

ESPON



Co-funded by
the European Union
Interreg

ANNEX 3 CASE STUDIES

Territorial cooperation for blue renewable energy (CoBren)

CoBren

Case studies // April 2025

This Annex 3 Case studies are conducted within the framework of the ESPON 2030 Cooperation Programme, partly financed by the European Regional Development Fund.

The ESPON EGTC is the Single Beneficiary of the ESPON 2030 Cooperation Programme. The Single Operation within the programme is implemented by the ESPON EGTC and co-financed by the European Regional Development Fund, the EU Member States and the Partner States, Iceland, Liechtenstein, Norway, and Switzerland.

This delivery does not necessarily reflect the opinions of members of the ESPON 2030 Monitoring Committee.

Coordination

Michaela Gensheimer (ESPON EGTC)

Outreach

Nikos Lampropoulos (ESPON EGTC)

Authors

Andreas Steinbach (Deloitte), Frank Holstein (Deloitte), Alexandra Rimpler (Deloitte), Yuki Esser (DMEC), Sander des Tombe (DMEC), Marloes Kraan (WUR), Sander van den Burg (WUR), Hatem Chouchane (WUR), Trond Selnes (WUR)

Technical Support

Martin Gauk (ESPON EGTC), Yuki Esser (DMEC), Aida Sutopo (DMEC)

Advisory group

Frederick Richters (MAT), Alba Villamor Anguiano (MITECO), Mathilde Konstantopoulou (Ministry of Economy & Development)

Information on ESPON and its projects can be found at www.espon.eu.

The website provides the possibility to download and examine the most recent documents produced by finalised and ongoing ESPON projects.

ISBN: 978-2-919839-00-1

© ESPON 2030

Layout and graphic design by BGRAPHIC, Denmark

Printing, reproduction or quotation is authorised provided the source is acknowledged and a copy is forwarded to the ESPON EGTC in Luxembourg.

Contact: info@espon.eu



ANNEX 3 CASE STUDIES //

**Territorial cooperation for
blue renewable energy
(CoBren)**

CoBren

Case studies // April 2025

Disclaimer

This document is a case study.

The information contained herein is subject to change and does not commit the ESPON EGTC and the countries participating in the ESPON 2030 Cooperation Programme.

Table of Contents

1	Purpose of this document.....	6
2	Case study objective and selection approach.....	7
3	Main observations and conclusions drawn from the case studies.....	9
4	Case study: AquaWind.....	12
4.1	Unlocking the Atlantic Sea Basin’s ORE potential	13
4.2	The role of maritime spatial planning for ORE deployment.....	14
4.3	Planning challenges & potential solutions experienced in the AquaWind project	16
4.4	Perspectives for territorial cooperation.....	17
4.5	Key lessons and future directions.....	18
4.6	Sources	18
5	Case study: UNITED	20
5.1	Unlocking the Baltic Sea’s ORE potential	21
5.2	The role of maritime spatial planning for ORE development.....	22
5.3	Planning challenges & possible solutions in the UNITED project.....	24
5.4	Key lessons and future directions.....	26
5.5	Sources	27
6	Case Study: EURO-TIDES.....	29
6.1	Unlocking the North Sea’s tidal energy potential.....	30
6.2	The role of maritime spatial planning for ORE development.....	30
6.3	Planning challenges and solutions experienced through EURO-TIDES.....	32
6.4	Key lessons and future directions.....	33
6.5	Sources	34
7	Case study: BLOW	35
7.1	Unlocking the Black Sea’s ORE potential	35
7.2	The role of maritime spatial planning for ORE development.....	37
7.3	Planning challenges and solutions experienced through the BLOW project.....	37
7.4	Key lessons and future directions.....	39
7.5	Sources	40
8	Case study: EU-SCORES	41
8.1	Unlocking the Atlantic Ocean’s ORE potential	42
8.2	The role of maritime spatial planning for ORE development.....	43
8.3	Stakeholder engagement	47
8.4	Nascent territorial cooperation.....	48
8.5	Key lessons and future directions.....	49
8.6	Sources	50
9	Case Study: ULTFARMS	52
9.1	Unlocking the North Sea basin’s ORE potential.....	53
9.2	The role of maritime spatial planning for ORE development.....	54
9.3	Territorial cooperation at the North Sea basin level	58
9.4	Key lessons and future directions.....	60
9.5	Sources	61
10	Case study MUSICA.....	63
10.1	Unlocking the Mediterranean Sea Basin’s ORE potential.....	64
10.2	The role of maritime spatial planning for ORE development.....	65
10.3	Experiences with planning challenges and solutions in the MUSICA project.....	65
10.4	Key lessons and future directions.....	68

10.5	Sources	70
------	---------------	----

Table of Maps

Map 1	Aquawind's <i>PLOCAN</i> test site and aquaculture cage test.....	15
Map 2	Middelgrunden Wind Farm location in the Baltic Sea	23
Map 3	EURO-TIDES location at the Fall of Warness tidal site in the North Sea	31
Map 4	Sea use in the Bulgarian Black Sea challenging location possibilities for BLOW	36
Map 5	EU-SCORES' location at the Aguçadoura Wave Test site in the Atlantic Ocean.....	44
Map 6	ULTFARM's FINO3 Platform located in the North Sea	55
Map 7	MUSICA's locations on Greece's Chios Island in the Mediterranean Sea.....	66

Table of Figures

Figure 1	W2Power floating technology with space for aquaculture	14
Figure 2	Orbital marine power tidal technology	29
Figure 3:	WindFloat Atlantic energy park.....	41
Figure 4	Stakeholder engagement plan EU-Scores	47
Figure 5	Multi-Use Park visualisation	52
Figure 6	MUSICA's multi-use platform	63

Table of Tables

Table 1	Overview of case study selection criteria.....	7
Table 2	Overview of selected case studies.....	8
Table 3	Yearly Business Growth Metrics (2017-2023)	25

1 Purpose of this document

In the context of the ESPON CoBren project, seven case studies supplement the findings on the potential for offshore renewable energy (henceforth “*ORE*”) and its position in maritime spatial planning (henceforth “*MSP*”) practices. These case studies provide detailed insights into specific projects, highlighting their geographical context, MSP tools, drivers and challenges for ORE deployment, and the role of territorial cooperation.

This document presents the seven case studies that have contributed to the CoBren main report.

Disclaimer

- Please note that the respective project holders have fully validated the following case studies: *EURO-TIDES*, *UNITED*, *BLOW*, *AquaWind*, *ULTFARMS* and *EU-Scores*.
- The *MUSICA* case study has not been validated by the project holder.

2 Case study objective and selection approach

The CoBren study presents seven case studies that together provide a comprehensive representation of ORE developments across the five European sea basins, as well as in one outermost and one island region. These case studies were selected to ensure geographical and thematic diversity, while reflecting the full range of relevant criteria identified by the project team (see Table 1).

The final selection of case studies was guided by the overarching objective to capture meaningful insights into the opportunities and challenges of ORE deployment across Europe. Each case study offers a distinct perspective, whether by demonstrating cross-sectoral collaboration (e.g. multi-use with aquaculture or tourism), technological innovation (e.g. tidal and floating wind), or addressing regional specificities (e.g. small islands, outermost regions).

The case studies have the following geographical focus:

- **Six case studies focused on specific sea basins:** Atlantic Ocean, Baltic Sea, North Sea, Mediterranean Sea, and Black Sea.
- **One case study addressing both an outermost and island region** (Canary Islands).

Table 1 provides an overview of the case study selection criteria. Table 2 provides an overview of the final case study selection, including the associated sea basin, project name and description, ORE type, and multi-use component (if applicable). Table 1 Overview of final selection of case studies

Table 1 Overview of case study selection criteria

Selection Criterion	Details/Options
Geographical Level	National Level (operating within one country) Cross-Border (involving multiple countries within a sea basin)
Type of Territory	Outermost Region (remote EU territories with specific regional challenges) Coastal Region (territories directly bordering the coastline) Island Region (standalone or semi-autonomous islands) Continental or Adjacent Territories (inland areas with direct or indirect coastal influence)
Sea Basin	Atlantic Ocean Baltic Sea Mediterranean Sea North Sea Black Sea
ORE Type	Wind Wave Tidal Other marine-related renewable sources (e.g. solar)
ORE Deployment Status	Unexploited (not yet operational) Developing (under development) Advanced (fully operational and contributing to energy production)
Project Category	Alignment Framework Innovation Framework Study/Assessment Multi-Use Project Tool/Platform/Cooperation Agreement ORE Capacity/Efficiency Gain
Technology Stage	Concept (preliminary idea or model) Testing (initial trials and assessments) Deployment (implemented and operational)
Budget of the Initiative	Budget in EUR

Source: CoBren project team, 2025

Table 2 Overview of selected case studies

Sea Basin/Case Study Focus	Initiative	Project Description	ORE	Multi-Use
1. Atlantic Ocean / Outermost Regions Island	Aquawind (EMFAF)	Canary Islands - AquaWind is a research and innovation project aimed at demonstrating a co-located and multi-use solution combining aquaculture with a renewable energy product. This entails integrating aquaculture activities into an existing marine renewable energy product, i.e. a wind power prototype.	Wind	Aquaculture
2. Baltic Sea	UNITED (Horizon 2020)	Denmark - Pilot in Denmark that combines offshore wind and tourism, enhancing the synergy between these sectors.	Wind	Tourism
3. North Sea	Eurotides (Horizon 2020, UKRI)	UK - The project aims to advance tidal energy technology and reduce the cost of generating tidal energy (reducing the levelized cost of energy - LCOE), and to accelerate commercialisation. To this end, the project consists of deploying four 2.4 MW Orbital Marine Power turbines at Orkney's <i>European Marine Energy Centre's</i> (EMEC) Fall of Warness site, resulting in delivering 9.6 MW power	Tidal	N/A
4. Black Sea	BLOW (Horizon 2020, UKRI)	Bulgaria - BLOW (<i>'Black Sea Floating Offshore Wind'</i>) is an innovative ORE project in the Black Sea, demonstrating possibilities to deploy floating wind technology in Bulgaria. The project seeks to increase renewable energy capacity in the Black Sea by leveraging an innovative floating wind technology previously tested in France by <i>Eolink</i> .	Floating wind	N/A
5. Atlantic Ocean	EU Scores (Horizon 2020)	Portugal - A 1.2 MW wave energy array by CoPower Ocean in Portugal, which will be grid connected. The production profile will be compared to the offshore floating wind farm WindFloatAtlantic.	Floating Wind	Wave, solar
6. North Sea	ULTAFARMS (2020Horizon 2020)	Baltic Sea - ULTAFARMS focuses on six Low-Trophic Aquaculture Pilots (ITAPs) located in different areas across the North and Baltic Seas, which will include Belgium-Denmark (Seaweed-Mussels-Oysters), the Netherlands-Bredside (Mussels), Germany-FIN02 (Seaweed-TNOs), Seaweed-Mussels & Oysters, and Denmark-Ambit Offshore Wind Farm (Seaweed-Mussels). These ITAPs will foster development and co-management by presenting industry-led tools to uniquely design and operate offshore conditions.	Wind	Aquaculture
7. Mediterranean Sea / Small Islands	MUSICA (Horizon)	Greece - MUSICA aims to achieve replicable smart marine space governance through collaboration with local stakeholders to advance the project, including Technology Readiness Level (TRL) 5 and Technology Readiness Level (TRL) 9 activities.	Wind, Wave	Aquaculture

Source: CoBren project team, 2025

3 Main observations and conclusions drawn from the case studies

The CoBren case studies provide complementary insights into the potential for ORE development and deployment, as well as the application of MSP practices in selected countries. The following section outlines the key observations and conclusions drawn from the seven case studies. These findings are structured around the core planning practices promoted through MSP, consistent with the approach taken in the main report and its Annex 2.

In conducting the case studies, a mixed-method approach was applied. This included targeted interviews with project holders and other relevant stakeholders, complemented by additional desk research. The analysis also integrated findings from the broader MSP review, particularly regarding planning procedures, stakeholder engagement, intersectoral cooperation, multi-use potential, and conflict resolution. Special attention was given to assessing the extent to which ORE is incorporated in national and regional planning documents.

Finally, where data availability allowed, spatial information was collected and analysed to provide a snapshot of current sea space uses in the case study areas. This helped to contextualise the positioning of ORE in relation to other maritime activities and to highlight potential spatial synergies or conflicts.

3.1 ORE development can benefit from coordinating the use of sea space and identifying a place for ORE development through maritime spatial planning

MSP is a key instrument to dedicate space for ORE development in line with other sea uses. The case studies illustrate different practices applied across Europe to do so and with that help to unlock the potential of ORE.

All case studies, except for *BLOW*, benefit from a dedicated zone for ORE development. The designated space allows the projects to develop their ORE without spatial conflicts with, for example, marine protected areas or military zones. The example of *EURO-TIDES* illustrates a particular case, where the project benefits from a dedicated space earmarked for the development and testing of tidal energy. The relevant country responsible for the sea space supports such developments by facilitating infrastructure (power cables) connection between the ORE deployment platform and the shore. An added value of grid connections is also noticed in the cases of *EU-SCORES*, *ULTFARMS* and *BLOW*. A location near existing power cables facilitates grid connections and commercialisation of the projects. A lack of mention of ORE development in the current MSP of Bulgaria hinders the *BLOW* project partners from finding a suitable place in relation to other sea uses.

All case studies, except *EURO-TIDES*, seek to advance ORE multi-use development by exploiting potentials for sea use synergies. Synergies with aquaculture and fisheries are mainly explored via multi-use as illustrated in *Aqua Wind*, *BLOW*, *EU-SCORES*, *ULTFARMS* and *MUSICA*. The *UNITED* case demonstrates possibilities for multi-use with tourism. These examples of multi-use across sea use functions, however, pose regulatory challenges. Even if multi-use is promoted through the MSP, many sectoral regulatory frameworks are not aligned. As a result, the developers of ORE require permits and licenses from multiple sectoral authorities at national and regional levels. In addition, the case studies demonstrate the multi-use of different ORE technologies, for example, in the cases of *EU-SCORES* and *MUSICA*. The combination of multiple ORE technologies poses fewer regulatory challenges, but more technological challenges. All in all, the case studies demonstrate the benefits of multi-use. Beyond optimising the use of sea space, the case studies highlight inter alia benefits for the local economy such as job creation as well as enhancing energy security. The latter is particularly relevant for certain

remote or less densely populated regions, as demonstrated through the *EURO-TIDES* and *MUSICA* cases.

Fisheries and nature conservation are among the main barriers for ORE development. ORE development is restricted in nature protected areas in most European countries. This is reflected in the case studies through the location of the projects, which are all outside of nature protected areas. In addition, ORE development is subject to environmental impact assessments (EIA). These planning tools allow ORE projects to monitor impacts, notably on nature and biodiversity as well as on fish and marine life in general. Therefore, the same tool is used to illustrate the effects of the ORE development on fishing communities that may oppose the development of ORE, as illustrated in the cases of *AquaWind*, *UNITED*, *ULTFARMS* and *MUSICA*. The EIA often allows ORE developers to demonstrate negative and positive effects for other sea-based activities, e.g. fishing. As an example of a positive externality, ORE projects may create artificial reefs which provide new ecosystems for marine life and thereby increase the number of fish.

3.2 Stakeholder involvement throughout the development cycle of an ORE project can help reduce potential conflicts, raise social acceptance and allow stakeholders to take part in shaping the project

All case study projects apply a stakeholder involvement process to advance the development of ORE. Similar as for MSP processes, the projects engage with local communities, which include stakeholders in the ORE supply chain to support the development, as well as regulatory bodies at national, regional and local levels.

The case studies stress the importance of liaising with stakeholders with potentially conflicting interests in sea use, such as fishermen and environmental NGOs. *AquaWind*, *EU-SCORES* and *MUSICA* demonstrate, for example, the importance of inclusive stakeholder engagement to raise acceptance and promote the benefits of (multi-use) ORE deployment. In the case studies analysed within CoBren, stakeholders are involved through workshops or online surveys, which allow them to provide input. In addition, stakeholders are informed about the project through (social) media. In the case of *EU-SCORES*, the organisation of joint dialogues aimed at establishing transparent communication and fact-based discussions for site selection, assessing environmental impacts and integration of energy infrastructure in existing MSP.

Stakeholders participate in various stages of the ORE development. In the cases of *MUSICA* and *BLOW*, stakeholders are involved to specify the need for and fine-tune the added value of ORE development. In the cases of *AquaWind*, *UNITED*, and *ULTFARMS*, stakeholders are mainly involved in relation to the EIA and address potential conflicts of sea use. In the case of *EURO-TIDES*, stakeholders are given a role in the ongoing monitoring. Fishermen support the project by assessing possible changes related to the fishing grounds in relation to the ORE development.

3.3 Clearly identified policy objectives at national and European levels can support the development of ORE

The acknowledgement of clear targets for ORE development in national policy documents provides ORE project partners with a lever to initiate and promote their project ideas, as mentioned in the cases of *UNITED*, *BLOW* and *EU-SCORES*. Stakeholders of *EU-SCORES* mentioned the added value of Portugal's commitment to ORE projects as a success factor for the project's initiation and implementation. In this context, the Portuguese government has placed a strong emphasis on offshore wind and wave energy development, which aligns with its broader decarbonisation objectives and the EU Green Deal. As such, Portugal's political backing has facilitated smoother regulatory pathways, enhanced financing opportunities, and fostered collaboration among key stakeholders across the energy and marine sectors. Finally, stakeholders in the cases of *UNITED* and *ULTFARMS* highlight trickling down effects of clear commitments and target setting in national policy documents for ORE.

Furthermore, case study representatives mention that alignment with overarching policy goals facilitates the transfer of lessons and thus serves as an enabling condition for territorial cooperation.

3.4 Case studies provide little evidence of territorial cooperation but highlight some perspectives for collaboration such as on aligning regulatory frameworks and resolving/avoiding sea use conflicts

The CoBren case studies illustrate little evidence for territorial cooperation to unlock the potential of ORE development through MSP. Most case studies are based on projects built around partnerships utilising expertise from partners from different countries. However, little evidence has been found on the transfer of lessons learned across territories. At the same time, the case studies provide perspectives for territorial cooperation. This suggests possibilities to enhance cooperation perspectives for ORE development. For example, the *ULTFARMS* case study illustrates the relevance of aligning MSPs of neighbouring countries and the relevance of transnational cooperation at sea basin level. Enhanced cooperation could facilitate further grid development and possibilities to make most efficient use of the electricity generated, depending on demand.

The *BLOW* and *MUSICA* projects illustrate the challenges of implementing a proven concept, i.e. the design of ORE technology in another geographic and regulatory context. In the case of *BLOW*, the Eolink technology developed and tested in France faces regulatory challenges for deployment in the Black Sea. The proven multi-use platform (MUP) focused on in the *MUSICA* project may be relevant for many small islands across Europe. The project aims to assess the potentials for transferability, yet this activity has not concluded yet. Both projects hint at challenges to transfer the respective technology due to different environmental, as well as technical and safety standards for ORE deployment across Europe.

In general, case studies assume technological aspects (e.g. availability of relevant infrastructure) as well as site selection (e.g. in dedicated areas/zones) in a way that addresses potential conflicts with other sea uses and builds social acceptance. To ensure that such best practices can be transferred to other ORE projects and locations, territorial cooperation should be embedded in ORE development projects from the start. Considering potentials for cooperation from the start enables reviewing, for instance, differences in regulatory frameworks and potentially highlighting these to relevant authorities.

4 Case study: AquaWind

AquaWind is a European pilot project for multi-use ORE development co-funded by the European Maritime and Fisheries Fund. The project aims to demonstrate the integration of aquaculture practices in floating wind installations off the coast of Gran Canaria, Spain. The project started in September 2022 and is currently expected to close by the end of 2025¹.



In more detail, AquaWind contributes to advance ORE multi-use practices through:

- **Technological advancements:** The project addresses the technological challenges of operating in the Atlantic's harsh maritime environment, characterised by high winds, deep waters, and strong currents. Deploying floating wind turbines co-located with aquaculture systems showcases advancements in adaptive platform designs. These platforms are engineered to withstand challenging conditions and support modular fish or algae farming systems, enabling efficient use of the ocean's resources. Through these innovations, AquaWind contributes to the development of cost-effective technologies that can diversify the EU's renewable energy mix while supporting the blue economy.
- **Demonstrating mutual benefits:** Co-location provides potential benefits such as artificial reef creation, which could boost marine biodiversity and enhance local fish stocks. This integration aligns with the EU's vision for sustainable ocean management under frameworks like the Atlantic Maritime Strategy.
- **Future expansion and integration:** The AquaWind project lays the groundwork for the integration of additional renewable energy systems, such as wave and tidal technologies, alongside its floating wind and aquaculture infrastructure. These complementary systems could enhance renewable energy output, contributing to a diversified and resilient energy mix for the Atlantic region.

AquaWind operates through a partnership of research institutions, SMEs, and maritime clusters. Prototypes are tested at the Canary Islands Oceanic Platform (*PLOCAN*), a renowned research and development facility in Spain, which serves as a shared resource for collaborative testing and innovation.² Every partner brings in specific expertise, such as modelling the mooring system, stakeholder engagement, aquaculture expertise, legal permits, health and safety, etc.³

The case study illustrates possibilities and challenges to develop ORE multi-use practices. Even though the MSP documents in Spain allow for co-existence between ORE and aquaculture, regulatory aspects are not fully aligned yet. As a result, sector specific authorities need to be addressed to obtain relevant permits for the advancement of the project. As a result, the development of multi-use ORE takes longer than anticipated.

The project also aims to provide lessons for the Atlantic Sea basin on the development of floating wind technologies with aquaculture activities. Whereas the project partners collect valuable lessons that could support to scale-up of the technology, the actual activities assessing possibilities to transfer the technology to other places are only foreseen for the second half of 2025. Therefore, the case illustrates limited evidence for territorial cooperation. Nevertheless, perspectives for territorial cooperation are described.

¹ AquaWind project website: <https://aquawind.eu/>

² <https://www.plocan.eu/>

³ AquaWind has published a promotional video explaining the projects and its objective in more detail: <https://www.youtube.com/watch?v=8kJJJ15hAY4>

4.1 Unlocking the Atlantic Sea Basin's ORE potential

The Atlantic Sea Basin offers diverse geographical and environmental conditions for ORE deployment, particularly for floating wind technologies. Characterised by vast open waters and consistent wind conditions, **the Atlantic provides an advantageous setting for deploying both fixed-bottom and floating wind turbines**, expanding the potential for renewable energy generation across Europe. These conditions are especially beneficial for floating wind turbines, which can be deployed further offshore to access stronger and more reliable wind resources.⁴

In addition, the Atlantic Sea Basin benefits from a complementary mix of wind and wave energy resources, although seasonal variations can still challenge a consistent energy supply. The integration of these renewable sources requires careful planning to manage fluctuations, particularly during the winter months when energy demand is higher.⁵

The Atlantic Sea Basin has several projects already underway or in the planning stages. Countries like the United Kingdom, France, and Portugal are leading in exploring and expanding their offshore wind capacities. Studies suggest that the Atlantic could contribute substantially to Europe's offshore wind capacity, particularly through large-scale floating wind farms.⁶

Countries bordering the Atlantic are actively developing comprehensive strategies to harness offshore renewable energy. The Atlantic Action Plan by the European Commission outlines measures to promote sustainable blue growth and enhance energy security through renewable sources. In more detail, **the Atlantic Action Plan** prioritises sustainable energy and blue economy initiatives in the Atlantic Basin. This plan **emphasises collaborative projects that integrate ORE development with other marine uses**, such as aquaculture and tourism, creating synergies that maximise resource utilisation.⁷ In addition, the Atlantic Strategy Group facilitates transnational cooperation by promoting research, development, and innovation in offshore wind and wave energy technologies. AquaWind is a key example of these efforts, as it integrates floating wind turbines with aquaculture facilities, demonstrating innovative multi-use solutions.⁸ These strategies aim to overcome logistical and environmental challenges and capitalise on the Atlantic's significant renewable energy potential.⁹

The Spanish MSP acknowledges the potential of ORE and identifies areas that are highly suitable for deploying commercial offshore wind energy infrastructures, with the potential for hybridisation with other offshore renewable technologies. In addition, the Spanish Roadmap for offshore wind and marine energy presents clear targets for ORE, namely, to reach 1-3 GW of offshore wind generation by 2030 and 40-60 MW generated through other marine energy (solar, tidal wave)¹⁰. As such Spain taps into part of its ORE potential. To give an example, the theoretical potential for offshore wind in Macaronesia (consisting of the Spanish Canary Islands and the Portuguese Azores) is 170 GW. In addition, there is a potential of 46GW for offshore solar and 134 GW of wave power, as assessed through the CoBren study¹¹.

The Canary Islands, as part of Spain's ORE strategy, are progressing towards the development of floating offshore wind projects. Spain's Offshore Wind Roadmap¹², approved in December 2021, outlines the development of 3 GW of floating offshore wind capacity by 2030, with an auction for

4 https://ec.europa.eu/maritimeaffairs/policy/sea_basins/atlantic_ocean_en

5 <https://www.worldbank.org/en/topic/energy>

6 <https://www.iea.org/reports/offshore-wind-outlook-2019>

7 <https://allatlanticocean.org/initiatives/atlantic-action-plan/>

8 https://blue-economy-observatory.ec.europa.eu/news/aquawind-project-offshore-platform-produce-electricity-and-food-2023-07-27_en

9 https://ec.europa.eu/maritimeaffairs/policy/sea_basins/atlantic_ocean_en

10 Roadmap offshore wind and marine energy in Spain page 8, source: [Roadmap offshore wind and marine energy in Spain](#).

11 See the study's main report and its Annex 1 for more details.

12 Roadmap offshore wind and marine energy in Spain.

offshore wind rights scheduled for 2023 in the Canary Islands region. The Offshore Wind Roadmap is coherent with the Spanish Integrated National Energy and Climate Plan (PNIEC) which “*envisages the development of a “Spanish Strategy for the development of offshore wind and marine energy”, coordinated and aligned with the Maritime Spatial Planning, the conclusions and objectives of which may be incorporated into the periodic reviews of this Plan*”. The region’s strong wind resources and deep waters make it an ideal location for floating wind technology, allowing energy generation in previously unsuitable areas for traditional fixed-bottom turbines.

AquaWind aims to unlock this potential by leveraging the W2Power floating wind technology. W2Power is an innovation adaption of proven, mature offshore technologies to the needs of emerging deep-water offshore wind. It enables 12 MW on one single floating foundation, using two commercially offshore wind turbines on the market today. As such the project contributes to unlocking the ORE potential in the Atlantic Sea Basin. In addition, the technology offers possibilities for multi-use, as the space between the wind turbines could serve as cage for aquaculture (see, Figure 1)

Figure 1 W2Power floating technology with space for aquaculture



Source: AquaWind

4.2 The role of maritime spatial planning for ORE deployment

The Spanish MSP enables possibilities for multi-use ORE development and defines zones for offshore wind farms by avoiding any conflict with environmental and military zones.

12% of Spain’s marine waters are protected as mentioned by a representative responsible for the drafting of the MSP¹³. Marine protected areas are governed through specific management plans and tools that regulate the sea use space in these areas. In Spanish law, these plans prevail over MSP documents. Therefore, ORE development is not possible in these areas. Similarly, the development of ORE is not permitted in military zones. These clear delineations aim to avoid any potential conflicts of sea uses.

Even if the provisions are not made explicit in the planning documents, the combination of ORE and aquaculture is suggested. The MSP document describes, for example, the need to assess the effects of ORE development on fisheries and defines a priority for the co-existence between wind farms and fishing activities¹⁴. In this context, the MSP also mentions the need to identify types of vessels that

¹³ Interview conducted in the framework of this study reviewing the MSP and the possibilities for ORE development in Spain. See also the CoBren main report and its Annex 2.

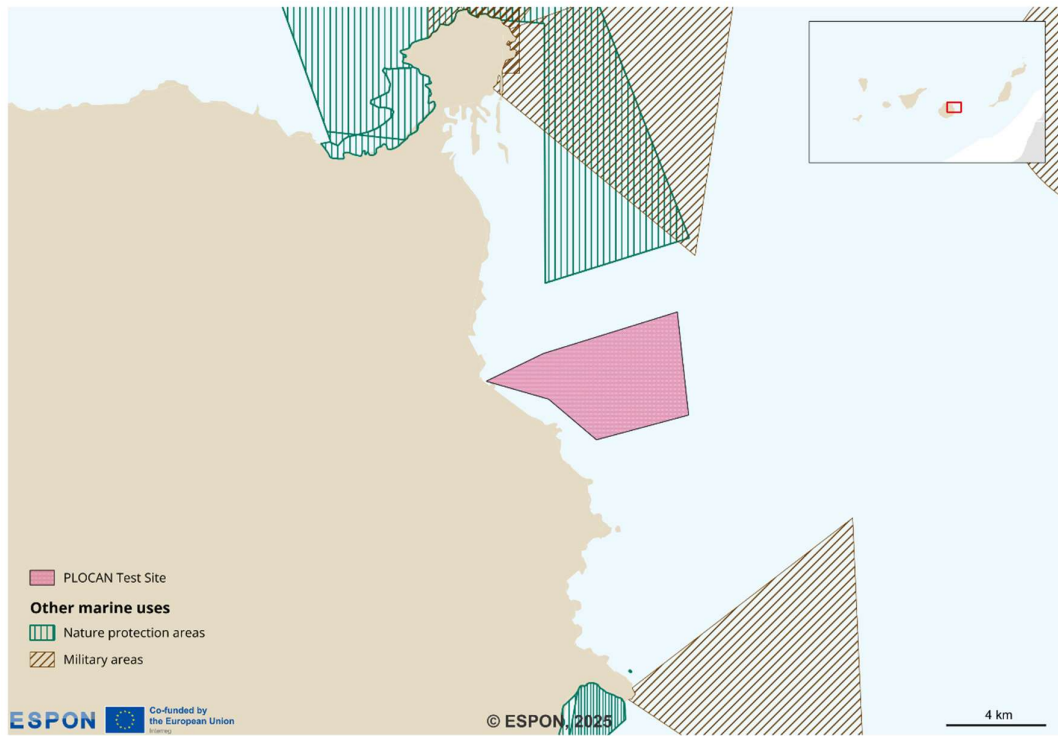
¹⁴ "Efforts shall be made to identify, whenever possible, those modalities of aquaculture that could coexist with the commercial wind farm or with other renewable energies that are implemented, and in those cases, facilitate said coexistence by the promoter", Source: MSP review Spain: [Disposición 5704 del BOE núm. 54 de 2023](#) (“*Se procurará identificar, siempre que sea posible, aquellas artes de pesca que podrían coexistir con el parque eólico comercial o con otras energías renovables que se implantasen, y en esos casos, facilitar dicha coexistencia por parte del promotor*”)

could still sail within the space occupied by a windfarm. Further provisions to address potential conflicts are not detailed.

In general, the Spanish MSP defines the permitting and regulatory framework for ORE development.¹⁵ ORE development is subject to Environmental Impact Assessments, identifying potential conflicts with regards to the spatial location of ORE deployment areas and the connectivity of ecosystems (such as migratory species), the protection of biodiversity, fisheries, protection of cultural heritage, military activities and safety and navigation. For example, the national MSP document describes restrictions to the installation of infrastructures involving the placement or anchoring of materials on the seabed within the area for the protection of underwater cultural heritage.

AquaWind's project partners consider these key spatial planning practices for the identification of the project's location and development. The location of the pilot project was determined by the cooperation/partnership with the *Oceanic Platform of the Canary Islands (PLOCAN)*, which has a designated testing area for research and development activities outside military and protected areas (see Map 1). Also, the W2Power prototype for this pilot will not be connected to electricity avoiding any anchoring installations to the seabed for the time being. This aligns with the project's primary purpose to test and demonstrate the possibility of the combination of the two activities of offshore energy and aquaculture.

Map 1 Aquawind's PLOCAN test site and aquaculture cage test



Territorial level: Exclusive economic zone (EEZ)
 ESPON Project: COBREN, 2025
 Origin of data: © Copernicus Climate Change Service ERA5, EMODnet, World Database on Protected Areas (WDPA), Marine Regions EEZ, and EuroGeographics

¹⁵ <https://maritime-spatial-planning.ec.europa.eu/practices/plano-de-ordenamento-do-espaco-maritimo-poem>

4.3 Planning challenges and potential solutions experienced in the AquaWind project

AquaWind's objective to develop a multi-use platform posed some planning challenges to the project partners. The combination of different sea-uses in one project required obtaining approvals from several sectoral ministries and national and regional levels, taking the project more time for implementation than anticipated. To advance this, the project partners paid particular attention to clearly highlight the project's added value in relation to local needs and concerns. To this end, the project applied stakeholder engagement activities.

4.3.1 Stakeholder engagement activities to gain insights on local needs and concerns

AquaWind project partners conducted several stakeholder engagement activities to understand local needs, address possible concerns, and ensure the project's development aligns with regional priorities. Stakeholder engagement activities included a participative survey and active engagement in events coupled with sound and diverse dissemination and communication actions such as social media campaigns, press releases, newsletters.¹⁶

AquaWind's stakeholder survey aimed to gain deeper insights into public perceptions and attitudes towards offshore wind development. The survey results illustrated support for renewable and marine energies, along with a rather positive perception of the combination of energy and aquaculture and their potential benefits for the community.¹⁷ The favourable perception of multi-use prototypes suggests a good disposition towards innovative solutions that optimise sea space use and strengthen both sectors (i.e. offshore wind and aquaculture activities).

While in AquaWind there were no direct sea-use conflicts due to the project's location in a designated research area, resistance from local fishing communities, aquaculture producers, and ecologists towards the development of offshore wind might often be the case. Therefore, other stakeholder engagement activities focused, among others, on awareness raising on the opportunities and benefits of multi-use, particularly targeting the fishery community. To do so, the project partners informed the local community on the environmental as well as socio-economic effects of the project.

This inclusive process not only strengthens community support but also enhances the project's resilience and adaptability to local needs, demonstrating the importance of public engagement in achieving sustainable development goals. Therefore, the results of the stakeholder engagement activities have been leveraged in discussions with local, regional and national authorities to advance the project.

4.3.2 The regulatory framework required significant administrative effort from project partners in the context of the development of a multi-use project

The AquaWind project partners focused the first two years of the project on adhering to legal and safety provisions, upgrading the W2Power prototype, designing and setting up the aquaculture cage and performing a first test with fish at the harbourside. Particularly the integration of the aquaculture inclusion in the W2Power prototype posed challenges, requiring interactions with more authorities than initially foreseen.

The project partners obtained relevant permits for the development and testing of the floating wind technology. Altogether the project required the approval of numerous documents, including:

¹⁶ <https://aquawind.eu/results/>

¹⁷ Ibid

- Non-substantial modifications of uses – depicting the possible environmental impact to neighbouring protected areas covered through the project’s Environmental Impact Assessment (EIA).
- Compatibility report with marine strategy – depicting compliance with MSP provisions such as the designated area outside protected and military areas.
- Commissioning of aeronautical easements – depicting compliance with height and other safety features
- Beacons authorisation – allowing the introduction of beacons to guide navigation.
- Authorisation for aquaculture activities of research and experimentation – allowing aquaculture in the selected location.
- Aquaculture general registration for livestock activities.

Different authorities at national, regional, and local levels reviewed the documents and provided the relevant approvals:

The Ministry of Energy and local maritime agencies provided permits for the ORE development required, for example, for conducting an EIA and specifying the technical and safety standards of the installation. For these, the project could build upon the existing work of the W2Power power type. The combination of floating wind and aquaculture required additional permits from the Ministry of Environment as well as from local authorities dealing with aquaculture.

The project’s EIA has been instrumental in collecting evidence for the different authorisations, for example, depicting the impact of the cage and the aquaculture activities on biodiversity and fishing. These aspects forced the project partners to include environmental assessments as an integral part of the project, with activities related to life cycle impact assessment and circular model approaches. Periodic in-situ surveys conducted by project partners specialised in marine life assessed the environmental impacts of the multi-use prototype, ensuring consideration of marine biodiversity and local ecosystems.

4.4 Perspectives for territorial cooperation

Overall, the AquaWind project aims to define a model for future multi-use initiatives in the Atlantic Sea Basin, offering valuable lessons for scaling up ORE while fostering sustainable marine resource management. Even though project partners have not concluded the mapping of potentials for transfer yet, project insights provide already some perspectives for territorial cooperations.

- Domestic regulatory frameworks mainly define possibilities to scale-up multi-use technologies. Whereas ORE development is largely supported in the Atlantic Sea Basin, national legislation and different provisions for co-location and multi-use which require project partners to specify and tailor impact assessments may hinder such developments at the sea basin level. This may be because such specific requirements per region or country make it difficult for project partners to re-use parts of the EIA for other locations, even if the ORE technology remains the same. For example, Spain and Portugal apply different lists of protected marine species, which need to be considered in the EIA for aquaculture and ORE practices. Moreover, the technological design needs to be assessed against national technical and safety standards which differ per country.
- International partnerships developing ORE facilitate potential transfer of practices. By leveraging a consortium across Spain, Portugal, and France, AquaWind demonstrates how territorial cooperation can drive innovation and sustainable marine space utilisation. Expertise and experience from project partners from different countries allow considering national requirements in the technical design of the multi-use of ORE installations.
- Aligning with broader EU strategies, such as the Atlantic Maritime Strategy and the European Green Deal, facilitates communicating the benefits and added value of the multi-use of ORE installations in different contexts.

4.5 Key lessons and future directions

AquaWind's multi-use approach highlights the potential for combining ORE development with other marine activities to achieve sustainability goals, enhance economic viability, and support regional energy security.

The AquaWind project demonstrates how ORE development and multi-use can contribute to enhancing regional economic development e.g. by offering opportunities for creating jobs in local value chains and promoting sustainable energy production. Its business model showcases potential cost reductions in commissioning, maintenance, and operation, making it a commercially viable solution for the Atlantic region. By integrating aquaculture in ORE deployment, AquaWind also supports food security and can contribute to the diversification of local economies, aligning with the EU's sustainability and climate objectives. AquaWind's initial positive results are further supported by the local governments who provided additional funding to incorporate a second fish cage in the prototype to further leverage the project's positive effects on the local community.

Whereas the multi-use ORE developments support making efficient use of space and reduce potential sea-use conflicts due to collaborative efforts, the set-up of these projects poses regulatory challenges. As a first project of its kind in Spanish waters, the project demonstrates a need for further policy coordination. The multi-use concept requires obtaining permits and licenses from multiple sectoral authorities, which in the case of Spain could be national or regional. This makes the processes to develop multi-use longer than single use ORE projects. In the view of project partners, MSP could be used to address such challenges by further streamlining processes for multi-use.

AquaWind project partners suggest improving legal guidelines for faster multi-use implementation, for example by defining maritime regulatory SandBoxes that allow ORE operators to test new multi-use applications under the supervision of one regulator. This could facilitate the implementation of additional real-world demonstration projects and advance technological designs for ORE multi-use.

4.6 Sources

- Aquawind Project Website: <https://aquawind.eu/>
- Blue Economy Observatory. (n.d.). *Blue Economy Indicators*. Retrieved from https://blue-economy-observatory.ec.europa.eu/blue-economy-indicators_en
- [Blue Economy Observatory](#)
- European Commission. (n.d.). *Atlantic Action Plan*. Retrieved from https://oceans-and-fisheries.ec.europa.eu/policy/atlantic-action-plan_en.
- European Commission. (n.d.). *Atlantic Strategy*. Retrieved from https://oceans-and-fisheries.ec.europa.eu/topics/sea-basins/atlantic-ocean_en.
- European Commission. (n.d.). *Aquaculture*. Retrieved from https://oceans-and-fisheries.ec.europa.eu/topics/aquaculture_en.
- European Commission. (n.d.). *Marine Spatial Planning*. Retrieved from <https://maritime-spatial-planning.ec.europa.eu/>.
- European Green Deal. (n.d.). *European Green Deal*. Retrieved from https://ec.europa.eu/green-deal_en.
- European Maritime Safety Agency. (n.d.). *European Maritime Safety Agency*. Retrieved from <https://www.emsa.europa.eu/>.
- Horizon Europe. (n.d.). *Horizon Europe*. Retrieved from https://ec.europa.eu/programmes/horizon2020_en.

- Interreg Atlantic Area. (n.d.). *Interreg Atlantic Area Programme*. Retrieved from <https://atlanticarea.eu/>.
- International Energy Agency (IEA). (n.d.). *Offshore Wind Outlook*. Retrieved from <https://www.iea.org/reports/offshore-wind-outlook>.
- World Bank. (n.d.). *Atlantic Marine Energy Potential*. Retrieved from <https://www.worldbank.org/en/topic/energy/brief/offshore-wind>.

5 Case study: UNITED

UNITED¹⁸ was a research project co-financed by the European Union Horizon 2020 programme. The project provided evidence on offering tourism activities on an offshore wind farm near Copenhagen, Denmark: Middelgrunden. As one of the few wind farms that allows visitors to tour a wind turbine and climb the nacelle, Middelgrunden offers a unique tourism experience. The project started in 2020 and ended in December 2023 and focused on



- **Promoting sustainable energy.** The project aimed to highlight sustainable energy production by showcasing offshore wind turbines as landmarks that can be visited, thus raising public awareness about renewable energy.
- **Enhancing tourism.** By offering guided tours and the opportunity to climb the turbines, the project integrates tourism with energy production, creating a unique multi-use marine space. To this date, this has attracted a diverse group of visitors, including tourists, students, government delegations, and professionals from the wind energy sector.
- **Address legal and insurance challenges.** One objective was to address and overcome the legal and insurance challenges associated with allowing public access to operational wind turbines. This included developing solutions for visitor insurance and safety protocols.
- **Boost economic synergies.** The project aimed to demonstrate the economic benefits of multi-use marine areas, potentially reducing operational costs and creating new revenue streams through tourism.
- **Promote social acceptance.** By involving local communities and visitors in the operation and benefits of offshore wind energy, the project sought to increase social acceptance and support for renewable energy initiatives.

The case study highlights the possibilities of ORE installations' multi-use, notably offering tourism activities to wind farms. Tourism activities not only enhance the economic output of the wind farm, but they also contribute to the social acceptance of offshore wind energy in general. These lessons could be relevant for wind farms in other locations as well. Although the project was implemented in parallel to other ORE multi-use initiatives, it did not explore potentials for territorial cooperation e.g. by sharing the lessons learned related to the tourism activities on the Middelgrunden windfarm with other projects..

Also, other perspectives for territorial cooperation were not in the focus of the project and during the development of the Middelgrunden wind farm. For example, stakeholders consider the output of the wind farm too marginal for making a connection to transnational grid connections today. While stakeholders perceive potential benefits of such connections, the additional costs to add the infrastructure would not outweigh potential benefits and cost savings. Nevertheless, the case study demonstrates the long duration and ongoing development of offshore wind farms. Planning of the Middelgrunden wind farm started in 1996. Construction started in 2000 and the UNITED project illustrates ongoing efforts to boost economic synergies and promote social acceptance.

¹⁸ UNITED stands for: 'multi-Use offshore platforms demonstrators for boosting cost-effective and Eco-friendly production in sustainable marine activities'.

5.1 Unlocking the Baltic Sea's ORE potential

The Baltic Sea Basin holds a cumulative potential capacity for offshore wind energy of 93 GW, with a generation of 325 TWh/year¹⁹. A large part of the potential is yet to be unlocked, as the installed offshore capacity in the Baltic Sea was 2 GW in 2019, and it is expected to increase to 9 to up to 14 GW by 2030 depending on the level of regional cooperation and national ambitions of the relevant countries²⁰.

Unlocking this potential in the Baltic Sea requires coordination with other sea functions:

- **Nature and ORE resources:** In countries like Denmark and Germany, there is a significant overlap between natural habitats and ORE resources. Denmark allows to build offshore wind farms in protected areas, if they comply with relevant nature protection obligations that apply in the protected area.²¹ In contrast, in Germany, it is not allowed under any circumstance to build a wind park in a protected area.²² In other Baltic Sea countries fewer potential conflicts between nature and ORE development are observed.
- **Military considerations:** The strategic location of the Baltic Sea results in heightened military concerns, especially after incidents like the Nordstream explosions. Consequently, eight Baltic Sea countries committed in the Vilnius Declaration to accelerate ORE deployment while enhancing the protection of offshore energy assets²³.
- **Aquaculture dynamics:** Aquaculture, particularly in Poland, represents a significant spatial claim. The overlap of aquaculture and ORE interests necessitates exploring coexistence strategies. The offshore wind industry already considered this in their 2020 Vision for the Baltic Sea²⁴. Danish authorities are further exploring these possibilities.
- **Other ORE:** The Baltic Sea is characterised by a seasonal complementarity between solar and wind energy, which means that the Baltic winter sees more wind, yet the days are cloudy and shorter, meaning less sun, while the summer generally sees less wind and longer days with more sun. This environment offers an interesting case for combined wind and solar projects. However, no specific energy policy initiatives have been identified to harness this potential, possibly due to challenges like sea ice, or lack of industry focus.

Denmark is at the forefront to unlocking the Baltic Sea's ORE potential demonstrating viable offshore wind deployment since 1991. The Middelgrunden wind farm contributes to unlocking Denmark's vast offshore wind capacity. Denmark has approximately 2.7 GW of installed offshore wind capacity²⁵, with ambitions to increase this to 12.9 GW in 2030²⁶. This potential represents a significant increase from the current capacity and highlights Denmark's commitment to continue developing offshore wind.

The Middelgrunden wind farm is one of Denmark's older wind farms and consists of turbines with bottom-mounted foundations, generating 40 MW from 20 turbines²⁷. The output represents 4.7% of Denmark's total offshore wind capacity, supplying electricity to 33,000 households, contributing to

19 Wind Europe (November 2019). Boosting offshore wind energy in the Baltic Sea. Retrieved from: <https://windeurope.org/wp-content/uploads/files/about-wind/reports/WindEurope-Boosting-offshore-wind.pdf>

20 Ibid.

21 Interview with Hans Chr Sørensen (August 13, 2024). Conducted by Alexandra Rimpler.

22 Ibid

23 Source: [Baltic Sea countries pledge closer collaboration to secure critical offshore energy infrastructure | WindEurope](#)

24 http://psew.pl/wp-content/uploads/2020/09/psew_raport_eng_v12_screen.pdf

25 Danish Energy Agency. (n.d.). Denmark's largest procurement procedure for offshore wind power launched. Danish Energy Agency. Retrieved from <https://ens.dk/presse/denmarks-largest-procurement-procedure-offshore-wind-power-launched>.

26 Enerdata (2022). Denmark aims to raise its 2030 offshore wind target by 45% to 12.9 GW. Retrieved from: <https://www.enerdata.net/publications/daily-energy-news/denmark-aims-raise-its-2030-offshore-wind-target-45-129-gw.html#:~:text=The%20Danish%20government%20is%20considering,would%20produce%2049.5%20TWh%2Fyear>.

27 Middelgrunden Wind Farm Website: <https://www.middelgrunden.dk/middelgrunden-windmill-cooperative/>

reducing greenhouse gas emissions and lowering dependence on fossil fuels. In more detail, the wind farm avoids emissions of about 187.5 tons of sulphur dioxide, 175 tons of nitrogen oxides, and more than 101,250 tons of carbon dioxide annually. In addition, the turbine foundations serve as artificial reefs, enhancing marine biodiversity and supporting local fish stocks, which benefits fishing activities. The project, therefore, represents a relevant source of renewable energy and a contribution to the achievement of sustainability objectives.

5.2 The role of maritime spatial planning for ORE development

The Middelgrunden wind farm is situated within Denmark's Exclusive Economic Zone (EEZ) and falls under the Danish Maritime Spatial Plan (MSP). The wind farm is owned by the Middelgrunden Cooperative, a private partnership with over 8,500 citizens as members and the utility company, Høfor²⁸. The wind farm was developed in 1996 with actual construction of the wind turbines starting in 2000, before the development of the Danish MSP in 2021²⁹. Nevertheless, the development considered planning practices that were later reflected in the MSP.

The Middelgrunden wind farm is in a development zone for renewable energy. This dedicated location for ORE development allows for renewable energy development without inherently restricting access to fishing or navigation, though such restrictions may arise from other legislation. It is noteworthy that this specific zone was designated prior to the development of the Danish MSP. The Danish government granted a lease to the Middelgrunden Cooperative for 25 years starting from the day of construction. Currently, discussions are underway between the cooperative operating the wind farm and the Danish government concerning the renewal of this lease.

During the development phase of the wind farm two other zoning frameworks had to be considered, namely the zone for Respect Distances for Aviation – to ensure safe distances for aviation, and the zone for Nature and Environmental Protection Areas – to focus on conservation efforts.

Due to the wind farm's proximity to Copenhagen Airport, the height of the turbines is limited to 115 meters, which did not pose any issues. Moreover, taller wind turbines were considered less economically viable.³⁰

In line with the Nature and Environmental Protection regulation, the Middelgrunden Cooperative performed an Environmental Impact Assessment (EIA), illustrating the impact of the wind farm's operations on the marine environment. The assessment illustrated significant benefits of the wind farm, including the reduction of pollutants such as sulphur dioxide, nitrogen oxides, and carbon dioxide. This reduction leads to cleaner air and decreased greenhouse gases. Moreover, turbine foundations serve as artificial reefs, enhancing marine biodiversity and supporting healthier fish stocks, thereby benefiting local fishing activities. These benefits supported the development of the wind farm.

The Danish Energy Agency³¹ simplified the approval process for offshore projects by acting as a one-stop shop, allowing input from relevant public institutions like the Ministry of Defence and the Ministry of Environment, with the Ministry of Energy granting the final approval.

28 Middelgrunden Cooperative (2023). Retrieved from: <https://www.middelgrunden.dk/middelgrunden-cooperative/>

29 Maritime spatial plan (n.d.). Denmark's maritime spatial plan. Retrieved from: <https://havplan.dk/en/page/info>

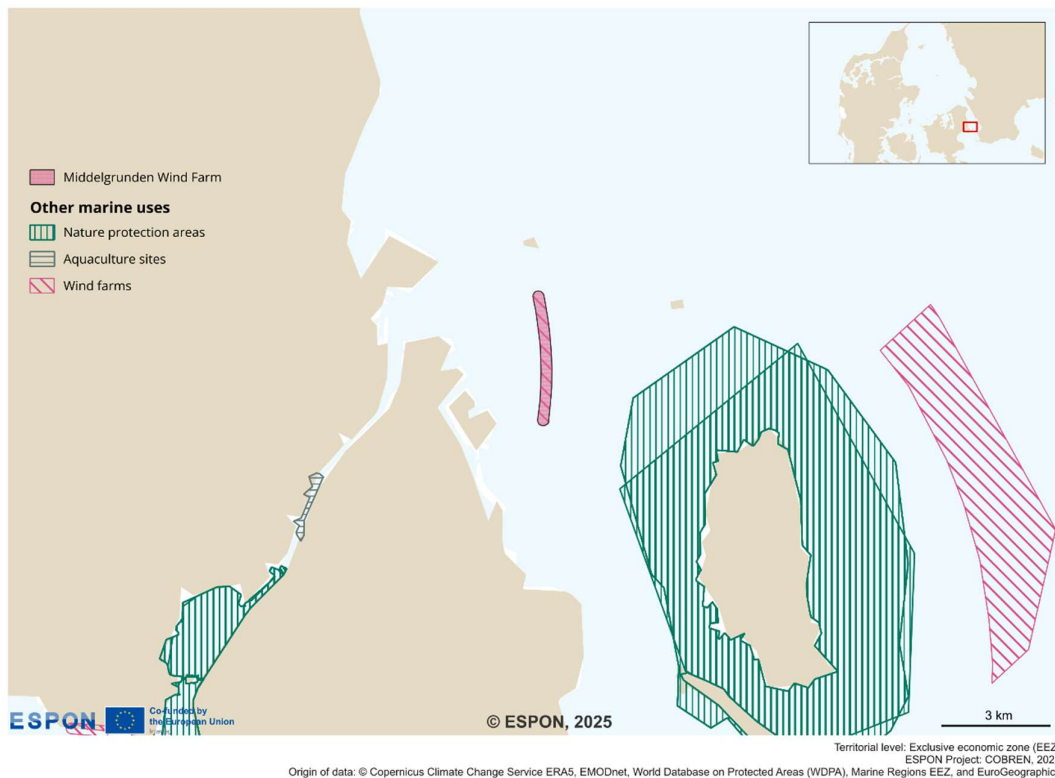
30 Interview with Hans Chr Sørensen (August 13 2024). Conducted by Alexandra Rimpler

31 Danish Energy Agency Website: <https://ens.dk/en>

Today, the Danish MSP considers ORE in a technology neutral manner, i.e. not differentiating between wind, wave, solar or tidal energy. Denmark benefits from ample sea space designated for ORE development. The plan allocates zones for renewable energy generation in addition to zones for nature protection, shipping lanes and military zones to name a few examples. The MSP document does not explicitly designate zones for multi-use, but studies are ongoing to facilitate the implementation of ORE multi-use and thus supporting the objectives of the UNITED project to offer tourism activities in the Middelgrunden wind farm.

Moreover, the existing license linked to the ‘Development Zone for Renewable Energy’ suggests a potential for multi-uses. Additional activities, such as tourism activities require permission from the concession holder, the Middelgrunden operator (Hofor)³².

Map 2 Middelgrunden Wind Farm location in the Baltic Sea



32 Lago, M; Zaiter, Y. (n.d) M3.1 Business Briefs: Danish pilot. Retrieved from: <https://www.h2020united.eu/images/PDFs/Denmark-business-model.pdf>

5.3 Planning challenges and possible solutions to offer tourism activities on a wind farm

During the construction of wind farms in Denmark, developers have addressed potential conflicts with fishing activities by compensating fishermen for lost catch. For instance, during the construction of the Middelgrunden Offshore Wind Farm fishing was temporarily prohibited in the designated construction area. To mitigate the impact on local fishermen, compensation was agreed with those affected.³³ Following the construction phase, fishing activities were allowed to resume, although with certain restrictions—such as prohibitions on bottom-scraping tools and anchoring within 200 metres of the sea cable.

Additionally, the Danish Fishermen's Association has welcomed the Danish government's new marine plan, which aims to balance the interests of various stakeholders, including the fishing industry and ORE developers³⁴.

These measures highlight the efforts made by developers and authorities to find compromises that compensate fishermen for lost revenues during wind farm construction phases.

Additionally, the developer conducted a study on the two species of fish typically found on the reef before and after the construction of the wind farm and found no difference. This way, potential conflict was avoided between the developers and the fishermen. The developers agreed this was a good practice because it also offered a chance to learn and understand that the wind farm did not harm the fish species. Overall, the compensation cost was considered small compared to the project's overall cost.

In this context the project holder mentions that statistics available at EU level, documenting what type of fish is caught, where and when, could also benefit future projects. Such data could help estimate an appropriate compensation.³⁵

To enable tourism activities to the wind farm, possibilities for multi-use had to be reviewed. Although the MSP and wind farm licenses do not prohibit multi-use of the Middelgrunden wind farm, UNITED project partners had to overcome several challenges to offering tourism activities on the wind farm:

- **Insurance and safety concerns:** A significant issue was the lack of dedicated insurance coverage for visitors who climb wind turbines. While service providers have standard safety equipment and insurance for workers, extending this coverage to tourists and other visitors remained new territory as there were no standard procedures. The Danish Energy Agency facilitated dialogues with the operator of the offshore windfarm to develop industry-wide safety standards and insurance solutions also addressing such touristic visits to windfarms, thereby improving safety protocols across the industry.
- **Planning and coordination of wind energy tours:** While combining tourism with wind energy operations offers potential additional income to help cover wind farm maintenance costs, it quickly became apparent in Middelgrunden that using the same vessels for both, wind farm maintenance and guided tours was impractical. The service boats used for maintenance tasks always have priority, which conflicts with the scheduling required for tourism activities. Instead, about 50% of the boats used for visitor tours are also employed for group leisure fishing. These activities necessitate careful logistical arrangements and the management of operational issues, such as weather conditions or technical difficulties.

³³ Middelgrunden Wind Farm Environmental Impact Assessment. Available at: <https://www.middelgrunden.dk/wp-content/uploads/2021/03/Environmental-Impact-Assessment-of-the-wind-farm-at-the-Middelgrunden-Shoal.pdf>

³⁴ Source: [The Fishing Daily](#)

³⁵ Interview with Hans Chr Sørensen (August 13, 2024). Conducted by Alexandra Rimpler

- **Scalability and design challenges:** The scaling up ORE projects presents significant challenges related to the design and technology of wind turbines. This is also the case for the Middelgrunden Offshore Windfarm. Older turbines, which might be considered for replication, face issues with reassembly, making them impractical for large-scale projects. Newer turbines, built after 2003, include advanced security systems that complicate both scaling efforts and visitor access. These design differences create unique challenges for replication and tourism activities. Therefore, offering tourism activities on other wind farms would require the Danish Energy Agency's involvement in coordinating technical standards to address these issues.

Despite these challenges, the synergy between wind energy and tourism provides long-term benefits to local communities by fostering innovation, entrepreneurship, and job growth, particularly benefiting rural areas needing economic boosts.

The Middelgrunden project contributes to Denmark's Travel and Tourism market³⁶ with tourism activities like boat tours reaching 75 annual trips in 2022, generating a turnover of 102,000 EUR. Approximately 50 % of the revenue went to the boat tour operators. These tours were operated by trained guides.

In 2023, the Middelgrunden pilot allowed 1900 guests to climb the wind turbines; more than 30 boat trips were organised annually³⁷. Table 4 provides an overview of the business's growth trajectory from 2020 to 2023, highlighting key metrics such as the number of trips, guests, and revenue in thousand EUR.

Table 3 Yearly Business Growth Metrics (2017-2023)³⁸

Year of business	2020	2021	2022	2023
Trips	4	13	75	90
Guests	130	246	1687	1912
Revenue (in thousand – EUR)	4.4	19.5	102.1	136.1

Source: Interview with the project holder *Hans Chr. Soerensen*

Besides economic benefits, tourism activities also contribute to continuous social acceptance of ORE. The tourism activities provide education experiences and promote an understanding of renewable energy generation to visitors. As such, tourism activities can contribute to enhancing the social acceptance of offshore energy.

³⁶ Copenhagen, ranked 73rd among the world's most visited cities, saw over 25 million tourists in the first six months of 2024, marking a 1.4% increase compared to the same period in 2023. The projected revenue for Denmark's Travel & Tourism market in 2024 is estimated to be US\$4,909.00 million.

³⁷ <https://www.h2020united.eu/pilots-denmark>

³⁸ Information received from project holder Hans Chr Soerensen

5.4 Key lessons and future directions

The UNITED case study illustrates the possibilities for multi-use:

- Economically, the integration of tourism with wind energy operations has generated additional benefits to the offshore wind farm. **Tourism activities**, including guided tours and open house days, **provide educational opportunities and create alternative revenue streams, diversifying income sources for local communities**. These initiatives strengthened the local community, particularly those facing declines in traditional sectors like fishing, and validated the viability of multi-use marine spaces in enhancing economic resilience.
- Social acceptance has been a critical factor in the success of this project, with a community ownership model fostering local support and involvement. Educational tours and open house events have increased public awareness and support for renewable energy, emphasising the importance of involving communities in the benefits and operations of such projects.

The UNITED project evolved into a commercially viable business. This success was achieved by expanding the wind farms tour programme on-site and virtually, establishing a comprehensive safety and security framework, and developing a guide to provide technical insights for tour guides. The project team hired more boat companies and guides, financed via ticket sales to match visitor demand, and confirmed that this would not have happened without the UNITED project.

To enhance future projects, further improvements in MSP and related mechanisms in Denmark could be considered:

- The effectiveness of MSP depends on political support and consistent adherence to established rules and processes. While planning systems have been effective over the past two decades, political uncertainties like changes in government priorities, policy shifts or bureaucratic bottlenecks can lead to significant delays in project implementation. A notable example is the abrupt halt of projects in Denmark two years ago, attributed to concerns about potential non-compliance with EU rules—an issue that remains unresolved and not fully understood.³⁹
- Initial development phases revealed knowledge gaps, such as differences in wind stability between Denmark's east and west coasts. Westerly winds are more unstable than easterly winds, impacting turbine operation and efficiency. On the East Coast, turbines may run longer at full capacity, necessitating higher-capacity transformers to prevent early replacements. Enhanced data sharing and research initiatives, supported by relevant government bodies, are vital for closing these knowledge gaps, ultimately promoting more efficient energy production and operational planning.

Finally, the lessons learned from the UNITED case could be relevant for multi-use ORE development elsewhere. Particularly, the possibility to visit ORE deployment sites to enhance awareness and social acceptance as well as technical aspects such as the type of wind turbines that allow for visits, and the logistical challenges to manage tourism visits in parallel to maintenance efforts could be easily transferred to another context.

³⁹ Interview with Hans Chr Sørensen (August 13, 2024). Conducted by Alexandra Rimpler

5.5 Sources

- CORDIS – EU Research Results. (n.d.). *Multi-Use Offshore Platforms Demonstrators for Boosting Cost-effective and Eco-friendly Production in Sustainable Marine Activities*. Retrieved from: <https://cordis.europa.eu/project/id/862915>.
- H2020 UNITED Project. (n.d.). About. Retrieved from: <https://www.h2020united.eu/about>
- Middelgrunden Wind Farm Website. Retrieved from: <https://www.middelgrunden.dk/middelgrunden-windmill-cooperative/>
- HOFOR Utilities. (n.d.). Renewable Energy - Wind Power. Retrieved from: <https://www.hofor.dk/english/hofor-utilities/renewable-energy-wind-power/>
- H2020 UNITED Project. (n.d.). Partners. Retrieved from: <https://www.h2020united.eu/partners>
- H2020 UNITED Project. (n.d.). Pilots - Denmark. Retrieved from: <https://www.h2020united.eu/pilots-denmark>
- Wind Europe. (November, 2019). *Boosting Offshore Wind Energy in the Baltic Sea*. Retrieved from: <https://windeurope.org/wp-content/uploads/files/about-wind/reports/WindEurope-Boosting-offshore-wind.pdf>
- Directorate-General for Energy. (n.d.). *Offshore Renewable Energy*. Retrieved from: https://energy.ec.europa.eu/topics/renewable-energy/offshore-renewable-energy_en
- Danish Energy Agency. (n.d.). *Denmark's Largest Procurement Procedure for Offshore Wind Power Launched*. Retrieved from: <https://ens.dk/presse/denmarks-largest-procurement-procedure-offshore-wind-power-launched>
- Enerdata. (2022). *Denmark Aims to Raise its 2030 Offshore Wind Target by 45% to 12.9 GW*. Retrieved from: <https://www.enerdata.net/publications/daily-energy-news/denmark-aims-raise-its-2030-offshore-wind-target-45-129-gw.html>
- Offshore Wind. (2023, April 14). *Swedish Energy Agency Outlines Where 30 GW of Offshore Wind Could Be Installed*. Retrieved from: <https://www.offshorewind.biz/2023/04/14/swedish-energy-agency-outlines-where-30-gw-of-offshore-wind-could-be-installed-calls-for-prioritising-energy-production-in-marine-planning/>
- Polish Wind Energy Association. (2020). *Offshore Wind Energy Report*. Retrieved from: http://psew.pl/wp-content/uploads/2020/09/psew_raport_eng_v12_screen.pdf
- Interview with Hans Chr Sørensen. (August 13, 2024). Conducted by Alexandra Rimpler.
- Maritime Spatial Plan. (n.d.). *Denmark's Maritime Spatial Plan*. Retrieved from: <https://havplan.dk/en/page/info>
- Lago, M., & Zaiter, Y. (n.d.). *M3.1 Business Briefs: Danish Pilot*. Retrieved from: <https://www.h2020united.eu/images/PDFs/Denmark-business-model.pdf>
- Directorate-General for Energy. (n.d.). *Baltic Energy Market Interconnection Plan*. Retrieved from: https://energy.ec.europa.eu/topics/infrastructure/high-level-groups/baltic-energy-market-interconnection-plan_en
- European Commission. (2021). *New Baltic Offshore Wind Work Programme Agreed Through BEMIP*. Retrieved from: https://commission.europa.eu/news/new-baltic-offshore-wind-work-programme-agreed-through-bemip-2021-10-29_en

- Baltic Offshore Grid Initiative. (2020). Retrieved from: <https://elering.ee/en/tsos-agreed-strengthen-cooperation-future-offshore-grid-baltic-sea>
- Marienborg Declaration. (2022). Retrieved from: <https://www.regeringen.dk/aktuelt/tidligere-publikationer/the-marienborg-declaration/>
- Vilnius Declaration. (2024). *Declaration of Energy Ministers*. Retrieved from: <https://windeurope.org/wp-content/uploads/files/newsroom/press-releases/20240410-Vilnius-Declaration-of-Energy-Ministers.pdf>
- WindEurope. (2021). *Significant Developments on Offshore Wind in the Baltic Sea*. Retrieved from: <https://windeurope.org/newsroom/significant-developments-on-offshore-wind-in-the-baltic-sea/>
- Travel and Tour World. (2024). *Denmark Sets New Tourism Record with Surge in German Visitors*. Retrieved from: <https://www.travelandtourworld.com/news/article/denmark-sets-new-tourism-record-in-2024-with-surge-in-german-visitors/>
- Statista. (n.d.). *Travel and Tourism Outlook: Denmark*. Retrieved from: <https://www.statista.com/outlook/mmo/travel-tourism/denmark>
- Danish Energy Agency. (n.d.). Retrieved from: <https://ens.dk/en>
- Deltares. (n.d.). About Us. Retrieved from: <https://www.delta3res.nl/en/about-us>

6 Case Study: EURO-TIDES

EURO-TIDES is a research project funded through Horizon Europe and UK Research and Innovation (UKRI). The project aims to advance tidal energy technology and reduce the cost of generating tidal energy (reducing the levelized cost of energy - LCOE), and to accelerate commercialisation. Therefore, the project aims to deploy four 2.4 MW Orbital Marine Power turbines at Orkney's European Marine Energy Centre's (EMEC) Fall of Warness site, resulting in delivering 9.6 MW power^{40,41}, which could supply approximately 3,200 households or charge between 1,900 and 2,400 electric cars.

EUROTIDES

Additionally, the project will integrate innovative systems for maintenance, monitoring, and digital infrastructure to enhance operational efficiency and minimise downtime. By testing and validating these technologies in a real-world environment, the project aims to demonstrate the feasibility and scalability of tidal energy as a sustainable and reliable energy source.⁴²

The project runs from 2023 to 2029, with full deployment expected by 2027 and operations planned for 15 years.⁴³ The results should facilitate scaling up tidal energy technologies and strengthen market confidence to develop the technology throughout Europe.

The case study highlights the importance of designating a specific location to test and deploy innovative ORE technologies and thereby limiting potential conflicts with other sea uses. This in turn allows project partners to focus on testing the technology, assessing its potential socio-economic and environmental impacts and facilitating scaling and transferring of the technology to other locations. As such, the development of tidal energy can be accelerated and support realising the potential for tidal of 19.5 GW by 2050 as estimated by the CoBren project (see main report). Since the project is currently still in the process of reaching its full deployment level, it can only provide limited evidence of territorial cooperation. This should, however, become more relevant once project results have materialised as these are expected to contribute to the scaling up of tidal energy.

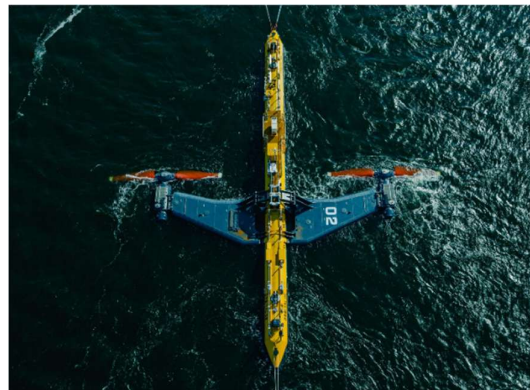


Figure 2 Orbital marine power tidal technology

Source: Euro-Tides

40 <https://www.orbitalmarine.com/euro-tides-announcement/>

41 <https://www.euro-tides.eu/overview>

42 <https://www.orbitalmarine.com/euro-tides-announcement/>

43 <https://www.euro-tides.eu/>

6.1 Unlocking the North Sea's tidal energy potential

The North Sea offers vast potential for energy generation, particularly from offshore wind, as well as tidal, and wave energy. The region's strong tidal currents, especially in the northern parts around Scotland, provide an excellent opportunity for tidal energy generation. The UK Wave and Tidal Key Resource Areas Project found that Scottish waters offer 32TWh/year of tidal stream resources, which represent a significant amount of the UK's and Europe's resources⁴⁴. Other places with key tidal resources in Europe can be found in northern France, the strait of Messina in Italy, in Portugal and northern Greece.

Areas with high tidal energy potential often overlap with other sea functions, such as areas for nature protection and conservation, military zones, fishing and aquaculture, as well as shipping routes.

In general, tidal energy installations may affect:

- **Marine ecosystems:** changes in water flow and sediment could impact fish, crustaceans, and other marine life, and the construction and operation of tidal energy systems can introduce noise, potentially disturbing marine wildlife, particularly species reliant on echolocation like dolphins and whales.
- **Navigation and safety:** Tidal energy installations can interfere with maritime routes and fishing areas. This can result in reduced fishing yields and necessitate changes in shipping routes, potentially increasing travel time and fuel consumption.

EURO-TIDES project partners consider these aspects in their project planning, in line with relevant provisions from MSP.

6.2 The role of maritime spatial planning for ORE development

EURO-TIDES benefits from a strong and clear commitment to ORE in the North Sea, the UK and Scotland. For example, the UK government's Clean Growth Strategy aiming to achieve a net-zero emissions future facilitates the implementation of the EURO-TIDES project. Moreover, the objectives to advance the UK's ORE deployment have been translated in MSP documents.

EURO-TIDES is located at the European Marine Energy Centre's (EMEC) Fall of Warness tidal site in Orkney, Scotland, a location with strong tidal movements and a dedicated space for tidal energy testing as defined in the relevant MSP documents.

MSP is a shared responsibility between different levels of government in the UK, each providing more detail for the planning. For example, the UK MSP document provides main guidance to coordinate planning of sea uses between England, Scotland, Wales, and Northern Ireland. The national MSP documents (i.e. Scottish, Welsh, English and Northern Irish documents) provide more detail on national interests and align closely with national laws and regulations on maritime activities. These plans address the management of resources such as fisheries, energy and natural habitats. Finally regional MSP documents, for example for the Orkney islands, provide details on sea uses and aim to involve local stakeholders and communities⁴⁵. All three levels of documents identify the site in Orkney as a tidal testing location.

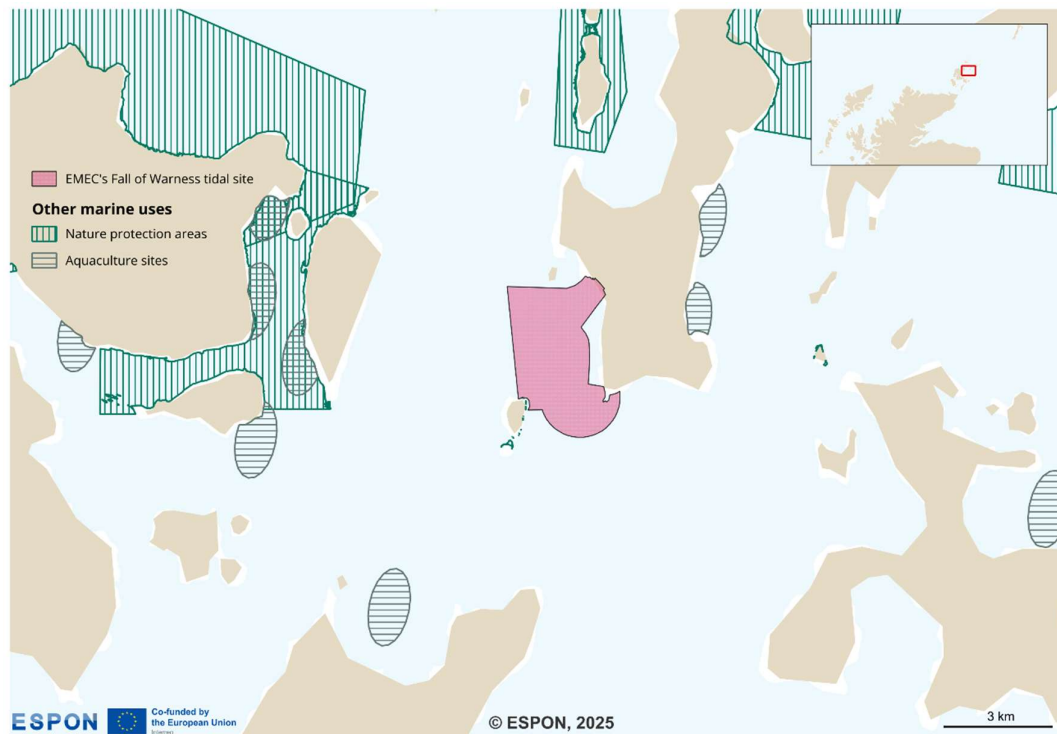
⁴⁴ The Scottish Government (2015) Scotland's national Marine Plan – A Single Framework for Managing Our Seas <https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2015/03/scotlands-national-marine-plan/documents/00475466-pdf/00475466-pdf/govscot%3Adocument/00475466.pdf>

⁴⁵ CoBren review of MSP documents, see also Annex 2 to the main report.

The draft Orkney MSP document prescribes a need for tidal energy developers to consider net economic impacts, the contribution of ORE installations to renewable energy targets and greenhouse gas emission reduction. In addition, developers should avoid, minimise or mitigate impacts on landscape, nature conservation, seal haul-out sites⁴⁶, water quality, historic environmental assets, aviation and defence interests, coastal processes (including erosion and flooding), other coastal and marine uses, amenity, including noise, light and vibrations⁴⁷.

A dedicated location for tidal energy installations minimizes potential sea use conflicts for the development of EURO-TIDES installations. Other sea-use functions, notably aquaculture and nature protection do not intervene with the EURO-TIDES location (Map 3). As a result, the project can focus on the development of the technology and assess its local effects with the aim of optimizing the technology, commercialising it and scaling it up. The project is further supported to do so, through the Crown Estate Scotland, who owns the location of the testing facility. The Crown Estate Scotland aims to bring new development opportunities to market by leasing areas of the seabed and managing the associated seabed rights. Moreover, Crown Estate Scotland facilitates enabling factors for the development of the technology, including power cables and funding⁴⁸. The site has a long history of being at the forefront of marine energy testing, and its infrastructure is well-equipped to support the large-scale testing and deployment of floating tidal turbines.⁴⁹ The present infrastructure facilitates the project to highlight its benefits to local communities.

Map 3 EURO-TIDES location at the Fall of Warness tidal site in the North Sea



Territorial level: Exclusive economic zone (EEZ)
 ESPON Project: COBREN, 2025
 Origin of data: © Copernicus Climate Change Service ERA5, EMODnet, World Database on Protected Areas (WDPA), Marine Regions EEZ, and EuroGeographics

46 Places where seals come on land to rest, moult or breed.

47 Orkney Islands Council (2024) Orkney Islands Regional Marine Plan: Consultation Draft 2024

<https://www.orkney.gov.uk/media/hvipwofn/orkney-islands-regional-marine-plan-consultation-draft-final-2.pdf>

48 <https://www.crownstatescotland.com/scotlands-property/marine/wave-and-tidal>

49 <https://www.oceanenergy-europe.eu/industry-news/orbital-marine-power-to-lead-the-delivery-of-flagship-9-6mw-tidal-array-project/>

6.3 Planning challenges and solutions experienced through EURO-TIDES

Despite a designated location to test the ORE technology and minimise potential conflicts with other sea uses, the project addresses several other planning challenges, namely assessing the socio-economic and environmental impacts to facilitate social acceptance and developing a suitable supply chain facilitating scaling up and transferring the technology to other locations.

6.3.1 Mapping the impact of tidal energy generation to facilitate social acceptance

In line with the provisions of the draft MSP for the Orkney islands, the project assesses the impact of the technology on the environment and economy.

As a floating tidal energy farm, the project is designed to have minimal impacts on marine ecosystems compared to traditional fixed-bottom installations. Nevertheless, the project assessed the environmental impacts to avoid disturbing sensitive marine habitats and migratory routes of fish. The project is committed to long-term environmental monitoring and data collection to ensure minimal impact on marine ecosystems. First results of the environmental monitoring show little disturbance for marine life while contributing to reducing CO₂ emissions by replacing fossil fuels with clean energy.

The economic benefits of the EURO-TIDES project are expected to be substantial. By harnessing the North Sea's tidal energy potential, the project reduces the reliance on imported fossil fuels and contributes to enhancing energy security. In addition, the development of the technology creates job opportunities in both the renewable energy and other maritime sectors. The installation, operation, and maintenance of floating tidal turbines are expected to generate demand for skilled workers, local supply chains, and services, providing economic stimulation to the region⁵⁰.

The expected economic effects of the installation are shared with the affected communities to facilitate social acceptance. EURO-TIDES project partners consider social acceptance an important factor of tidal energy projects. By demonstrating how tidal energy can generate clean energy, create jobs, and contribute to environmental protection, the project fosters public support and underscores the importance of local involvement, particularly by engaging fishing communities in operational and maintenance roles. This inclusivity not only mitigates opposition but also fosters economic benefits by integrating local skills into the project's lifecycle. Therefore, the project actively engages with local communities and stakeholders early in the development process. Understanding and addressing local concerns about potential impacts on fishing, tourism, and other traditional industries is vital to ensure broad support. The project continues to hold dialogues with local communities, ensuring their voices are heard and their needs are met.

6.3.2 Planning to commercialise tidal energy across Europe

Despite positive outlooks on the environment and the economy with regards to tidal energy technology, the project experiences some challenges concerning the scaling-up and commercialising of the technology.

The relatively remote location of the installation away from population centres and large ports poses challenges for the project partners to ensure a reliable and short supply chain. Therefore, installing the technology as well as ensuring equipment and staff for monitoring and maintenance requires effort for the project partners which poses a challenge for scaling-up and commercialisation. In addition, convincing industrial stakeholders to fully embrace tidal energy remains difficult, and the project will

⁵⁰ The project offers opportunities for regional economic growth, particularly in rural coastal areas. It could lead to more stable energy prices by diversifying energy sources, benefiting local economies. The long-term revenue from energy production will also allow for reinvestment into regional infrastructure and energy networks, further bolstering economic resilience.

continue efforts to demonstrate the technology's economic benefits and commercial viability through rigorous testing and performance data.

EURO-TIDES' international partnership as well as explicitly linking the project objectives to policy objectives at sea basin and European levels support addressing this challenge. The project leverages both, local expertise from the European Marine Energy Centre (EMEC) located in the Orkney islands, as well as expertise from international partners. The involvement of partners from elsewhere facilitates transferring lessons learned from EURO-TIDES and possibly implementing the technology in other locations.

Moreover, the project, its planning, and the design of the technology are coherent with European objectives and policy documents. For example, the project adheres to the principles of the EU Renewable Energy Directive, which guides renewable energy projects across the EU, and the EU's Marine Strategy Framework Directive (MSFD), which focuses on achieving "Good Environmental Status" for European seas and promoting the sustainable use of marine resources. In addition, the North Seas Energy Cooperation (NSEC) is vital for scaling up and commercialising the project's outputs in the sea basin through the cooperation's focus on coordinating spatial planning and infrastructure for ORE in the sea basin.

6.4 Key lessons and future directions

The EURO-TIDES project illustrates the advantages of clear designation of sea space for ORE development. The assigned space for tidal energy highlighted in the MSP documents reduces potential spatial conflicts with shipping, fishing and aquaculture as well as nature conservation. Moreover, the Scottish site supports technological advancement for ORE development by offering grid connections. Therefore, the project can focus on further developing tidal energy and its commercialisation. In doing so, the project team performs relevant planning activities notably assessing environmental and economic impacts of developing and deploying the technology.

As the project progresses, it will continue fostering international cooperation and refining technological innovations. The North Sea's established energy landscape offers vast potential, and the project's success will depend on its ability to scale effectively while engaging with local communities. The lessons learned from EURO-TIDES will guide future tidal energy projects in the North Sea and provide valuable insights for the broader transition to renewable energy in similarly mature markets.

6.5 Sources

- **Euro-Tides Project**
 - "EURO-TIDES Project Overview." Euro-Tides. Accessed [2 November 2024]. Available at: <https://www.euro-tides.eu/>
- **Orbital Marine Power**
 - Orbital Marine Power. "EURO-TIDES Announcement." Accessed [February 2025]. Available at: <https://www.orbitalmarine.com/euro-tides-announcement/>
- **Ocean Energy Europe**
 - Ocean Energy Europe. "Orbital Marine Power to Lead the Delivery of Flagship 9.6MW Tidal Array Project." Accessed [February 2025]. Available at: <https://www.oceanenergy-europe.eu/industry-news/orbital-marine-power-to-lead-the-delivery-of-flagship-9-6mw-tidal-array-project/>
- **The Crown Estate**
 - The Crown Estate. "Offshore Wind Evidence and Change Programme." Accessed [February 2025]. Available at: <https://www.thecrownestate.co.uk/our-business/marine/offshore-wind-evidence-and-change-programme>
- **Offshore Wind Industry News**
 - "North Sea and Baltic Sea Countries Enter Pacts to Protect Offshore Energy Infrastructure Amid Concerns Over Russian Sabotage." Offshore Wind, 11 April 2024. Accessed [February 2025]. Available at: <https://www.offshorewind.biz/2024/04/11/north-sea-baltic-sea-countries-enter-pacts-to-protect-offshore-energy-infrastructure-amid-concerns-over-russian-sabotage/>
- **European Marine Energy Centre (EMEC)**
 - "European Marine Energy Centre (EMEC) - Tidal Energy." EMEC. Accessed [February 2025]. Available at: <https://www.emec.org.uk/>
- **Marine Scotland**
 - Marine Scotland. "Marine Renewable Energy and Environmental Regulations." 2023.
- **North Sea Energy Cooperation**
 - "North Sea Energy Cooperation." Accessed [February 2025] Available at: [The North Seas Energy Cooperation](#).
- **Horizon Europe Programme**
 - "Horizon Europe - European Commission." Accessed [February 2025] Available at: [Horizon Europe - European Commission](#).
- **Marine Conservation Society**
 - "Marine Conservation Society - Tidal Energy and Marine Biodiversity." Accessed [February 2025] Available at: [How the ocean and climate change are linked | Marine Conservation Society](#).
- **European Commission**
 - "EU Green Deal." European Commission. Available at: [The European Green Deal - European Commission](#) Accessed [February 2025].
- **Orkney Islands Council**
 - "Renewable Energy Initiatives." Orkney Islands Council. Available at: [Orkney-Sustainable-Energy-Strategy-2017-2025-1.pdf](#) Accessed [February 2025].

7 Case study: BLOW

BLOW⁵¹ (*Black Sea Floating Offshore Wind*) is an innovative ORE project in the **Black Sea**, demonstrating possibilities to deploy **floating wind technology** in Bulgaria. The project seeks to increase renewable energy capacity in the Black Sea by leveraging an innovative floating wind technology previously tested in France by *Eolink*.



By further testing the technology in the Black Sea, the project partners aim to create awareness and **unlock the significant offshore wind potential in the Black Sea, estimated to be around 166 GW, equivalent to five times the electricity consumption of Bulgaria and Romania.**⁵²

This case study highlights the importance of regulatory frameworks enabling ORE projects. The project started in 2023 with an initial timespan of 1.5 years. The project envisaged to deliver an operational pilot technology in the Black Sea in June 2024, serving as a critical milestone in the timeline. However, project partners faced several regulatory challenges that have put the project on hold until today. Neither the MSP of Bulgaria nor the MSP for Romania specify specific locations for ORE deployment, even though the development of ORE is considered as a potential area of interest⁵³.

7.1 Unlocking the Black Sea's ORE potential

The Black Sea region holds considerable ORE potential. Studies indicate that the Black Sea can produce up to 10 GW of offshore wind capacity, which, although still in early stages, is projected to grow significantly⁵⁴. Several countries, including Romania, Bulgaria, and Turkey, are exploring their offshore wind potential as part of national energy strategies, aiming to diversify energy sources and reducing dependence on fossil fuels⁵⁵.

Tapping into the Black Sea's wind energy potential requires predominantly floating wind deployment due to the sea basin's geographical and environmental conditions. The Black Sea is characterised by relatively deep waters, which challenges the development of fixed-bottom turbines that do not lend themselves to deep waters. Moreover, floating wind turbines allow access to stronger and more consistent wind resources, offering significant potential for renewable energy generation⁵⁶.

51 <https://blow-project.eu/>

52 Balkan Green Energy News. (2022, October 19). BLOW project: Pioneering 5 MW floating offshore wind turbine in Black Sea. Retrieved from <https://balkangreenenergynews.com/blow-project-pioneering-5-mw-floating-offshore-wind-turbine-in-black-sea/>

53 Cyzak, P. and K. Rangelova (2024). A breath of fresh air: Offshore wind in Bulgaria. <https://ember-energy.org/latest-insights/a-breath-of-fresh-air-offshore-wind-in-bulgaria/>

54 Bulgaria proposes offshore wind projects totalling up to 3 GW until 2030 and Romania projects totalling up to 7 GW until 2035, Source CoBren main report

55 Romanian Ministry of Energy: <https://www.ministerulenergiei.ro/>

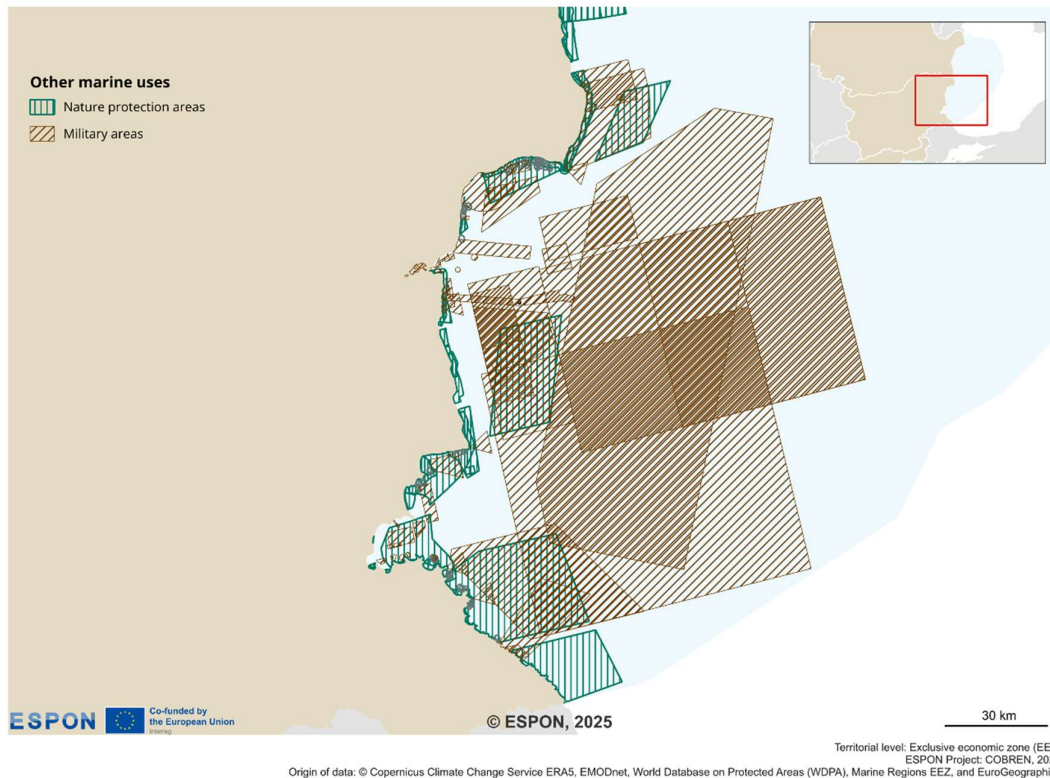
56 Black Sea Strategy, European Commission. https://enlargement.ec.europa.eu/what-is-enlargement/black-sea-strategy_en

Despite the potential for ORE developments in the Black Sea, little ORE development is currently in place, partially due to other sea uses:

- **Nature:** Bulgaria and Romania have allocated large parts of sea space for nature conservation and protected areas as illustrated by the CoBren research mapping the potential for ORE.
- **Military considerations:** The Black Sea also faces significant military interests, as it is a region of strategic importance. Therefore, countries have allocated large parts of their sea space to military activities, for example in Bulgaria (Map 4). Military zones in the region can pose indirect challenges to ORE expansion, as they often occupy vast areas that overlap with potential wind farm sites.
- **Aquaculture:** In terms of aquaculture, the growing industry in the Black Sea could present spatial conflicts with ORE development, especially in countries like Romania and Bulgaria, where aquaculture is becoming increasingly significant.
- **Synergies with other ORE:** There is potential for (combinations of) wave, solar, and wind, as illustrated by the CoBren research, which mapped the potential for ORE deployment. Neither Romania nor Bulgaria is exploring these opportunities in their offshore policy strategies.

BLOW project partners currently aim to identify a suitable location to test and scale-up their floating wind technology considering these sea functions. While the location has not been identified yet, map 4 below provides an overview of the current sea use activities in the relevant part of the Bulgarian Black Sea.

Map 4 Sea use in the Bulgarian part of the Black Sea challenging location possibilities for BLOW



7.2 The role of maritime spatial planning for ORE development

The BLOW project benefits from strong political commitment and support to develop ORE: For example, the Bulgarian National Energy and Climate Plan (NECP) envisages a total installed capacity of offshore wind of 3.84 GW by 2050⁵⁷. The development of (offshore) renewable energy is expected to contribute to making Bulgaria's as well as the region's energy production less dependent on import of fossil energy⁵⁸. The BLOW project benefits from political commitment providing a long-term vision, stimulating public awareness and support, and initiating regulatory updates.

Despite commitment to develop ORE in the Black Sea from the Bulgarian government, the BLOW project experiences several regulatory challenges, notably a lack of mentioning of ORE development in the national MSP document. Bulgaria's MSP, officially adopted in 2023, does not provide details about how offshore wind could be developed in the Black Sea, nor does it identify specific areas or reference detailed potential studies⁵⁹.

Despite that lack of designated zones for ORE developments in the Bulgarian MSP document, the plan allows for multi-use in military zones as well as with marine protected areas, which cover large parts of the sea space (see Map 4).

In addition, Bulgaria's government is discussing an Offshore Wind Law. A draft law has been presented to Parliament in early 2024 and is currently under revision without clear view on the adoption of the law⁶⁰. The draft law aims to unlock the potential for ORE development and avoid potential conflicts with other sea uses formalised in other sectoral legislation. The law would coordinate the competencies of the authorities that govern the different phases of implementation of power generation facilities at sea, such as offshore wind projects (including planning, construction, operation and decommissioning). The law could open market competition and attract experienced companies from mature markets in Europe. It would guarantee that the Bulgarian government will be positioned to develop the areas with the best natural wind energy potential in the Bulgarian section of the Black Sea at the lowest cost for society and in the most sustainable manner⁶¹.

7.3 Planning challenges and solutions experienced through the BLOW project

The lack of designated areas for ORE in Bulgaria's MSP document, as well as uncertainties considering the conclusion of the Offshore Wind Law, forced the BLOW project partners to adopt creative measures to implement their project, concerning the location for the floating wind technology, mapping of potential conflicts, and facilitating stakeholder involvement.

57 Center for the study of democracy (2024) Offshore wind in the black sea: towards a strategic legal framework in Bulgaria. Policy Brief No. 151, November 2024 https://www.euki.de/wp-content/uploads/2024/12/BRIEF_151_ENG_WEB.pdf

58 Ibid.

59 Cyzak, P. and K. Rangelova (2024). A breath of fresh air: Offshore wind in Bulgaria. <https://ember-energy.org/latest-insights/a-breath-of-fresh-air-offshore-wind-in-bulgaria/>

60 Cyzak, P. and K. Rangelova (2024). A breath of fresh air: Offshore wind in Bulgaria. <https://ember-energy.org/latest-insights/a-breath-of-fresh-air-offshore-wind-in-bulgaria/>

61 Center for the study of democracy (2024) Offshore wind in the black sea: towards a strategic legal framework in Bulgaria. Policy Brief No. 151, November 2024 https://www.euki.de/wp-content/uploads/2024/12/BRIEF_151_ENG_WEB.pdf

7.3.1 Innovative solutions to define a suitable location for the floating wind technology

The BLOW project carefully identified potential locations to implement the pilot for floating wind technology. Eventually, project partners proposed to connect the floating turbine to a gas platform operated by the Bulgarian company *Petroceltic*, offering an innovative approach to integrating renewable energy within existing infrastructure.⁶² In addition, the partners proposed to identify the floating structure as a boat in regulatory terms. This step was necessary given the lack of a regulatory environment for ORE in Bulgaria to ensure a viable solution in terms of licensing and insurance.

This location strategy also optimises resource use, presenting a cost-effective solution with the aim to ensure continuous acceptance from stakeholders, including regulatory bodies and maritime operators. Furthermore, by aligning with national maritime safety and environmental standards, the project reduces the need for new regulatory assessments for separate wind farm sites, ensuring seamless integration with existing maritime governance frameworks.

In addition, the location minimises potential sea-use conflicts as the identified location limits fishing and military activities. By leveraging established maritime zones, the project builds on well-documented and respected navigation and operational protocols, reducing the risk of disruption and enhancing operational efficiency. In addition, the identified location avoids sensitive marine habitats and migratory routes.

Unfortunately, since the identification of a suitable location took the project partners longer than expected, the pilot installation has not yet been implemented.

7.3.2 Conducting an EIA to map and mitigate potential conflicts

The project partners continue planning for the development of the floating wind technology, notably by performing an Environmental Impact Assessment (EIA). The BLOW project has integrated environmental sustainability into its core development framework. The project shows how floating offshore wind can be a sustainable alternative to fossil fuels by ensuring minimal environmental disruption while providing clean energy solutions.

As a floating offshore wind farm, the project is designed to have minimal impacts on marine ecosystems compared to traditional fixed-bottom wind farms.

While still in the early stages, the BLOW project will benefit marine life in the long term. Floating wind turbines can act as artificial reefs, enhancing local biodiversity and supporting fish stocks. The project's EIA process minimises potential negative effects, with long-term monitoring strategies in place. The development of the Black Sea's offshore wind potential can significantly improve the environmental balance of the region.

7.3.3 Stakeholder engagement

In anticipation of deploying the BLOW floating wind technology, the project partners started stakeholder engagement activities, notably aimed at enhancing social acceptance.

To date, social acceptance of the development of floating wind is measured through regular surveys, aimed at understanding and addressing local concerns on potential impacts of the ORE deployment on fishing and tourism. First results illustrate strong support for ORE development, along with a positive perception of the combination of ORE deployment and aquaculture, and their potential benefits for the local community. The favourable perception of multi-use prototypes suggests a good disposition towards innovative solutions that could further optimise space use and strengthen multiple sectors.

⁶² Ibid.

The project will continue to hold dialogues with local communities, ensuring their voices are heard and their needs are met.

As floating offshore wind technology is still relatively new to the region, stakeholder engagement also involves raising awareness of the benefits of renewable energy. Demonstrating how offshore wind can generate clean energy, create jobs, and contribute to environmental protection will be critical to fostering public support.

7.4 Key lessons and future directions

The BLOW project illustrates the challenges of implementing a proven concept - *Eolink's* floating wind technology, developed and tested in France - in another geographic context – the Black Sea in Bulgaria's waters. The project highlights the importance of considering the regulatory environment when transferring a technology from one location to the other.

A lack of designated areas for ORE development in the Black Sea, in addition to delays to adopting Bulgaria's Offshore Wind Law, forced the project partners to adopt innovative solutions. Nevertheless, the project advances performing planning activities, including conducting the EIA and stakeholder engagement activities.

The case study illustrates a need for the Bulgarian MSP to consider ORE development to advance its deployment. The Bulgarian MSP supports navigating regulations and employing the adequate tools to dealing with multiple sea uses such as environmental impact assessments, territorial cooperation, and stakeholder engagement. Today, the project partners built upon experiences from other countries, and other policy fields to deal with these practices which may not be tailored to the case of Bulgaria, or ORE development.

In addition, to the need of enhancing regulatory frameworks in Bulgaria, the project could benefit from stronger collaboration at sea basin level. Coordinating MSP practices across the countries around the Black Sea would support the project's objectives to scale-up the technology once proven relevant and applicable. Coordinating MSP practices in early stages could facilitate aligning approaches and practices, e.g. whether to allow ORE development in military zones or nature protection areas. Coordinated MSPs could also enhance the supply chain for ORE development and deployment, e.g. using infrastructure from different countries.

Such collaborative efforts could build upon existing initiatives, including forums like Central and South-Eastern Europe Energy Connectivity (CESEC) high level group⁶³ facilitating cross-border and transnational energy infrastructure projects⁶⁴ or drawing on the lessons from the MARSPLAN-BS project, aimed to facilitate cross-border MSP for the Black Sea, Bulgaria and Romania⁶⁵. The creation of collaborative communities of practice, such as the Black Sea Renewable Energy Coalition, launched in the summer of 2023, is another important step in accelerating the development of the offshore wind sector. This coalition brings together stakeholders from Romania, Bulgaria, Ukraine and Turkey to facilitate knowledge exchange, share best practices and develop a common understanding of challenges. It can collectively address technical, environmental, and social barriers, while supporting capacity building in regional low carbon offshore energy markets and the decarbonisation of coal dependent energy systems⁶⁶.

⁶³ [Central and South-Eastern Europe Energy Connectivity](#)

⁶⁴ Central and South-Eastern European Energy Connectivity: https://energy.ec.europa.eu/topics/infrastructure/high-level-groups/central-and-south-eastern-europe-energy-connectivity_en

⁶⁵ <https://maritime-spatial-planning.ec.europa.eu/projects/cross-border-maritime-spatial-planning-black-sea-bulgaria-and-romania>

⁶⁶ Center for the study of democracy (2024) Offshore wind in the black sea: towards a strategic legal framework in Bulgaria. Policy Brief No. 151, November 2024 https://www.euki.de/wp-content/uploads/2024/12/BRIEF_151_ENG_WEB.pdf

7.5 Sources

- **Balkan Green Energy News.** (2022, October 19). BLOW project: Pioneering 5 MW floating offshore wind turbine in Black Sea. Retrieved from <https://balkangreenenergynews.com/blow-project-pioneering-5-mw-floating-offshore-wind-turbine-in-black-sea/>
- **Black Sea Commission.** “Energy Cooperation.” Accessed November 2024. <http://www.bs-commission.org/>
- **Black Sea Economic Cooperation (BSEC).** “Economic Cooperation.” Accessed November 2024. <https://www.bsec-organization.org/>
- **BLOW Project.** Accessed November 2024. <https://blow-project.eu/>
- **CEPS.** (n.d.). Black Sea Floating Offshore Wind (BLOW). Retrieved from <https://www.ceps.eu/ceps-projects/black-sea-floating-offshore-wind-blow/>
- **Common Maritime Agenda.** “Military and Environmental Strategy.” Accessed November 2024. <https://www.blackseacommission.org/>
- **Common Maritime Agenda for the Black Sea.** Accessed November 2024. <https://www.blackseacommission.org/>
- **European Commission.** “Black Sea Strategy.” Accessed November 2024. https://ec.europa.eu/maritimeaffairs/policy/sea-basin-strategies/black-sea_en
- **European Commission.** “Marine Spatial Planning.” Accessed November 2024. https://ec.europa.eu/maritimeaffairs/policy/marine_spatial_planning_en
- **European Commission.** (n.d.). Horizon 2020. Retrieved from https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-2020_en
- **European Union.** “Central and South Eastern Europe Energy Connectivity (CESEC).” Accessed November 2024. https://ec.europa.eu/energy/topics/infrastructure/energy-connectivity/central-and-south-eastern-europe-energy-connectivity_en
- **European Union.** “EU Strategy for the Danube Region (EUSDR).” Accessed November 2024. <https://www.danube-region.eu/>
- **European Union.** “Habitats Directive.” Accessed November 2024. https://ec.europa.eu/environment/nature/legislation/habitatsdirective_en.htm
- **European Union.** “Policy on Aquaculture.” Accessed November 2024. https://ec.europa.eu/fisheries/cfp/aquaculture_en
- **International Energy Agency (IEA).** “Offshore Wind Energy Policy in Turkey.” Accessed November 2024. <https://www.iea.org/reports/offshore-wind-energy>
- **MSPGreen.** (2024, May). Exploring Potential for Allocation of Offshore Aquaculture Areas and Their Integration in MSP. Retrieved from <https://mispgreen.eu/wp-content/uploads/2024/05/VP-Bulgaria-Exploring-potential-for-allocation-of-offshore-aquaculture-areas-and-their-integration-in-MSP.pdf>
- **Romanian Ministry of Energy.** “Energy Strategy.” Accessed November 2024. <https://www.energy.gov.ro/en>
- **World Bank.** “Black Sea Energy Potential.” Accessed November 2024. <https://www.worldbank.org/en/topic/energy>

8 Case study: EU-SCORES

EU-SCORES⁶⁷ is a research project co-financed by the European Union Horizon 2020 programme. The project consortium consists of 25 partners⁶⁸ led by the Dutch Marine Energy Centre (DMEC)⁶⁹. It aims to demonstrate the integration of offshore wind, wave, and solar energy in multi-source parks through two demonstration sites:

1. The *WindFloat Atlantic* wave energy array in Portugal co-located with a floating wind farm,
2. An offshore solar PV system in Belgium co-located with a bottom fixed windfarm.



Combining offshore wind, sun, and wave energy production systems in multi-source parks offers the benefits of providing continuous power output, leading to a more resilient and stable power system, higher capacity energy production, resulting in a reduction of required marine space as well as lower total cost per MWh produced. Finally, such parks also offer the possibility of green hydrogen production and the co-usage of electrical infrastructure.



Figure 3: WindFloat Atlantic energy park

Source: AquaWind

This case study focuses on demonstrations of the **integration of offshore wind and wave energy in the *WindFloat Atlantic* energy park in Portugal**. The WindFloat Atlantic wind farm is located at the *Aguçadoura pilot* site in Portugal.⁷⁰ The demonstration in Portugal consists of a 1.2 MW wave energy array, co-located with the semi-submersible floating offshore wind farm.⁷¹ The project is currently in its deployment and testing phase (2022-2024). In addition to the wave array, a floating electrical connection hub will be designed and built which will enable the interconnection with the offshore wind infrastructure.

One of the core challenges in deploying offshore wind and wave energy in the Atlantic Ocean is overcoming the region's deep waters and harsh marine conditions. The EU-SCORES project addresses these challenges by deploying floating wind platforms and wave energy systems capable of operating effectively in dynamic environments. The technology being tested is designed to adapt seamlessly to local environmental conditions, ensuring efficiency and reducing the cost of energy.

⁶⁷ <https://euscores.eu/>

⁶⁸ CorPower Ocean, Oceans of Energy, INESC TEC, POM West-Vlaanderen, WavEC Offshore Renewables, Dutch Marine Energy Center, Efacec, KTH Royal Institute of Technology, Laminaria, MARIN, ABO Wind, Deltares, Rijkswaterstaat, EDP, Ghent University, University of Edinburgh, VLAIO, ArcelorMittal, Ocean Data Factory Sweden, Sustainable Energy Authority of Ireland, Tecnalia, TNO, University of Algarve, Flanders Marine Institute, Ramboll.

⁶⁹ <https://www.dutchmarineenergy.com/>

⁷⁰ <https://euscores.eu/#wave-wind>

⁷¹ <https://www.windfloat-atlantic.com/>

8.1 Unlocking the Atlantic Ocean's ORE potential

The Atlantic Sea Basin holds immense potential for offshore energy development, especially in renewable sectors such as wind, wave, and solar energy. The expansive marine areas and favourable wind conditions make it an ideal location for offshore wind farms. Moreover, the incorporation of wave and solar energy technologies can complement wind energy, contributing to a more diversified and balanced energy portfolio. The strategic development of these energy resources could significantly contribute to the energy transition goals of the countries bordering the basin, promoting energy security, sustainability, and economic growth.

The analysis of the various sea-use activities in the **Atlantic Ocean presents both synergies and barriers** for the development of ORE due to the overlap of natural habitats and ORE resources in the European part of the sea basin:

- **Nature and ORE resources:** The overlap between nature and ORE potential in countries such as France suggests co-existence is possible. However, ORE strategies generally treat nature as a barrier for nearshore ORE development in the Atlantic Ocean. This approach seems especially problematic in areas with multiple overlapping areas, such as the Spanish coast near Portugal.
- **Military zones:** Different conclusions can be drawn on whether military activities provide a barrier or potential synergy for countries neighbouring the Atlantic Ocean. For example, Ireland's spatial claim is limited, while Portugal could significantly benefit from exploring synergies with military zones.
- **Aquaculture dynamics:** Most countries bordering the Atlantic Ocean see aquaculture as a barrier for ORE development, as their nearshore location overlaps with developers' preference for shallow waters. In some countries, such as Ireland, the limited spatial claim restricts the push for co-existence. However, existing overlaps in countries such as Spain suggest that the search for synergies and co-existence might be worthwhile.
- **Other ORE:** The Atlantic Ocean holds significant wave and wind potential compared to the other European sea basins. For now, Northern Portugal, the west coast of Ireland, and Spain have considered wave energy in the most detail in their respective MSPs. Despite the significant wave resources and deep waters, there is also potential for offshore solar and wind, yet countries have not fully identified this potential in their ORE strategies.

Focusing on the Portuguese part of the Atlantic, the mapping of ORE activities (see CoBren main report) reveals that Portugal faces **significant barriers** related to nature conservation, military areas, and aquaculture as:

- Portugal's EEZ is predominantly designated for aquaculture, limiting wind, wave, and offshore solar energy potential. The main barrier revolves around the impact of nearshore OWF on fish stocks in Northern Portugal.⁷² The fishery sector provides less of a barrier for OWF projects further offshore.⁷³
- Planned wind farms overlap with aquaculture areas, suggesting potential for synergy.

The western EEZ offers wind and offshore solar energy potential, overlapping with military and nature areas. For instance, nature conservation has proven to be a barrier rather than an accelerator for

⁷² Fishermen threaten to 'stop fishing', take legal action over massive block of offshore wind farms <https://www.portugalresident.com/fishermen-threaten-to-stop-fishing-take-legal-action-over-massive-block-of-offshore-wind-farms/>.

⁷³ Porto offshore wind farms to be moved 35 kms further out to sea to save fishing <https://www.portugalresident.com/porto-offshore-wind-farms-to-be-moved-35-kms-further-out-to-sea-to-save-fishing/>.

offshore wind development in Portugal, with requests filed for the exclusion of zones neighbouring Natura2000 areas.⁷⁴

In spite of these barriers, there is a **promising synergy in the development of other OREs**, such as wave energy and offshore solar. For example, Portugal's southern coast presents offshore solar energy as well as wave and offshore solar energy co-location potential with minimal overlaps with other maritime activities. The western coast also offers diverse ORE development opportunities, although overlaps with military and nature areas are common. Expanding ORE designations could therefore optimise Portugal's potential.

8.2 The role of maritime spatial planning for ORE development

The *Aguçadoura pilot* site of the EU-SCORES project has benefitted from the Portuguese approach to planning of ORE activities in various forms, ranging from the selection of the pilot site in a designated zone, the available infrastructure to connect to the energy grid to the forward-looking licensing approach (see also 8.7 Annex: “*Overview of the planning process in Portugal*” for more detail about each step of the process). These and additional examples of the MSP process in the context of this case study are presented in more detail in the following section.

8.2.1 Designated pilot zones to develop ORE technologies

The Portuguese MSP identifies pilot zones that serve as a testing ground for ORE technologies (wind and wave). This planning approach reflects Portugal's proactive stance in leveraging its maritime resources to enhance energy security and sustainability. As outlined in its MSP, the country is preparing for the commercial deployment of technologies that have reached Technology Readiness Level (TRL) 9, which indicates readiness for market entry as highlighted. Portugal has set ambitious policy goals for renewable energy, targeting 0.2 GW of wave energy and 2 GW of offshore wind by 2030, with aspirations to increase offshore wind capacity to 10 GW by the same year⁷⁵.

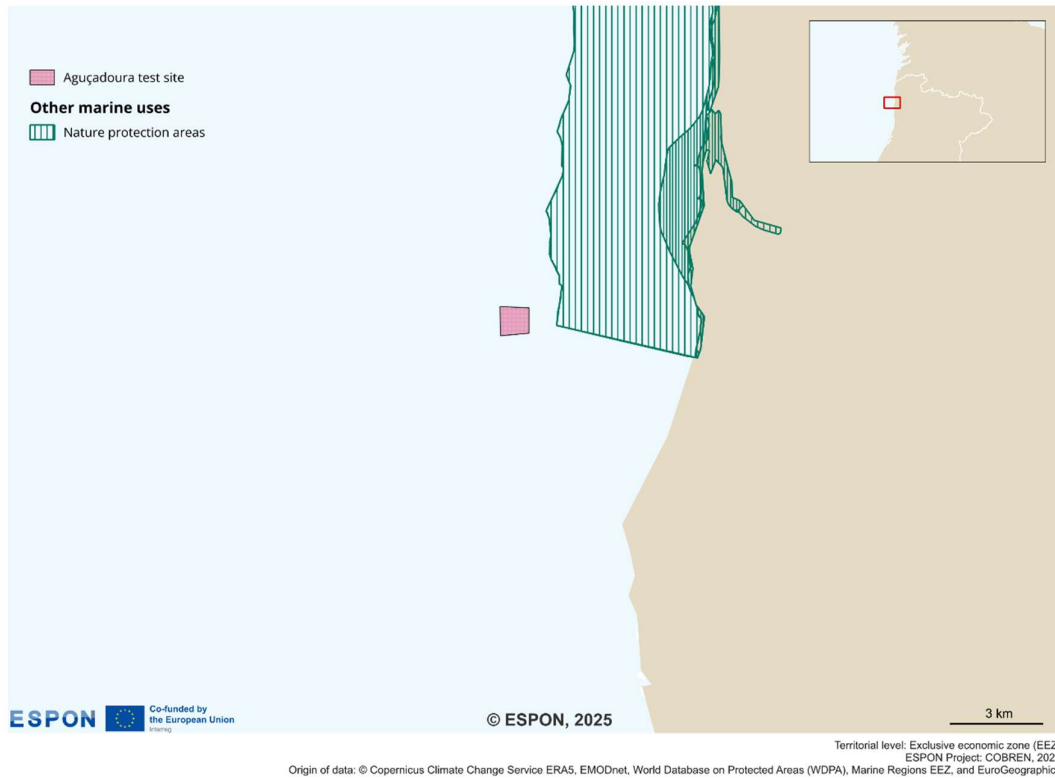
The EU-SCORES pilot's infrastructure is situated within Portugal's Exclusive Economic Zone (EEZ). The initial testing zone for wave energy was designated before the MSP framework was introduced in 2017. When MSP was implemented, these pre-existing areas were incorporated into the planning. Presently, the government is expanding these wave zones solely for pilot testing purposes due to the early stage of wave energy technology, rather than for commercial use. It is noteworthy that many energy projects in Portugal (?) were already established prior to the official introduction of MSP and the government's subsequent enlargement initiatives.

The *WindFloat Atlantic* wind farm is located 18 km off the coast of Viana do Castelo in Portugal outside of designated nature protection areas as illustrated by Map 5. As the wind farm and the EU-SCORES wave energy array are planned to be interconnected through a floating electrical connection hub, the wave array is assumed to be in a similar location.

74 Environmental NGOs want plans for three offshore windfarms scrapped <https://www.portugalresident.com/environmental-ngos-want-plans-for-three-offshore-windfarms-scrapped/>

75 EU-SCORES Stakeholder Engagement Event. Under the theme ‘Accelerating offshore multi-source renewable energy parks’, the Policy Summit & Local Stakeholder Event took place on July 1st & 2nd 2024 in Belgium. <https://euscores.eu/highlights-eu-scores-policy-summit-local-stakeholder-event-july-1st-2nd-brussels-ostend-belgium/>

Map 5 EU-SCORES' location at the Aguçadoura Wave Test site in the Atlantic Ocean



Portugal's MSP framework in the form of the Allocation Plan for ORE under the Portuguese Maritime Ordinance also ensures⁷⁶ that offshore renewable energy developments like EU-SCORES are sited in areas that do not interfere with major shipping routes. This strategic placement is crucial, given the busy shipping lanes off Portugal's coast, optimising the use of marine space while avoiding conflicts with other marine activities.

8.2.2 Site location to ensure seamless grid connection

The EU-SCORES project benefits significantly from Portugal's established MSP framework, which emphasises grid connectivity as central to its regulatory landscape that facilitates the development of ORE projects. For example, the *Aguçadoura pilot* uses pre-installed subsea cables to connect directly to the national grid, ensuring efficient wave and wind energy technology integration. This is ensured via the *CorPower C4 wave energy converter*, launched from Viana do Castelo connecting the *Aguçadoura site* to the national grid through a subsea export cable. This system demonstrates the efficiency of combining renewable energy sources while also refining operational and maintenance practices, such as device retrieval and servicing at offshore sites.⁷⁷ The forward-thinking approach, therefore, supports the testing and validation of multi-source renewable energy systems in real-world conditions, ensuring the scalability of hybrid solutions across Europe.⁷⁸

⁷⁶ <https://www.psoem.pt/plano-de-afetacao-para-energias-renovaveis-offshore/>

⁷⁷ <https://euscores.eu/multi-source-offshore-energy-parks-developments/>

⁷⁸ <https://euscores.eu/official-go-for-eu-scores-project/>

8.2.3 Exploring colocation opportunities to make optimal use of available sea space

The *Aguçadoura* pilot aims to demonstrate how floating wind and wave energy installations can coexist harmoniously particularly concerning fishing activities, marine conservation efforts and colocation with other ORE development to optimise the use of marine spaces:

Fisheries and renewable energy: The project explores synergies with the local fishing industry. Offshore wind farms and wave energy systems can create artificial reefs, benefiting marine life and enhancing fish stocks. Through planning and stakeholder engagement, the pilot aims to minimise any adverse impacts on fishing activities and integrate renewable energy infrastructure with sustainable fisheries management

Environmental monitoring and marine conservation: The EU-SCORES pilot contributes significantly to environmental monitoring efforts by assessing the potential impacts of offshore wind and wave energy systems on marine ecosystems. The project supports biodiversity by providing artificial reefs and fostering marine life regeneration in traditionally low-biodiversity areas. A thorough environmental monitoring process ensures adherence to EU regulations on marine conservation and impacts on protected areas

Colocation potential with other ORE: As the EU-SCORES pilot progresses, there is significant potential for integrating additional marine energy technologies, such as tidal or current energy, alongside the floating wind and wave energy systems. This multi-technology/hybrid approach would enhance the overall renewable energy output, increasing the resilience and sustainability of the region's energy mix. Another expected benefit relates to fostering the scalability for similar hybrid setups across Europe.

Economic benefits of colocation: The project illustrates the value of hybrid energy systems by integrating infrastructure, such as subsea cables and anchors, which lowers costs and increases energy production efficiency per square kilometre.

8.2.4 EU scores benefits from forward-looking political support

Portugal has demonstrated significant political support for ORE projects, with the EU-SCORES pilot benefiting from this commitment as part of the national energy transition. The Portuguese government has placed a strong emphasis on offshore wind and wave energy development, which aligns with its broader decarbonisation objectives and the EU Green Deal. As such, Portugal's political backing has facilitated smoother regulatory pathways, enhanced financing opportunities, and fostered collaboration among key stakeholders across the energy and marine sectors.

For instance, the *Aguçadoura* pilot site is supported by long-term leasing agreements from the Portuguese government which consider the future development of the site:

- Current leases align with the floating wind and wave prototypes' 20-25-year operational lifespans as the project scales to include larger arrays or additional hybrid parks. Lease renewals will need to reflect expanded operational footprints and infrastructure requirements.⁷⁹
- Future prospects include scaling up the hybrid model across Europe, with Portugal serving as a reference point for leasing frameworks that prioritise sustainable energy production and economic viability. Discussions surrounding dynamic leasing mechanisms - where terms evolve to accommodate technological advancements or increased energy outputs - are emerging as key areas for policy innovation. These mechanisms could further incentivise private investment and international collaboration, strengthening Portugal's leadership in the ORE sector.

⁷⁹ <https://euscores.eu/corpower-ocean-deploys-c4-wave-energy-converter/>

Portugal has also committed to support large-scale offshore projects under its Energy and Climate Plan (NECP) and through regional initiatives like the Atlantic Action Plan. Concretely, Portugal's involvement in EU-SCORES aligns with its national strategy to transition towards a low-carbon economy. The project supports the national goal of generating 80% of its electricity from renewables by 2030, with ORE playing a key role in this ambition.

8.2.5 Planning challenges related to environmental impact assessment and developing the ORE supply chain

The Plano de Situação governs Portugal's permitting process for ORE do Ordenamento do Espaço Marítimo Nacional (PSOEM), which identifies priority zones for ORE, including pre-consented areas like Viana do Castelo.⁸⁰ Developers must secure a TUPEM (Title for Private Use of Maritime Space) from the Directorate-General for Natural Resources (DGRM), demonstrate alignment with national strategies, and undergo an EIA overseen by the Portuguese Environment Agency (APA).⁸¹ Public consultations, multiple licences (e.g. for construction, grid connection, navigation), and environmental monitoring are required. While streamlined through a one-stop-shop approach, challenges remain due to fragmented responsibilities and data gaps.⁸²

One of the **primary challenges** in advancing ORE projects in Portugal pertains to the Environmental Impact Assessment (EIA) process. In Portugal, EIAs for marine renewable energy projects often rely on desk-based studies, with some developers conducting baseline surveys as mandated by EIA declarations. Post-deployment, monitoring is typically required, with periodic reports analysed by the Portuguese Institute for Nature Conservation and Forests (ICNF)⁸³. However, challenges persist due to incomplete understanding of marine ecosystems, limited consideration of fishery resources and socioeconomic impacts, and a lack of comprehensive, accurate assessments that account for geographical differences.^{84 85}

A **second significant challenge** involves the development of a robust supply chain to support floating wind and wave energy systems. Portugal's offshore wind sector is still emerging, and its supply chain and grid infrastructure have yet to meet the demands of large-scale offshore wind projects. The country lacks the manufacturing facilities and specialised vessels necessary for the rapid deployment and maintenance of extensive offshore energy systems. To address this, Portugal is taking proactive steps, such as establishing a Technological Free Zone off the coast of Viana do Castelo, to foster innovation and collaboration in the offshore wind sector. Additionally, the government plans to launch its first offshore wind auction with a capacity of up to 2 gigawatts as part of broader efforts to increase the share of renewables in its energy consumption to 51% by 2030. These initiatives are crucial for building a sustainable and robust domestic supply chain, which is essential for scaling up projects like EU-SCORES and supporting future offshore energy developments.^{86 87}

⁸⁰ Ocean Energy Systems. Portugal Country Overview. <https://www.ocean-energy-systems.org/ocean-energy-in-the-world/portugal>

⁸¹ Li, Y. et al. (2024). "Assessing the Impact of Marine Renewable Energy in Portugal." *Frontiers in Energy Research*. <https://www.frontiersin.org/articles/10.3389/fenrg.2024.1362371/full>

⁸² Offshore Engineer Magazine. "Portugal Ushers in Floating Wind Era." December 2024. <https://www.oedigital.com/news/520322-portugal-ushers-in-floating-wind-era>

⁸³ <https://iucn.org/our-union/members/iucn-members/instituto-da-conservacao-da-natureza-e-das-florestas>

⁸⁴ Ocean Energy Systems. 'Portugal.' <https://www.ocean-energy-systems.org/ocean-energy-in-the-world/portugal/>

⁸⁵ Li, Y., et al. "Assessing the impact of marine renewable energy in Portugal." *Frontiers in Energy Research*, vol. 12, 2024. <https://www.frontiersin.org/articles/10.3389/fenrg.2024.1362371/full>

⁸⁶ Offshore Engineer Magazine. "Portugal Ushers in Floating Wind Era." December 16, 2024. <https://www.oedigital.com/news/520322-portugal-ushers-in-floating-wind-era>

⁸⁷ Reuters. 'Portugal's leap into floating wind clouded by snap election' February 29, 2024. <https://www.reuters.com/business/energy/portugals-leap-into-floating-wind-clouded-by-snap-election-2024-02-29/>

8.3 Stakeholder engagement

A key part of the EU-SCORES project is stakeholder engagement. The project has hosted various events to foster dialogue among local communities, local and regional policymakers, and industry stakeholders, particularly concerning the challenges of multi-source offshore energy parks. Key topics included site selection, environmental impacts, and the integration of energy infrastructure into existing MSP.

8.3.1 Stakeholder engagement at the local and international level

Throughout the EU-SCORES project stakeholder engagement has taken place at different levels:

- **International level:** In the context of the Overall EU-SCORES initiative which includes countries such as Portugal, Belgium and the Netherlands, a policy summit in Belgium emphasised the need for coherent regulatory frameworks, future grid planning, and solutions to supply chain challenges to align economic and environmental interests with energy transition goals⁸⁸.
- **Local level:** In Portugal, the EU-SCORES project engages key stakeholders, including fisheries, aquaculture, environmental NGOs, local policymakers, local communities, and the maritime industry, using tailored strategies to address opportunities and concerns in ORE development. Public perception and social acceptance are crucial, with ongoing dialogues, consultations, and stakeholder meetings focused on balancing energy production with marine conservation, fishing, and tourism to ensure long-term support.

Figure 4 Stakeholder engagement plan EU-Scores



Source: EU-Scores

In the figure above, the (key) stakeholder groups are visualized. Stakeholder prioritisation is shown by bubble size and proximity to the centre. Stakeholder groups with higher prioritisation are depicted as larger and closer to the centre.. Light blue bubbles portray areas where Portugal has set lower priority compared to other countries where EU-SCORES pilots are being deployed (e.g. the Netherlands)⁸⁹.

⁸⁸ <https://euscores.eu/highlights-eu-scores-policy-summit-local-stakeholder-event-july-1st-2nd-brussels-ostend-belgium/>

⁸⁹ <https://euscores.eu/wp-content/uploads/2022/11/D2.5-EUSCORES-Stakeholder-engagement-plan-V1-DMEC-YE-31-10-2022.pdf>

8.3.2 Stakeholder engagement to raise social acceptance, promote the benefits of ORE developments and provide a forum for addressing conflicts

Stakeholder engagement has focused on three main objectives related to ORE developments: raising social acceptance, promoting the benefits and providing a forum to address conflicts:

A main challenge of the project has been to ensure that stakeholders understand the potential benefits of multi-source energy parks, particularly in terms of job creation, technological leadership, and the integration of offshore wind with other renewable technologies like solar and wave energy. However, stakeholders such as fisheries and NGOs have been cautious, often raising concerns about the potential impacts on marine ecosystems and local industries.⁹⁰

Furthermore, the project aims to address the social acceptance of offshore projects, especially within local coastal communities that may have concerns regarding the impact on tourism and fishing activities. While many stakeholders are still in the early stages of awareness about the project, engagement efforts are increasingly focusing on educating and involving them to ensure that their concerns are addressed.

In terms of conflicts, during the implementation phase of the pilot, fisheries claimed certain areas, leading to management challenges that resulted in court actions and subsequent compensations. This coincided with an election period, making the issue particularly sensitive. Efforts were made to compensate the fisheries, and business plans were developed to mitigate for their losses. In 2024, NGOs have advocated for mitigation measures by using risk maps to highlight the impact on marine bird migratory routes. Concurrently, most fishermen are pursuing additional compensation as the government expands designated areas for ORE development.

8.4 Nascent territorial cooperation

While this case study has not identified any concrete examples of territorial cooperation, Portugal is enhancing its cooperation mechanisms with countries such as Spain and Belgium to optimise the use of sea space for renewable energy projects, particularly offshore wind, wave, and hybrid energy systems. Below are some key frameworks and cooperation platforms where Portugal actively participates:

- **Atlantic Action Plan 2.0** - This initiative outlines strategic priorities for the sustainable development of the Atlantic region. The plan promotes collaboration between the EU's Atlantic states, including Portugal, Spain, France, and Ireland, to optimise maritime space for energy production, particularly offshore wind. The plan supports the creation of a coordinated approach to energy infrastructure, ensuring that offshore wind farms do not interfere with shipping lanes, fishing zones, or protected marine areas.⁹¹
- **Atlantic Interactions Network** - This cooperation platform connects research organisations and industry players across the Atlantic region and across borders, including Portugal, to foster innovation in renewable energy technologies. The network enhances cooperation on shared goals, such as maximising sea space for renewable energy while mitigating environmental impacts. It helps align ORE projects with EU sustainability objectives.⁹²

⁹⁰ Ibid.

⁹¹ https://ec.europa.eu/oceans-and-fisheries/sea-basins/atlantic_en

⁹² <https://www.atlantic-interactions.eu/>

8.5 Key lessons and future directions

The EU-SCORES project with its *Aguçadoura* pilot site demonstrates the integration of offshore wind and wave energy in the *WindFloat Atlantic* multi-source energy park in Portugal. Combining different ORE production systems in such multi-source parks offers several benefits such as the possibility of providing continuous power output leading to a more resilient and stable power system. They can also contribute to higher capacity energy production resulting in a reduction of required marine space as well as lower total cost per MWh produced. Finally, such parks also offer the possibility of green hydrogen production and the co-usage of electrical infrastructure.

In terms of ORE potential at the Atlantic Sea basin level, the analysis has identified both synergies and barriers with other sea uses for the development of ORE. These mainly relate to the overlap of natural habitats and ORE resources. In the Portuguese EEZ of the Atlantic Ocean, the mapping of ORE activities reveals significant barriers related to nature conservation, military areas, and aquaculture activities. While there is a promising synergy in the development of other ORE such as wave energy and offshore solar, aquaculture, can pose a barrier due to the impact of nearshore OWF on fish stocks in Northern Portugal.⁵⁹ The fishery sector provides less of a barrier for OWF projects further offshore.⁶⁰ Nature conservation has also proven to be a barrier rather than accelerant for offshore wind development in Portugal, with requests filed for the exclusion of zones neighbouring Natura2000 areas.⁶¹

To account for the identified synergies and barriers related to other sea uses, Portuguese MSP supports the development of ORE in different ways as illustrated by the *Aguçadoura* pilot site of the EU-SCORES project:

- The **designation of pilot zones** for ORE (wind and wave) technologies approaching the commercialisation stage **supports the development of pilots in an environment that minimises potential conflicts with other sea uses** such as shipping routes.
- The selection of a **site that already provides relevant infrastructure such as underwater cables to ensure seamless grid connection supports the development of the pilot by testing and validating multi-source renewable energy systems in real-world conditions.**
- Significant political support from the Portuguese government for ORE projects (wind and wave) such as **long-term leasing agreements for the pilot site**, which also consider the future development of the site toward commercialisation, **provide long term planning security for the ORE developer.**

In addition to these points, the EU-SCORES project is exploring colocation opportunities with other sea uses and ORE sources to further optimise the use of available sea space and reduce the likelihood of conflicts. In this regard, EU-SCORES' expansive stakeholder engagement activities focus on promoting the benefits of multiuse, raising social acceptance of ORE developments and providing a forum to address conflicts.

Despite these positive developments, some challenges remain related to the need of developing a specific process for Environmental Impact Assessments (EIA) for offshore energy projects as well as the need of developing the necessary supply chain for floating wind and wave energy systems in Portugal.

Finally, this case study has not identified any concrete examples of territorial cooperation. It, however, shows that cooperation initiatives and platforms such as the *Atlantic Action Plan 2.0* and the *Atlantic Interactions Network* are in place and that going forward, collaboration with neighbouring countries such as Spain will be crucial for the development of ORE, particularly in terms of

- harmonising MSP efforts,
- aligning grid connections, and
- ensuring that shared marine spaces are used efficiently.

The successful development of ORE in Portugal will depend on furthering these cross-border partnerships with Spain as well as the other members of the EU-SCORES pilot such as Belgium and The Netherlands, as well as harmonising MSP practices across Atlantic and European waters. For instance, linking offshore energy systems across borders will enable better integration of renewable energy into the EU grid, enhancing energy security and stability for all involved nations.

8.6 Sources

- ABO Wind, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- ArcelorMittal, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- CorPower Ocean. "C4 Wave Energy Converter Deployed by EU-SCORES." <https://corpowersocean.com/>
- Deltares, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- Dutch Marine Energy. "EU SCORES – Developing World-First Bankable Multi-Source Energy Parks." <https://www.dutchmarineenergy.com/>
- EDP, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- Efacec, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- European Commission. "Atlantic Ocean Basin: EU Policies and Projects." *Oceans and Fisheries*. https://ec.europa.eu/oceans-and-fisheries/sea-basins/atlantic_en
- European Commission. "European Scalable Offshore Renewable Energy Source – EU SCORES." *CORDIS EU Projects*. <https://cordis.europa.eu/project/id/101036457>
- European Commission. "Maritime Spatial Planning." *Oceans and Fisheries*. https://ec.europa.eu/oceans-and-fisheries/maritime-spatial-planning_en
- EU-SCORES. "European Scalable Offshore Renewable Energy Sources (EU SCORES)." <https://euscores.eu/>
- EU-SCORES. "Stakeholder Engagement Plan for Multi-Source Offshore Energy Parks." *EU SCORES Project Report*. <https://euscores.eu/wp-content/uploads/2022/11/D2.5-EUSCORES-Stakeholder-engagement-plan-V1-DMEC-YE-31-10-2022.pdf>
- Flanders Marine Institute, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- Ghent University, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- INESC TEC, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- Laminaria, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- MARIN, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- NOAA. "Impacts of Offshore Energy Development on Marine Ecosystems." <https://www.noaa.gov/>
- Ocean Energy Europe. "€45M EU SCORES Project to Deliver World-First Bankable Multi-Source Offshore Parks." <https://www.oceanenergy-europe.eu/>

- OSPAR Commission. "Offshore Renewables and Marine Spatial Planning." *OSPAR*. <https://www.ospar.org/>
- Portugal Resident. "Fishermen Threaten Legal Action over Offshore Wind Farms." *Portugal Resident*. <https://www.portugalresident.com/fishermen-threaten-to-stop-fishing-take-legal-action-over-massive-block-of-offshore-wind-farms/>
- Portugal Resident. "Porto Offshore Wind Farms Moved 35km to Protect Fishing." *Portugal Resident*. <https://www.portugalresident.com/porto-offshore-wind-farms-to-be-moved-35-kms-further-out-to-sea-to-save-fishing/>
- Ramboll, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- Sustainable Energy Authority of Ireland, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- Tecnalia, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- TNO, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- University of Algarve, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- University of Edinburgh, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- VLAIO, *Partner Contributions*. Listed on the EU-SCORES website and institutional profiles.
- WindFloat Atlantic. "Overview of WindFloat Offshore Wind Farms." <https://www.windfloat-atlantic.com/>

9 Case Study: ULTFARMS

The ULTFARMS initiative aims to combine aquaculture (such as seaweed and shellfish farming) with ORE infrastructure, leveraging innovations in engineering, ecological processes, and resource management to address challenges in harsh offshore environments and low-salinity waters. While the project does not focus on expanding and developing offshore wind as a stand-alone industry, it still focuses on co-development, co-management, and co-investment in multi-use projects combining offshore renewables with Low-Tropical Aquaculture.^{93,94} The ULTFARMS project is funded under the Horizon 2020 programme⁹⁵ and its key objectives are:



- **Promoting co-use of marine areas for energy and aquaculture production:** Integrating wind and aquaculture to help reducing marine spatial conflicts, enhance biodiversity through restoration measures, and boost renewable energy output alongside food production.⁹⁶
- **Advancing low trophic aquaculture techniques** by integrating them with offshore wind farms.
- Enhancing sustainable aquaculture practices and minimising ecological risks such as diseases or invasive species.



Figure 5 Multi-Use Park visualisation
(Source UNITED: Ocean Multi-Use Blueprint)

Six pilot (demonstration) sites across the North and Baltic Seas (in Belgian, Dutch, German, and Danish waters) are being run. These pilots showcase the feasibility of co-locating aquaculture systems with ORE.⁹⁷

This case study focuses on the pilot project consisting of co-locating offshore wind farms with seaweed farming using the existing FINO3 platform in the German part of the North/Baltic Sea (?) to test aquaculture technologies. The project is led by Fachhochschule Kiel - University of Applied Sciences (FUE),⁹⁸ with a consortium of partners from across Europe contributing their expertise to the implementation of multi-use offshore solutions⁹⁹.

Key aspects of the pilot involve establishing a commercially viable aquaculture operation in challenging conditions, researching seaweed seeding for offshore cultivation, and developing cost-effective monitoring techniques. The pilot

93 <https://ultfarms.eu/pilots/> and <https://cordis.europa.eu/project/id/101093888>

94 ULTFARMS draws on insights gained from previous offshore aquaculture and multi-use projects like MERMAID, Wier and Wind, IMPAQT, HiSea, Coastbusters, BONUS-OPTIMUS, EDULIS, MUSICA, and the Horizon 2020 UNITED project. These initiatives have advanced the Technology Readiness Level (TRL) of various aspects of offshore LTA aquaculture, yet significant challenges remain (see: ULTFARMS Deliverable 7.2: Nature-inclusive designing of offshore multi-use infrastructure)

95 <https://www.h2020united.eu/about>

96 <https://cordis.europa.eu/project/id/101093888>

97 Ibid

98 <https://www.fh-kiel-gmbh.de/en/>

99 The other project partners include: SUB (Sustainable Use of Bio-resources), KMF (Kiel Marine Field), DNV (Det Norske Veritas), UG (University of Gothenburg), NSF (North Sea Fisheries), DTU (Technical University of Denmark), BBE (Blue Bioeconomy)

aims to plan the combination of seaweed and mussel cultivation at an offshore wind park boundary, explore profitable seaweed strains, utilise renewable energy produced on-site, and study environmental interactions between cultivated species and the marine ecosystem.

9.1 Unlocking the North Sea basin's ORE potential

The North Sea Basin is a critical region for ecological and economic activities, offering significant opportunities for renewable energy development, particularly offshore wind, wave, and solar power. Located between countries such as the UK, the Netherlands, Denmark, Norway, and Germany, it is a major hub for offshore energy projects, with favourable conditions for large-scale wind farms. Geographical and environmental characteristics—such as estuaries, wetlands, continental shelves and consistent wind patterns—are critical to the development of ORE technologies, including the pilot project's integration of aquaculture and offshore wind.

In addition to its energy potential, the North Sea supports diverse marine ecosystems and important economic activities like fishing, shipping, and aquaculture. The basin's economic contribution is further strengthened by the increasing number of ORE projects poised to create jobs and enhance regional energy security. For example, the North Seas Energy Cooperation (NSEC) aims to increase offshore wind capacity in the region to 260 GW by 2050, which would play a key role in meeting the EU's renewable energy targets.¹⁰⁰

Human activities in this region continue to intersect with environmental conservation efforts, and the combination of these factors provides both opportunities and constraints for energy development projects, particularly for multi-use offshore parks like those being tested in the ULTFARMS project. The North Sea is, for instance, governed by multiple international agreements and cooperation mechanisms, including OSPAR (the Convention for the Protection of the Marine Environment of the North-East Atlantic)¹⁰¹, which protects the marine environment.

The analysis of the various sea-use activities in the North Sea presents both synergies and barriers for the development of ORE due to the overlap of natural habitats, aquaculture and military areas and ORE resources:

- **Nature and ORE resources:** Arguably one of the busiest sea basins, countries surrounding the North Sea seem to have realised that the sea basin is not big enough to accommodate all users and activities separately. Inevitably, synergies must also be explored to restore the deteriorated state of nature in the North Sea. Nature conservation, cumulative impacts, and multi-use are working tracks in the Greater North Sea Basin Initiative (GNSBI). Most countries already look at nature-inclusive design via prequalification and non-price criteria in ORE auctions to strengthen the environment in tandem with ORE deployments. Belgium went further and successfully explored possibilities of responsible ORE deployments in nature-sensitive areas with both NGOs and the wind industry.
- **Military zones:** The importance of identifying synergies between ORE and the military can be illustrated with the North Seas Energy Cooperation (NSEC) declaration, which includes a political commitment to foster stronger collaboration within offshore energy security. Similarly, members of the Seabed Security Experimentation Centre (SeaSEC) aim to improve information-sharing methodologies by monitoring seabed infrastructure (such as pipelines) in the North Sea and Baltic Sea. The research will have access to military and civilian databases. Four North Sea countries (Denmark, Netherlands, Germany and Norway) joined the initiative on seabed security, looking in part at potential synergies with ORE development¹⁰².

¹⁰⁰ https://energy.ec.europa.eu/topics/infrastructure/high-level-groups/north-seas-energy-cooperation_en

¹⁰¹ <https://www.ospar.org/>

¹⁰² [Research Centre for Submarine Infrastructure Security opened in The Hague | News item | Defensie.nl](#)

- **Aquaculture dynamics:** The increased spatial claims from shipping, sand extraction, nature, military, and ORE development in the North Sea heavily impact specific types of fisheries. Therefore, initiatives such as GNSBI aim to formulate recommendations on long-term perspectives for fisheries based on effective MSP while considering the various transitions and the carrying capacity of the North Sea. At the national level, the Netherlands is experimenting with area passports that aim to facilitate the permitting process needed for certain types of fishing and aquaculture, such as farmed mussels and seaweed within OWF.
- **Other ORE:** Other types of ORE are needed to go beyond the 300 GW of offshore wind¹⁰³. No barriers have been identified, as tidal energy provides solutions for areas such as the Danish Faroe Islands and the U.K., where OWF are not planned due to the tidal velocity. Offshore solar provides a different case in point, as the Dutch government is considering tendering 3 GW of offshore solar within new OWFs. For wave energy, a similar focus on the combination with OWFs is taken by the industry.¹⁰⁴

In the context of the ULTFARMS *FINO3* pilot, it can also be noted that Germany's North Sea Basin presents significant ORE potential with extensive overlap between wind, wave, and offshore solar resources and nature areas. Encouraging other forms of ORE within offshore wind parks could optimise resource use.

9.2 The role of maritime spatial planning for ORE development

The MSP in Germany encompasses the EEZs of the North Sea and Baltic Sea, as well as the territorial sea, which is under the jurisdiction of the three coastal federal states - Lower Saxony, Schleswig-Holstein, and Mecklenburg-Vorpommern. Germany adopted its 'Maritime Spatial Plan for the German Exclusive Economic Zone in the North and Baltic Sea' on 1 September 2021. This plan focuses on several key areas, including ensuring the safety of shipping, promoting the development of the blue economy, facilitating scientific use, and safeguarding the marine environment.

The *FINO3 pilot* site of the ULTFARMS project has benefitted from the German approach to MSP of ORE activities due to the selection of the pilot site in a designated area that also leaves room for coexistence with other sea uses and which offers a connection to the energy grid. Nevertheless, some planning challenges related to the lengthy permitting process as well as the lack of consideration of aquaculture activities in the designated areas remain. These and additional examples are presented in more detail in the following section.

9.2.1 Designated priority areas for specific maritime uses to avoid conflicts and allow for flexibility for co-use

Strengthened role of ORE development in MSP: Germany's MSP has evolved significantly compared to previous versions, particularly with regard to ORE development. The revised Maritime Spatial Plan for Germany's EEZ, effective from September 2021, plays a critical role in balancing the competing demands on its marine space. This plan is designed to coordinate the growing number of activities, such as offshore wind farms, aquaculture, shipping, and environmental protection, ensuring that renewable energy projects are strategically placed without compromising other uses.

In this regard, the German MSP designates priority areas for specific maritime uses, effectively excluding other uses in those zones if they are incompatible with the primary use. However, exceptions exist, such as the combination of military usage with sand and gravel extraction and military with environmental protection.

103 [https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/659313/EPRS_BRI\(2020\)659313_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/659313/EPRS_BRI(2020)659313_EN.pdf)

104 <https://www.offshore-energy.biz/danish-duo-to-investigate-the-potential-of-wave-wind-combo/>

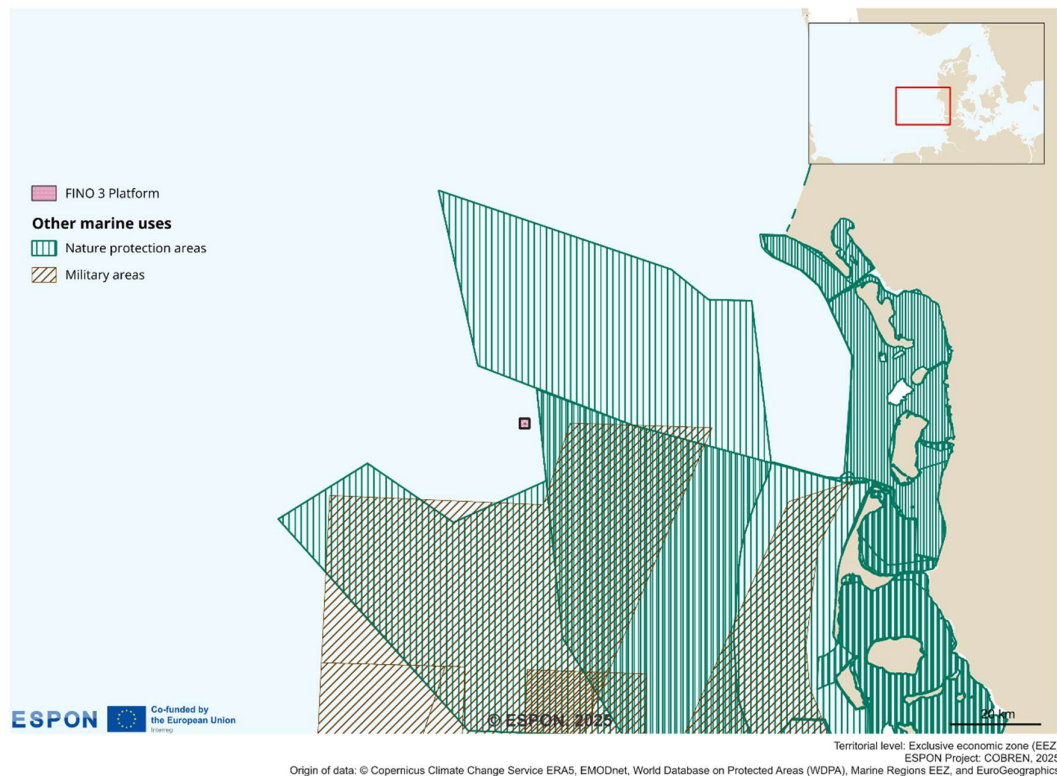
Concretely, the German MSP allocates suitable areas for wind farms while considering environmental impacts, shipping lanes, and military zones. The country ensures that its wind farms are strategically placed to avoid conflicts with marine traffic or ecologically sensitive areas. This approach is part of a broader effort to implement sustainability principles within ORE development, ensuring that marine ecosystems and biodiversity are protected while optimising energy production.¹⁰⁵

This comprehensive approach also allows for multi-use solutions, where sectors like aquaculture can be integrated with offshore wind energy, creating synergies and increasing overall economic value. In addition, Germany's commitment to expanding its offshore wind capacity is reflected in its plans to increase installed capacity, with ambitious targets set for the coming decades¹⁰⁶.

9.2.2 Site location to allow ORE integration with energy grid infrastructure and development of aquaculture activities

The *FINO3* platform, positioned 80 km off Sylt, a German island in the North Sea, serves as a testbed for wind farm technology and provides valuable data that supports the planning, construction, and operation of offshore wind farms. The platform is located outside of designated nature protection and military areas (see Map 6).

Map 6 ULTFARM's FINO3 platform located in the North Sea, Germany



¹⁰⁵ https://maritime-spatial-planning.ec.europa.eu/sites/default/files/planning_criteria_2.pdf

¹⁰⁶ The current Government (November 2024) has set significantly increased targets for the installed capacity of offshore wind energy, with at least 30 GW in 2030, at least 40 GW in 2035, and at least 70 GW in 2045. The Baltic Sea will only play a minor role in this scheme, with a potential cumulative installed capacity (EEZ and territorial sea) of ca. 3 - 4 GW. Source: VASAB Country Fiche Germany page 11

The project location benefits from available infrastructure allowing the integration into the national grid. The *FINO3* platform's connection to pre-existing subsea cables allows efficient transmission of generated wind and wave energy, supporting the integration of hybrid energy systems into Germany's energy infrastructure. This location approach allows testing the multi-source renewable energy system under realistic operational conditions.^{107 108} The location is also ideal for deploying aquaculture systems like mussel and seaweed farming in its exposed offshore environment. Serving as a research hub, it focuses on sustainable aquaculture and renewable energy systems.

9.2.3 Balancing ORE growth with environmental considerations

Germany is addressing both substantial barriers and emerging synergies in the development of ORE. In response to the energy crisis and climate targets, the government has accelerated plans to significantly increase offshore wind capacity—aiming for 30 GW by 2030 and 70 GW by 2045.¹⁰⁹ However, this rapid expansion has introduced tensions with environmental protection objectives.

In terms of barriers, and to fast-track offshore wind deployment, recent legislative proposals have sought to simplify and shorten permitting procedures, including limiting the scope and depth of Environmental Impact Assessments. This has raised concern among environmental organisations and coastal stakeholders, who warn that such measures may undermine biodiversity conservation and conflict with EU nature directives. These reforms may allow projects to proceed in ecologically sensitive marine areas with reduced scrutiny, reflecting the government's prioritisation of energy security over environmental safeguards.¹¹⁰

In terms of synergies, Germany is promoting multi-use approaches in offshore zones, particularly by integrating aquaculture with wind energy installations. Projects under EU funding, including those linked to the Horizon and Interreg programmes, have explored the co-location of seaweed and mussel farming within wind farm areas. These initiatives aim to enhance ecological benefits—such as improved water quality and biodiversity—while generating additional economic value from sustainable seafood production.¹¹¹

Germany is furthermore investing in transnational cooperation to ensure the sustainability and resilience of its offshore infrastructure. Through collaborations in the North and Baltic Seas—such as the North Seas Energy Cooperation (NSEC)—Germany is working with neighbouring countries to strengthen maritime security, safeguard energy assets, and harmonise cross-border infrastructure planning.¹¹²

¹⁰⁷ <https://cordis.europa.eu/project/id/101093888>

¹⁰⁸ <https://ultfarms.eu/associate-regions/>

¹⁰⁹ German Federal Government. Offshore Wind Energy Expansion. <https://www.bundesregierung.de/breg-en/issues/offshore-wind-energy-act-2024112>

¹¹⁰ Bloomberg. “Germany to Sacrifice Nature in Bid to Speed Up Offshore Wind.” <https://www.bloomberg.com/news/articles/2024-02-01/germany-to-sacrifice-nature-in-bid-to-speed-up-offshore-wind>

¹¹¹ Thünen Institute. “Combination of Offshore Wind Parks and Marine Aquaculture in Germany” <https://www.thuenen.de/en/institutes/sea-fisheries/projects/combination-of-offshore-wind-parks-and-marine-aquaculture-in-the-north-sea-a-realistic-scenario>

¹¹² North Seas Energy Cooperation (NSEC). European Commission. https://energy.ec.europa.eu/topics/infrastructure/north-seas-energy-cooperation_en

9.2.4 Stakeholder engagement to support the permitting process for new multiuse ORE initiatives and to raise social acceptance of ORE initiatives

The ULTFARMS *FINO3* pilot project underscores the importance of extensive stakeholder engagement in aquaculture multi-use initiatives to build social acceptance and positively influence public perception of such projects. This engagement involves offshore wind farm and aquaculture operators, fishers, and other stakeholders from the groups of civil society, science, industry and policy & governance¹¹³ to align on operational needs and project plans¹¹⁴.

At the *FINO3* site, the ULTFARMS project implemented a range of stakeholder engagement measures to support social acceptance of offshore multi-use concepts. This included close collaboration with permitting authorities to create a strong data foundation and support risk assessment for insurers. Public outreach efforts—such as educational materials, videos, and TV documentaries—helped raise awareness, reaching millions of viewers. In parallel, the project developed training modules and a practical roadmap to guide future offshore multi-use developments.¹¹⁵

The project team further developed public awareness materials, including flyers, posters, roll-ups, videos, and a website, to enhance outreach and engagement. Educational learning and training blocks were established, covering key topics such as multi-use business cases and economics, offshore operations, safety and logistics, environment and biology, technology, socioeconomics, and law and regulation. Additionally, workshops were conducted to provide in-depth discussions and knowledge exchange on these critical aspects of offshore multi-use projects¹¹⁶.

9.2.5 Planning challenges related to specific activities such as aquaculture and a lengthy permitting process

Marine aquaculture is still emerging, and the German maritime spatial plan currently does not designate specific areas for aquaculture. This domain falls under the responsibility of fishery authorities, with administrative control at the state level¹¹⁷. Research activities are coordinated by decentralised institutions. Generally, neither aquaculture nor trawling is permitted in offshore windmill zones, although this stance could evolve with successful examples of multi-use in other North Sea countries.¹¹⁸

¹¹³ These groups include:

- Civil Society: (environmental) NGOs, consumers, educational sector, General media, Recreational sector, Society at large
- Science: Research institutes and universities, Research infrastructure networks
- Industry: (Wind) energy, Aquaculture, Business support/consultancies, Company innovation clusters, Classification societies, Fisheries, Food industry, Future investors, Insurance, Ports, Marine contractors, Tourism, Trade organisations
- Policy & Governance: Intergovernmental bodies, Local governmental bodies, national governmental bodies, Regional governmental bodies

¹¹⁴ https://ultfarms.eu/wp-content/uploads/2023/08/D2.1_Multi-stakeholder-Engagement-Strategy_Final_compressed.pdf

¹¹⁵ ULTFARMS Project (2024). More information available at: <https://ultfarms.eu> and <https://www.fino3.de/en/aquaculture-systems.html>

¹¹⁶ https://bluemissionbanos.eu/wp-content/uploads/2023/11/4_new_EVA_UNITEDGothenburgDay1pilotDE.pdf

¹¹⁷ Implementation of the maritime spatial plan in the EEZ falls under the responsibility of the Federal Maritime and Hydrographic Agency (BSH), while the respective state authorities manage the territorial sea (within 12 nautical miles).

Source: ULTFARMS: Deliverable 9.2

¹¹⁸ ULTFARMS: Deliverable 9.2

As a result, the permitting process for offshore wind energy projects and aquaculture remains lengthy:

- Germany is committed to improving the permitting and regulatory processes for offshore wind energy projects¹¹⁹. This includes ensuring that the legal and environmental frameworks are aligned with national energy goals and EU regulations. The focus is on speeding up the permitting process to meet ambitious offshore wind deployment targets while balancing the interests of local communities, fishermen, and conservationists.¹²⁰
- The development of combining renewable energy production with sustainable food production is in an experimental phase. For example, the ULTFARMS projects run a pilot project in the EEZ of Germany. Even when executed within a research context, these projects undergo lengthy administrative processes, as predefined rules are lacking. Commercial aquaculture permits typically take 5-10 years, reflecting a robust regulatory approach that may sometimes hinder innovation.

9.3 Territorial cooperation at the North Sea basin level

While this case study has not identified any concrete examples of territorial cooperation in the context of the ULTFARMS pilot project deployed at the *FINO3* platform, **Germany is involved in several initiatives aimed at improving the interconnectedness of energy grids within the North Sea basin as well as combining offshore wind energy with other renewable energy sources.** The country has also collected feedback from neighbouring countries during the update of its latest maritime spatial plans.

Below are some key frameworks, programmes and cooperation platforms where Germany actively participates, as well as more information on the above-mentioned initiatives at sea basin level:

- **North Seas Energy Cooperation (NSEC):** The NSEC is a prominent initiative aimed at fostering collaboration among North Sea and other relevant countries to accelerate the development of ORE, including wind energy. It focuses on grid interconnections, hybrid offshore wind farms, and the integration of renewable energy into European grids. The NSEC plays a critical role in addressing regulatory challenges and harmonising energy policies.¹²¹
- **Interreg North Sea Region Programme:** Funded by the European Regional Development Fund (ERDF), this programme supports transnational projects that enhance the North Sea's sustainability and energy resilience. Projects under Interreg address innovation, renewable energy, and climate adaptation in MSP.¹²²
- **North Sea Wind Power Hub:** This cross-border initiative focuses on developing large-scale offshore wind hubs in the North Sea, enabling the efficient integration of renewable energy into Europe's power system. It emphasises collaboration in building interconnected energy islands and shared grid infrastructure.¹²³

119 The BSH oversees the energy permitting application process for wind farms in the German EEZ. However, the German federal states' regional governments along the North Sea coast serve as the permitting authorities for near-shore developments and grid connections in the coastal sea. This process involves adhering to various national laws and regulations, making it a time-consuming process. Source: ULTFARMS: Deliverable 9.2

120 <https://www.gov.uk/government/publications/developing-the-north-seas-as-a-green-power-plant-of-europe-north-sea-summit-declarations/ostend-energy-ministers-declaration-on-the-north-seas-as-europes-green-power-plant>

121 https://ec.europa.eu/energy/topics/infrastructure/north-seas-energy-cooperation_en

122 <https://northsearegion.eu/>

123 <https://northseawindpowerhub.eu/>

- **Energy Cooperation through the Pentalateral Energy Forum¹²⁴:** The forum extends cooperation to North Sea countries, facilitating integrated energy policies, sharing of best practices, and joint offshore wind energy projects. This platform enables better grid integration and promotes investments in offshore energy solutions.
- **Joint Ventures in Maritime Spatial Planning:** North Sea countries actively cooperate in MSP efforts, such as maritime (?) spatial planning for offshore wind farms going beyond national borders. These initiatives streamline permitting processes, reduce conflicts with other maritime sectors, and create a cohesive approach to ORE expansion.
- **Combining offshore wind with other renewable energy sources:** Germany is also involved in hybrid energy projects combining offshore wind energy with other renewable sources like solar or hydrogen production. For example, the *Kriegers Flak* Combined Grid Solution, a collaboration between Denmark and Germany, integrates offshore wind with grid connections to create a more flexible energy system.¹²⁵ Additionally, Germany's involvement in developing offshore hydrogen projects, such as the Offshore Renewable Hydrogen initiative, reflects its commitment to diversifying energy sources and advancing green hydrogen to decarbonise sectors like heavy industry.¹²⁶

Finally, it can also be noted that the German MSP process has included international consultations¹²⁷ with neighbouring countries to ensure that spatial planning decisions align with broader regional and European energy goals. The “*Cross-border participation*” was organised by the Federal Maritime Hydrographic Agency (BSH) on behalf of the Federal Ministry of the Interior, for Building and the Home Affairs (BMI). Concretely, the littoral states of the North Sea (and the Baltic Sea) were notified of the revision of German maritime spatial plans. Feedback was collected in the form of:

- Early international participation through:
 - Comments on the conception of the revision and during the scoping of the strategic environmental assessment.
 - An international consultation meeting held in April 2020.
- International participation on the draft plan and environmental reports asking for comments and feedback. In this context the following countries provided feedback: Great Britain (England), the Netherlands, Sweden, Poland, Latvia and Estonia. Belgium, Denmark and Ireland requested further participation but did not provide comments.

This strategic planning is crucial as Germany seeks to harness the full potential of its maritime resources for both, renewable energy production and sustainable marine ecosystem management.^{128,129}

124 <https://www.benelux.int/nl/info-burgers/benelux/pentalateral-energy-forum/>

125 <https://maritime-spatial-planning.ec.europa.eu/practices/north-seas-countries-offshore-grid-initiative-nscofi>.

126 <https://www.gov.uk/government/publications/developing-the-north-seas-as-a-green-power-plant-of-europe-north-sea-summit-declarations/ostend-energy-ministers-declaration-on-the-north-seas-as-europes-green-power-plant>

127 https://www.bsh.de/EN/TOPICS/Offshore/Maritime_spatial_planning/Maritime_Spatial_Plan_2021/_Anlagen/Downloads/Zweiter_Entwurf/Consultation_letter_June_2021.pdf?__blob=publicationFile&v=2

128 https://iho.int/uploads/user/Inter-Regional%20Coordination/IENWG%20and%20EC%20-%20IHO%20Cooperation/IENWG13/IENWG13_2023_04C_MSP_in_Germany.pdf

129 FuE-Zentrum FH Kiel GmbH. Circular low-trophic offshore aquaculture in wind farms. Available at:

<https://www.fino3.de/en/aquaculture-systems.html>

https://www.bsh.de/EN/TOPICS/Offshore/Maritime_spatial_planning/Maritime_Spatial_Plan_2021/_Anlagen/Downloads/ROP_2021/Evaluation_International_Consultation_Second_Draft.pdf?__blob=publicationFile&v=2

9.4 Key lessons and future directions

The ULTFARMS FINO3 pilot project in Germany consist of co-locating offshore wind farms with seaweed farming to test aquaculture technologies. It has made progress in combining seaweed and mussel cultivation at an offshore wind park boundary, exploring profitable seaweed strains, utilising renewable energy produced on-site, and studying environmental interactions between cultivated species and the marine ecosystem.

In terms of ORE potential at the North Sea basin level, the analysis has identified both synergies and barriers with other sea uses for the development of ORE. Barriers mainly relate to the overlap of natural habitats, aquaculture and military areas and ORE. To overcome these barriers with natural habitats and nature protection areas, most countries consider nature-inclusive design in the context of ORE developments to create synergies. Four North Sea countries (including Germany) furthermore collaborate under the SeaSEC initiative on seabed security to explore synergies within military areas. Germany's North Sea Basin also presents significant ORE potential with extensive overlap between wind, wave, and offshore solar resources and nature areas highlighting potential for multi-use.

One key feature of the German MSP approach is the designation of priority areas for maritime uses such as offshore wind energy. This strategy enables spatial conflicts to be avoided while maintaining flexibility for multi-use solutions. The FINO3 site exemplifies how designated areas can accommodate both energy generation and aquaculture, offering a practical model for coexistence that aligns with national energy and biodiversity goals.

Another critical lesson from the FINO3 pilot concerns site selection. Choosing a location already equipped with subsea infrastructure, including grid connection points, proved advantageous for integrating the project into the national electricity system. This infrastructure readiness allowed for the efficient transmission of energy and enabled the deployment of hybrid systems—such as combined wind and wave energy installations—demonstrating the potential for technical and economic optimisation through integrated planning.¹³⁰

The pilot also highlighted the potential of hybrid energy integration within offshore platforms. At FINO3, co-locating different technologies such as wind, wave, and aquaculture helped increase system resilience and maximise the productive use of marine space. This multi-use model supports energy diversification while contributing to sustainable marine resource management.

Finally, effective stakeholder engagement was essential to the project's progress. The ULTFARMS team worked closely with permitting authorities, establishing a strong data foundation that supported the approval process and helped de-risk future projects. Public awareness campaigns, educational materials, and outreach—including TV documentaries and workshops—were instrumental in fostering public acceptance and building trust with key stakeholders.¹³¹

Despite these positive developments, some challenges remain related to the planning process when it comes to specific activities such as aquaculture, which is currently not included in the MSP for the designated zones, as well as the lengthy permitting process.

While there has not been any territorial cooperation in the context of the ULTFARMS pilot project deployed at the *FINO3* platform, **Germany is involved in several initiatives aimed at improving the interconnectedness of energy grids within the North Sea basin, as well as combining offshore wind energy with other renewable energy sources.** Finally, the country has collected feedback from neighbouring countries during the update of its latest maritime spatial plans to ensure alignment with the plans of neighbouring countries.

¹³⁰ ULTFARMS Project. Pilot 3: FINO3 Platform. Available at: <https://ultfarms.eu/pilot-3-fino3-platform/>

¹³¹ ULTFARMS Project. Outreach and stakeholder materials. Available at: <https://ultfarms.eu>

9.5 Sources

- Web sources
- BMUV (n.d.) *German Maritime Spatial Plan*. Available at: https://iho.int/uploads/user/Inter-Regional%20Coordination/IENWG%20and%20EC%20-%20IHO%20Cooperation/IENWG13/IENWG13_2023_04C_MSP_in_Germany.pdf (Accessed: 3 December 2024).
- Bloomberg (2024) *Germany to Sacrifice Nature in Bid to Speed Up Offshore Wind*. Available at: <https://www.bloomberg.com/news/articles/2024-02-01/germany-to-sacrifice-nature-in-bid-to-speed-up-offshore-wind> (Accessed: 3 December 2024).
- CORDIS (n.d.) *ULTFARMS: Ocean Multi-Use Blueprint*. Available at: <https://cordis.europa.eu/project/id/101093888> (Accessed: 3 December 2024).
- Deltares (n.d.) Available at: <https://www.deltares.nl/> (Accessed: 3 December 2024).
- FH Kiel GmbH (n.d.) Available at: <https://www.fh-kiel-gmbh.de/en/> (Accessed: 3 December 2024).
- HI News (2023) *Launching into an EU Project to Farm Kelp and Mussels at Offshore Wind Farms*. Available at: <https://www.hi.no/en/hi/news/2023/january/launching-into-an-eu-project-to-farm-kelp-and-mussels-at-offshore-wind-farms> (Accessed: 3 December 2024).
- Offshore Energy (n.d.) *Danish Duo to Investigate the Potential of Wave-Wind Combo*. Available at: <https://www.offshore-energy.biz/danish-duo-to-investigate-the-potential-of-wave-wind-combo/> (Accessed: 3 December 2024).
- OSPAR (n.d.) Available at: <https://www.ospar.org/> (Accessed: 3 December 2024).
- Offshore Wind Biz (2024) *North Sea and Baltic Sea Countries Enter Pacts to Protect Offshore Energy Infrastructure Amid Concerns Over Russian Sabotage*. Available at: <https://www.offshorewind.biz/2024/04/11/north-sea-baltic-sea-countries-enter-pacts-to-protect-offshore-energy-infrastructure-amid-concerns-over-russian-sabotage/> (Accessed: 3 December 2024).
- ULTFARMS (n.d.) *ULTFARMS Pilots*. Available at: <https://ultfarms.eu/pilots/> (Accessed: 3 December 2024).
- ULTFARMS (n.d.) *ULTFARMS Associate Regions*. Available at: <https://ultfarms.eu/associate-regions/> (Accessed: 3 December 2024).
- FINO3 (n.d.) Available at: <https://www.fino3.de/en/> (Accessed: 3 December 2024).
- European Commission (n.d.) *North Seas Energy Cooperation (NSEC)*. Available at: https://energy.ec.europa.eu/topics/infrastructure/high-level-groups/north-seas-energy-cooperation_en (Accessed: 3 December 2024).
- North Sea Wind Power Hub (n.d.) Available at: <https://northseawindpowerhub.eu/> (Accessed: 3 December 2024).
- Interreg North Sea Region (n.d.) Available at: <https://northsearegion.eu/> (Accessed: 3 December 2024).
- Benelux (n.d.) *Pentalateral Energy Forum*. Available at: <https://www.benelux.int/nl/info-burgers/benelux/pentalateral-energy-forum/> (Accessed: 3 December 2024).
- Maritime Spatial Planning Platform (n.d.) *North Seas Countries' Offshore Grid Initiative (NSCOGI)*. Available at: <https://maritime-spatial-planning.ec.europa.eu/practices/north-seas-countries-offshore-grid-initiative-nscogi> (Accessed: 3 December 2024).

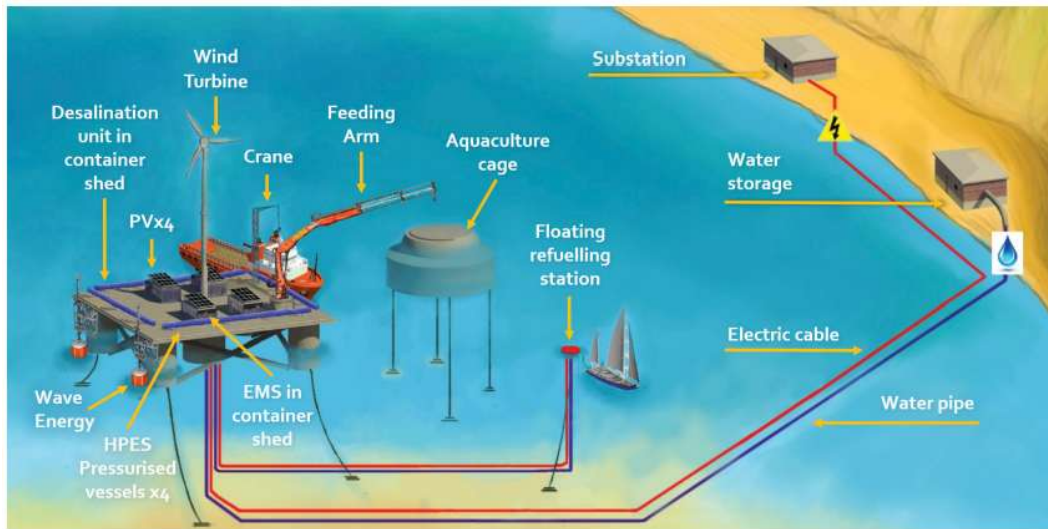
- UK Government (n.d.) *Ostend Energy Ministers Declaration on the North Seas as Europe's Green Power Plant*. Available at: <https://www.gov.uk/government/publications/developing-the-north-seas-as-a-green-power-plant-of-europe-north-sea-summit-declarations/ostend-energy-ministers-declaration-on-the-north-seas-as-europes-green-power-plant> (Accessed: 3 December 2024).
- Maritime Spatial Planning Platform (n.d.) *Planning Criteria*. Available at: https://maritime-spatial-planning.ec.europa.eu/sites/default/files/planning_criteria_2.pdf (Accessed: 3 December 2024).
- Reports and deliverables
- ULTFARMS (n.d.) *Deliverable 7.2: Nature-Inclusive Designing of Offshore Multi-Use Infrastructure*.
- ULTFARMS (n.d.) *Deliverable 9.2: Mapping of the Governance Landscape*.
- ULTFARMS (n.d.) *WP7: Environmental Sustainability Assessment of Biodiversity in Multi-Use Activities*.
- ULTFARMS (n.d.) *Deliverable 10.1: State of the Art Revisions for Long-Term Agreements in Offshore Wind Farms*.
- ULTFARMS (n.d.) *Ocean Multi-Use Blueprint*.
- Scientific articles
- Bellard, C., Leclerc, C. & Courchamp, F. (2012) 'Impact of climate change on the future of biodiversity', *Ecology Letters*, 15(4), pp. 365–377.
- Maclean, I.M.D., Wilson, R.J. & Hassall, C. (2011) 'Predicting biodiversity responses to climate change', *Ecology Letters*, 14(8), pp. 756–767.
- Malhi, Y., Franklin, J., Seddon, N. et al. (2020) 'Climate change and ecosystems: Threats, opportunities, and solutions', *Science*, 369(6509), pp. 1355–1360.
- Ohashi, K., Satou, Y., Shibata, Y. et al. (2019) 'Evaluating ecosystem responses to multi-scale environmental changes', *Global Change Biology*, 25(11), pp. 3722–3733.
- Degraer, S., Brabant, R., Rumes, B. & Vigin, L. (2020) *Environmental Impacts of Offshore Renewable Energy Projects in the North Sea*. Brussels: Royal Belgian Institute of Natural Sciences.
- Tidbury, H., Degraer, S., Brabant, R. et al. (2020) 'Marine biodiversity and multi-use offshore activities: Lessons from North Sea pilot projects', *Marine Policy*, 122, 104221.

10 Case study MUSICA

MUSICA (*‘Multiple Use of Space for Island Clean Economy’*) is a project funded through Horizon 2020 that aims to develop a one-stop decarbonisation solution for small islands in the form of a multi-use platform (MUP)¹³². The MUP combines wind, solar and wave energy generation with energy storage facilities, a water desalination unit and aquaculture¹³³. As such the multi-functional offshore platform shall contribute to small island’s sustainable development.



Figure 6 MUSICA’s multi-use platform for renewable energy, aquaculture, floating electricity, water recharging station services, and connection to shore



Source: MUSICA project

MUSICA defines a “small island” as an island with a population of maximum 2,000. These islands often experience specific challenges to move towards climate neutrality and secure energy and fresh water supply, due to limited access to infrastructure, technology, or labour. Of the 2,700 EU islands referred to in the Clean Energy for EU Islands initiative, 75% are “small islands” considering the definition applied by MUSICA¹³⁴.

The MUSICA project aims to further develop a proof of concept for a MUP developed in previous projects and develop a testing facility off the coast of the Greek island of *Innouses* in the Aegean Sea. The testing facility contributes to accelerating the commercialisation of the MUP. The project partners focus on demonstrating the possibilities of combining different functions on one offshore platform and on ways to facilitate social acceptance for such platforms. The project’s results shall facilitate transferring the multi-use platform to other small islands in the Mediterranean. The project started in January 2020 and is planned to run until September 2025.

¹³²European Commission. (n.d.). Horizon 2020. Retrieved from https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-2020_en.

¹³³ <https://musica-project.eu/>

¹³⁴ https://new.musica-project.eu/wp-content/uploads/2020/07/Musica_Abtract_BiFold_Flyer_30June.pdf

This case study highlights regulatory challenges to address and consider for the technical design of MUPs as well as the importance of inclusive engagement with the island's population, industry, research, and representatives from the public sector to enhance social acceptance for the development of the ORE.

10.1 Unlocking the Mediterranean Sea Basin's ORE potential

The Mediterranean has a capacity of about 604 GW of offshore wind, 1,174 GW of offshore solar and 134 GW of offshore wave energy, as estimated in the CoBren study¹³⁵. Particularly in the East Mediterranean, offshore solar is a dominant resource with further potential if co-location with other ORE deployment is considered. The CoBren study assumes 21% increase in total capacity if ORE development is combined in the same location.

At the same time, relatively little ORE is currently deployed compared to other sea basins. For example, there are no ORE installations in Greece yet. In many cases utilising the ORE potential in the Mediterranean is challenged by other sea uses.

The Mediterranean is a biodiversity hotspot with numerous marine protected areas (MPAs), requiring careful spatial planning to balance energy development with ecological preservation. Additionally, the region's geopolitical landscape, with multiple countries that have overlapping maritime claims, adds complexity to offshore energy planning¹³⁶. Some of the main drivers and hurdles to ORE development include:

- **Geographical and environmental conditions:** The Mediterranean Sea is characterised by diverse depths, with many areas suitable for both fixed-bottom and floating wind technologies. While the Mediterranean does not have the deep waters prevalent as, for example, in the Black Sea, it presents a variety of wind resources that can be harnessed effectively with the right technology. The region benefits from more consistent wind patterns in certain areas, making it favourable for renewable energy deployment¹³⁷.
- **Military:** Profound differences between countries can be found based on the allocation of military zones alone. In some countries (e.g. Cyprus), these zones take up a large part of the EEZ and often overlap with ORE resources, while military zones in other countries (e.g. Greece) rarely overlap with ORE resources.
- **Aquaculture:** Aquaculture is a growing industry in the Mediterranean, particularly around the Greek islands, where the cultivation of fish and shellfish is economically significant¹³⁸. Especially closer to shore, both Greece and Slovenia generally treat aquaculture more as an obstacle to ORE development than a synergy. However, enhancing the use of renewable energy to fulfil aquaculture's energy demand is identified as an objective in Greece's aquaculture strategy.
- **Protected areas:** The Mediterranean Sea and the Greek islands are home to numerous MPAs, necessitating careful planning for any ORE infrastructure development. These areas are vital for preserving biodiversity, fishing practices, and the migratory patterns of marine species. Generally, nature protected areas are considered a barrier for ORE development in Greece. Outside these protected areas development is possible, yet it must adhere to stringent environmental standards. Projects are required to conduct thorough EIAs and comply with EU Habitats Directive guidelines to ensure minimal disruption to sensitive ecosystems.¹³⁹

135 See the study's main report and Annex 1 for more details.

136 Source: Mediterranean Action Plan - United Nations Environment Programme (UNEP)

137 Source: European Commission – Offshore Renewable Energy Strategy

138 European Commission - Aquaculture

139 European Commission: Marine Spatial Planning, EU Habitats Directive

MUSICA can be considered a pioneering project, demonstrating the possibilities of multi-use ORE development in Greece. As such the project facilitates meeting Greece's targets to integrate ORE (mainly wind) in its energy mix. Greece aims to deploy 2GW by 2030, expanding to 10GW by 2040 and 17 GW by 2050¹⁴⁰.

10.2 The role of maritime spatial planning for ORE development

At the time of developing this case study, Greece has not adopted a MSP document in line with the EU MSP Directive yet¹⁴¹. As a result, a coordinated policy framework providing a holistic approach to dealing with potential sea use conflicts is lacking. Therefore, different frameworks provide guidance for ORE development.

Regional Spatial Planning Frameworks (RSPF) provide a framework for sustainable and balanced spatial development for each of the 13 regions in Greece. These frameworks consider the principles from the Barcelona Convention for the protection of marine environment in the Mediterranean and specify provisions for the protection of marine and coastal ecosystems, landscapes, cultural heritage as well as the involvement of local communities and stakeholders.

The **revision of the Special Spatial Planning Framework for Renewable Energy Sources** provides directions for the various ORE technologies (wind, wave, tidal, solar and geothermal energy production), which are related to specific criteria in both the terrestrial and the maritime space. For example:

- The **national offshore wind farm development programme** outlines areas with offshore wind energy and defines conditions for development. Areas excluded for wind farms include areas of absolute nature protection, national parks, declared monuments, priority habitats, world heritage sites, areas for telecommunication infrastructure and radar, aquaculture, diving parks and shipping. Moreover, the development of offshore wind shall respect the National Plan for Energy and Climate, general provisions for the protection of environment and biodiversity (e.g. performing an Environmental Impact Assessment) and consider national security requirements.
- **The Greek law 4951/2022 regulates offshore solar plants**. The law initially provides provisions for 10 pilot projects for offshore solar plants with capacities between 0.5 and 1 MW. Provisions consider among others licensing and permitting (including zoning approvals), environmental protection (including requirements for an EIA and continuous monitoring), grid connectivity, safety and technical standards that must be adhered to during the construction, operation and maintenance of the offshore installations.

10.3 Experiences with planning challenges and solutions in the MUSICA project

Current frameworks relevant for ORE development in Greece do not provide provisions for multi-use, as foreseen in the MUSICA project, even though draft versions of the MSP document for Greece indicate possibilities for such developments. The draft MSP may aim to “sustainably and rationally organise the marine space with balanced interactions of multiple uses”, as specified by a representative for MSP in Greece¹⁴². The MSP shall identify key planning principles and guidelines, that promote the efficient use of marine space by encouraging co-existence and synergy among the different activities/uses. Sustainable marine economy is also promoted to support existing and future economic

140 Source: AP News

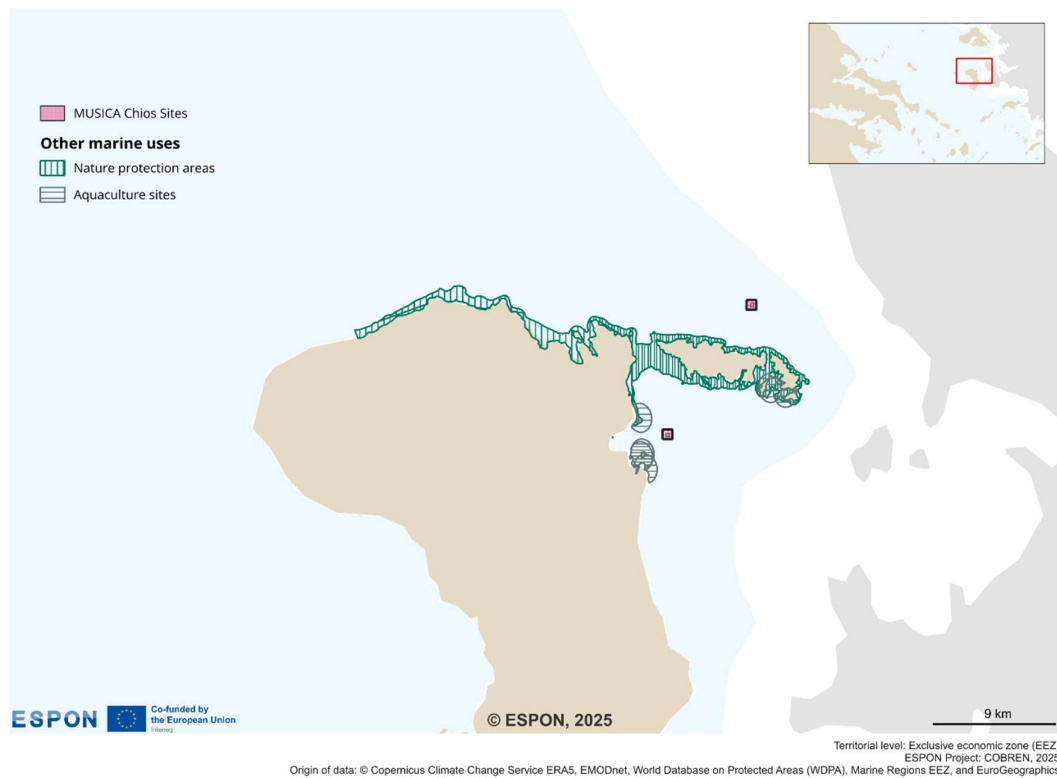
141 See for more details the CoBren main report and Annex 2 to the main report.

142 Interview conducted for the review of MSP. See also Annex 2 to the main report.

activity, along with the sustainable use of natural resources. MUSICA’s objectives to develop a multi-use platform offering space for offshore wind, solar and wave generation as well as other sea activities, relate thus to the objectives of the future Greek MSP, yet the location of the platform is subject to current legislation.

MUSICA project partners identified two suitable locations for the MUP (Map 7). The locations are outside of the nature protection areas and dedicated sites for aquaculture, avoiding potential conflicts of sea use. In addition, the identified locations are relatively far off the coast to limit disturbing views from the island (“*Horizon pollution*”), as requested by the local communities. The economy of the islands of *Innouses* and the neighbouring *Chios* rely to some degree on tourism. Stakeholders in this sector, as well as inhabitants of the two islands, voiced concerns on possible disturbances of views and limiting touristic values due to the MUP. The identified sites consider these concerns to avoid any conflicts and enhance social acceptance. Selecting a suitable location for the MUP is a key planning step in the project. Other planning steps concern the alignment with multiple regulatory frameworks and optimising the technology to meet all standards and stakeholder engagement to enhance social acceptance.

Map 7 MUSICA's locations on Greece's Chios Island in the Mediterranean Sea



10.3.1 Optimising technologies meeting regulatory requirements

The MUP developed in the framework of the MUSICA project builds upon concepts delivered in previous projects funded through Europe's research and innovation programmes. The concept was developed by the University of the Aegean and has been tested in Heraclea (Greece) in 2010 for two years. The MUSICA project aims to optimise the technologies of the multi-use platform in line with the different regulations relevant for such platforms.

Project partners saw a need to adapt the initial MUP design to meet increasing demand for renewable energy while ensuring that environmental and social impacts remain minimal. Various environmental aspects need to be considered during the construction and operational phases of the MUP, including potential disruption to marine habitats or effects on migratory species. In addition, specific environmental conditions, such as varying wind speeds and maritime geography such as bathymetry¹⁴³ need to be considered. MUSICA addresses these challenges by using multi-use platform technology, which allows for the integration of wind, solar, and wave energy systems. The technological focus of the project includes adaptable platforms that can operate efficiently in the Mediterranean's complex maritime environment. These innovations are in early stages of development but are considered crucial for the project's success and are expected to lead to greater cost efficiencies as the technology matures.

The MUSICA project is also used to assess possibilities to scale the existing concept. Successful upscaling requires addressing technical innovations and logistical challenges, such as access to the required vessels for deployment, operation, and maintenance.

Furthermore, the logistical challenge of connecting these multi-use platforms to the onshore power grid remains a barrier. This necessitates the development of robust electrical infrastructure and the alignment of offshore and onshore systems to ensure stable and efficient energy distribution. Other logistical challenges relate to the relatively remote location of the island and the reduced access to infrastructure due to the small scale of the island. This requires establishing local manufacturing facilities for platform components, transport logistics, and specialised vessels for platform installation and maintenance. The project's objectives to fine-tune the MUP's technology and assess its viability in a different context contribute to developing standardised components that can be manufactured centrally and assembled on the locations near the small islands.

10.3.2 Public perception and social acceptance

While testing and exploring the different options for the MUP, stakeholder engagement remains vital. Therefore, the MUSICA project partners work closely with the local stakeholders through workshops and webinars¹⁴⁴. Even though the project experienced initially some resistance to the development of the platform the project currently enjoys the support of local communities. Initial resistance was particularly voiced by representatives of fishing and tourism industries and general inhabitants for the islands.

MUSICA project partners engaged with these stakeholders via public engagement workshops, to mitigate concerns and foster community acceptance. The project's success relies on demonstrating tangible benefits, such as job creation, economic diversification, and long-term environmental sustainability.

Each of these aspects are included in the MUP's concept and initial design, e.g. promoting energy and freshwater security of supply while offering a place for aquaculture. Moreover, building, operating, and maintaining these platforms will require skilled labour and robust supply chains, thus stimulating regional economic activity. Beyond direct economic impacts, the MUSICA initiative offers growth

¹⁴³ Bathymetry refers to submarine topography i.e. the depths and shapes of underwater terrain (see also: [What is bathymetry?](#))

¹⁴⁴ <https://musica-project.eu/events/first-public-engagement-workshop-with-the-island-communities-of-chios-and-oinousses-2/>

opportunities for coastal and island economies. By diversifying energy sources, it could lead to more stable energy pricing, benefiting local markets. Additionally, the revenue from clean energy production can be reinvested into infrastructure, enhancing regional economic resilience. More concretely, the island of *Innouses* has a population of 800 which can benefit from the MUSICA concept for two key reasons:

1. *Innouses* has 0% renewable energy sources, which results in islanders paying three times the land rate for grid electricity. Moreover, the quality and reliability of the electricity is poor (20kV grid connection to *Chios* Island); and
2. *Innouses* has no local water source and 30% of the island water is produced by a desalination plant powered by diesel. Different awareness raising campaigns through workshops as well as local and social media helped to illustrate these benefits, gain social acceptance, and overcoming public opposition to the development of the MUP.

10.4 Key lessons and future directions

The MUSICA case study illustrates specific challenges to developing ORE in the absence of MSP. In the case of MUSICA, the regional spatial planning framework, national offshore wind farm development programme and law on offshore solar plants, including their specific provisions are, among others, to be considered:

1. **The case study highlights the additional complexity of developing a multi-use platform (MUP) in the absence of a finalised MSP framework.** This is particularly relevant in the case of the development of a MUP as regulations and provisions of other sectors need to be considered as well. Even though sector specific regulations may consider similar topics, such as environmental impact assessments or meeting safety and technical standards, the scope of the provisions differs per framework, requiring the project to obtain a multitude of permits and licenses from different sectoral authorities.
2. **Therefore, going forward, MSP can provide a framework to coordinate the different sectoral frameworks.** Particularly the inclusion of multi-use ORE development in the Greek MSP could be a lever to coordinate legislation and enhance the efficiency of ORE development. Moreover, it may encourage the development of a one-stop-shop for ORE (multi-use) development, offering ORE projects or developers a single point of contact to obtain relevant permits and licenses.
3. **The case study has shown the importance of stakeholder engagement to develop business plans and demonstrate the viability of the MUP.** Concretely, the case study demonstrates the importance of inclusive engagement, considering the island population, industry (ORE developers, fisheries, tourism), research and representatives from the public sector. To enhance social acceptance, project partners demonstrated the MUP's tangible benefits, such as job creation, economic diversification, and long-term environmental sustainability.

10.4.1 Perspectives for territorial cooperation

The lessons learned from MUSICA are relevant for other small islands as well. Therefore, the project foresees preparing business plans and commercial economic feasibility studies for five other small islands namely *Telendos*, *Heraclea* and *Chios* in Greece, *Gozo* in Malta and *La Gomera* in Spain (Canary Islands). MUSICA's project partners facilitate the transfer of lesson from the *Innousses* MUP to the other locations, e.g. the research institute *COPLAN* from the Canary Islands facilitates transferring the lessons in the context of *La Gomera*. The University of Malta supports the transfer of lessons in a similar way for *Gozo*. The Network of Sustainable Greek Islands takes this role for the Greek islands. Each of these organisations is part of MUSICA's project partnership.

The transfer of lessons is supported by the embeddedness of MUSICA's project objectives in EU and transnational policy documents. Aligning the project's outputs with strategic documents for the Mediterranean and the EU. For example, MUSICA's objectives and expected outputs align with:

- **WestMED Initiative:** The Initiative for the Sustainable Development of the Blue Economy in the Western Mediterranean aims to enhance maritime safety, promote sustainable economic growth, and foster job creation. It involves countries such as Italy, Spain, and France and focuses on integrating ORE solutions like offshore wind and solar energy¹⁴⁵.
- **BLUEMED Initiative:** This initiative promotes cooperation for research and innovation in the Mediterranean, focusing on the sustainable development of marine and maritime sectors. It aims to enhance the integration of ORE technologies and address shared environmental challenges¹⁴⁶.
- **Union for the Mediterranean (UfM):** The UfM fosters regional cooperation among Mediterranean countries in areas including energy and the environment. It promotes ORE development by facilitating dialogue, policy harmonisation, and joint projects among its member states¹⁴⁷.
- **Mediterranean Information Office for Environment, Culture and Sustainable Development (MIO-ECSDE):** MIO-ECSDE supports sustainable development across Mediterranean countries, emphasising renewable energy integration and environmental protection. The organisation's efforts align with EU sustainability goals and promote regional strategies for ORE¹⁴⁸.

Moreover, MUSICA project partners are actively involved in the WestMED Initiative and the Union for the Mediterranean which further allows MUSICA project partners to contribute to harmonising MSP practices across borders, minimising conflicts and ensuring efficient implementation. This collaborative framework also promotes the sharing of knowledge and best practices, leveraging collective expertise in multi-use platform technologies.

Despite the alignment with policy objectives and participation in transnational initiatives, cooperation and transfer of practices remains a challenge, especially with differing national interests and priorities in offshore energy development. Coordinating and developing large-scale offshore projects in the Mediterranean requires overcoming regulatory complexities, such as shared marine resources, cross-border energy grid connections, and potential maritime conflicts (e.g., with shipping or tourism industries).

145 <https://westmed-initiative.ec.europa.eu/>

146 <https://www.bluedmed-initiative.eu/>

147 <https://ufmsecretariat.org/>

148 <https://mio-ecsde.org/>

10.5 Sources

- **Toto Holding.** (2022). *Inauguration of Beleolico: The first offshore wind farm in the Mediterranean.* Retrieved from <https://totoholding.it/en/media/inaugurato-oggi-a-taranto-beleolico-il-primo-impianto-eolico-marino-del-mediterraneo/>
- **Associated Press (AP News).** (2023). *Nine EU countries pledge to turn the Mediterranean into a renewable energy hub.* Retrieved from <https://apnews.com/article/europe-renewable-energy-hub-meeting-larnaca-mediterranean-9deb40e67ddb8839d37a8b5a7c4dfd49>
- **DAFNI Network.** (2023). *MUSICA Project – Multiple Use of Space for Island Clean Autonomy.* Retrieved from <https://dafninetwerk.gr/en/portfolio/musica-project/>
- **Offshore Energy.** (2020). *SINN Power demonstrates Ocean Hybrid Platform in Greece.* Retrieved from <https://www.offshore-energy.biz/sinn-power-demonstrates-ocean-hybrid-platform-in-greece/>
- **European Commission.** (2020). *Horizon 2020 – MUSICA Project (ID: 862252).* Retrieved from <https://cordis.europa.eu/project/id/862252>
- **WestMED Initiative.** (2023). *Sustainable Development of the Blue Economy in the Western Mediterranean.* Retrieved from <https://www.westmed-initiative.eu/>
- **Union for the Mediterranean (UfM).** (2023). *Renewable Energy Transition in the Mediterranean Region.* Retrieved from <https://ufmsecretariat.org/>
- **WindEurope.** (2022, April 5). *Spain issues a plan for up to 3 GW offshore wind by 2030.* Retrieved from <https://windeurope.org/newsroom/news/spain-issues-plan-for-up-to-3-gw-offshore-wind-by-2030-in-perfect-time-for-windeurope-2022-in-bilbao/>
- **European MSP Platform.** (2023). *Maritime Spatial Planning for Offshore Renewable Energy Development.* Retrieved from <https://www.msp-platform.eu/>
- **Offshore Wind Journal.** (2023). *The future of offshore wind energy in the Mediterranean: Challenges and opportunities.* Retrieved from <https://www.offshorewindjournal.com/>

ESPON



Co-funded by
the European Union
Interreg

espon.eu



ESPON 2030

ESPON EGTC
11 Avenue John F. Kennedy
L-1855 Luxembourg
Grand Duchy of Luxembourg
Phone: +352 20 600 280
Email: info@espon.eu
www.espon.eu

The ESPON EGTC is the Single Beneficiary of the ESPON 2030 Cooperation Programme. The Single Operation within the programme is implemented by the ESPON EGTC and co-financed by the European Regional Development Fund, the EU Member States and the Partner States, Iceland, Liechtenstein, Norway, Switzerland and the United Kingdom.

Disclaimer

This delivery does not necessarily reflect the opinion of the members of the ESPON 2030 Monitoring Committee.