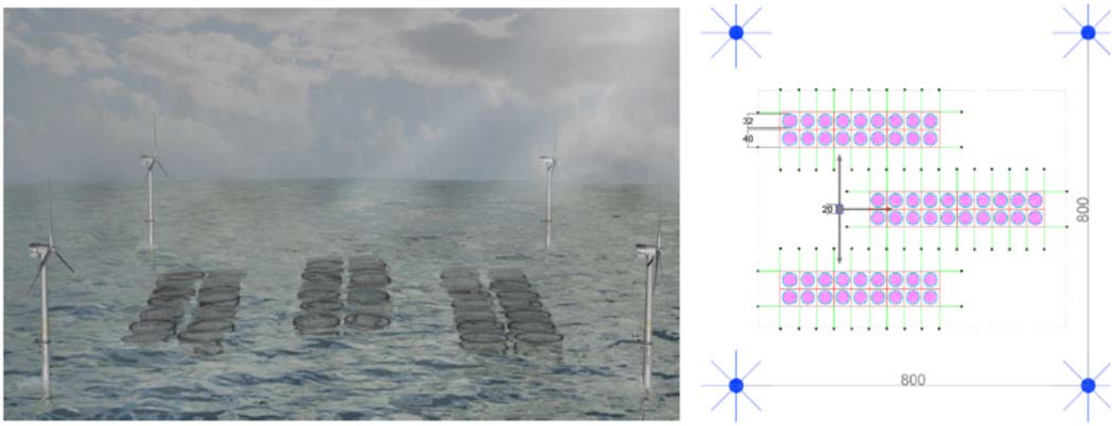

Table 5-8 Representation and layout of the selected multi-use platform at Mediterranean sea (Source: MERMAID Project Deliverable D7.3 "Site Specific design conditions").

One of the main challenges of this MUOP is connection to the grid, due to the costs induced by the long distance to shore and the environmental impacts of the cables on the soft bottom.

In the Mediterranean Sea no public authorities at national or regional level have decided to realize MU platforms to date. Even so, in a series of research projects (including ADRIPLAN, TROPOS, IMP-MED, SEANERGY2020, ADRICOSM, and RITMARE) it is documented that a vision for multiple use appears in national plans for oceans space and Marine Spatial Planning (MSP), as documented in a series of research projects (Stuiver et al., 2016).

Based on the stakeholder dialogues in the project workshops, a series of obstacles for the development of marine activities in MU Platforms have been identified in the Mediterranean basin (Stuiver et al., 2016). They are legal and policy obstacles (bureaucratic complications and lack of clear competences among different public institutions), social obstacles (possible conflicts with fisheries, tourism, shipping activities) and environmental obstacles (risk of eutrophication and pollution, natural disturbance and harm to biodiversity).

b. TROPOS

TROPOS (Modular Multi-use Deep Water Offshore Platform Harnessing and Servicing Mediterranean, Subtropical and Tropical Marine and Maritime Resources, www.troposplatform.eu) is a European collaborative project that was funded by the European Commission under the 7th

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Framework Programme for Research and Development, more specifically under FP7-OCEAN.2011-1 "Multi-use offshore platforms".

The TROPOS Project was a €7-Million European Project in which the European Commission committed to fund €4.9 Million. The Project gathered 19 European partners from 9 countries (Spain, the United Kingdom, Germany, Portugal, France, Norway, Denmark, Greece and Taiwan), under the coordination of PLOCAN (Spain - http://www.plocan.eu/es/).

It was a 3 years – project, starting from February 1st, 2012.

The TROPOS project aimed to develop a floating modular multi-use platform system for use in deep waters, with an initial geographic focus on the Mediterranean, Tropical and Sub-Tropical regions, but designed to be flexible enough so as not to be limited in geographic scope. The floating design facilitates access to deep sea areas and resources where deployment of conventional platform types is not possible.

The modular multi-use approach allows the integration of a range of functions from four different sectors: **Transport, Energy, Aquaculture, and Leisure** (in short: TEAL). Three different concepts were developed in the scope of TROPOS with various combinations of TEAL functions: the Green & Blue concept, the Leisure Island and the Sustainable Service Hub. Appropriate locations for the different concepts were identified and final TROPOS scenarios were defined with the help of a specifically developed GIS support tool.

These three scenarios are designed and specified in detail (Project Deliverable D.4.3, "Complete design of specification of 3 reference TROPOS systems").

- Green & Blue concept included a floating offshore platform infrastructure, based on **energy** and **aquaculture** components and avoiding industrial activities which might compromise the water quality.
- Leisure Island concept included a floating platform moored not very far away from the coast, focused on **leisure**, looking for synergies with **energy** and **aquaculture**.
- The Sustainable Service Hub concept is a modular industrial type of a far offshore infrastructure. It is focused on **transport** and its **energy** related aspects. It includes a large floating offshore port with dedicated infrastructure.

To identify the most suitable locations for multi-use offshore platforms within the target regions a Geographic Information System (GIS) tool was developed which integrates a multitude of data for a geographical assessment of different regions (Project deliverable D2.4). This application considers and integrates a multitude of data specific to a particular resource, but also data on water depth, seabed geology, distance to grid or distance to port, and data to be used in the definition of restricted areas.

Suitable locations for the TROPOS concepts which were finally chosen for the case studies include:

- North of Crete (southern Aegean Sea) at about 100km distance from the shore in about 450m water depth. This site is optimal for harnessing wind energy.
- Southwest of Taiwan, 3nm distance from Liuqiu Island in 300-400m water depth. The vertical temperature gradient along the water column in this area allows for the operation of an Ocean Thermal Energy Conversion (OTEC) plant.
- Southwest of Gran Canaria, 2nm from the shore in about 50m water depth. This is a suitable location for the exploitation of solar energy and touristic activities.

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- North Sea, on the Dogger Bank (UK), about 100km from the shore in about 30m water depth. This site suitable for harnessing wind energy.
- The Gulf of Panama in depths around 150 meters.

The final TROPOS modular multi-use offshore platform scenarios were configured while considering all different aspects regarding site characteristics, economy, environment, technology, design, logistics and society. Three official final solutions were defined by the Interdisciplinary Cohesion Subcommittee (ICS), the TROPOS ICS scenarios.

For each scenario, environmental and socio-economic effects of multi-use platforms were compared to effects of single-use approach (Project deliverable D.6.5). This comparison allowed understanding the advantages and drawbacks of multi-use installations in relation to single-use, from an environmental and socio-economic perspective. The analysis of the environmental impacts of the multi-use and the single-use analysis showed that the multi-use platform has nearly the same impacts than the single-use (in some cases lower in others slightly higher). Additionally, factors that are not included in the environmental impact analysis as energy and water consumptions show clearly the advantage of the multi-use platform, in which the energy produced by the wind farm and the photovoltaic (PV) plant is used to operate the aquaculture facilities, the products' processing and the desalination of the seawater and the treatment of the residues. Therefore, the multi-use has similar impact than the single-use approach as well as the advantage of the integration of diverse activities in the same location.

No proper information about Drivers and Barriers have been detected in the available Project documents. So the collected information mainly addresses the added values/impacts of the multi-use approach, in comparison to the single use approach. In Table 5-9, the major features of each considered case-study is reported.

The map of the selected sites for the designed scenarios is reported in Figure 5-1. A brief description, based upon the Project Final Report, Project deliverables (D6.5 - Comparative statement/assessment for selected deployment locations including comparison to non-multiuse platforms, D4.3 Complete Design Specification of 3 reference TROPOS systems) and the website contents is provided below.

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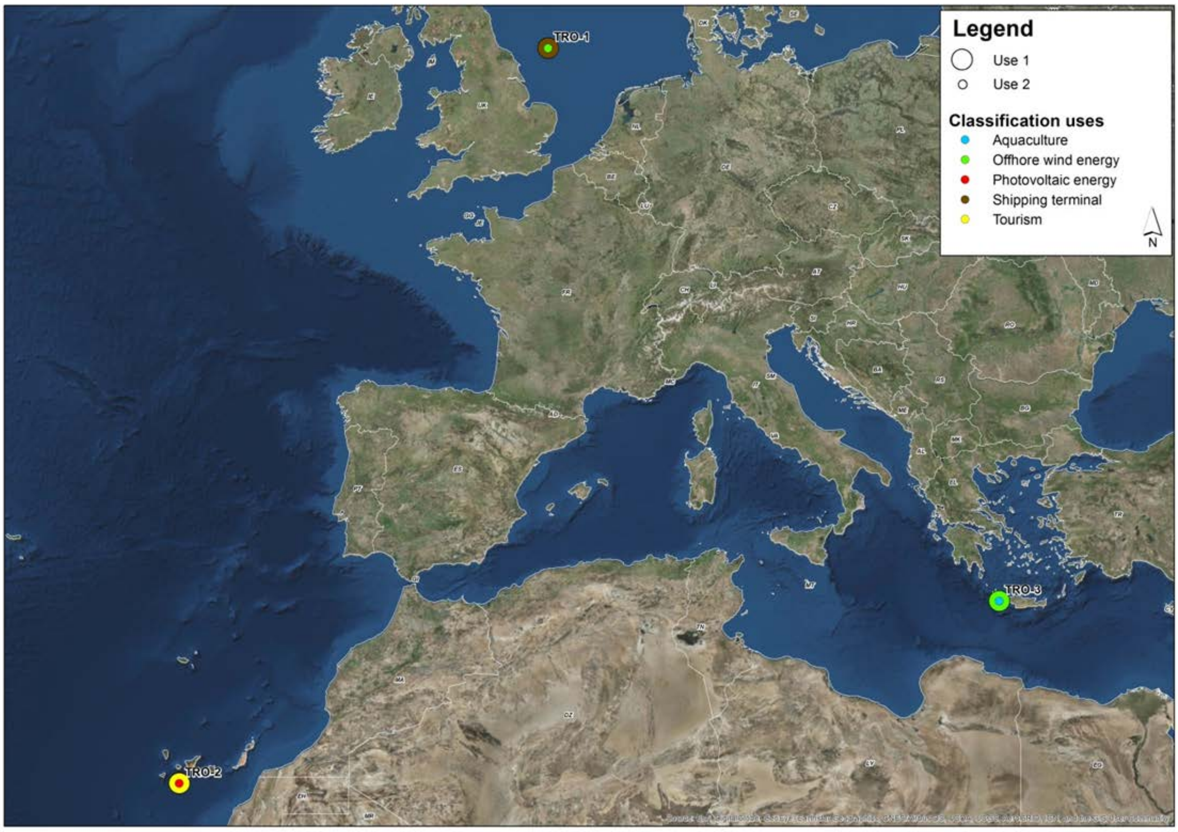

Figure 5-1 Localization of the 3 final solutions of TROPOS Project and proposed combinations of uses.

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Table 5-9 TROPOS Project: summary of case-studies.

Sea Basin	Case Study Location	Case-study code	Environmental characteristics/ Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2
North Sea	Dogger bank	TRO-1	Large shallow sandbank Water depths range from 15 m to 35 m. High wind speeds of over 10 m/s. Important habitat for a multitude of species.	"Sustainable Service Hub" concept Large floating offshore port with dedicated infrastructure Modular infrastructure, focusing on transport and energy related needs	Joint development site-specific concept design	Shipping terminal	Offshore wind energy
Atlantic	Canary Island	TRO-2	Protected area (natural reserve); Volcanically active zone with narrow and steep continental shelf.	"Leisure Island" concept; Floating platform with leisure facilities for tourists and local residents with a photovoltaic energy plant	Joint development site-specific concept design	Tourism	Photovoltaic energy
Mediterranean	Crete	TRO-3	Habitat of numerous ecologically and economically relevant species	"Green & Blue" concept; Floating offshore platform with fish and microalgae aquaculture and energy from wind turbines	Joint development site-specific concept design	Offshore wind energy	Aquaculture-fish Aquaculture-seaweed

Dogger Bank (UK North Sea)

The proposed concept is a "Sustainable Service Hub". This scenario is located in the Dogger Bank, a special ecosystem within the North Sea representing an important habitat for a multitude of species. Despite its apparent resilience this ecosystem deserves protection and preservation.

The Sustainable Service Hub scenario (Figure 5-2) is designed to support an offshore wind farm, including installation and maintenance. It focuses on **transport** and **energy** related needs of the offshore renewable energy sector and serves as an offshore **wind** hub for a wind farm assembled around the platform. The service hub consists of 4 modules: a quick reaction maintenance base, a substation, and an accommodation module for service staff and a helipad. The electrical energy

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generated by the wind turbines directly supplies the electrical power requirements for the entire facility. Due to the accommodation infrastructure for the workforces, this concept has the capacity to host a large number of people. The infrastructure is also available for external visits (controlled and following strict security measures). The waste heat of the electricity generation is used for heating purposes.

Figure 5-2 Sustainable Service Hub Dogger Bank – Conceptual design (left) and Engineering design (right). Source: TROPOS Project Final Report.

<u>Canary Islands (Atlantic)</u>

The proposed concept at this site is "Leisure Island". This scenario is located southwest of Gran Canaria Island within the Special Area of Conservation (SAC) "Franja Marina of Mogán" (Natura 2000 network). The project involves a multitude of **leisure** facilities for tourists and local residents, including the full range of hotel services (Figure 5-3). **Energy** demand of the platform is partially met by a **photovoltaic** (PV) plant; as backup additional electricity might be provided via an HVAC cable from land. This scenario includes several modules integrated into the central unit platform: a visitors' centre, food & beverages, accommodation, monitoring, energy storage, and a marina. Visitors as well as staff are transported via daily shuttle transfers between Gran Canaria and the platform. Visitors can also approach the platform with private yachts by entering the marina.

The Leisure Island was designed to be located in a protected area (natural reserve) and therefore it will be necessary to apply appropriate legislation for environmental impacts assessment, monitoring strategies and efficient management to mitigate any negative environmental impact on the surrounding, due to vessel traffic, liquid and solid wastes, artificial lighting, physical presence of the platform.

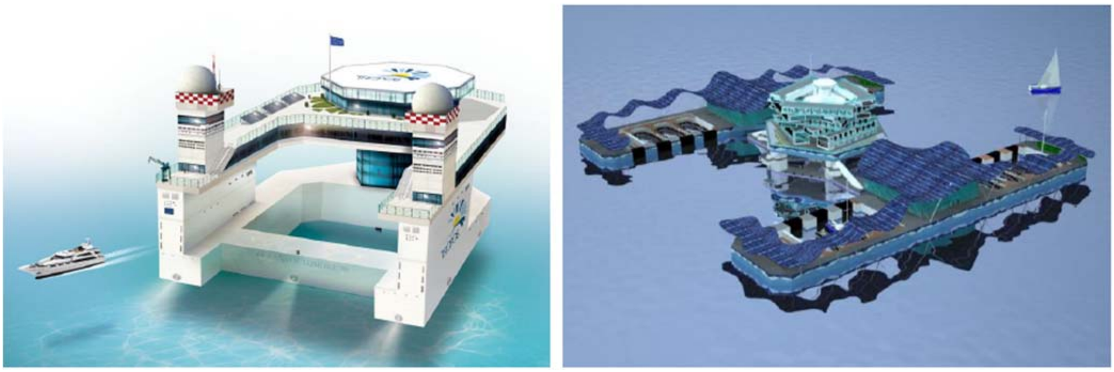

Figure 5-3 Leisure Island – Conceptual design (left) and Engineering design (right). Source: TROPOS Project Final Report.

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Crete (Mediterranean Sea)

The proposed concept at this site is "Green & Blue". In this scenario, **fish** and **microalgae** aquaculture are combined with a floating offshore **wind farm**. The aquaculture units are part of 30 floating satellite units, each consisting of one fish cage and one algae floater. Each satellite unit is equipped with two 2-3.3 MW wind turbines; some also include small photovoltaic (PV) units. Aquaculture units, wind turbines and PV units are controlled and monitored online from the central unit. The central unit includes a workshop, a fish processing unit, an algae biorefinery, storage facilities, accommodation for staff, and a substation for the electrical connection between wind turbines, central unit and onshore grid. The conceptual and engineering design is illustrated in Figure 5-4.

The selected location for this scenario is situated North of Crete. The Cretan Sea, as part of the Mediterranean Sea, is considered as one of the least productive sea regions in the world. Nevertheless it is the habitat of numerous ecologically and economically relevant species. The Cretan Sea is a relevant habitat for some endangered species, among them the most endangered pinniped species in the world, the Mediterranean monk seal. Therefore the preservation and protection of the Cretan Sea environment is mandatory.

An additional possible application of Green & Blue Concept has been developed also for Taiwan, close to Liuqiu Island. Fish and macroalgae aquaculture are combined with a floating Ocean Thermal Energy Conversion (OTEC) for energy supply.

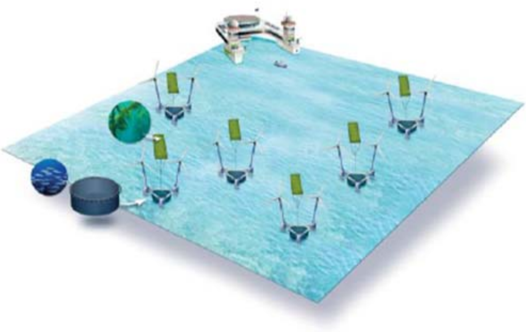
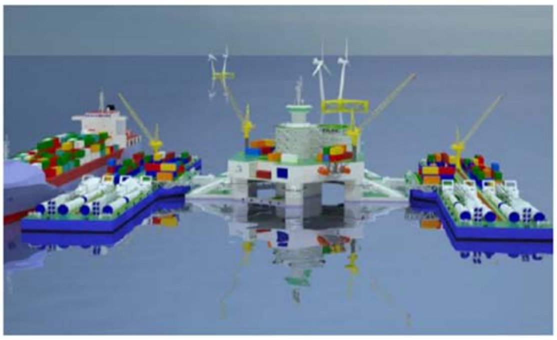

Figure 5-4 Green & Blue Crete – Conceptual design (left) and Engineering design (right). Source: TROPOS Project Final Report.

c. H2Oceans

H2Oceans (Development of a wind –wave power open sea platform equipped for hydrogen generation with support for multiple users of energy, http://www.h2ocean-project.eu/index.php) is a project funded by the FP7-OCEAN.2011-1 "Multi-use offshore platforms". The project had a cost of 6 million EUR and the European Union granted a financial contribution of 4,5 million EUR (FP7-OCEAN.2011-1 "Multi-use offshore platforms").

The project activities started on the 1st of January, 2012 and ended on the 31st of December, 2014.

The H2OCEAN Consortium is composed of 17 partners from 5 European countries (Spain, United Kingdom, Denmark, Germany and Italy).

H2OCEAN is a project aimed at developing an innovative design for an economically and environmentally sustainable multi-use open-sea platform. Wind and wave power will be harvested

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and part of the energy will be used for multiple applications on-site, including the conversion of energy into hydrogen that can be stored and shipped to shore as a green energy carrier and a multi-trophic aquaculture farm.

The unique feature of the H2OCEAN concept, besides the integration of different activities into a shared multi-use platform, lies in the novel approach for the transmission of offshore-generated renewable electrical energy through hydrogen. This concept allows effective transport and storage of the energy, decoupling energy production and consumption, thus avoiding the grid imbalance problem inherent to current offshore renewable energy systems. Additionally, this concept also circumvents the need for a cable transmission system which takes up a significant investment share for offshore energy generation infrastructures, increasing the price of energy.

The integrated concept has the advantage of several synergies between the activities within the platform significantly boosting the Environmental, Social and Economic potential impact of new maritime activities, increasing employment and strengthening European competitiveness in key economic areas.

The project main output is a proof-of concept design for a fully integrated multipurpose platform with an impact assessment of such platform at environmental and economic level. The environmental requirements for this platform include an adequate distance from the coast (minimum 25 Km and maximum 100 Km offshore) and an adequate depth (maximum 100m). The minimum distance of 25km from shore was selected to satisfy the condition that the H2Ocean array is an offshore installation that should not be visible from land. The maximum distance of 100km from shore and a maximum water depth of 100m was selected for practical design and maintenance reasons.

Three sites that meet the minimum requirements of the different technologies had been provisionally selected in order to provide a starting point for the conceptual design of the project:

- An Atlantic site off the west coast of Portugal, west of the Wave Pilot Zone, which offers an excellent wave resource and a good wind resource.
- A North Sea site, approximately 50km east of Peterhead in Scotland, which offers an excellent wind resource and infrastructure that is capable of supporting future H2Ocean arrays.
- A Mediterranean site off the coast of Sardinia which represents a relatively benign wind and wave energy site, offering a different multi-trophic solution to the North Sea and Atlantic sites.

As well as varying in their physical characteristics, the proposed sites are located in different countries with varying levels of development in terms of their licensing and consenting procedure for offshore projects. Each site also has differing levels of environmental data available which were evaluated in the scoping study (Deliverable D9.1).

The final conceptual development of the H2OCEAN system has been drawn for the Atlantic coast of Portugal, west of the Wave Pilot Zone, 50 Km from the coast (Table 5-10).

H2Ocean involved harvesting **wind** and **wave** energy with vertical axis wind turbines (VAWTs) and wave energy converters (WECs), to produce a number of products including Hydrogen, Oxygen and drinking water. In addition, the concept supports a multi-trophic **aquaculture** farm which produces finned **fish**, **seaweed** and **shellfish**. An onsite floating bio-digester provides power for the aquaculture and is fuelled by waste resources from the H2Ocean facility and passing vessels. The conceptual design of the H2OCEAN system is reported in Figure 5-5.

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In the final project documents there was insufficient information to describe elements of barrier, drivers, added values and impact of the multi-use solution. However, from the environmental point of view (Project Deliverable D9.6), the impact of the proposed installation has been assessed as highly significant, firstly for the construction phase and secondly for the operation and maintenance phase. Consequently extremely close attention was suggested to be paid for the selection of the site for such project to minimise the environmental risk. Consideration should be given to all levels of the ecosystem from seabirds to benthic biota. The assessment of the environmental impact to any section of the marine biota should then be treated as a trophic cascade and modelled against population dynamics to assess the final impact of this proposal.

Furthermore, the installation of this sea deployment is huge and involves high cost of investment, with an assessed negative balance between costs and benefits. Currently its realisation has not been considered imminent, due to the low technology readiness level of many parts and the novelty of such configuration.

Table 5-10 H2Ocean Project: summary of case-studies.

Sea Basin	Case Study Location	Case-study code	Environmental characteristics/Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2
Atlantic	West Coast of Portugal	H2O-1	Excellent wave resource and good wind resource	Integrated multipurpose platform including vertical axis wind turbine, wave energy converter, production of Hydrogen, Oxygen and drinking water. Supporting Multi-trophic aquaculture	Joint development site-specific concept design	Offshore wave energy	Desalinisation Hydrogen generation Aquaculture-seaweed Aquaculture-shellfish Aquaculture-fish

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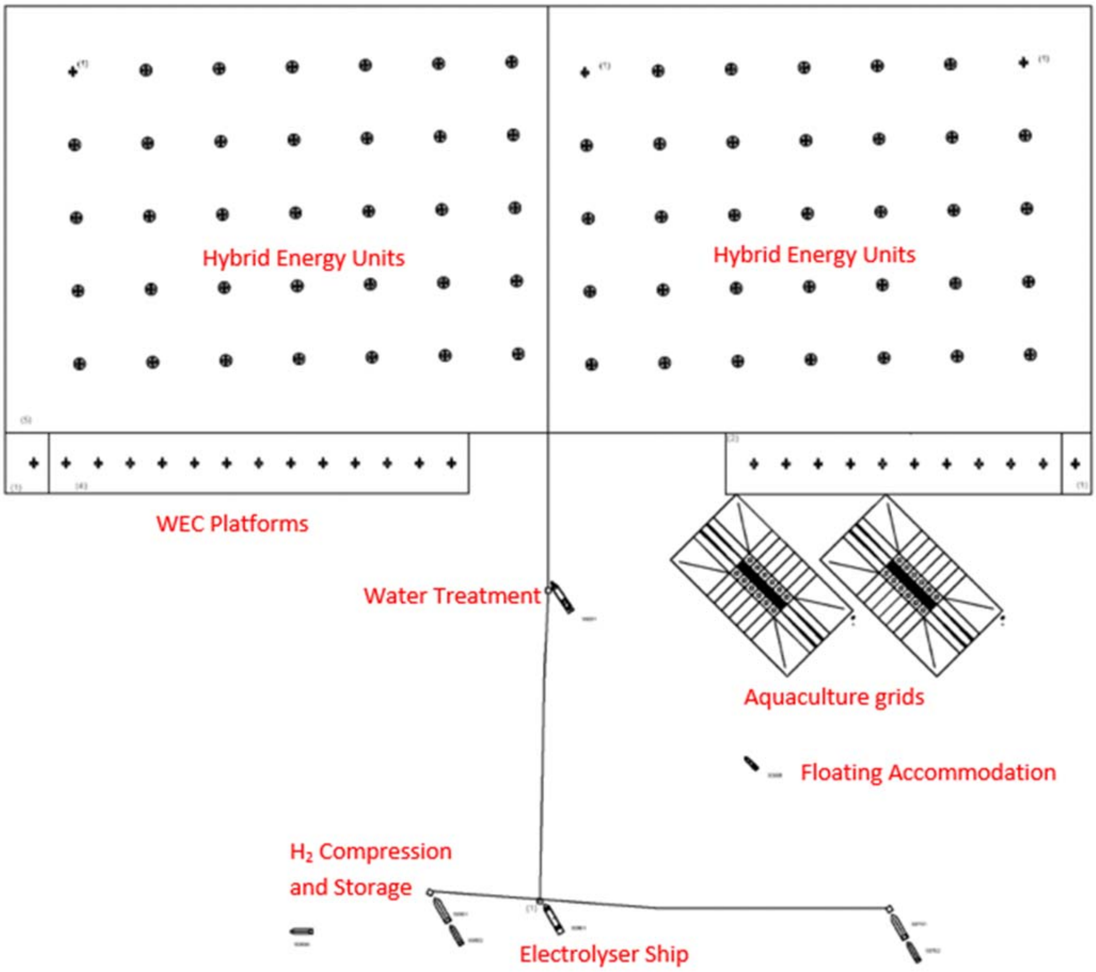

Figure 5-5 Conceptual layout of the H2Ocean project approximately 50 km off the coast of Portugal. Source: H2Oceans Project deliverable D10.5 "Project Risk Register".

d. MARIBE

MARIBE (unlocking the potential of multi-use of space and multi-use of platforms, www.maribe.eu) is a project funded under the European Commission's Horizon 2020 programme.

It's a 18-month project (2015-2016), led by a consortium of 11 partners from Ireland, United Kingdom, Belgium, Spain, Italy, Malta and the Netherlands. It was coordinated by University College Cork (MaREI). The project had a cost of 2 million EUR.

The project aims were to unlock the potential of multi-use of space in the offshore economy (also referred to as Blue Economy). This forms part of the long-term "Blue Growth" strategy to support sustainable growth in the marine and maritime sectors as a whole.

MARIBE is particularly interested in promoting smarter and more sustainable use of the sea through the sharing of space. It has investigated the potential of combining the activities of different maritime sectors in the same place or on a specifically built platform in order to make more efficient use of space and resources. It pays particular attention to new and emerging industries that can benefit greatly from the synergies created, increasing their chances of survival and enabling future

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growth. These sectors are often referred to as Blue Growth industries: Marine Renewable Energy, Aquaculture, Marine Biotechnology and Seabed Mining.

MARIBE assessed the potential for combination of different Blue Growth or Blue Economy sectors, from a technical, environmental, socio-economic, financial and commercial perspective. This resulted in the identification of a list of high-potential combinations which were then shortlisted in liaison with the European Commission.

According to the Project Deliverable 5.4 "Comparative review of the situation in the 4 basins", the most suitable combinations for the studied basins are:

For the Atlantic basin: wave energy with wind energy;

aquaculture with wave energy or/and wind energy.

For the Baltic basin: aquaculture with wind energy;

aquaculture with offshore fixed terminal/shipping;

For the Caribbean basin: aquaculture with offshore fixed terminal/shipping;

aquaculture with tourism.

For the Mediterranean and Black Sea basin: wave energy with oil and gas;

aquaculture with wave energy;

aquaculture with biotechnology.

Nine case studies were finally selected for combination concepts. MARIBE engaged with industry partners to conduct these case studies located in four European sea basins: Atlantic, North and Baltic Seas, Mediterranean and also the Caribbean (Figure 5-6). Information on MU projects are available on the MARIBE website and in the MARIBE Project Booklet. The Main advantages of the proposed combinations of uses are highlighted (added values according to terminology adopted in the MUSES Project). No information has been detected for the other elements (drivers, barriers, impacts). Indeed, an important conclusion of the Deliverable 5.4 of the Project "Comparative review of the situation in the 4 basins", is that most of the encountered barriers for the four studied basins affect one sector and are due to one sector, but they don't depend on the combination of them, regardless of the different basins.

A summary of the main features of each case-study is provided in Table 5-11.

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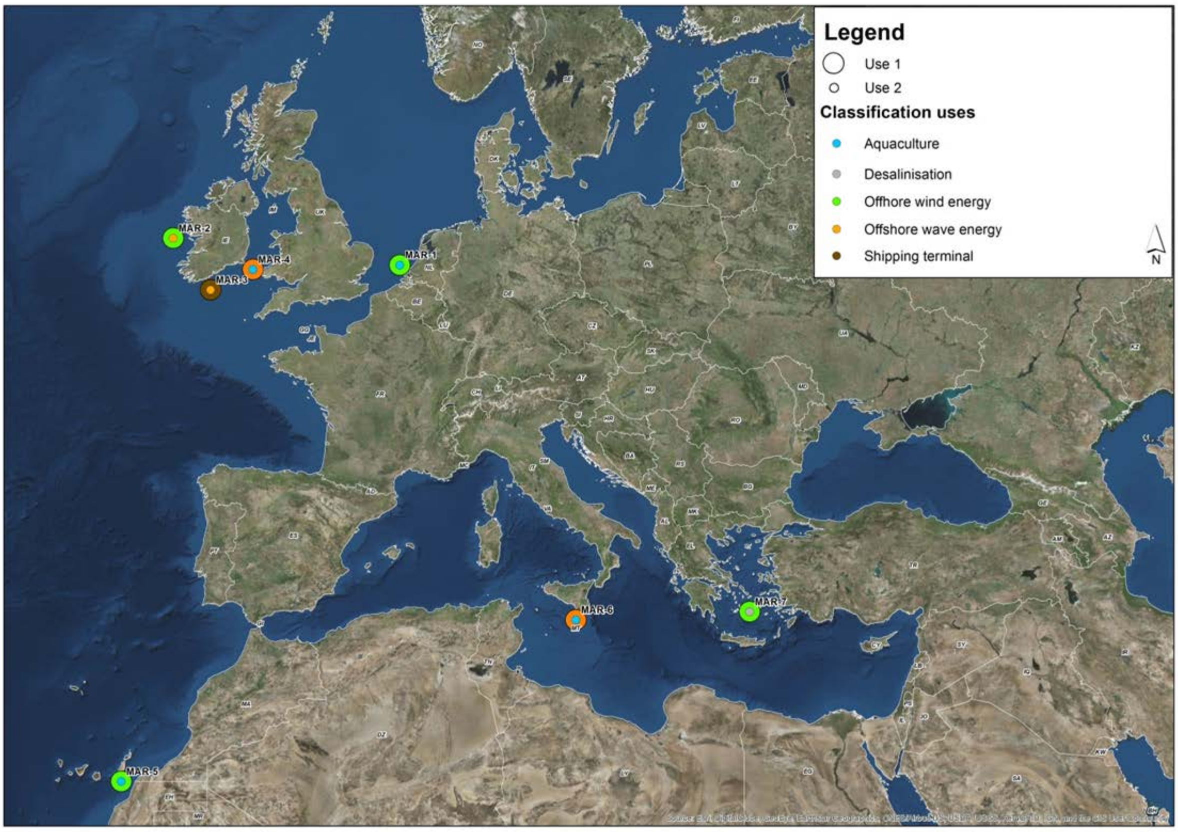

Figure 5-6 Localization of case-studies sites for MARIBE Project in the Atlantic basin, North Sea basin and Mediterranean basin and proposed combinations of uses. A further case-study (not shown in the map) is located in the Caribbean sea.

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Table 5-11 MARIBE Project: summary of case-studies.

Sea Basin	Case Study Location	Case-study code	Environmental characteristics/Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2
North Sea	Borssele wind park	MAR-1	Distance of 500 metres to the continental shelf of the border with Belgium; Optimal wind resource	Bottom fixed wind turbines with mussel aquaculture	Staggered development site-specific concept design	Offshore wind energy	Aquaculture-shellfish
Atlantic	West coast of Ireland	MAR-2		Floating Mixed use platform (MUP). Oscillating Water Column (OWC) wave energy converters, wind turbine mounted on the platform via a steel superstructure	Joint development site-specific concept design	Offshore wind energy	Offshore wave energy
Atlantic	South coast of Ireland	MAR-3		Pneumatically stabilized platform. Floating Central hub shipping and container terminal. Oscillating Water Column Wave energy converter	Joint development site-specific concept design	Shipping terminal	Offshore wave energy
Atlantic	Welsh coast	MAR-4		Array of wave energy converters (WEC) combined with a seaweed farm	Joint development site-specific concept design	Offshore wave energy	Aquaculture-seaweed
Atlantic	Gran Canaria	MAR-5	Annual average wind speed 23.3-25.3 km/h main wind direction from NNE and N	Offshore wind turbines mounted on floating platforms, sharing the same space as an aquaculture installation	Joint development site-specific concept design	Offshore wind energy	Aquaculture-fish
Mediterranean	Malta	MAR-6		Special Purpose Vehicle to use wave energy for aquaculture pourpouse	Joint development site-specific concept design	Offshore wave energy	Aquaculture-fish
Mediterranean	Cyclades Islands	MAR-7	Located at few km from the shore water depth exceeding 40 meters; Good wind resource	Semi-submersible steel platform, accommodating an offshore wind turbine and a desalination plant	Joint development site-specific concept design	Offshore wind energy	Desalinisation
Caribbean	Caribbean Sea	MAR-8	Maritime cross route between from East to West, Central America and Western Africa, and from South to North, Brazil and Caribbean Islands.	Floating multi-use terminal for Shipping, Oil and gas and aquaculture	Joint development site-specific concept design	Shipping terminal	Oil and gas Aquaculture-general

Atlantic basin

Four sector combinations were analysed for the Atlantic basin:

1. Floating Offshore **Wind** and **Wave**

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The proposed combination is a mixed use platform (MUP) consisting of a large V---shaped concrete structure incorporating Oscillating Water Column (OWC) wave energy converters, with a wind turbine mounted on the platform via a steel superstructure.

The concrete construction is modular allowing easier fabrication and assembly. Other advantages of the concrete construction include the cost---effectiveness of concrete as opposed to an entirely steel construction, ease of maintenance and the proven technique of slip-form concrete construction.

By combining wave and wind technology in the same platform, the economic viability of the technology will be increased. The aggregation of wind and wave energy converting technologies reduces the variability of the power generated by the platform as a whole with respect to time. It will also be able to make maximum use of the resources available at any particular location, and due to the floating aspect, will be deployable in water depths previously beyond the limits of current fixed offshore wind technology.

Planned deployment location for the pilot is off the west coast of Ireland (Atlantic).

2. Floating Terminal **Shipping**/**Wave**

The proposed solution combines a floating shipping terminal with wave technology. The envisaged multi-use platform serves as a central hub shipping and container terminal using a wave energy converter as a complementary renewable energy sources for powering the platform and/or potentially export to the grid.

The identified location is off the South coast of Ireland (Atlantic), an ideal location for a central hub shipping and container terminal providing Short Sea Shipping re-distribution of in/outbound container traffic entering European waters.

Pilot testing (“proof-of-concept”) was at Galway Bay, with a small floating structure and 10 wave energy units. Pre-commercial and commercial deployment was on the south coast of Ireland, with increased number of both floating units and wave energy devices.

Benefits from the combination between wave energy and shipping include a general cost reduction and in an increased ease of access (for wave energy point of view) and wave attenuation as well as autonomous supply of clean renewable energy (for the platform).

3. **Wave**/**Seaweed** aquaculture

This concept envisaged an array of wave energy converters (WEC) combined with a seaweed farm.

The seaweed farm will benefit from calmer water behind the devices, enabling them to be located in areas which would not normally be viable. During periods of rough seas, electricity from the WECs can be used to winch the seaweed farms lower into the water, protecting them from any ill---effects. Electricity from the WECs could be exported to the grid. The combination can benefit from an easier licensing process due to the multiple use of space, and there are also significant synergies for installation, inspection and maintenance operations.

The expected location of the pilot deployment is off the Welsh coast (Atlantic).

4. **Wind/ Aquaculture**

The combination involved offshore wind turbines mounted on floating platforms, sharing the same space as an aquaculture installation.

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The deployment location was planned off the South--East coast of Gran Canaria (Atlantic). The concept was identified and examined previously in the EU TROPOS project (par.b).

The commercial development envisaged a beginning with 5 offshore wind turbines mounted on floating platforms, sharing the same offshore space with an operational finfish type aquaculture installation. This pre-commercial first stage is underway having secured part of the funding required from NER 300 (offshore wind farm project FLOCAN). Expansion to a full commercial farm might be the next phase with additional wind units and aquaculture cages installed at the same site. Market entry will be completed with a 2nd commercial farm at a new site at Gran Canaria followed by a 3rd commercial project including 25 offshore wind turbines and 24 cages for Seabass production to be deployed at the PLOCAN testing site off the South-East coast of Gran Canaria.

The advantages of this multiple use of space (MUS) include more efficient use of scarce licenced space and possible complementarities, including, among others, using the floating structures to protect part of the “cages” from the damage of strong currents and shared security and monitoring systems.

Mediterranean basin

Two combinations have been explored for the Mediterranean Sea:

1. **Wave/Finfish aquaculture**

A Special Purpose Vehicle (SPV) has been proposed to provide wave energy for aquaculture purposes, exploiting synergies in sea-space equipment usage, facilitating amongst others the movement of commercial cage farming further offshore. Utilising the combination, fish can be produced with a vastly reduced environmental impact by utilising the renewable electricity provided by the Wave Energy device (WaveNet) to service specifically the energy requirements of the farming operations.

The SPV’s target market focuses on both existing and new cage farming operations, however it is envisaged that the WaveNet will also be utilised extensively to provide power (and potentially potable water) to shore based marine aquaculture facilities in areas where wave energy is suitably abundant and supply of grid---based electricity is expensive or unavailable.

Advantages of this combination include (but are not limited to) cost savings, increased sustainability of operations, protection from rough seas (calmer waters for aquaculture farm), guaranteed sale of electricity to aquaculture customer, development of aquaculture in an offshore, clean-water site.

The planned location of the pilot is off the coast of Malta (Mediterranean Sea). A possible expansion of the wave energy element would enable export potential to the Maltese grid where electricity costs are high and the use of renewable energy is still low.

2. **Wind/Desalinisation**

The combination of the proposed technologies is based on a semi-submersible steel platform, accommodating an offshore wind turbine (2 MW) and a desalination plant using Reverse Osmosis (RO) desalination with a maximum output of 3360 m3 per day. They can desalinate seawater at times of high wind resource which is transferred via water pipes to the islands and stored in existing drinking water storage tanks.

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The intended deployment location is the Cyclades islands (Mediterranean Sea), Greece within a few kms from the shore at a water depth exceeding 40 meters. The area has good wind resource with average wind speed measured offshore to Santorini island at 8.6 m/s at a 100m elevation. During installation the MUP was towed to location avoiding the use of costly specialist vessels which also enables the unit to be easily towed to the nearest harbour for major maintenance. While initially the MUP turbines will focus simply to power the desalination process they can also export surplus electricity to the island grid via cable.

North Sea basin

The project draws on the results of the MERMAID consortium (cfr par. a). One of the most promising designs for the North Sea included wind farms with bottom-fixed offshore **wind** turbines and **mussel aquaculture**.

The envisaged system is a multi---use of space (MUS) only. The turbine foundations are not used to attach the mussel aquaculture systems.

The project focused on the windpark "Borssele" (North Sea), consisting of 4 plots, with a total site area of 344 km², located 12 nautical miles (22-39 km) offshore. Grid connection is scheduled to be ready 31 August 2019.

The development builds upon experience with existing wind parks, and technologies for offshore wind are available and tested. The permitted foundations are monopile, tripod, jacket, gravity based and suction bucket for turbines in the range of 4 to 10 MW. The government support scheme is a contract-for-difference (CFD). In this combination, multi-use of the wind parks includes the production of mussels. Due to the growing pattern of mussel aquaculture mussel seed, half-grown and full-size consumption mussels are produced. The Dutch Mussel industry and NGO's have agreed to collect mussel using long-lines. Although these devices are mainly used in the Wadden Sea, it is expected that by 2020, 5.5 million kg of mussel seed will be collected annually in the North Sea. In the commercialisation phase of the project the installation of 98 ha of mussel aquaculture units was proposed. This equates to 98 ha of support lines. The wind park development was guaranteed.

The commercial development plan for the technology has three key stages: A first test (pre-pilot) is to generate further knowledge on the potential risks of mussel aquaculture in the offshore wind park. The second stage is the first multi-use pilot, to provide evidence for safe and feasible operating practices, as well as contribute to fine-tuning of technologies for offshore maintenance and harvesting. To this end, a mussel aquaculture farm the size of 9 ha was suggested in the existing wind park Amalia. The third stage included full-scale commercial operations.

Advantages of the combination include (but are not limited to) general socio---economic societal benefit (as 100% renewable sources are employed) and cost reduction. Moreover, the wind park provides the mussel companies with an area that is not accessible to other larger vessels, reducing risk that the mussel facilities are negatively affected by these vessels. Mussel aquaculture makes the area less accessible for other vessels, reducing risk of collisions with unfamiliar vessels (benefit for wind farm). Mussel aquaculture can have a wave dampening effect, reducing fatigue and resultant Operation and Maintenance for wind farm structures.

Caribbean Sea

The envisaged floating multi-use terminal served three main sectors: **shipping** (container transfer hub), **oil & gas** logistics hub, and **aquaculture** support.

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The company involved is the Grand Port Maritime de Guyane, one of 11 large sea ports operated by the French State. The current ports on the coast of Guyana Shelf are all river ports and require regular, expensive dredging in order to accommodate modern container vessels. It will not be possible to extend this dredging programme to an extent that the new generation of Panamax container vessels can be hosted.

For this reason, the envisaged facility will be located in the Caribbean Sea, on the maritime cross route between from East to West, Central America and Western Africa, and from South to North, Brazil and Caribbean Islands.

The location also has the added advantage of potentially serving most of the Guyana Shelf Oil & Gas production platforms and enabling offshore aquaculture in one of the most propitious area in the world. The multi-use offshore platform architecture will be scalable and its structure will be constructed using multiple floating concrete modules.

e. ORECCA

The ORECCA (Offshore Renewable Energy Conversion Platform Coordination Action, www.orecca.eu) Project is an EU FP7 funded collaborative project in the offshore renewable energy sector. The project (duration from 2010-03-01 to 2011-08-31) had a cost of 1.8 million EUR and the European Union granted a financial contribution of 1.6 million EUR.

The project's principal aim was to overcome the fragmentation of know how available in Europe and its transfer amongst research organisations, industry stakeholders and policy makers stimulating these communities to take the necessary steps to foster the development of the offshore renewable energy sector in an environmentally sustainable way.

The project's focus is pan European and pan technology, with a specific focus on the opportunities that exist across Europe when the three offshore renewable energy sectors within the project's scope are considered together: Offshore **Wind**, **Wave** and **Tidal** Energy.

These energy sectors have been identified as those that are currently expected to make significant contributions to the energy system in the medium to long term.

According to the analysis performed in Orecca (Project deliverable of WP4), offshore wind was the more advanced sector, while for tidal stream energy no commercial devices were available at that time, while a large number of devices were under various stages of development. In the wave energy sector there were a large number of different devices at various stages of development, based on a number of different principles.

Combined use of different renewable energy and complementary use of a platform for aquaculture (e.g. biomass and fishes) and monitoring of the sea environment (e.g. marine mammals, fish and bird life) were also addressed by the Project.

The ORECCA project considered three target geographical areas: North and Baltic Sea, Atlantic Ocean and Mediterranean and Black Sea. No specific case studies have been identified.

The Final Output of the project is a "Roadmap" (ORECCA, 2011) developed for the offshore wind, wave and tidal stream energy sectors, focussed on the synergies, opportunities and barriers to development that are revealed when the sectors are investigated together in pan-technology and pan-European context.

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The roadmap is structured around five key streams which are essential to the development of the offshore renewable energy sector: resource, finance, technology, infrastructure, environment regulation and legislation.

The map of Table 5-12 reports where offshore wind, wave and tidal stream resources exist across Europe, but also reveals the potential for combined resources.

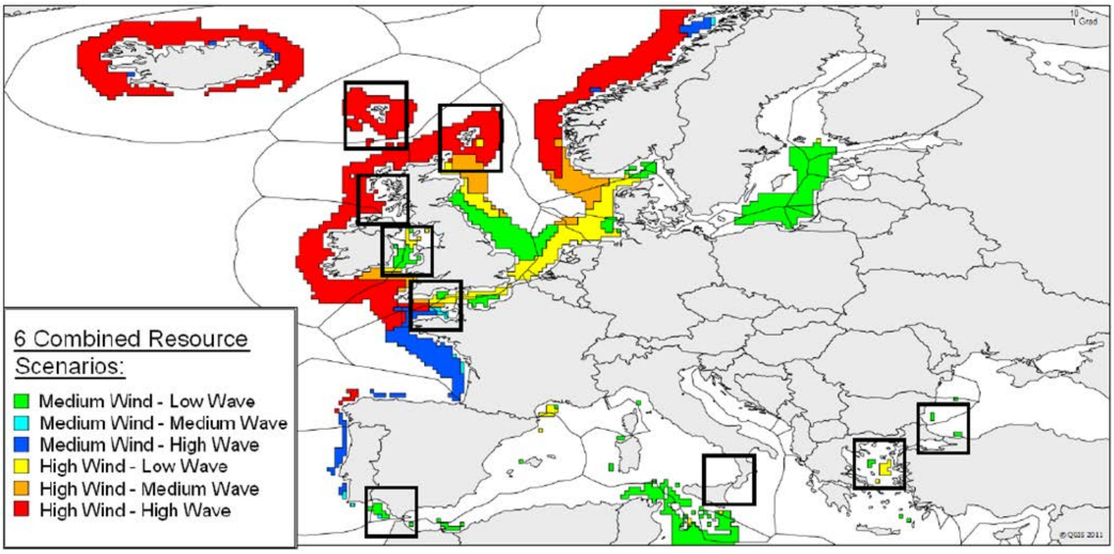

Table 5-12 Combined resource map showing wind and wave resource across 6 scenarios with the tidal stream resources overlaid and highlighted in the black panes. Source: ORECCA, 2011.

North Sea and Baltic Sea

Large amount of resource across offshore wind, wave and tidal, particularly concentrated in the Northern part of the North Sea, off the coasts of the UK and Norway. Approximately 40% of the resource area in the region is further than 100km from shore and approximately 60% lies in water depths of greater than 60m.

Atlantic Ocean

Large amount of high intensity resource, across offshore wind, wave and tidal, particularly concentrated in the Northern part of the Atlantic region, off the coasts of Ireland, Scotland, the UK and France. Approximately 60% of the resource area in the region is further than 100km from shore and approximately 97% lies in water depths of greater than 60m. Therefore developing devices which can be deployed in water depths of greater than 60m will increase the potentially exploitable resource area by more than thirty-fold.

Mediterranean and Black Sea

Relatively small amount of resource compared to the other two geographical areas. Tidal resource exists in the region, but is concentrated in a small number of specific areas. Wind resources exist but wave resources in the region are low intensity. Approximately 30% of the resource area in the region is further than 100km from shore and approximately 94% lies in water depths of greater than 60m.

The roadmap (ORECCA, 2011) identified two principal "hotspots" where a large amount of high intensity combined resource (across offshore wind, wave and tidal energy) exists in Europe:

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- The Western facing Atlantic coastline, off the coasts of Scotland, the UK, Ireland, Spain and Portugal.
- The Northern North Sea, off the coasts of Norway and the UK.

The roadmap concludes that in the short to medium term, main focus should be on facilitating developments in these two areas which present the largest opportunity for the sector.

A less intense, but still significant combined natural resource also exists in other regions. This resource presents a future opportunity for the sector once floating wind and offshore wave power are commercial.

The following combinations of devices have been envisaged, by sharing areas (co-location) or even by sharing platforms (ORECCA Project deliverable of WP4):

- WIND-WAVES: a large number of sites in Northern Europe are suitable for a combination of wind and waves; in the Atlantic Ocean most of these sites feature water depths where floating installations have to be used; in the Mediterranean and Black Sea combinations of wind turbines and more cost-effective, purposely-developed wave devices can be considered.
- TIDAL-WIND and TIDAL-WAVES: widespread combination of tidal resources with wind and/or wave resources seems more critical because it is highly site-dependent and sites are generally not very large. However a number of sites exist in Northern Europe, but the feasibility and convenience of developing them has to be carefully evaluated locally. In the Mediterranean area a good site for wind-current combination seems to be the marine area near Gibraltar.
- WIND-SOLAR and WAVES-SOLAR: this combination seems to have a chance in the Mediterranean basin and however at latitudes at which solar energy is significant. Offshore solar energy converters have already been under consideration and their combination with wave devices has already been proposed. Recently the idea of floating solar panels has been proposed even though for production “Synergies, innovative designs and concepts for multipurpose use of conversion platforms” results of ORECCA Project – WP4 -of fresh water at the moment. Corrosion problems due to marine environment have to be investigated.
- WIND-AQUACULTURE: this seems to be one of the most promising of all combinations because the two technologies are already at a fairly advanced stage of development. Combined environmental impacts (such as underwater noise) have to be investigated. Combination of aquaculture and wave devices is strictly related to the type of wave device in consideration.
- WAVES-BREAKWATER: this seems to be a promising combination because in many marine contexts breakwaters have to be built for protection of coasts against waves.
    - OTHERS: Combination of offshore renewable energy converters with desalination, transport, storage systems and tourism could be taken into account too.

f. MARINA Platform

MARINA Platform was a large European collaborative R&D project on multi-purpose offshore renewable energy platforms that ran from January 2010 through June 2014, within the 7th Framework Programme (FP7), Energy sector, with a total budget of 12.8 million euro.

The project was led by the Spanish utility Acciona Energía and included a series of universities, technology centres and specialized companies from many European countries.

The primary objective of the MARINA Platform Project was to provide a set of protocols covering the engineering and economic evaluation of multi-purpose Marine Renewable Energy (MRE) platforms, taking into account also non-energy uses and planning & consenting issues surrounding their deployment.

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MARINA has established criteria for generating, assessing and evaluating combined concepts for wind & ocean energy utilisation, produced an atlas for the combined offshore renewable energy resources, and a wide set of system design, modelling and optimisation tools. Cost aspects, risk modelling, key components, grid issues, and other relevant aspects of multi-purpose energy platforms have been addressed.

The project combines deep-water engineering experience from European oil gas developments during the last 40 years, state-of-the-art concepts for offshore wind energy, and the most promising concepts in today's R&D pipeline on wave energy and other marine renewables.

Research in the MARINA Platform project aimed to establish a set of equitable and transparent criteria for the evaluation of multi-purpose platforms for marine renewable energy (MRE). Using these criteria, the project produced a novel, whole-system set of design and optimisation tools addressing, inter alia, new platform design, component engineering, risk assessment, spatial planning, platform-related grid connection concepts, all focussed on system integration and reducing costs

The first project period identified more than 90 novel concepts for multi-purpose platforms exploiting wind, wave and tidal resources. During the second reporting period, 10 generic concepts were selected from the original ones and developments related to assessment tools were employed to whittle the 10 down to 4 or 5 for the final project period.

Specifically, the team put the final data from 10 years of wind, wave and tidal data collected over the whole of Europe into a site-selection tool. Scientists developed numerical models of each of the 10 concepts individually for a set of representative locations. Structural models focused on survivability, power production and responses to forces and stresses in the extreme environments in which the platforms will operate. Researchers evaluated critical components and conducted statistical cost analyses with a tool developed within the project. Finally, they made important progress in assessing grid availability for selected locations and defining cost-effective solutions for connection and distribution.

Ultimately, MARINA PLATFORM delivered a variety of tools to assess the engineering, economic and environmental suitability of multi-purpose MRE platforms as well as a spatial planning decision support tool. In addition, recommendations were developed for standardisation and certification groups that should facilitate safe, effective and efficient exploitation of MRE.

g. Submariner Project

Submariner Project (Sustainable Uses of Baltic Marine Resources, http://www.submariner-project.eu/) was funded by the Baltic Sea Region (BSR) Programme 2007-2013. It had a total budget of € 3.6 million, of which € 2.8 million are ERDF co-finance and € 0.8 million are partners' contributions. It ran from October 2010 to December 2013.

The SUBMARINER Project brought together a strong consortium of partners from all Baltic Sea Region countries which offered all expertise necessary for the project from their own sources. It combined national environmental decision-makers interested in the ecologically sound development of the Baltic Sea Region, centres of excellence for all new uses under discussion, regional development agencies and innovation centres.

From the initial SUBMARINER project (2010–2013), the SUBMARINER Network has been constituted, bringing together an unlimited range of public and private actors and stakeholders from around the

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BSR countries, in order to further promote and realise activities necessary for using marine resources innovatively and sustainably.

The SUBMARINER project focused on the Baltic Sea Region which is facing enormous challenges including new installations, fishery declines, excessive nutrient input, the effects of climate change as well as demographic change. Novel technologies and growing knowledge also provide opportunities for new uses of marine ecosystems, which can be both commercially appealing and environmentally friendly.

Within the project, a comprehensive assessment of the Baltic Sea Region has been provided, covering not only natural science, but also economic, technological, institutional and legal aspects of marine uses.

The two main output of the Project are:

- the Submariner Compendium, providing the first comprehensive assessment of the potential for innovative and sustainable uses of Baltic marine resources.
- the Submariner Roadmap, recommending necessary policy steps to promote beneficial uses and mitigate against negative impacts.

In the Submariner Compendium (Schultz-Zehden et al., 2012) the current state of knowledge has been gathered and set against the backdrop of environmental, institutional and regulatory conditions for the following topics:

- Macroalgae Harvesting & Cultivation
- Mussel Cultivation
- Reed Harvesting
- Large-Scale Microalgae Cultivation
- Blue Biotechnology
- Wave Energy
- Sustainable Fish Aquaculture
- Combinations with Offshore Wind Parks.

As for the last issue, which is the most relevant for the MUSES Project, the concept of combining different uses of the sea space with offshore wind parks has been explored (Schultz-Zehden et al., 2012).

The potential area of Baltic Sea available for "combined uses" within offshore wind-parks has been estimated in the range of 850 Km^2 by 2030 representing 25% of the total space between individual mills in these parks.

Possible combinations with Offshore Wind Parks (Table 5-13) include: harvesting of natural fouling agents in the submerged parts of the windmill constructions (source of proteins for fish feed or biomass contribution to local energy systems), macroalgae cultivation, mussel cultivation, fish farming, wave energy and microalgae cultivation.

According to the Submariner assessment, whereas planning for offshore wind is advanced, little is known on various forms of combination with mariculture and even less is known about wind-wave combinations. The compendium highlights the needs of practical evidence for multi-use and of political support to promote demonstration plants and pilot tests.

As for wind-mariculture combination, one single practical pilot application has been identified throughout the Baltic Sea, in the Danish Rødsand II wind park, covering an area of 34 Km^2, off the

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south coast of Lolland, producing 800millKWh per year and supplying 200.000 households with electricity.

A test on biomass production was conducted in this area over a one year long period from September 2012 to August 2013 (Christensen et al., 2013). A pilot plant was constructed, consisting of two 30x4m nets kept in position by anchors, a carrying line with buoys to keep them elevated and a weight line to secure the vertical position. The nets were arranged one after another on a straight line between the two wind mills at the water depth of 10m (Figure 5-7). Sampling was done 5 times on each net during the experiment and estimates of yearly biomass and sequestrated nitrogen were performed, leading to promising results. A great potential for removing nutrients from the Baltic Sea using installations suitable for the cultivation of biomass was highlighted. At the same time the pilot project revealed important challenges and needs of further investigations.

The map of the whole study area of the Submariner Project, with the location of the Rødsand II wind park is shown in Figure 5-8.

A summary of the main features of the considered case-study is provided in

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Table 5-14. For the specific case of Rødsand II wind park, a combination of three uses is proposed: Offshore Wind Energy, Environmental Protection and Aquaculture.

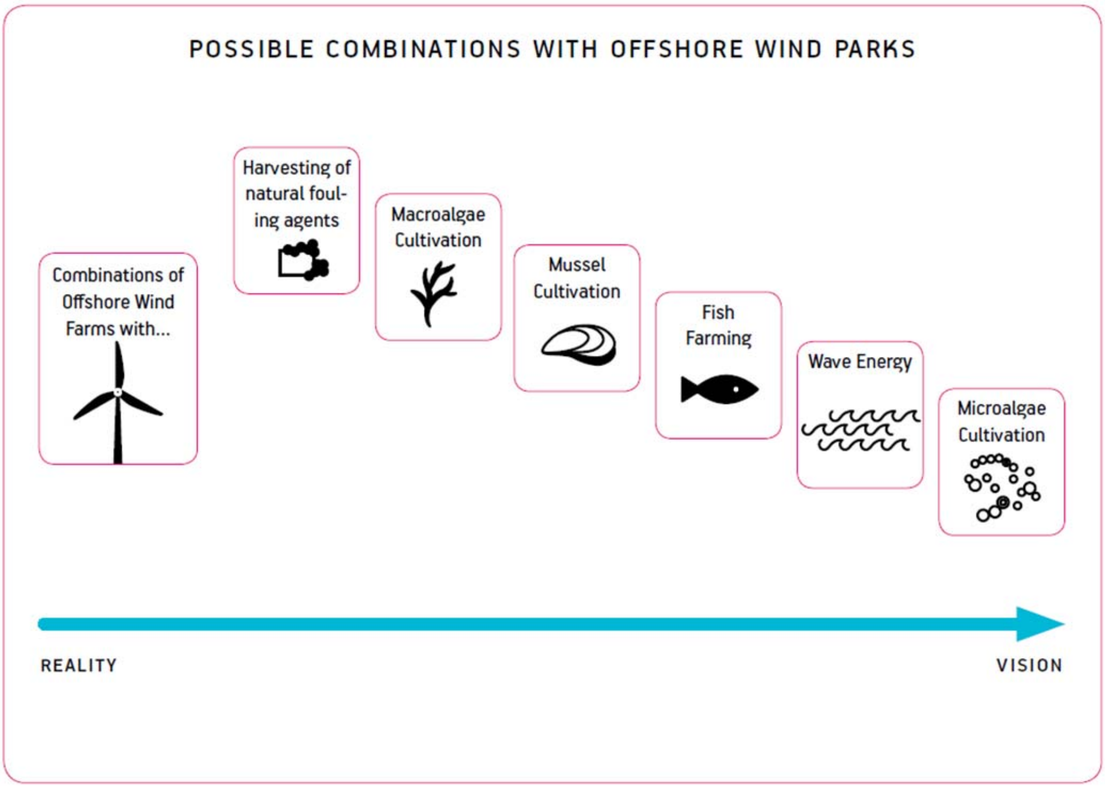

Table 5-13 Possible combinations with Offshore Wind Parks. Source: Submariner Compendium, Schultz-Zehden et al., 2012.

Figure 5-7 The established pilot plant inside the Rødsand 2 wind park. Source: Christensen et al., 2013.

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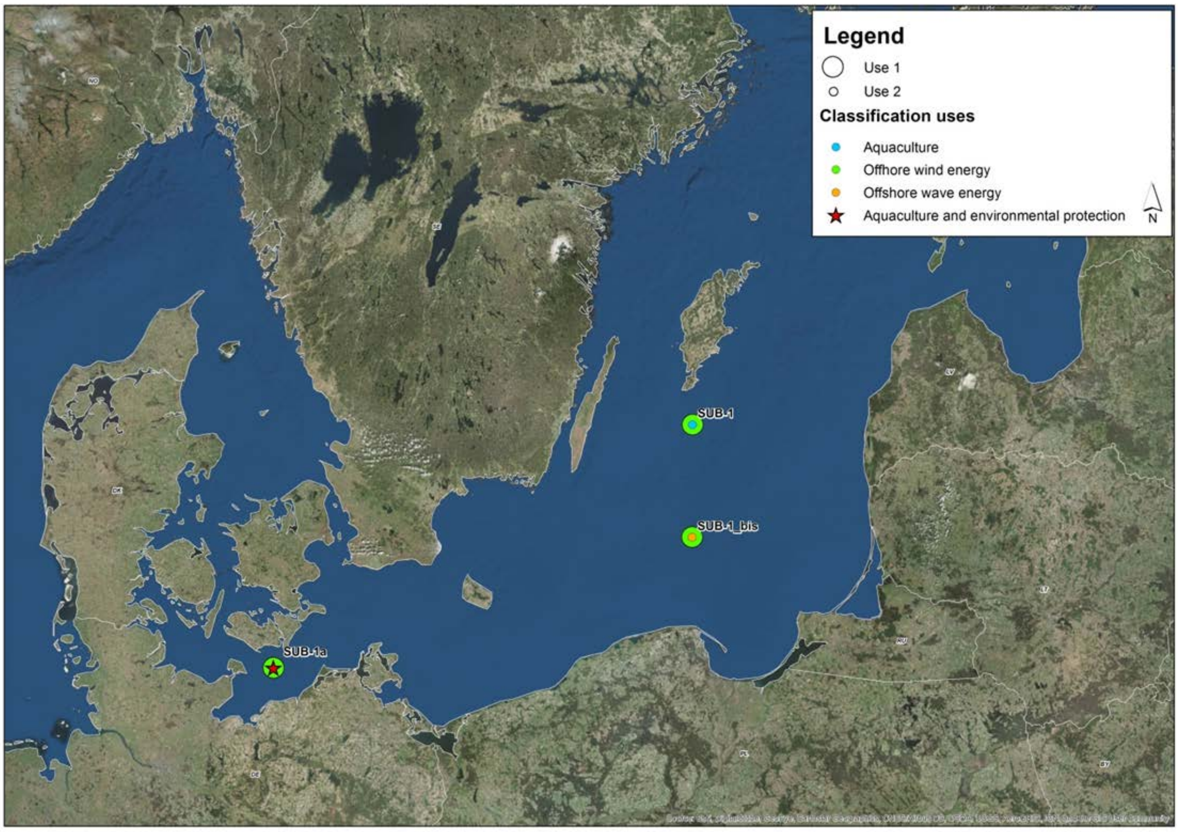

Figure 5-8 Main combinations of uses explored by the Submariner project. SUB-1 and SUB-1bis refer to the whole Baltic Sea Region and not to specific points of Baltic Sea. On the contrary, SUB1a refer to the specific location of Rødsand pilot plant.

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Table 5-14 SUBMARINER Project: summary of case-studies.

Sea Basin	Case Study Location	Case-study code	Environmental characteristics/Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2
Baltic	Baltic Sea Region	SUB-1	Optimal oceanographic conditions. The highest wind energy technical potential in EU	Possible combinations between offshore Wind Parks and other marine uses	Staggered development evaluation of co-location potentials	Offshore wind energy	Aquaculture-general
						Offshore wind energy	Offshore wave energy
	Rødsand II wind park	SUB-1a	Shallow waters near to the Danish coast. Excellent wind resource	Wind park- gravity foundations, 5 rows of 18 turbines each. Nets arranged between two mills	Staggered development Experimental field test	Offshore wind energy	Environmental protection Aquaculture-shellfish Aquaculture-seaweed

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3. DESCRIPTION OF NATIONAL MULTI-USE PROJECTS AND STUDIES

a. TripleP@Sea

TripleP@Sea research (Smart use of marine ecosystem services providing sustainable Profit of the Planet for People) focused on the production, processing and profitability of seaweed as a source for feed, chemicals and fuel. Seaweed is an important marine product, with total production exceeding 15 million tonnes, representing a market value of more than 4 billion US$.

The Research project (2012-2015) was part of the Wageningen UR strategic R&D programme and it was partly funded by the Dutch Ministry of Economic Affairs through the KB programme 'Sustainable Development of Green and Blue Space'.

The project aims were to provide sound scientific and societal applicable knowledge that stimulates widespread offshore production of marine protein, taking into account ecosystems values, value chains and the involvement of stakeholder communities.

Research results are reported in Burg et al., 2012 (www.wageningenUR.nl/en/lei), a joint result of researchers of various Wageningen UR institutes which integrates multiple scientific disciplines. The report combines new research with knowledge and expertise from various research projects Wageningen UR is involved in.

Specific case studies were not been considered, furthermore designs of multi-use were not proposed. The study area was the whole North Sea (Table 5-15), where the feasibility of seaweed production in multi-use platforms has been assessed from a Triple P perspective: Profit, Planet and People.

In the first part of the study, the state-of the art in North Sea seaweed production and application is examined. Possibilities for production of seaweed in Integrated Multi-Trophic Aquaculture where nutrient emitted from fin-fish aquaculture can be used for seaweed cultivation, were also addressed, concluding that North Sea conditions are not favourable for fish culture. Initial focus should be given to combinations of **shellfish** (mussels) and **seaweed** production. Development of technical solutions for offshore culture of bivalves, seaweeds and even fish culture are a key issue for aquaculture development in offshore areas. It is also important to define the growth potential of each species for the specific environmental conditions in the North Sea.

In the second part of the study, the feasibility of seaweed production in the North Sea was assessed from a Triple P perspective, evidencing costs and revenues (Profit), eco-sustainability issues (Planet) and governance requirements (People). The possibility of including aquaculture in Multi Use Platforms at Sea (MUPS) has also been assessed.

According to the study, the development of MUPS, despite the interest in the concept, is at a very early stage in the North Sea, with no real-life applications yet. MUPS can be found only as designs on paper, or as the first experiments with seaweed production on sea. As a consequence, there is no established framework of policies and regulations describing what conditions MUPS should meet. At present no manifest interest in investing in MUPS has been identified, because there is not yet a clear business case and many risks are identified.

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Table 5-15 TripleP@Sea Project: summary of case-studies.

Sea Basin	Case Study Location	Case-study code	Environmental characteristics/ Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2
North Sea	North Sea	TRIP-1		No design specification The possibility of developing offshore seaweed aquaculture as part of multi-use platforms at sea (MUPS) has been assessed	Joint/Staggered development evaluation of co-location potentials	Aquaculture -seaweed	Aquaculture -shellfish Offshore Wind energy

b. SAGB Co-location Study

"**Aquaculture** in Welsh offshore **wind farms**, a feasibility study into potential shellfish cultivation in offshore wind farm sites" has been undertaken on behalf of the Shellfish Association of Great Britain (SAGB) and was funded by Welsh Government and the European Fisheries Fund (EFF). The project aimed to develop a pathway enabling and encouraging the cultivation of shellfish in Welsh offshore wind farms. The project involved desk-top studies and the development of links between the shellfish industry, off-shore renewable operators and developers, regulators, academics and marine resource managers to ensure that the study benefited from and included the multiple perspectives and interests of many stakeholders.

The EFF Co-Location Project originally envisaged two principal outputs, namely:

- Aquaculture Opportunities - A review of past studies, policy drivers and permission for shellfish cultivation within offshore wind farm sites. An Aquaculture Opportunities Report on the results of the review of past studies, policy drivers and permission/licensing for shellfish cultivation within offshore wind farm sites, with recommendations on what shellfish culture options appears most feasible and why, was produced as the first output.
- A Guidance Manual on how to cultivate shellfish within an offshore wind farm site

The results of the two reports have been integrated in the project final document (Syvret et al., 2013) available in the web site of the Shellfish Association of Great Britain (SAGB).

According to this study, the most obvious candidate for economically viable commercial culture operations in offshore wind farms can be identified in the blue mussel (*Mytilus edulis*), while in the medium-long term, an opportunity to diversify aquaculture into other shellfish species or seaweed has also been explored.

Permissions and licensing in order to undertake marine aquaculture activities offshore, both outside and within a wind farm have been investigated.

As for policy drivers, encouragement for co-location across Europe and in the UK has been found through Marine Spatial Planning.

Case studies revealed that marine planning is generally at a very early stage but co-location has already been driven into practice by interest from aquaculture industries, aquaculture research institutes and facilitation from wind farm developers.

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From an operational perspective the co-location of aquaculture with offshore wind farms (OWFs) resulted in a very challenging issue. The compatibility assessments of marine activities indicated potential conflict of a moderate level of difficultly to accommodate colocation. However an important distinction was made between the difficulties of co-location of aquaculture in the direct vicinity of the turbines as opposed to the possibility of co-location within the wider OWF area.

The compatibility of aquaculture with OWFs has been considered in terms of the various risk factors from an OWF perspective. Technological solutions such as infrastructure and equipment components have been considered, in conjunction with relevant existing co-location trials.

Two case studies (Figure 5-9) have been analysed in order to examine the practical steps that have already been taken to trial techniques for co-location of aquaculture and offshore wind farms. The first case study is located in North Wales, with a mussel cultivation trial in North Hoyle Wind Farm. The second case-study is located in the German North Sea, reviewing research, development and trials of suitable aquaculture systems in co-location with offshore wind farms. Both case studies present technical considerations, ecological considerations, social and economic considerations and the applicable Policy Drivers for each site. No conceptual design for multi-use installation is provided by this study.

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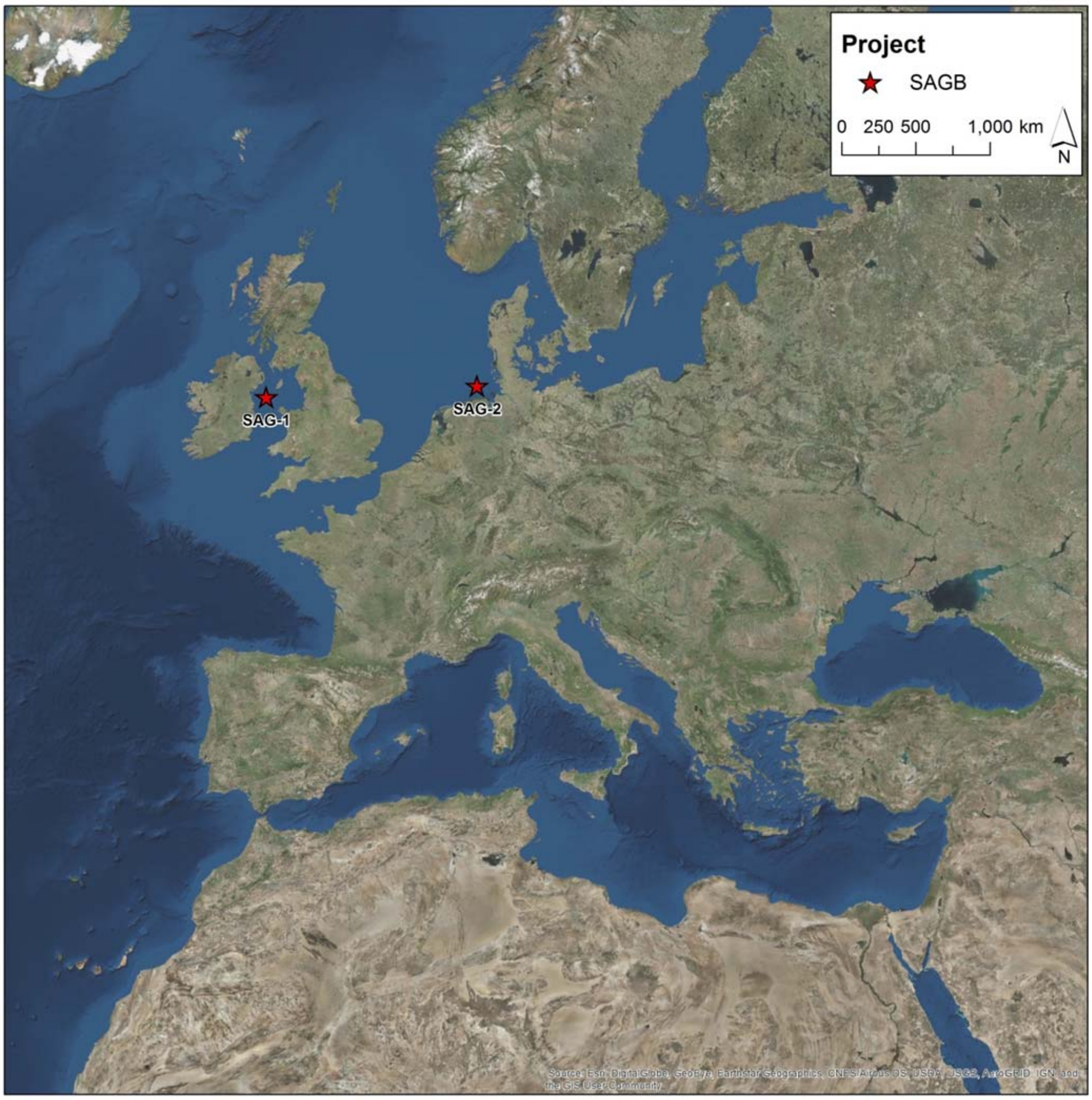

Figure 5-9 Case-studies for SAGB co-location project (North Hoyle Wind Farm-North Wales and German North Sea) and proposed combinations of uses..

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Table 5-16 SAGB Co-location Study case-studies summary.

Sea Basin	Case Study Location	Case-study code	Environmental characteristics/Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2
Atlantic	North Hoyle Wind Farm	SAG-1	Liverpool Bay Special Protection Area. Relatively shallow waters, good strong winds and proximity to the national electricity network	Real case of mussel cultivation in nearshore wind farm	Staggered development experimental field test	Offshore wind energy	Aquaculture-shellfish
North Sea	Alpha Ventus Wind farm	SAG-2	The site location is beyond the Wadden Sea World Natural Heritage site. High wind speed and wave heights	Aquaculture options within the Alpha Ventus Wind Farm and more in general for the German North Sea	Staggered development Evaluation of co-location potentials	Offshore wind energy	Aquaculture-seaweed Aquaculture-shellfish

North Wales case study

On-going mussel research trials have been carried out in the North Hoyle Wind Farm (Liverpool bay, North East Wales).

North Hoyle consists of 30 monopile offshore wind farm turbines in 10m of water at low tide, constructed in 2003. Three small lays of mussel spat have been located at separate sites within North Hoyle OWF using a technique known as Seabed Ranching or Seabed Cultivation in the summer of 2010. This is the only known offshore seabed culture activity so far carried out in the UK.

The North Hoyle trials have proved that existing technology and operational practises for seabed mussel cultivation, in what might be termed nearshore wind farms, can be successfully carried out without any negative impacts on wind farm operators. Further work is however required to investigate the correct timing for laying seed mussels in these highly productive waters and to assess if the physical characteristics of the site might cause mussel mortalities due to possible smothering events.

In addition co-location operational issues were explored for the Gwynt-Y-Mor Offshore wind farm, also located in North Wales, as a case study to develop a planning scenario (for illustrative purposes only) using a range of aquaculture options.

German North Sea

Germany is the European country that has been most active in investigating the potential for co-location or multi-use of the marine space within offshore wind farms.

The research focused on aquaculture systems developed for integration within offshore wind farms in the German North Sea, especially including Alpha Ventus OWF.

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The Alpha Ventus offshore wind farm was constructed in 2010-2011, 60km offshore in the German EEZ. The 12 wind turbines are separated by 800m and arranged on a grid formation covering four square kilometres. All general shipping and fishing vessels are prohibited from entering the entire area of the wind farm. The distance offshore of the wind farm site is due to consenting requirements in the German North Sea, which impose a location beyond the Wadden Sea World Natural Heritage site and beyond the near-coastal shipping routes.

This location, with high wind speed and wave heights, offered a case study other than the inshore North Hoyle trial.

The significant work investigating offshore aquaculture options in relation to Alpha Ventus offshore wind farm have been coordinated at the Alfred-Wegener-Institut, Bremerhaven, Germany.

Aquaculture options in relation to Alpha Ventus offshore wind farm have been discussed, enhancing benefits of co-location. The primary species discussed for offshore aquaculture were seaweeds (Sugar Kelp - *Saccharina latissima* and Dulse - *Palmaria palmata*) and bivalves (the blue mussel - *Mytilus edulis* and the oyster species - *Ostrea edulis* and *Crassostrea gigas*).

These species could be maintained extensively in the offshore region, require low labour for cultivation, have a good tolerance to offshore environment and can offer economic benefits.

The experience of Germany in co-locating aquaculture in wind-farms is further discussed in section g, describing national projects developed in the German Bight area.

c. COWRIE Research

COWRIE (Collaborative Offshore Wind Research into the Environment) was set up by The Crown Estate as an independent body to carry out research into the impact of offshore wind farm development on the environment and wildlife.

Within this research, Ichthys Marine produced a report for COWRIE that identified options and opportunities to mitigate any adverse impacts on fishing activities that resulted from constructing and operating windfarms in co-location with Marine Conservation Zone (Blyth-Skyrme, 2011).

The research doesn't include proposals of designs of multi-use platform or installation, nor identifies specific case-studies. The study refers, more in general, to the area of UK marine waters, exploring the potential conflicts and synergies of different combination of uses (Table 5-17).

The introduction of windfarms (which has recently grown considerably according to the UK Government commitment of producing 30% of its electricity from renewable energy) and Marine Conservation Zones in the UK marine waters posed possible conflicts with fishing activities, limiting where and how fishing can be undertaken. Therefore, the possibility of co-locate **windfarms** and **MCZs** has been explored according to the idea that co-location might reduce their combined impact on the **fishing** industry.

Through some interviews, literary review and stakeholder consultation, potential benefits and disadvantages were so identified for such co-location.

The report concludes that there is considerable concern over co-locating windfarms with MCZs, although some potential benefits were identified. Several uncertainties have been highlighted about the implication of such co-location, including unknown risk factors, possible additional responsibilities and costs, possible difficulties of gaining consent, concern over the effective attainment of marine conservation targets.

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Moreover, the potential of co-location to positively or negatively impact fishing activities has to be considered on a site by site basis, depending on fisheries management regimes within windfarms and MCZs, the willingness to fish inside windfarms and the space available to displacement into other suitable grounds.

Local knowledge of each system is finally needed for understanding the implication of co-location on fishing activity.

Table 5-17 COWRIE study: case-studies summary.

Sea Basin	Case Study Location	Case-study code	Environmental characteristics/ Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2
Atlantic	UK marine waters	COW-1		Benefits and disadvantages for fishing sector of co-locating windfarm and Marine Conservation Zones	Joint/Staggered development evaluation of co-location potentials	Offshore wind energy	Environmental Protection Commercial fishery
North Sea							

d. DTU Aqua

The combination of **shellfish aquaculture** with **wind farm** industry has been considered feasible in Danish waters by the study carried out by DTU Aqua (National Institute of Aquatic Resources, Stenberg et al, 2010). The study stems on the fact that windfarms in the Dutch North Sea are increasing in number, so that their volume and spatial placement calls for multiple uses of the large areas. This study aimed to investigate whether shellfish production can be combined with the wind industry in Danish waters. Three of the world's largest offshore wind farms (Horns Rev 1, Anholt & Nysted) were used as cases (Table 5-18, Figure 5-10). Mariculture (especially mussel and lobster) is considered possible in windfarm, even if present design of windfarm, organisation and maintenance and rough wind/wave conditions provide challenges.

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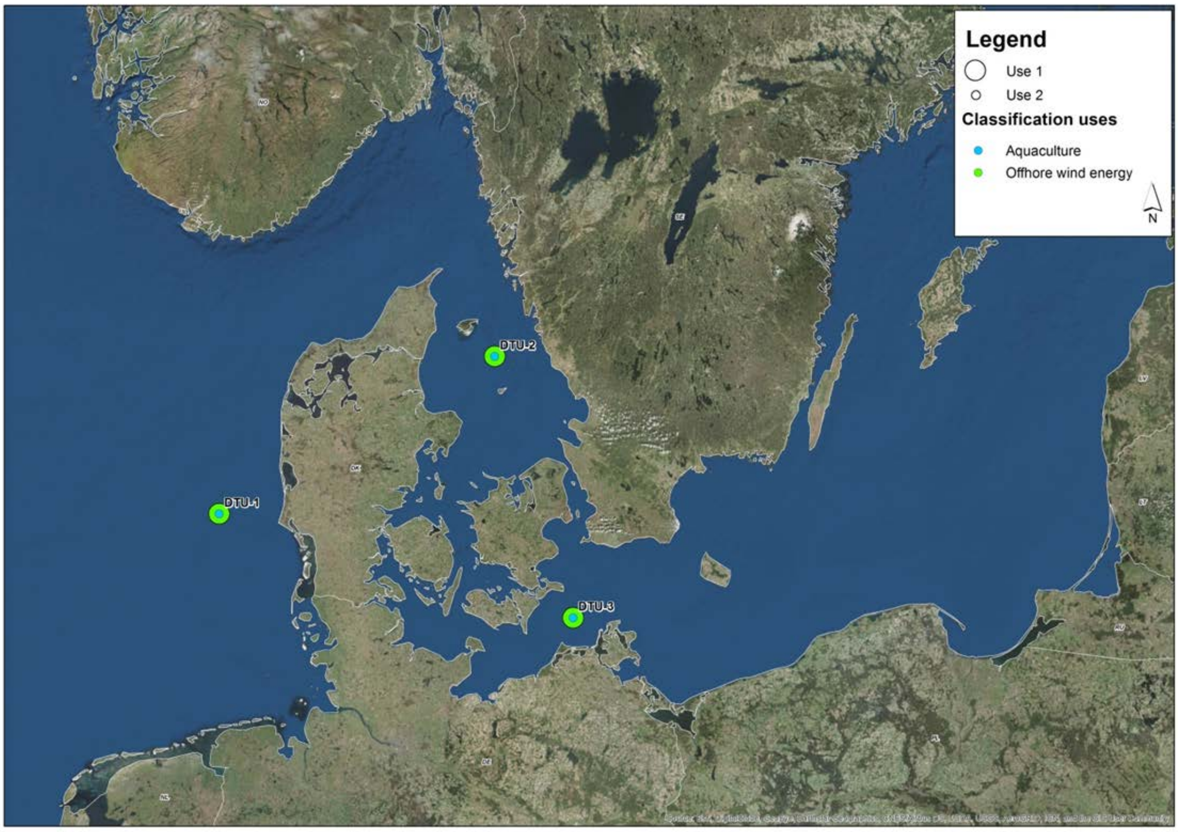

Figure 5-10 Localization of case-studies of DTU Aqua Study and proposed combinations of uses.

Table 5-18 DTU Aqua Study: case-studies summary.

Sea Basin	Case Study Location	Case-study code	Environmental characteristics/Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2
North Sea	Danish waters- Horns Rev 1 Wind farm	DTU-1	Shallow Danish waters relatively closed to the harbour. Strong winds and strong salinity gradients	Potential of windfarms for shellfish aquaculture	Staggered development evaluation of co-location potentials	Offshore wind energy	Aquaculture-shellfish
Baltic	Danish waters - Anholt Wind farm	DTU-2					
	Danish waters - Nysted Wind farm	DTU-3					

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e. The feasibility of offshore aquaculture and its potential for multi-use in the North Sea[11]

The feasibility of offshore aquaculture development and its potential for multi-use with other maritime activities is discussed in a recent paper of Jansen et al. (2016) where the Dutch North Sea is used as a case-study. The paper reviews and synthetize information from national and international studies that have been performed over the past decade. The ecological, technical and economic conflicts and benefits arising from multi-use of space between aquaculture and other sectors, with a special focus on wind farms, has been explored in order to identify whether multiuse is a viable solution for efficient use of marine space. Potential risks and synergies have been highlighted. One of the most promising solution has been identified in the possibility of combining mussel culture in or around wind parks, with possible economic benefits.

Table 5-19 Case-study summary from Jansen et al. (2016).

Sea Basin	Case Study Location	Case-study code	Environmental characteristics/Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2
North Sea	Dutch North Sea	JAN-1	Sea Basin with high potential for offshore aquaculture. Highly productive sea High hydrodynamic forces	Development of offshore aquaculture and smart combinations with other sea uses	Joint/Staggered development evaluation of co-location potentials	Aquaculture-seaweed Aquaculture-shellfish	Offhore wind energy (main considered use among possible combinations)

f. Billia Croo Fishery Project

The Billia Croo Fishery project was funded by the Scottish Government in 2010 in order to investigate the possible effects of marine energy converter deployments on resident crustacean species. This collaborative project, led by EMEC (European Marine Energy Centre), had scientific input from Herriot Watt University's International Centre for Island Technology (ICIT) and Seafood Scotland, and industry input from Orkney Fishermen's Society (OFS) and Orkney Fishermen's Association (OFA).

The investigated area is the test site of the EMEC **wave energy converter** located at Billia Croo, Orkney Islands, off the Northern coast of Scotland (Atlantic). The wave converter is located within an area commonly used as a lobster fishery.

The main focus of the project was lobsters and their **commercial fishery**, with two broad aims. The first aim was to determine the likely influence of a small-scale refuge area (the wave energy converter) on local lobster population abundance and availability to the fishery. Secondly, and

[11] (Jansen et al., 2016)

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especially relevant for MUSES Project, the project aimed to explore the potential for using such areas to augment local lobster stocks by using them as nursery grounds for the release of hatchery-reared juveniles. A supplementary aim of the project was to characterise experimental creel catches of all crustacean species in the area in the context of catches experienced by the commercial fishery operating in adjacent areas open to fishing. Data from the project can also be used to inform fisheries science on the growth rate and movement patterns of lobster in the area.

The study (EMEC, 2012) concludes that the area within the EMEC wave test site at Billia Croo provides suitable feeding and refuge habitat for lobster, and has the potential to act as a nursery area to both the local fishery and to the Orkney Islands as a whole. Continuation of the project will be essential in order to assess the survivability and mobility of juvenile lobster electronically tagged and released during this project. The potential for artificial structures placed on the seabed during development of marine renewable projects to act as juvenile lobster habitat also requires further investigation. Previous sampling of lobster and brown crab landings across Orkney can provide valuable information on catch composition, but data on effort and catch rate are lacking and should be an important component of any future monitoring programme in order to determine stock abundance.

Table 5-20 Billia Croo Fishery Project: summary of case studies.

Sea Basin	Case Study Location	Case-study code	Environmental characteristics/Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2
Atlantic	Billia Croo Orkney Island	BILL-1	Very high energy coastal environment. Marine conservation areas exist in the vicinity of the site	Possibile role of wave energy converter in increasing local lobster stocks	Staggered development Field investigation	Offshore wave energy	Commercial fishery

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g. The German case-studies

The German Bight area, located in the Southern North Sea (German EEZ), was used as test site in several projects for a number of field and laboratory experiments, aiming to demonstrate the possibility of **Offshore Aquaculture** development in combination with **Wind farms**.

Major findings of these projects are described in the recent work of Buck et al. (2017) where the perspective of developing aquaculture in multi-use sites is explored.

Eight projects concerning this issue have been specifically identified as relevant for this work. They were carried out from early 2000 to 2015 and they all involved the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI). They cover different aspects of the combination between aquaculture and wind farms (biology of the cultured species, technological, economic and social issues).
Each project is briefly described in the following text, based on Buck et al. (2017) and from the web site content of AWI https://www.awi.de/en/science/special-groups/aquaculture/marine-aquaculture/projects/finished-projects/aqualast.html).

Offshore Aquaculture(2001-2004) is the first project proposing a multifunctional use of offshore wind farms in the German North Sea. All marine areas of the investigated area, where wind farms are planned were equipped with mooring systems to test the settlement and/or growth of candidate species. Seaweed (*Laminaria saccharina*), oysters (*Ostrea edulis, Crassostrea gigas*) and *Mytilus edulis* were the investigated species. The outcomes of this project provided an expertise for the feasibility of offshore wind farm areas for the extensive culture of bivalves and seaweed.

Roter Sand Project (2001-2004) investigated different anchored longlines installed in order to test their suitability under open sea conditions in terms of material and functionality and to obtain insights on how to connect these systems to wind farm foundations. Various test devices were deployed offshore in multi-use with the wind farm “Energiekontor” 17 nautical miles off Bremerhaven.

AquaLast (2004-2006) is a project that was funded by the Ministry for Construction, Environment and Transport in Bremen (Germany) in order to investigate the supplemental loads on the support structures of offshore wind energy converters caused by attached mussel longlines. Several alternative connection points were tested. A test facility was set up in the open ocean 14 nm off the island of Sylt. This facility consists of a roughly 60 meters long submerged longline with load sensors where mussel collectors are replaced by test bodies. The installation is submerged to account for the rough weather in the German Bight and the test bodies resemble a mussel collector which is fully grown. This allows for a full year of measuring. The data are logged and supported by oceanographic measurements taken at the same site.

Mytifit (2004-2007) is a project that was financed by the Ministry of Construction, Environment and Transport of Bremen and the AWI in Bremerhaven. The culture potential and the response of the blue mussel (*Mytilus edulis)* growing under offshore conditions was investigated in detail. The focus of this project was the overall health of the candidate, regarding the loads of micro and macro parasites, the shell stability, the attachment strength of mussels using different artificial substrates and its lysosome membrane stability of the digestive gland cells as an indicator of the overall energy status of the mussel. The testing area was near Nordergründe, 17 nautical miles off the coast from the city of Bremerhaven.

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Coastal Future (2004-2008) is a project that was funded by the German Ministry of Education and Research (2004), as part of the joint research project "Zukunft Küste - Coastal Futures", which aims to establish a sustainable as well as Integrated Coastal Zone Management (ICZM) at the western coast of Schleswig-Holstein, Germany. The project mainly focussed on the perception of stakeholders in the offshore realm, which have been experiencing increasing attention in the North Sea.

Open Ocean Multi-Use (2009-2012). This interdisciplinary research project investigated synergies between foundations of offshore wind energy turbines and potential co-use for the cultivation of aquatic organisms. Those organisms are mainly fish but also mussels and macroalgae. In the scope of an extended feasibility study, methods from social- and natural sciences as well as economy and engineering were applied. The results created a basis for the future realization of a prototype system, alllowing to minimize the identified barriers. The integration of industry stakeholders into the project can increase the operability of the results.

NutriMat (2011-2013) is a project that investigated the possible use of naturally fouling organisms (*Mytilus edulis)*, originally settling in vast amounts on the foundations of offshore wind farms, as aquaculture feeds. The removal of fouling organisms at regular intervals is mandatory for wind farmers to allow annual inspection of the condition of the foundation and exclude any possible damage causing potential risk. Mussels were scraped off the foundation and transferred to the land-based facilities to produce feed in various mixtures with common fish feed and then fed to turbot, which was cultivated within a Recirculating Aquaculture System. The outcome of this project was that mussel meal has a high potential to serve as supplement or fish meal replacement in feed for turbot raised in aquaculture systems and therefore reduces the impact of fisheries for fish meal production.

Offshore Site Selection (2012-2015). The project aimed to create a multi-use road map as a tool for the future use of marine areas in the German Bight. The combination of eco-friendly aquaculture with other infrastructures, such as offshore-wind farms as well as new strategies in the field of passive fisheries was examined. The focus of the project was to provide support to the future planning and management of marine areas in the context of an aquaculture-wind farm combination. In addition, suitable test sites for multiple uses were identified by using GIS decision tools, which are based on verified site-selection criteria. As a result, this analysis aimed to obtain a review, adjustment and/or amendment of the “Marine Facilities Ordinance” as well as further required investigation (Environmental Impact Assessment, Licensing Procedure for Offshore Wind Farms I, II & III) to simplify the multiple-use of marine areas.

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4. ANALYSING CONFLICTS AND SYNERGIES AMONG USES IN MSP PROJECTS: THE EXAMPLE OF COEXIST

As mentioned in Preface, a long list of MSP projects exist and are provided in Deliverable 2.1. In several project documents a detailed analysis of conflicts and synergies among different uses of the sea can be found, making it possible to utilise the information when considering the potentiality of a multi-use approach. Therefore gathering this information for each MUSES case-study is essential for the analysis.

The COEXIST Project is a prime example of this aspect at European level, with case-studies in all the European sea basins. This is described further in this section.

COEXIST Project (Interaction in European coastal waters: A roadmap to sustainable integration of aquaculture and fisheries) was a three year (2010-2013) collaborative project funded by the European Commission within the Seventh Framework Programme (Cooperation, Food, Agriculture and Fisheries, and Biotechnology). It involved thirteen partners from ten European countries, coordinated by the Norwegian Institute of Marine Research. The project cost was 3.8 million euro, with a total EC contribution of almost 3 million euro.

COEXIST is a broad, multidisciplinary project which evaluated competing activities and interactions in European coastal areas. The ultimate goal of the COEXIST project was to provide a roadmap to better integration, sustainability and synergies across the diverse activities taking place in the European coastal zone, with special attention for integration of aquaculture and fisheries with other activities.

The Project doesn't propose conceptual designs of multi-use platform nor suggest specific co-location of different uses in the coastal area. However it offers a deep analysis of conflicts and synergies between aquaculture & fisheries and other different activities existing in the examined coastal areas.

Six Case Studies from a number of different regions have been considered. The case study areas varied in size and types of major activity, and represented sea areas from northern and southern Europe. These case studies represented specific conditions and combinations of activities of European coastal areas of particular importance for aquaculture and coastal fisheries.

For each case-study, a matrix of interaction between aquaculture & fisheries versus other activities was constructed.

The six case studies are listed below and summarized in the following table, with a short description of the uses under consideration, extracted from the COEXIST case-studies fact cards and from the deliverable D5.1 (Stelzenmüller et al., 2013) which also proposes a cross case study comparison.

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Table 5-21 COEXIST Project: case-studies summary.

Case Study location	Environmental characteristics	Combination of uses
Hardangerfjord (Norwegian North Sea)	Norway's second largest fjord Several side fjords, constituting a deep valley both below and above sea level. Ancient cultural landscapes	Aquaculture & Fishing vs: Cables and pipelines Hydroelectric power Marine Protected Areas Military activities Oil and gas extraction Shipping and transport Tourism
Ireland coast (Atlantic)	Continental shelf with water depths not exceeding 200 m	Aquaculture & Fishing vs: Cables and pipelines Coastal constructions Dredging Marine Protected Areas Military activities Oil and gas extraction Shipping and transport Tidal and wave energy Tourism Urban and rural residues Wind parks
Brittany coast (Atlantic)	Public marine protected area and Natura 2000 sites High tides, with high diversity of substrates and habitats	Aquaculture & Fishing vs: Cables and pipelines Coastal constructions Marine Protected Areas Military activities Shipping and transport Tourism Urban and rural residues
Algarve coast (Atlantic)	Most productive area of the Iberian Peninsula. High diversity of the resources Generally calm ocean conditions	Aquaculture & Fishing vs: Cables and pipelines Coastal constructions Dredging Marine Protected Areas Military activities Salt production Shipping and transport Tourism Urban and rural residues
Coastal Adriatic Sea (Mediterranean)	Narrow epicontinental basin with low topographic gradient. Counter clockwise current flow Slight tidal movements Eutrophic waters	Aquaculture & Fishing vs: Cables and pipelines Coastal constructions Dredging Marine Protected Areas Oil and gas extraction Shipping and transport Tourism Urban and rural residues

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Coastal North Sea	Semi-enclosed sea of the continental shelf of the North-East Atlantic Ocean Shallow coastal area up to 50m depth of the North Sea Wadden sea included High productivity	Aquaculture & Fishing vs: Cables and pipelines Coastal constructions Dredging Marine Protected Areas Military activities Oil and gas extraction Shipping and transport Tourism Urban and rural residues Wind parks
Bothnian Sea (Baltic Sea)	Semi-closed brackish water sea. High number of islands in the Arcipelago sea, sheltered area. Brackish water Average depth of the Archipelago around 23m.	Synergies and conflicts among aquaculture, fishing and Cables and pipelines Coastal constructions Dredging Marine Protected Areas Military activities Shipping and transport Tourism Urban and rural residues Wind parks

Hardangerfjord (Norwegian North Sea)

The Hardangerfjord is an important area due to its various functions, including fisheries, aquaculture, recreation and tourism. It affords a strong cultural identity, acts as a climate moderator in the fruit growing districts and as a transportation route for people and cargo. There is a large salmon-farming industry in the fjord and there is considerable concern about proliferation of pathogenic organisms from salmon farms affecting wild salmon, and the genetic impact from escapees. The associated rivers are utilized for large scale hydroelectric power production and tourism and leisure activities are important in the area.

Main conflicts include fisheries vs. salmon farming (involving cage escapes and the production of salmon lice larvae affecting wild salmon), salmon farming vs. environmental conservation and hydroelectric plants (and high-voltage cables) vs. environmental conservation.

Main synergies include salmon hatcheries and salmon fishery in rivers and on sea (hatcheries producing salmon for restocking); salmon farming and tourist fisheries.

Ireland and Brittany coast (Atlantic)

The case-study considered two different areas of the Atlantic coast: the Atlantic coast of Ireland (Irish and Celtic Sea) and the Atlantic coast of France (Iroise Sea, Brittany).

As for Ireland, important cities stand along the coastline including the capital of Dublin and Cork. The area is used for aquaculture, fisheries, conservation, cables/pipelines, shipping and transport and tourism and recreation. It also includes an operational wind farm.

Ecological and spatial conflicts between seed mussel dredgers and shell fish potters have been highlighted. Synergies between aquaculture and fisheries have been found, as improved infrastructure and services such as harbour development might create opportunities for coexistence

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As for France, the Iroise Sea area is subject to a very strong tidal influence. Due to these natural conditions, a large variety of substrates and habitats are found in this area. Fishing activities, such as shellfish fisheries, are relatively important in the area with mainly small fishing vessels operating in coastal areas with aquaculture limited to the Bay of Brest. Seaweed harvesting is an important activity which partly takes place in conservation areas, such as Natura 2000 sites.

Main conflicts have been found between agricultural activities (residues from rivers) and fisheries and between seaweed harvesting and some fishing activities (spatial conflicts).

Synergies can be found between aquaculture and fisheries and aquaculture and environmental conservation (increased biodiversity).

Algarve coast (Atlantic)

The Algarve (Southern Portugal) coastal waters are among the most productive of the Iberian Peninsula with heavily exploited fisheries and important bivalve aquaculture production occurring in inshore estuarine-lagoon systems. The study area is near the Ria Formosa lagoon, which is an inland water area bordered by sandy barrier islands, and comprising an extensive area of salt marshes. The most important fisheries target pelagic fish, cephalopods and crustacean. Aquaculture activities mainly take place in inland waters, where clam plots leased from the government are developed; more recently offshore aquaculture has also been developed both for fish and bivalve production. Other activities include ferry transports from and to sandy barrier islands and shipping via the Mediterranean Sea.

Conflicts concern fisheries and aquaculture (competition from fish produced in inland aquaculture), sand extraction and fisheries (clam dredging and bottom trawling forbidden if there is sand extraction), cables & pipelines and fisheries (clam dredging and bottom fishing gear forbidden where there are cables and pipelines), aquaculture (finfish) and shell and sand extraction (decrease of water quality)

Synergies concern fisheries/aquaculture and environmental conservation (ecological and oceanographic research benefits from data obtained from the tuna trap firm), vessel construction and fisheries.

Coastal Adriatic Sea (Mediterranean)

The study area is the coastal area of the Marche region (Italy) which has a total surface area of approximately 21000 km². and is characterised by eutrophic waters The main activities which take place are fisheries, aquaculture (mussel culture on long-lines and on artificial reefs), gas extraction, cables and pipelines, conservation (Marine Protected Areas/MPAs, Natura 2000), recreational sailing, fishing , diving, dredging/dumping, tourism, shipping and transport, coastal construction (urban development, harbors, marinas, coastal protection), refurbishment of beaches, artificial reefs, urban and rural residues and military activities.

Conflicts concern set gear fisheries and aquaculture (spatial conflicts), fisheries and tourism (space and resources competition), shipping & transport and fisheries (fishing activities not allowed in vessel channels), oil/gas extraction and. Fisheries (reduction of available space for fisheries).

Synergies concern oil/gas extraction & cables/pipelines and fisheries (positive effect on marine resources targeted by fisheries), tourism and aquaculture/fisheries (increase of the income for fisheries and aquaculture), set gear fisheries and artificial reefs (positive effects on marine resources targeted by set gear fisheries).

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Coastal North Sea

The coastal North Sea is a cross-border case-study comprising the south eastern part of the North Sea, including the Wadden Sea, and extends offshore to the 50-m depth contour. In the North Sea important human activities include shipping, mining (oil, gas, gravel), offshore wind farms, cables/pipelines and various forms of fisheries, including beam trawling for flat fish, shrimp fishing, and pelagic trawling for round fish (e.g. herring), dredging for mussels, oyster and mussel cultivation, dumping, nature conservation (national parks and Nature 2000), military activities and tourism and recreation.

Conflicts concern wind parks and oil/gas extraction versus fisheries (mobile fishing gear usually not allowed within the safety zone surrounding wind parks and oil and gas installations).

Synergies concern fisheries and tourism (appreciation of the maritime atmosphere and seafood products), wind parks and aquaculture (multifunctional use of space).

Bothnian Sea (Baltic Sea)

The study area is part of the Baltic Sea, a semi enclosed sea with brackish water. The waters in the case study area are inshore waters (Archipelago and Bothnian Sea) between Finland and Sweden, with the major human activities comprising fisheries, aquaculture, conservation, recreation, tourism, dredging and sand extraction. Aquaculture consists mostly of rearing rainbow trout in net cages. Commercial fisheries use relatively small family owned boats and typically use gill nets and trap nets. Leisure use of the area ranges from recreational fishing, holidaying in summerhouses, boating and organized tours. Environmental protection and private water ownership have limited operational opportunities for fish farming and fishing.

Conflicts concern fish farm production and environmental management policy, recreational fisheries and professional fisheries, commercial fisheries and environmental conservation (spatial restriction for fishing), urban & rural activities and professional & Recreational fisheries (discharge of urban & rural waste).

Synergies concern fish farming and commercial fishing (fish marketing chains), professional fisheries and tourism (appreciation of fresh local fish), recreational fisheries and aquaculture (fish farms producing valuable fish which are often stocked in the waters for recreational fishers to catch).

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5. SELECTION OF RELEVANT PROJECTS FOR MUSES CASE-STUDIES

The analysis performed in the previous section led to identify 35 case-studies of multi-use application. They are located in the Atlantic basin, Mediterranean basin, North Sea and Baltic Sea. No case-studies were detected for the Black Sea.

The geographic location of all the considered case-studies is illustrated in the map of Figure 5-11 which also shows the proposed combination of uses. The complete list of the mapped case studies is then reported in Table 5-22, where the spatial correspondence with the seven MUSES case-studies is highlighted. With the term “spatial correspondence” we don’t mean exact spatial coincidence among case-studies but we refer to a wider area around them, representative of similar environmental conditions. For example for the case-study n.2, Northern Atlantic Site (West coast of Scotland), we can consider relevant also the MARIBE case-study located in the Welsh Atlantic coast.

This first “spatial filter” identifies a selection of 27 case-studies, which can be considered relevant for MUSES Project, because of their location.

A further second selection was then performed considering the concept of multi-use, i.e. considering if the combination of uses analysed in every case –study can be assessed as relevant for those sectors identified for every MUSES case-study (see Table 5-2 in the preface for reference).

This “sector filter” identified 26 case-studies (only the H2Oceans case-study is filtered out).

The location of these case-studies is finally illustrated in Figure 5-11 and in the map of Figure 5-12.

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Table 5-22 Complete list of all case-studies and first selection based on spatial relevance.

Project	Sea Basin	Case study Short name	Code	Spatial Relevance (YES or NO)	Correspondent MUSES case study	Sector Relevance (YES or NO)
MERMAID	NorthSea	Gemini Wind Park	MER-1	YES	1 (North Sea)	YES
MERMAID	Atlantic	Cantabrian Offhore Site	MER-2	NO	--	--
MERMAID	Baltic	Kriegers Flak	MER-3	YES	5 (Baltic Sea - Denmark)	YES
MERMAID	Mediterr.	Northern Adriatic Sea	MER-4	YES	6 (Mediterranean Sea - Italy)	YES
TROPOS	North Sea	Dogger Bank	TRO-1	YES	1 (North Sea)	YES
TROPOS	Atlantic	Canary Islands	TRO-2	NO	--	--
TROPOS	Mediterr	Crete Island	TRO-3	YES	7 (Mediterranean Sea -Aegean Sea - Cyclades)	YES
H2OCEANS	Atlantic	West Coast of Portugal	H2O-1	YES	3 (Southern Atlantic Sea)	NO
MARIBE	North Sea	Borssele wind park	MAR-1	YES	1 (North Sea)	YES
MARIBE	Atlantic	West coast of Ireland	MAR-2	NO	--	--
MARIBE	Atlantic	South Coast of Ireland	MAR-3	NO	--	--
MARIBE	Atlantic	Welsh Coast	MAR-4	YES	2 (Northern Atlantic Sea)	YES
MARIBE	Atlantic	Canary Islands	MAR-5	NO	--	--
MARIBE	Mediterr	Malta	MAR-6	NO	--	--
MARIBE	Mediterr	Cyclades Island	MAR-7	YES	7 (Mediterranean Sea -Aegean Sea - Cyclades)	YES
SUBMARINER Project	Baltic	Baltic Sea Region	SUB-1	YES	4 (Baltic Sea - Sweden) 5 (Baltic Sea - Denmark)	YES
SUBMARINER Project	Baltic	Baltic Sea Region	SUB-1a	YES	5 (Baltic Sea - Denmark)	YES
SAGB	Atlantic	North Hoyle Wind Farm	SAG-1	YES	2 (Northern Atlantic Sea)	YES
SAGB	North Sea	Alpha Ventus Wind farm	SAG-2	YES	1 (North Sea)	YES
TripleP@Sea	North Sea	North Sea	TRIP-1	YES	1 (North Sea)	YES
Cowrie 2010	Atlantic	UK marine waters	COW-1	YES	1 (North Sea)	YES
Cowrie 2010	North Sea	UK marine waters		YES	2 (Northern Atlantic Sea)	YES
DTU Aqua	North Sea	Danish waters	DUT-1	NO		-
DTU Aqua	North Sea	Danish waters	DUT-2	NO		-
DTU Aqua	Baltic	Danish waters	DUT-3	YES	5 (Baltic Sea - Denmark)	YES
BILLIA CROO	Atlantic	Northern Coast of Scotland	BILL-1	YES	2 (Northern Atlantic Sea)	YES

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Project	Sea Basin	Case study Short name	Code	Spatial Relevance (YES or NO)	Correspondent MUSES case study	Sector Relevance (YES or NO)
Fishery Project						
Jansen et al. (2016)	North Sea	Dutch North Sea	JAN-1	YES	1 (North Sea)	YES
OOMU	North Sea	German North Sea	GER-1a	YES	1 (North Sea)	YES
OSS	North Sea	German North Sea	GER-1b	YES	1 (North Sea)	YES
Coastal Futures	North Sea	German North Sea	GER-1c	YES	1 (North Sea)	YES
AquaLast	North Sea	German North Sea	GER-1d	YES	1 (North Sea)	YES
MytiFit	North Sea	German North Sea	GER-1e	YES	1 (North Sea)	YES
NutriMat	North Sea	German North Sea	GER-1f	YES	1 (North Sea)	YES
Roter Sand	North Sea	German North Sea	GER-1g	YES	1 (North Sea)	YES
Offshore Aquacultur e	North Sea	German North Sea	GER-1h	YES	1 (North Sea)	YES

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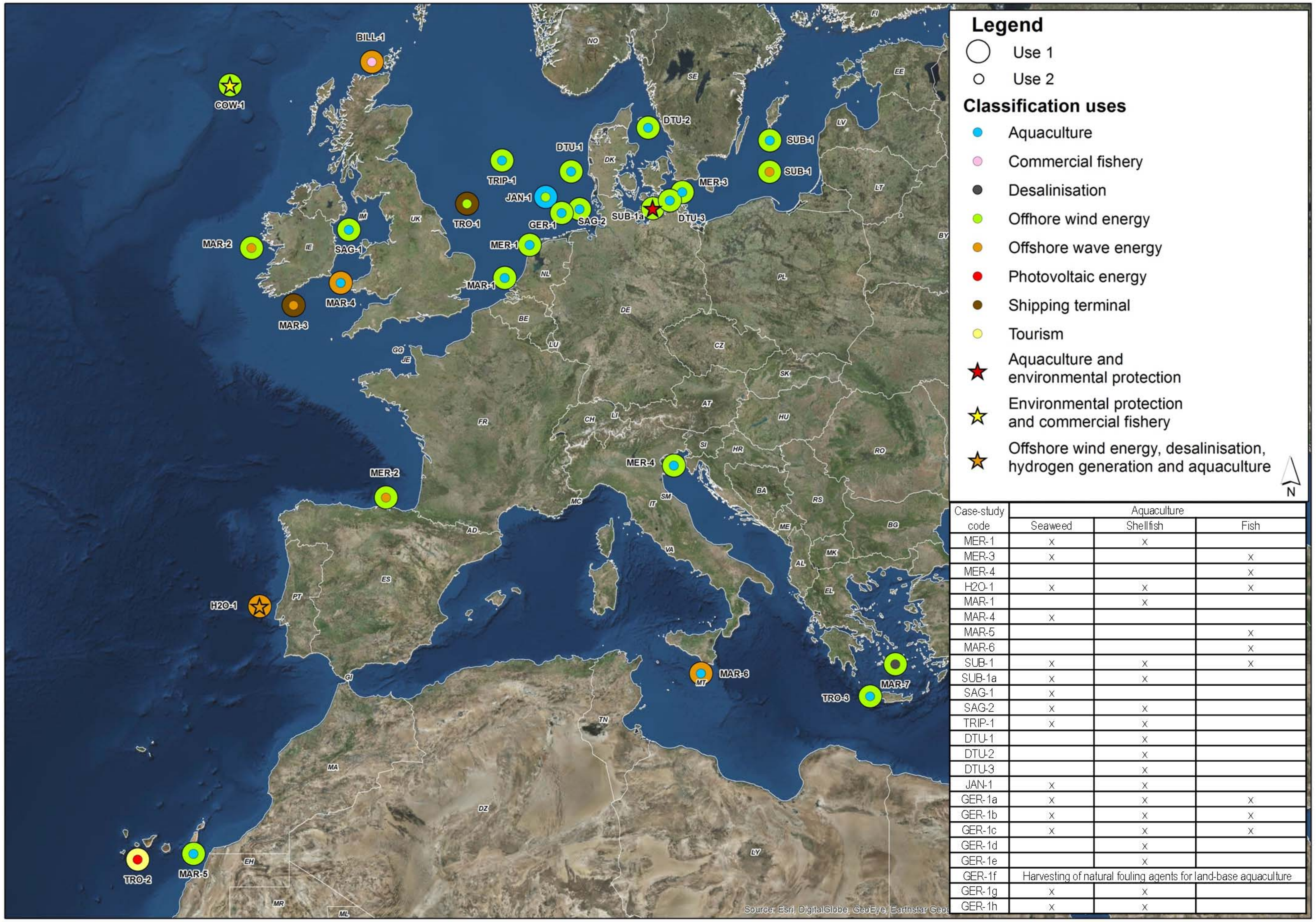

Case-study code	Aquaculture		
	Seaweed	Shellfish	Fish
MER-1	x	x	
MER-3	x		x
MER-4			x
H2O-1	x	x	x
MAR-1		x	
MAR-4	x		
MAR-5			x
MAR-6			x
SUB-1	x	x	x
SUB-1a	x	x	
SAG-1	x		
SAG-2	x	x	
TRIP-1	x	x	
DTU-1		x	
DTU-2		x	
DTU-3		x	
JAN-1	x	x	
GER-1a	x	x	x
GER-1b	x	x	x
GER-1c	x	x	x
GER-1d		x	
GER-1e		x	
GER-1f	Harvesting of natural fouling agents for land-base aquaculture		
GER-1g	x	x	
GER-1h	x	x	

Note: SUB-1, TRIP-1 and COW-1 refer respectively to the whole Baltic Sea Region, North Sea and UK marine waters and not to specific points. GER-1 refers to 7 different projects concerning the same location and the same combination of uses.

Figure 5-11 Localization of all case-studies examined in the background analysis and combination uses.

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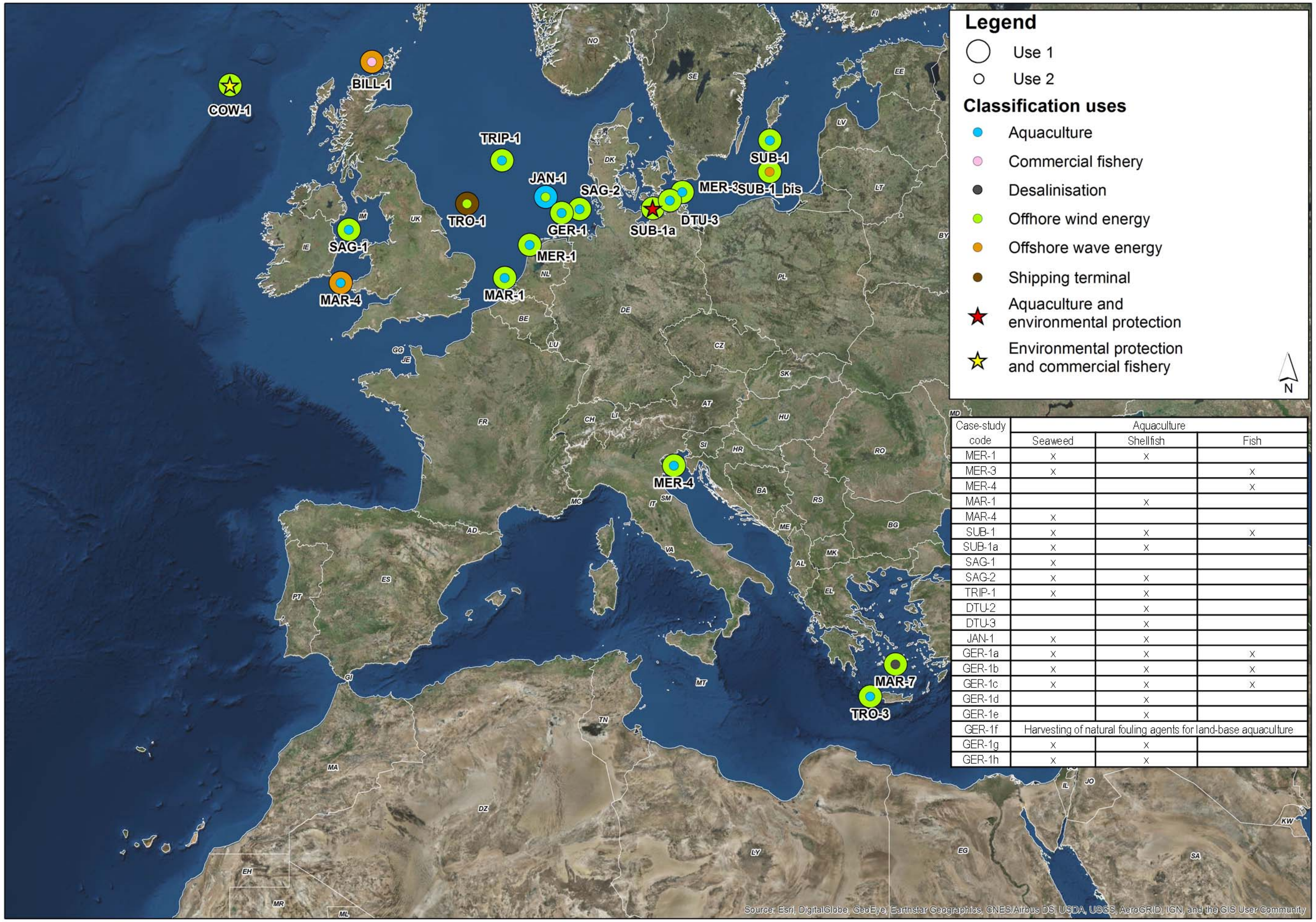

Case-study code	Aquaculture		
	Seaweed	Shellfish	Fish
MER-1	x	x	
MER-3	x		x
MER-4			x
MAR-1		x	
MAR-4	x		
SUB-1	x	x	x
SUB-1a	x	x	
SAG-1	x		
SAG-2	x	x	
TRIP-1	x	x	
DTU-2		x	
DTU-3		x	
JAN-1	x	x	
GER-1a	x	x	x
GER-1b	x	x	x
GER-1c	x	x	x
GER-1d		x	
GER-1e		x	
GER-1f	Harvesting of natural fouling agents for land-base aquaculture		
GER-1g	x	x	
GER-1h	x	x	

Note: SUB-1, TRIP-1 and COW-1 refer respectively to the whole Baltic Sea Region, North Sea and UK marine waters and not to specific points. GER-1 refers to 7 different projects concerning the same location and the same combination of uses.

Figure 5-12 Localization of selected case-studies, relevant for spatial and sector correspondence with MUSES case-studies.

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6. MAIN COMBINATIONS OF USES

a. Offshore Wind Energy and Aquaculture

A cross case-study comparison revealed that the prevailing combination of uses involve the "Offshore Wind Energy" sector with the "Aquaculture" sector. This combination type is included in 23 case-studies, belonging to 16 different projects. Among them the "TripleP@Sea" study is included (for the North Sea basin); it deals in more general terms with the development of offshore seaweed aquaculture in combination with shellfish aquaculture, but also explores the opportunities of co-location with other activities in MU platforms at sea, with special attention to the wind energy sector. The Rødsand II wind park experience, mentioned in the Submariner Project as example of mariculture combined with wind energy (case study SUB-1a, see 2.g) is also included. However, the test was performed in order to investigate biomass potential and nitrogen sequestration in the Baltic Sea by arranging nets between two wind mills and collecting samples of mussel and seaweed from the nets. Therefore this case study also includes the "Environmental Protection" use.

The analysis of all case-studies reveals that the development of multi-use is often triggered by an existing use, i.e. the presence of an operating (or planned) wind farm (Table 5-23).

Different species have been considered for offshore aquaculture in wind farms, depending on the environmental characteristics of each site and on the specific proposal design. Seaweeds and shellfish (in separated or combined plant proposals) are the most frequent examples considered in the analysed projects. Fish are specifically considered at 6 sites (from projects MERMAID, TROPOS, MARIBE, SUBMARINER and from German projects). Within the Submariner project, such a combination has been considered as a possible future combination for the Baltic Sea, when larger wind farms are expected to be developed. For the North Sea, Offshore fish aquaculture has been excluded, due to unsuitable environmental conditions.

The main drivers, barriers, added values and negative impacts of the combination between Offshore wind energy and Aquaculture have been identified. These elements refer to Offshore Aquaculture in general, and make it impossible to differentiate among different sectors (fish, shellfish and seaweed), because several projects refer to different specific combined solutions (fish and shellfish, seaweed and shellfish, seaweed and fish) or explore co-location of aquaculture in wind farms without distinction among different sectors.

The analysis of DABI elements evidences the high potential of this combination, driven by the high and increasing number of the existing and planned wind farms (especially in the North and Baltic Sea), by the economic interest in expanding the aquaculture sector in the offshore environment and by the vision of a possible solution for an increasingly crowded sea. Several barriers however exist, including a general lack of regulatory framework and clear procedure for obtaining permissions. Added values specially refer to economic, societal and environmental benefits, even if increased risks for structure damages as well as safety of people and operators have been highlighted by different case-studies as impacts. A general lack of experience and uncertainty of possible unknown impacts is also considered as a barrier, (limiting investment in this sector) and also generating people concern.

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Table 5-23 Offshore Wind Energy and Aquaculture: list of case-studies.

Project Name	Sea Basin	Case Study Location	Case-study code	Joint/Staggered development of uses + level of development	Aquaculture		
					Seaweed	Shellfish	Fish
MERMAID	North Sea	Gemini wind farm	MER-1	Staggered development site-specific concept design	x	x	
MERMAID	Baltic	Kriegers Flak	MER-3	Joint development site-specific concept design	x		x
MERMAID	Mediterranean	Northern Adriatic Sea	MER-4	Joint development site-specific concept design			x
TROPOS	Mediterranean	Crete	TRO-3	Joint development site-specific concept design	x		x
MARIBE	North Sea	Borssele wind park	MAR-1	Staggered development site-specific concept design		x	
MARIBE	Atlantic	Gran Canaria	MAR-5	Joint development site-specific concept design			x
SUBMARINER	Baltic	Baltic Sea Region	SUB-1	Staggered development evaluation of co-location potentials	x	x	x
		Rødsand II wind park	SUB-1a	Staggered development Experimental field test	x	x	
SAGB	Atlantic	North Hoyle Wind Farm	SAG-1	Staggered development Experimental field test		x	
SAGB	North Sea	Alpha Ventus Wind farm	SAG-2	Staggered development evaluation of co-location potentials	x	x	
TripleP@Sea	North Sea	North Sea	TRIP-1	Joint/Staggered development evaluation of co-location potentials	x	x	
DTU Aqua, 2010 (Poster)	North Sea	Danish waters-Horns Rev 1 Wind farm	DTU-1	Staggered development evaluation of co-location potentials		x	
	Baltic	Danish waters - Anholt Wind farm	DTU-2				
		Danish waters - Nysted Wind farm	DTU-3				
Jansen et al., 2016 (paper)	North Sea	Dutch North Sea	JAN-1	Joint/Staggered development evaluation of co-location potentials	x	x	
OOMU	North Sea	German North Sea	GER-1a	Joint development of co-use Pilot and laboratory scale tests	x	x	x
OSS	North Sea	German North Sea	GER-1b	Joint development of co-use Laboratory scale tests	x	x	x
Coastal Futures	North Sea	German North Sea	GER-1c	Joint/Staggered development for current and future set-ups Stakeholder engagement project	x	x	x
AquaLast	North Sea	German North Sea	GER-1d	Joint/Staggered development for current and future set-ups Pilot scale tests		x	
MytiFit	North Sea	German North Sea	GER-1e	Joint/Staggered development for current and future set-ups Pilot scale tests		x	
NutriMat	North Sea	German North Sea	GER-1f	Joint/Staggered development for current and future set-ups Laboratory scale tests	Harvesting of natural fouling agents for land-based aquaculture		
Roter Sand	North Sea	German North Sea	GER-1g	Joint/Staggered development for current and future set-ups Pilot scale tests	x	x	
Offshore Aquaculture	North Sea	German North Sea	GER-1h	Joint/Staggered development for current and future set-ups Pilot scale tests	x	x	

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b. Offshore Wind Energy and Offshore Wave energy

This combination of uses has been explored in two specific case-studies located in the Atlantic basin from the project MERMAID (Cantabrian Offshore Site) and the project MARIBE (West coast of Ireland). Furthermore, the combination of offshore wind and wave energies has been also explored for the Baltic Sea, within the project SUMARINER.
Finally, within the H2O framework, wind and wave energy has been considered in a complex MU platform, also involving hydrogen generation, drinking water production and Multi trophic Aquaculture.
A lack of proper know-how for such combination, relative immaturity of the offshore renewable energy technologies and no pilot application for the studied basins has been highlighted. However, according to the considered project results, large benefits can be expected from the combination of these two forms of renewable energy, sharing the same infrastructures, operation and maintenance activities.
Both energy sources also share a similar context in terms of governmental and marine policies, marine stakeholders and spatial constraints (Schultz-Zehden et al., 2012).

Table 5-24 Offshore Wind Energy and Offshore Wave Energy: list of case-studies.

Project Name	Sea Basin	Case Study Location	Case-study code	Joint/Staggered development of uses + level of development
MERMAID	Atlantic	Cantabrian Offshore Site	MER-2	Joint development site-specific concept design
MARIBE	Atlantic	West coast of Ireland	MAR-2	Joint development site-specific concept design
SUBMARINER	Baltic	Baltic Sea Region	SUB-1	Staggered development evaluation of co-location potentials
H2Oceans*	Atlantic	Coast of Portugal	H2O-1	Joint development site-specific concept design

* A MU Platform has been proposed, involving offshore wind and wave energy, hydrogen generation, desalinisation and multi-trophic aquaculture

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c. Offshore Wave energy and Aquaculture

Offshore Wave energy and Aquaculture have been evaluated in combined solutions in three case-studies, coming from the project MARIBE (off the Welsh coast in the Atlantic basin and Island of Malta in the Mediterranean basin) and from the project H2Oceans, in a site located off the Atlantic coast of Portugal. In this last case, a complex MU platform has been effectively planned, also harvesting wind energy and producing hydrogen and drinking water.

The DABI analysis reveals social and economic drivers deriving from the combination of two environmentally friendly products, as a good alternative to secure food sources and energy supply. This combination can lead to several added values which were detected in the investigated projects, leading for example to possible cost sharing ad better dispersion of pollution. Other synergies between the two users can exist, facilitating seaweed farm operation and ensuring a better detection of potential anomalies due to more frequent activities on site.

High investment costs and low technology readiness level can however act as barriers for the development of such combination, whereas potential impacts of combining offshore wave energy and aquaculture are scarcely investigated.

Table 5-25 Offshore Wave Energy and Aquaculture: list of case-studies.

Project Name	Sea Basin	Case Study Location	Case-study code	Joint/Staggered development of uses + level of development	Aquaculture		
					Seaweed	Shellfish	Fish
MARIBE	Atlantic	Welsh coast	MAR-4	Joint development site-specific concept design	x		
MARIBE	Mediterranean	Malta	MAR-6	Joint development site-specific concept design			x
H2Oceans*	Atlantic	Coast of Portugal	H2O-1	Joint development site-specific concept design	x	x	x

* A MU Platform has been proposed, involving offshore wind and wave energy, hydrogen generation, desalinisation and multi-trophic aquaculture.

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d. Other combinations of uses

Other combinations of uses refer to single case-studies, as reported in Table 5-26. The elements of the DABI refer therefore to the information gathered from the only one available source and in some cases result poorly detailed.

Table 5-26 Other combinations of uses: list of case-studies

Combination of uses	Project Name	Sea Basin	Case Study Location	Case-study code	Joint/Staggered development of uses + level of development
Shipping Terminal and Offshore Wind Energy	TROPOS	North Sea	Dogger Bank	TRO-1	Joint development site-specific concept design
Shipping Terminal and Offshore Wave Energy	MARIBE	Atlantic	South coast of Ireland	MAR-3	Joint development site-specific concept design
Tourism and Photovoltaic Energy	TROPOS	Atlantic	Canary Island	TRO-2	Joint development site-specific concept design
Offshore Wave Energy and Commercial Fishery	BILLIA CROO fishery	Atlantic	Billia Croo Orkney Island	BILL-1	Staggered development Field investigation
Offshore Wind Energy and Desalinisation	MARIBE	Mediterranean	Cyclades Islands	MAR-7	Joint development site-specific concept design
Offshore Wind Energy, Environmental Protection and Commercial Fishing	COWRIE	Atlantic and North Sea	UK marine waters	COW-1	Joint/Staggered development evaluation of co-location potentials

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6 APPENDIX

ELEMENTS OF DRIVERS, BARRIERS, ADDED VALUES AND IMPACTS (DABI)

FOR EACH CASE-STUDY AND FOR EACH COMBINATION OF USES

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Project List

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Project Name	Sea Basin	Case Study Location	Case-study code	Environmental characteristics/Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2	Drivers		Barriers		Added value		Impacts	
									Category	Factor	Category	Factor	Category	Factor	Category	Factor
MERMAID	North Sea	Gemini wind farm	MER-1	High wind energy potential. Optimal conditions for seaweed. North and Wadden Sea sediment exchange	Gravity-based foundations. Wind turbines. Extensive aquaculture	Staggered development site-specific concept design	Offshore wind energy	Aquaculture-seaweed Aquaculture-shellfish	D.1 Policy D.2 Interaction with other uses D.3 Economic D.4 Societal	MU explicitly mentioned in Dutch policies Wind farm already existing Market demand of mussel Increasing stakeholder interest	B.1 Legal B.2 Administrative B.4 Technical B.6 Environmental	Regulatory framework is missing. Forbidden third-party access to the offshore wind parks. No area designated for aquaculture in the North Sea Spatial Plans Licence only for single use High distance to the nearest port. Lack of experience for offshore aquaculture Extreme wave heights during storm	V.1 Economic V.2 Societal V.3 Environmental V.5 Technical	Cost sharing for logistic optimization Creating new jobs Creating new habitat for filter feeders Wave attenuation by seaweeds reducing fatigue loads and favouring longevity of material	I.1 Economic I.2 Societal	Conflicts with fishermen (reduction in the area available for fishery) increased risk for navigation
MERMAID	Atlantic	Cantabrian Offshore Site	MER-2	Narrow continental shelf combined with open sea conditions. Very high wind and wave energy potential The high energy content makes the site very attractive for developing multi-use offshore platforms.	Semi-submersible floating platform composed of wind turbines wave energy converters	Joint development site-specific concept design	Offshore wind energy	Offshore wave energy	D.4 Societal	Stakeholder interest in including marine renewable energies Social encouragement for green energy	B.1 Legal B.2 Administrative B.4 Technical B.5 Social B.6 Environmental	Lack of cross-border cooperation in MSP is complicating projects crossing several EEZ. Not unique interpretation of environmental legislation exists Insufficient coordination between different administrations levels and complex permitting procedures Difficulty to identify a feasible location (extensive waves and depths) Visual impact is considered critical by the Cantabrian community, due to the nearness to the coast Harsh environmental condition	V.1 Economic V.2 Societal V.3 Environmental	Combining several uses in the same floating platform allows reducing the final cost of energy, which can be highly competitive. The creation of green energy exploitations would attract external companies to be established in the region. Creating new jobs Creation of a sheltered area, positive for ictiofauna		
MERMAID	Baltic	Kriegers Flak	MER-3	High wind energy potential. Estuarine site. Optimal condition for temperate fish. Baltic and North Sea floe exchange	Gravity based foundations. Wind turbines. Extensive mariculture	Joint development site-specific concept design	Offshore wind energy	Aquaculture-fish Aquaculture-seaweed	D.1 Policy D.2 Interaction with other uses D.4 Societal	Danish political goal to be independent from fossil fuel by 2050. Political vision to increase aquaculture Wind farm already scheduled by 2020 Increasing stakeholder interest in MU opportunities	B.1 Legal B.2 Administrative	Marine Spatial Planning facing different interests and stakeholders is still at the beginning in the Baltic Sea. No official plans or visions yet to have MUPS realised by the Baltic Sea Single sectors are governed by different sets of authorities and regulations. Coordination is needed for MU development. Long and complex procedure for permission	V.1 Economic V.2 Societal V.3 Environmental	Cost sharing Creating new jobs Pylons and Turbine foundations can create new habitat for sessil filter feeders, sequestering part of the	I.2 Societal I.4 Technical	Increased risk for navigation Increased structure damages caused by floating fish cages during storms
MERMAID	Mediterranean	Northern Adriatic Sea	MER-4	Mild wind and wave energy potential. Good conditions for mussels and fishes. Lowest marine renewable energy potential in the Mediterranean	Gravity-based foundations Wind turbines Fish farming	Joint development site-specific concept design	Offshore wind energy	Aquaculture-Fish	D.2 Already existing uses	MU can solve some o the competing claims for space in the Mediterranean basin	B.2 Administrative B.4 Technical B.5 Social	Bureaucratic complications and lack of clear competences among different public institutions (at Mediterranean scale) Great distance between the MUP and the shore Conflicts with different uses of the area. High social sensitivity to the construction of new marine infrastructures near the city of Venice	V.3. Environmental	Possible habitat enhancement, due to a new hard substratum	I.1 Economic	Uncertainty about Economic profitability
TROPOS	North Sea	Dogger bank	TRO-1	Large shallow sandbank Water depths range from 15 m to 35 m. High wind speeds of over 10 m/s. Important habitat for a multitude of species.	"Sustainable Service Hub" concept Large floating offshore port with dedicated infrastructure Modular infrastructure, focusing on transport and energy related needs	Joint development site-specific concept design	Shipping terminal	Offshore wind energy					V.2 Societal V.3 Environmental	Reduction of the congestion of shipping traffic. Benefit for fishery industry (offering repair, short term accommodation and energy recharge) Reduction of overall negative impact in the multi-use scenario compared to single-use scenario. Reduction in CO2 emission, waste and waste water emission from the shipping. Reduction of the disturbance to the local marine animals.		
TROPOS	Atlantic	Canary Island	TRO-2	presence of protected area (natural reserve); Volcanically active zone with narrow and steep continental shelf. Optimal location for all the components studied in the project. Tourism is one of the most important activities	"Leisure Island" concept; Floating platform with leisure facilities for tourists and local residents with a photovoltaic energy plant	Joint development site-specific concept design	Tourism	Photovoltaic energy	D.1 Policy	The objectives of the project are in agreement with strategies and actions defined by the EC			V.1 Economic V.2 Societal V.3 Environmental V.5 Technical	Undertaking the project, the Canary Islands will receive an important boost for the local economy Better spatial management; Decreasing visual impacts and cultural losses; Improved management of transports; Improved health and quality of living in the region Impact reduction on Air Quality Generation of "know how", which would be applied in other islands or countries	I.3 Environmental	MU negative impacts have been assessed similar to single use negative impacts.
TROPOS	Mediterranean	Crete	TRO-3	100Km to the coast. Habitat of numerous ecologically and economically relevant species Oligotrophic waters. Favourable conditions for aquaculture	"Green & Blue" concept; Floating offshore platform with fish and microalgae aquaculture and energy from wind turbines	Joint development site-specific concept design	Offshore wind energy	Aquaculture-fish Aquaculture-seaweed	D.1 Policy D.3 Economic	The "Green & Blue" concept is in line with the EU policies for Blue Growth and the exploitation of the marine environment. The development of offshore aquaculture is in line with the European Aquaculture Technology and Innovation Platform (EATiP) which has set the target of increasing aquaculture production in Mediterranean through the development of efficient technologies.			V.1 Economic V.3 Environmental	A support to the development of the local economy is expected. Further opportunities for new joint activities towards a "blue" economy can be created. Cost sharing with the other activities developed in the platform. Reduction of overall negative impact in the multi-use scenario compared to single-use scenario (mainly lower air emission).		

Project Name	Sea Basin	Case Study Location	Case-study code	Environmental characteristics/Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2	Drivers		Barriers		Added value		Impacts	
									Category	Factor	Category	Factor	Category	Factor	Category	Factor
H2Oceans	Atlantic	West Coast of Portugal	H2O-1	Excellent wave resource and good wind resource	Integrated multipurpose platform including vertical axis wind turbine, wave energy converter, production of Hydrogen, Oxygen and drinking	Joint development site-specific concept design	Offshore wave energy	Offshore Wind energy Desalinisation Hydrogen generation Aquaculture-seaweed Aquaculture-shellfish Aquaculture-fish	D.3 Economic	A multi-use platform can be seen a very good alternative to secure food sources and energy supply	B.3 Financial/risk	High cost of investment is needed			I.1 Economic	A negative balance between costs and benefits has been highlighted
											B..4 Technical	Low technology readiness level of many parts and novelty of the envisaged configuration			I.3 Environmental	The environmental impact of the whole proposed installation has been evaluated as highly significant
MARIBE	North Sea	Borssele wind park	MAR-1	Distance of 500 metres to the continental shelf of the border with Belgium; Optimal wind resource	Bottom fixed wind turbines with mussel aquaculture	Staggered development site-specific concept design	Offshore wind energy	Aquaculture-shellfish					V.1 Economic	Cost reduction by integration of offshore activities and O&M costs due to shared facilities and possibly shared vessel.		
													V.2 Societal	Reduced risk of collisions with unfamiliar vessels		
													V.3 Environmental	Autonomous supply of clean renewable energy		
													V.5 Technical	Reduced impacts for mussel facilities from other vessel which cannot access to the wind farm area. Wave dampening effect due to mussel aquaculture		
MARIBE	Atlantic	West coast of Ireland	MAR-2		Floating Mixed use platform (MUP). Oscillating Water Column (OWC) wave energy converters, wind turbine mounted on the platform via a	Joint development site-specific concept design	Offshore wind energy	Offshore wave energy					V.1 Economic	Increased economic viability of the technology by combination of wave and wind technology		
													V.5 Technical	Reduction of the whole power variability generated by the platform due to the aggregation of wind and wave energy		
MARIBE	Atlantic	South coast of Ireland	MAR-3		Pneumatically stabilized platform. Floating Central hub shipping and container terminal. Oscillating Water	Joint development site-specific concept design	Shipping terminal	Offshore wave energy					V.1 Economic	Reduced cost of installation and Operation & maintenance		
													V.3 Environmental	Autonomous supply of clean renewable energy		
													V.5 Technical	Wave attenuation, improving of ship docking		
MARIBE	Atlantic	Welsh coast	MAR-4		Array of wave energy converters (WEC) combined with a seaweed farm	Joint development site-specific concept design	Offshore wave energy	Aquaculture-seaweed	D.4 Societal	Good public perception due to the combination of two environmental friendly products			V.1 Economic	Synergies for installation, inspection and maintenance operation		
													V.3 Environmental	Autonomous supply of clean renewable energy Cleaner water for aquaculture products due to offshore installation		
													V.5 Technical	Calmer waters (due to wave energy converters) facilitating seaweed farm; More days of operational activities for seaweed farm during bad weather conditions; More frequent activities on site due to different uses can facilitate a better detection of potential anomalies		
													V.6 Administrative	Easier licensing process due to the multiple use of space.		
MARIBE	Atlantic	Gran Canaria	MAR-5	Annual average wind speed 23.3-25.3 km/h main wind direction from NNE and N	Offshore wind turbines mounted on floating platforms, sharing the same space as an aquaculture installation	Joint development site-specific concept design	Offshore wind energy	Aquaculture-fish	D.3 Economic	Possible tax exemption due to renewable energy			V.1 Economic	Cost savings on Operation & Maintenance due to shared vessels. Companies can advert their products as environmentally friendly produced.		
													V.2 Societal	Good public perception		
									D.4 Societal	Good public perception in renewable energy use			V.3 Environmental	Autonomous supply of clean renewable energy Less environmental pollution due to distance from coast.		
													V.5 Technical	Calmer waters for aquaculture cages due to wind turbine installation; Security camera and radar systems can be installed at the turbine to protect finfish farm from robbery.		
MARIBE	Mediterranean	Malta	MAR-6		Special Purpose Vehicle to use wave energy for aquaculture porpoise	Joint development site-specific concept design	Offshore wave energy	Aquaculture-fish					V.1 Economic	Cost savings due to shared vessels		
													V.3 Environmental	Autonomous supply of clean renewable energy Less environmental pollution due to distance from coast and better dispersion. Increased sustainability of operations		
													V.5 Technical	Calmer waters for aquaculture farm due to wave energy installations;		
MARIBE	Mediterranean	Cyclades Islands	MAR-7	Located at few km from the shore water depth exceeding 40 meters; Good wind resource	Semi-submersible steel platform, accommodating an offshore wind turbine and a desalination plant	Joint development site-specific concept design	Offshore wind energy	Desalinisation					V.1 Economic	Cost reduction by integration of offshore activities Guaranteed customers for electricity purchase		
													V.3 Environmental	Autonomous supply of clean renewable energy		

Project Name	Sea Basin	Case Study Location	Case-study code	Environmental characteristics/Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2	Drivers		Barriers		Added value		Impacts	
									Category	Factor	Category	Factor	Category	Factor	Category	Factor
SUBMARINER	Baltic	Baltic Sea Region	SUB-1	Optimal oceanographic conditions. The highest wind energy technical potential in EU	Possible combinations between offshore Wind Parks and other marine uses	Staggered development Evaluation of co-location potentials	Offshore wind energy	Aquaculture-general	D.1 Policy	Both combination of uses Spatial efficiency has been introduced as a principle of maritime spatial planning in the Baltic Sea Region and is thus promoted by planning procedures Wind-Wave Wind and wave energy sectors share the same governmental and marine policies.	B.1 Legal	A satisfactory regulatory framework for combining aquaculture in wind farms is needed.	V.1 Economic	Both combination of uses Benefits from the use of the existing offshore infrastructure and possibly common operations		
													V.2 Societal	Wind-Aquaculture Mariculture installations can be more or less hidden within offshore wind parks, minimising their impacts on the landscape.	I.3 Environmental	Both combination of uses Information on environmental impacts of combined uses is limited. Aquaculture-wind Any kind of added uses to the wind park can lead to disturbance on biological community Potential impacts due to co-location can be: Increased traffic intensity for operation and management, with related risks to the environment. Disturbance of the "windmill landscape; Interference of any additional use with biotopes can be on the windmill foundations
									D.2 Interaction with other uses	Both combination of uses Spatial limitations is especially dramatic in the Baltic Sea Region, where coastal and near shore areas host a highly competitive group of uses. The high and increasing number of wind farms in Baltic Sea call for multiple use concepts.	B.2 Administrative	Both combination of uses Combined uses are much more difficult to be approved than singular uses.	V.3 Environmental	Both combination of uses Reduced emissions from transport and handling if operation and infrastructure are shared Wind-Wave All the considered environmental impacts of a wave energy device become either neutral or are moderated when a combined wave-wind park deployment is considered		
							Offshore wind energy	Offshore wave energy	D.3 Economic	Wind-Aquaculture Relatively mild conditions and easy access to the sites can result in relatively low cost of investment	B.4 Technical	Both combination of uses Lack of Knowledge about various forms of combination between wind farm and mariculture; Even less is known about wind-wave combinations. Scarce practical pilot applications exist. Research into the combination of uses in offshore wind farms is still at a very early stage.				
									D.4 Societal	Wind-Aquaculture Aquaculture in wind farm could be a way to compensate for losses in the traditional fishery areas Wind-Wave Wind and wave energy sectors share the same stakeholders	B.6 Environmental	Wind-Aquaculture Windmill farms are generally located in areas with strong winds and often also high waves, which can hamper operations for mariculture and ship traffic				
		Rødsand II wind park	SUB-1a	Shallow waters near to the Danish coast. Excellent wind resource	Wind park-gravity foundations, 5 rows of 18 turbines each. Nets were arranged between two mills	Staggered development Experimental field test	Offshore wind energy	Environmental protection Aquaculture-shellfish Aquaculture- seaweed	D.2 Relation with other uses	Rødsand II wind park already in operation. Great willingness of the wind energy company to cooperate in the experiment.	B.1 Legal	Lack of legal and planning incentives to promote co-localization of wind parks with other activities.	V.1 Economic	Sharing of wind energy company boats for the installation of the pilot plant. Sharing of smaller vessel for sampling with local fishermen.	I.3 Environmental	Information on environmental impacts of combined uses is limited
											B.2 Administrative	Difficulties in obtaining the environmental permits				
											B.3 Financial/risk	Need for economic incentives and necessary funding for scaling up pilot projects				
											B.4 Technical	Lack of accurate investigations with respect to the technologies applied.				
									D.4 Societal	Interest of local fishermen who cooperated in the project	B.5 Social	Lack of tradition for cooperation between different sectors, with possible conflicting interests	V.3 Environmental	Good potential for nutrient sequestration and production of aquatic biomass		
											B.6 Environmental	Possible steep salinity gradients, water temperature flux during the year and different nutrient availability can made difficult the proper site selection for biomass production . Lack of accurate investigations for possible negative interference with the natural system				
SAGB	Atlantic	North Hoyle Wind Farm	SAG-1	Liverpool Bay Special Protection Area. Relatively shallow waters, good strong winds and proximity to the national electricity network	Real case of mussel cultivation in nearshore wind farm	Staggered development Experimental field test	Offshore wind energy	Aquaculture-shellfish	D.1 Policy	The potential for co-location of aquaculture within offshore wind farms is highlighted by the Welsh Fish Strategy and by UK Marine Policy Statement	B.1 Legal	No clear legislation for aquaculture development beyond 12 nm and within Wind farm. Need for a review on legal status in terms of licensing of multi-functional use of a leased area within a wind farm. A byelaw exemption for North Hoyle trial has been sought to the Government allowing the activity to be undertaken under an experimental exemption.	Added values are not detailed for North Hoyle trial. However, several added values have been mentioned in the Study Report, exploring potential co-location between wind farm and aquaculture in general.		I.4 Societal	Additional risks for the wind farm operators (managing and mitigating any additional risks must be addressed by specific protocols)
									D.2 Interaction with other uses	A Wind farm is already operating						
									D.3 Economic	Expanding seafood provision from UK waters						
									D.4 Societal	Expanding employment opportunities						
SAGB	North Sea	Alpha Ventus Wind farm	SAG-2	The site location is beyond the Wadden Sea World Natural Heritage site. High wind speed and wave heights	Aquaculture options within the Alpha Ventus Wind Farm and more in general for the German North Sea	Staggered development Evaluation of co-location potentials	Offshore wind energy	Aquaculture-seaweed Aquaculture-shellfish	D.1 Policy	The Germany Spatial plan for the German Exclusive Economic Zone explicitly recommends combinations among facilities for mariculture and existing installations such as the foundations of offshore wind turbines. Laws/regulations now require that wind farm developers must consider co-location as part of their application for a permit to develop a new wind farm.	B.4 Technical	Offshore environment provides high demands on infrastructures and difficulty of access to service aquaculture installations	V.1 Economic	Logistic optimization (mainly for aquaculture)	I.1 Economic	Uncertain profitability: higher economic costs for operating in a offshore environment (for aquaculture); No great effect on economic return by sharing vessel. Exclusion of other shipping and fishing activities from wind farm sites
									D.2 Interaction with other uses	A Wind farm is already operating in the site. Massive offshore wind farm development is planned in the North Sea.			V.2 Societal	Benefits are perceived if income from existing sources such as fishing and tourism are affected by renewable energy developments Provision of further employment for local communities		
									D.4 Societal	Aquaculture in wind farm could compensate the reduction of the available area, due to the establishment of Marine Parks Co-location enhances the social acceptance of Offshore aquaculture			V.5 Technical	Exclusion of other shipping and fishing activity from wind farm sites		
TripleP@Sea	North Sea	North Sea	TRIP-1		No design specification The possibility of develop offshore seaweed aquaculture as part of multi-use platforms at sea (MUPS) has been assessed	Joint/Staggered development Evaluation of co-location potentials	Aquaculture-seaweed	Aquaculture-shellfish Offshore Wind energy	D.1 Policy	In the Policy Note North Sea 2009-2015 it is explicitly mentioned that co-use of offshore wind energy parks should be allowed as much as possible	B.1 Legal	No established framework of policies and regulations describing what conditions MUPS should meet. In the Integral Management plan for the North Sea (2006) there is no space indicated for offshore aquaculture for the Dutch part of the North Sea. Therefore aquaculture activities in wind energy platforms need to get exemption to be applied. The current practice of regulators is to forbid third-party access to the offshore wind parks. The new renewable energy subsidy programme no longer includes offshore wind development.				
											B.3 Financial/risk	At present no manifest interest in investing in MUPS has been identified, because there is not yet a clear business case and many risks are identified				

Project Name	Sea Basin	Case Study Location	Case-study code	Environmental characteristics/Resources	Design concept/ explored use combinations assessed	Joint/Staggered development of uses + level of development	Use 1	Use 2	Drivers		Barriers		Added value		Impacts	
									Category	Factor	Category	Factor	Category	Factor	Category	Factor
											B.4 Technical	The development of MUPS, despite the interest in the concept, is at a very early stage in the North Sea, with no real-life applications yet. MUPS can be found only as designs on paper, or as the first experiments with seaweed production on sea. Technological innovations are needed to develop MUPS				
COWRIE	Atlantic	UK marine waters	COW-1		Benefits and disadvantages for fishing sector of co-locating wind farm and Marine Conservation Zones	Joint/Staggered development Evaluation of co-location potentials	Offshore wind energy	Environmental Protection Commercial fishery	D.1 Policy	UK is committed to produce 30% of its electricity from renewable sources by 2020. At the same time, the Government committed marine conservation targets and networks of Marine Conservation Zones have to be introduced.	B.2 Administrative B.3 Financial/risk	Co-location may make gaining consent more difficult, putting investment at risk	V.1 Economic	Marine Conservation Zone management efforts can be reduced by joint routine operations with wind farms	I.1 Economic	Co-location may increase responsibilities and costs for wind farmers
COWRIE	North Sea										B.6 Environmental	Turbines and wind farm infrastructures may prevent the attainment of MCZ conservation objectives	V.2 Societal	Co-location may minimize social and economic impacts on fishing industry. Co-location discussion may support wind farm developer's efforts to engage with local fishing communities	I.2 Societal	Possible limitation to fishing inside wind farms; possible inadequate compensation for lost fishing opportunities
													V.3 Environmental	Co-location may provide opportunities for wind farm developers to demonstrate their environmental performance. Co-location may support the attainment of habitat conservation targets and conservation objectives (due to fishing restriction in the area)	I.3 Environmental	The choice of MCZ location can suffer from wind farm location
DTU Aqua, 2010 (Poster)	North Sea	Danish waters-Horns Rev 1 Wind farm	DTU-1	Shallow Danish waters relatively closed to the harbour. Strong winds and strong salinity gradients	Potential of wind farms for shellfish aquaculture	Staggered development Evaluation of co-location potentials	Offshore wind energy	Aquaculture-shellfish	D.2 Interaction with other uses	The increasing number of wind farms, their volume and spatial placement calls for multiple uses of sea	B.4 Technical	Existing wind farm designs and operation/maintenance efforts provide challenges to the development of MU				
	North Sea	Danish waters - Anholt Wind farm	DTU-2													
	Baltic	Danish waters - Nysted Wind farm	DTU-3								B.6 Environmental	Environmental conditions are not always suitable for offshore aquaculture (harsh conditions or low salinity can limit the production)				
BILLIA CROO fishery project	Atlantic	Billia Croo Orkney Island	BILL-1	Very high energy coastal environment. Marine conservation areas exist in the vicinity of the site	Possible role of wave energy converter in increasing local lobster stocks	Staggered development Field invvestigation	Offshore wave energy	Commercial fishery								
Jansen et al., 2016 (paper)	North Sea	Dutch North Sea	JAN-1	Sea Basin with high potential for offshore aquaculture. Highly productive sea High hydrodynamic forces	Development of offshore aquaculture and smart combinations with other sea uses	Joint/Staggered development Evaluation of co-location potentials	Aquaculture-seaweed Aquaculture-shellfish	Offshore wind energy (main considered use among possible combinations)	D.1 Policy	Interest in combining functions is declared in policy documents	B.1 Legal	MSP approach has not yet completely been applied in the North Sea. Laws and regulation don't encompass combination of uses. Recent law modification to overcome this barrier are in progress	V.1 Economic	Estimated reduction of cost due to combined operating and maintenance activities	I.1 Economic	Possible increased cost of insurance in multi-use settings, because of risk increasing
													V.2 Societal	Reduced risk of boat collision, because of the restricted access to the wind farm	I.3 Environmental	Potential cumulating effects have to be assessed case by case
									D.3 Economic	The recent experienced decrease of mussel production level can be seen as an incentive to expand offshore the aquaculture development	B.3 Financial/Risk	Commercial interest is currently limited. Hesitance from the wind energy sector for possible increase of insurance cost; Extended financial inputs to secure structures. Reliable information on site-specific costs and benefits is difficult to access. Investment is limited by uncertainties of several elements.	V.3 Environmental	Better protection of mussel cultivation from external influence due to restricted public and boat access to the wind farm area	I.4 Technical	Possible damage from one activity to the other (drifting longline construction may strike and damage foundations of fixed structures)
											B.4 Technical	Scarce knowledge about resistance of aquaculture structures to harsh conditions; Lack of culture protocols and strategies specifically adapted for offshore cultivation; Technical feasibility at commercial scale still needs to be proven; Knowledge gaps on ecological performance				

Project Name	Sea Basin	Case Study Location	Case-study code	Environmental characteristics/Resources	Design concept/ explored use combinations	Joint/Staggered development of uses + level of development	Use 1	Use 2	Drivers		Barriers		Added value		Impacts	
									Category	Factor	Category	Factor	Category	Factor	Category	Factor
Open Ocean Multi-use (OOMU)	North Sea	German North Sea	GER-1a	High energy environment, flat sea, nutrient rich water body, extremely used sea by several users	Development of offshore aquaculture within wind farm sites - directly connected, indirectly in the vicinity	Joint development of co-use Pilot and laboratory scale tests	Offshore wind energy	Aquaculture-seaweed Aquaculture-shellfish Aquaculture -fish	D.2 Interaction with other uses	Avoidance of more offshore sites can promote multi-use and aquaculture	B.4 Technical	Technical connectiveness of aquaculture to wind farm foundations, lack of acceptance by wind farm operators	V.1 Economic	Good Socio-economic impacts Economic benefits for both users	I.1 Economic	Problems related to insurance
									D.3 Economic	Economic considerations, suggesting a benefit for both users, can promote MU			V.2 Societal	The project increase stakeholder participation	I.2 Societal	Problems of safety of people
															I.4 Technical	Possible concern for safety of installations
Offshore Site-Selection (OSS)	North Sea	German North Sea	GER-1b	High energy environment, flat sea, nutrient rich water body, extremely used sea by several users	Development of offshore aquaculture within wind farms, passive fisheries combinations, IMTA, economy as well as jurisdiction/regulations and social science	Joint development of co-use Laboratory scale tests	Offshore wind energy	Aquaculture-seaweed Aquaculture-shellfish Aquaculture -fish Commercial fishery	D.2 Interaction with other uses	Avoidance of more offshore sites can promote multi-use and aquaculture	B.1 Legal	Lack of a regulative framework	V.1 Economic	Good Socio-economic impacts Economic benefits for both users		
									D.3 Economic	Economic considerations, suggesting a benefit for both users can promote MU	B.5 Social	The offshore aquaculture is a matter of concern for some stakeholders who don't accept industrialization in the North Sea at all.	V.2 Societal	The project increase stakeholder participation		
Coastal Futures	North Sea	German North Sea	GER-1c	High energy environment, flat sea, nutrient rich water body, extremely used sea by several users	Stakeholder participation and co-management of multi-uses/ stakeholder willingness	Joint/Staggered development for current and future set-ups Stakeholder engagement project	Offshore wind energy	Aquaculture-general	D.4 Societal	Willingness of some stakeholder to use space in a multi-use manner	B.5 Social	Lack of acceptance to multi-use at all, bivalve farmers from nearshore environments are afraid to be kicked out to the offshore realm	V.2 Social			
AquaLast	North Sea	German North Sea			Technical feasibility to set-up aquaculture in combination with wind farm foundations to guarantee stable aquaculture, resistant to storm conditions	Joint/Staggered development for current and future set-ups Pilot scale tests	Offshore wind energy	Aquaculture-shellfish	D.3 Economic	The demand for high quality seafood (e.g. blue mussels and seaweed) is constantly rising, promoting the development of offshore aquaculture	B.4 Technical	The big calculated loads on the grounding structures of offshore wind turbines require structural modifications to make them suitable for co-use with marine offshore aquacultures	V.1 Economic	Possibility to expand aquaculture where no aquaculture could previously be realized	I.2 Societal	Possible concern for safety of people
			GER-1d	High energy environment, flat sea, nutrient rich water body, extremely used sea by several users	direct connection of a mussel and oyster longline device to a tripod foundation and technical modifications of tripods										I.4 Technical	Possible concern for safety of installations
MytiFit	North Sea	German North Sea	GER-1e	High energy environment, flat sea, nutrient rich water body, extremely used sea by several users	Health conditions of respective wind farm sites (avoiding local "hot spots")	Joint/Staggered development for current and future set-ups Pilot scale tests	Offshore wind energy	Aquaculture-shellfish	D.3 Economic	Possibility of expand healthy seafood due to offshore resistance of the candidate	B.3 Financial/Risk	Farmers were afraid to invest	V.1 Economic	Possibility to expand aquaculture where no aquaculture could previously be realized		
					development of offshore adapted mussel collector types						B.5 Social	Bivalve farmers from nearshore environments are afraid to be kicked out to the offshore realm				
NutriMat	North Sea	German North Sea	GER-1f	High energy environment, flat sea, nutrient rich water body, extremely used sea by several users	technical development of automated fouling harvest robots	Joint/Staggered development for current and future set-ups Laboratory scale tests	Offshore wind energy	Aquaculture (Harvesting of natural fouling agents)	D.2 Relation with other uses	The presence of natural fouling agents in the foundation of wind farms promotes the exploitation of this resource	B.4 Technical	Acceptance of offshore wind farm operators in using the foundations for any other purpose, which could potentially lead to a damage Problems in the realisation of an automated harvesting machine	V.1 Economic	Cheap feed production for fish cultivation Benefit for wind farm cleaning requirement (wind farms need to clean their foundations from any fouling to allow annual inspection of the condition of the foundation and guarantee that there is no risk)		
					quality test of mussels for aquaculture feed											
					feeding trials of new feed for turbot											
Roter Sand	North Sea	German North Sea	GER-1g	High energy environment, flat sea, nutrient rich water body, extremely used sea by several users	Development of offshore adapted bivalve and seaweed systems	Joint/Staggered development for current and future set-ups Pilot scale tests	Offshore wind energy	Aquaculture-seaweed Aquaculture-shellfish	D.2 Interaction with other uses	Interest in not covering too many areas with any use (promote the combined use of space)	B.5 Social	People concern about offshore aquaculture Problem of overall acceptance as this was the first multi-use project internationally and globally				
Offshore Aquaculture			GER-1h		Tests of offshore wind farms sites for seaweed, oyster and mussel cultivation (site-selection)				D.3 Economic	Economic interest in increasing aquaculture production						

Wind-Aquaculture List

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 727451

Drivers		Barriers		Added value		Impacts	
Category	Factor	Category	Factor	Category	Factor	Category	Factor
D.1 Policy		B.1 Legal		V.1 Economic	Cost savings due to synergies for installation, inspection and maintenance operation and due to shared vessels	I.1 Economic	A negative balance between costs and benefits has been highlighted (H2Oceans platform)
D.2 Interaction with other uses		B.2 Administrative		V.3 Environmental	Autonomous supply of clean renewable energy Less environmental pollution for aquaculture products due to distance from coast and better dispersion of pollution Increased sustainability of operations	I.2 Societal	
D3 Economic	A multi-use platform can be seen as a very good alternative to secure food sources and energy supply	B.3 Financial/Risk	High cost of investment is needed	V.4 Insurance policy and risk management		I.3 Environmental	The environmental impact of the whole proposed installation has been evaluated as highly significant (H2Oceans platform)
D.4 Societal	Good public perception due to the combination of two environmental friendly products	B.4 Technical	Low technology readiness level of many parts and novelty of the envisaged configuration	V.5 Technical	Calmer waters (due to wave energy converters) facilitating seaweed farm More days of operational activities for seaweed farm during bad weather conditions More frequent activities on site due to the different uses can lead to better detection of potential anomalies		
		B.5 Social		V.6 Administrative	Easier licensing process due to the multiple use of space.		

Wind-Wave List

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 727451

Drivers		Barriers		Added value		Impacts	
Category	Factor	Category	Factor	Category	Factor	Category	Factor
D.1 Policy	Spatial efficiency has been introduced as a principle of maritime spatial planning in the Baltic Sea Region and is thus promoted by planning procedures Wind and wave energy sectors share the same governmental and marine policies.	B.1 Legal	Lack of cross-border cooperation in MSP is complicating projects crossing several EEZ Not unique interpretation of environmental legislation exists A satisfactory regulatory framework for combining aquaculture in wind farms is needed	V.1 Economic	Benefits from the use of the existing offshore infrastructure and possibly common operations Combining several uses in the same floating platform allows reducing the final cost of energy, which can be highly competitive The creation of green energy exploitations would attract external companies to be established in the region Increased economic viability of the technology by combination of wave and wind technology	I.1 Economic	
D.2 Interaction with other uses	Spatial limitations is especially dramatic in the Baltic Sea Region, where coastal and near shore areas host a highly competitive group of uses. The high and increasing number of wind farms in Baltic Sea call for multiple use concepts.	B.2 Administrative	Insufficient coordination between different administrations levels Complex permitting procedures for MU	V.2 Societal	Creating new jobs	I.2 Societal	Visual impact
D.3 Economic		B.4 Technical	Difficulty to identify a feasible location (extensive waves and depths) Lack of Knowledge about wind-wave combinations Scarce practical pilot applications exist Research into the combination of uses in offshore wind farms is still at a very early	V.3 Environmental	Creation of a sheltered area, positive for ictiofauna Reduced emissions from transport and handling if operation and infrastructure are shared All the considered environmental impacts of a wave energy device become either neutral or are moderated when a combined wave-wind park deployment is considered	I.3 Environmental	Information on environmental impacts of combined uses is limited.
D.4 Societal	Stakeholder interest in including marine renewable energies Social encouragement for green energy Wind and wave energy sectors share the same stakeholders	B.5 Social	Visual impact is considered critical, if the platform is near to the coast	V.4 Insurance policy and risk management			
		B.6 Environmental	Harsh environmental condition	V.5 Technical	Reduction of the whole power variability generated by the platform due to the aggregation of wind and wave energy		

Wave-Aquaculture List

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 727451

Drivers		Barriers		Added value		Impacts	
Category	Factor	Category	Factor	Category	Factor	Category	Factor
D.1 Policy		B.1 Legal		V.1 Economic	Cost savings due to synergies for installation, inspection and maintenance operation and due to shared vessels	I.1 Economic	A negative balance between costs and benefits has been highlighted (H2Oceans platform)
D.2 Interaction with other uses		B.2 Administrative		V.3 Environmental	Autonomous supply of clean renewable energy Less environmental pollution for aquaculture products due to distance from coast and better dispersion of pollution Increased sustainability of operations	I.2 Societal	
D3 Economic	A multi-use platform can be seen as a very good alternative to secure food sources and energy supply	B.3 Financial/Risk	High cost of investment is needed	V.4 Insurance policy and risk management		I.3 Environmental	The environmental impact of the whole proposed installation has been evaluated as highly significant (H2Oceans platform)
D.4 Societal	Good public perception due to the combination of two environmental friendly products	B.4 Technical	Low technology readiness level of many parts and novelty of the envisaged configuration	V.5 Technical	Calmer waters (due to wave energy converters) facilitating seaweed farm More days of operational activities for seaweed farm during bad weather conditions More frequent activities on site due to the different uses can lead to better detection of potential anomalies		
		B.5 Social		V.6 Administrative	Easier licensing process due to the multiple use of space.		

Shipping - Wind List

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 727451

Drivers		Barriers		Added value		Impacts	
Category	Factor	Category	Factor	Category	Factor	Category	Factor
				V.2 Societal	Reduction of the congestion of shipping traffic Benefit for fishery industry (offering repair, short term accommodation and energy recharge)		
				V.3 Environmental	Reduction of overall environmental negative impact in the multi-use scenario compared to single-use scenario Reduction in CO2 emission, waste and waste water emission from the shipping Reduction of the disturbance to the local marine animals.		

Shipping - Wave List

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 727451

Drivers		Barriers		Added value		Impacts	
Category	Factor	Category	Factor	Category	Factor	Category	Factor
				V.1 Economic	Reduced cost of installation and Operation & maintenance		
				V.3 Environmental	Autonomous supply of clean renewable energy		
				V.5 Technical	Wave attenuation, improving of ship docking		

Tourism - Photovoltaic List

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 727451

Drivers		Barriers		Added value		Impacts	
Category	Factor	Category	Factor	Category	Factor	Category	Factor
D.1 Policy	The objectives of the project are in agreement with strategies and actions defined by the EC			V.1 Economic	Undertaking the project, the Canary Islands will receive an important boost for the local economy	I.3 Environmental	MU negative impacts have been assessed similar to single use negative impacts.
				V.2 Societal	Better spatial management; Decreasing visual impacts and cultural losses; Improved management of transports; Improved health and quality of living in the region		
				V.3 Environmental	Impact reduction on Air Quality		
				V.5 Technical	Generation of “know how”, which would be applied in other islands or countries		

Wind - Desalination List

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 727451

Drivers		Barriers		Added value		Impacts	
Category	Factor	Category	Factor	Category	Factor	Category	Factor
				V.1 Economic	Cost reduction by integration of offshore activities Guaranteed customers for electricity purchase		
				V.3 Environmental	Autonomous supply of clean renewable energy		

Wind – Environmental Protection - Fishing List

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 727451

Drivers		Barriers		Added value		Impacts	
Category	Factor	Category	Factor	Category	Factor	Category	Factor
D.1 Policy	UK is committed to produce 30% of its electricity from renewable sources by 2020. At the same time, the Government committed marine conservation targets and networks of Marine Conservation Zones have to be introduced.	B.2 Administrative	Co-location may make gaining consent more difficult, putting investment at risk	V.1 Economic	Marine Conservation Zone management efforts can be reduced by joint routine operations with wind farms	I.1 Economic	Co-location may increase responsibilities and costs for wind farmers
		B.6 Environmental	Turbines and wind farm infrastructures may prevent the attainment of MCZ conservation objectives	V.2 Societal	Co-location may minimize social and economic impacts on fishing industry. Co-location discussion may support wind farm developer's efforts to engage with local fishing communities	I.2 Societal	Possible limitation to fishing inside wind farms Possible inadequate compensation for lost fishing opportunities
				V.3 Environmental	Co-location may provide opportunities for wind farm developers to demonstrate their environmental performance. Co-location may support the attainment of habitat conservation targets and conservation objectives (due to fishing restriction in the area)	I.3 Environmenta	The choice of MCZ location can suffer from wind farm location