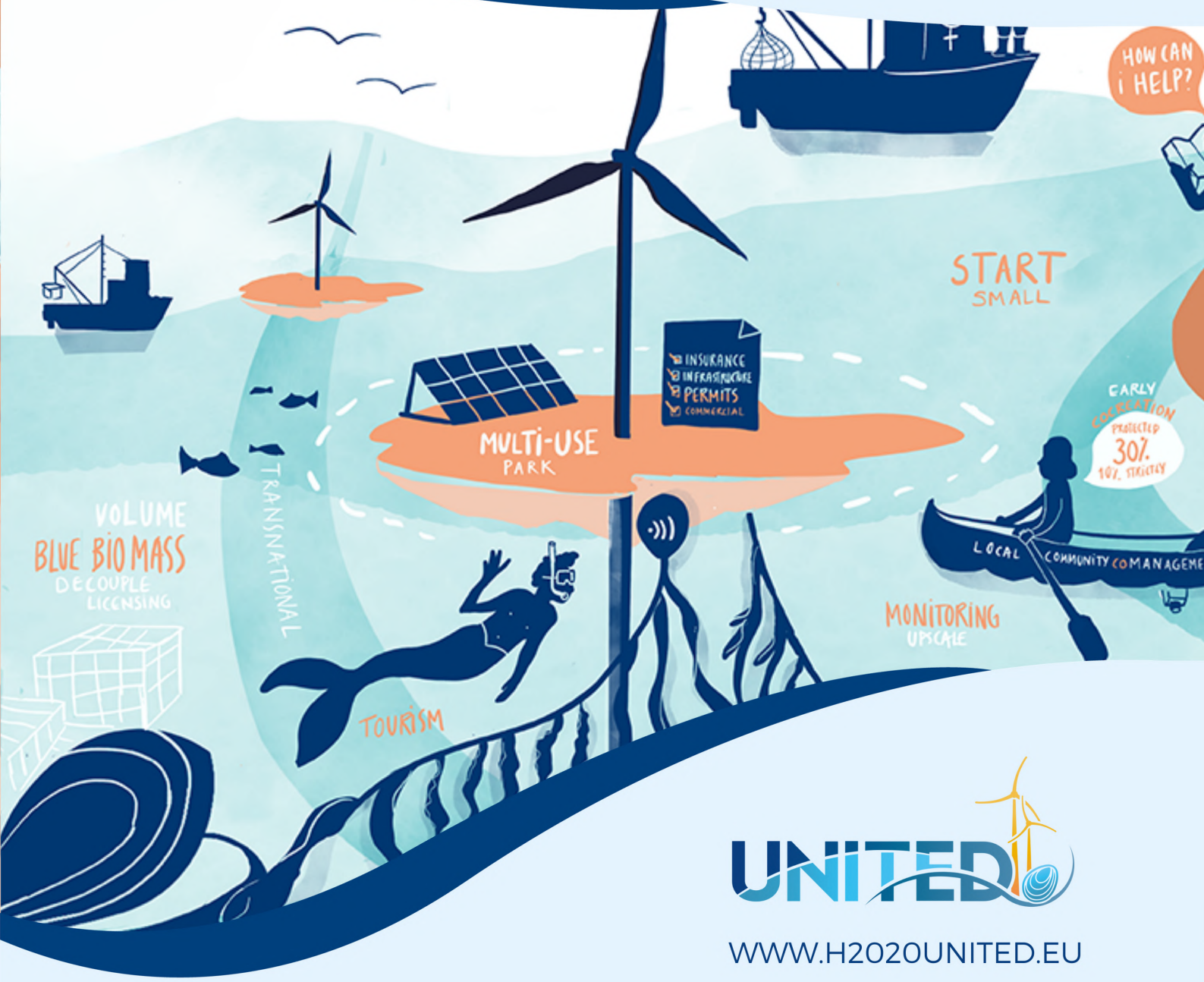
OCEAN MULTI-USE

COMMERCIALISATION ROADMAP



UNITED

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AUTHORS

Ivana Lukic, Agnese Cosulich, Franziska Drews-von Ruckteschell

SUBMARINER NETWORK FOR BLUE GROWTH

Eva Strothotte, Tim Staufenberger

FuE-Zentrum FH Kiel GmbH

Marijn Rabaut, Frank Maes, Molly Hughes, Annelies Declercq

Ghent University

Ghada el Serafy, Alex Ziemba, Rieke Santjer

Deltares

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INTRODUCTION

MULTI-USE HOLDS THE PROMISE TO RECONCILE COMPETING MARITIME PRIORITIES

Maritime Spatial Planners are challenged with the task of harmonising spatial demands driven by **ambitious renewable energy objectives** and the **need for sustainable, locally sourced marine food**, all while trying to meet nature **conservation targets**. The concept of multi-use presents a promising solution to unite these multifaceted, sometimes competing, priorities.

Ocean multi-use involves the intentional shared use of marine resources in close geographic proximity by two or more maritime activities.[1] It signifies a departure from the traditional concept of exclusive resource rights toward inclusive resource sharing and space utilisation by one or more users. The level of connectivity between maritime uses can vary in terms of **spatial, temporal, provisioning, and functional dimensions**.[1] This variation can range from activities merely sharing the same maritime space (co-location) to sharing operations, logistics, and offshore infrastructure. Thus, multi-use encompasses not only shared physical installations but also joint activities.

While multi-use holds the potential for significant **space-saving, socio-economic benefits, and environmental advantages**, it is essential to recognise that it may not always be the optimal choice. Acknowledging that there are uncertainties regarding its impacts, careful consideration of effects and the **application of the precautionary approach** are crucial.

[1] Learn more about the multi-use concept from Schupp et al. 2019 and Ocean Multi-Use Action Plan. 2018.

INTRODUCTION

ABOUT UNITED

The Horizon 2020 UNITED project has been running for a period of 4 years between January 2020 and December 2023. The project has piloted **five multi-use solutions in the real environment** in five European Member States, increasing the **TRL from 4 to 7** for most of the solutions.

- **Belgium: Offshore wind, flat oyster aquaculture and restoration, and seaweed cultivation.**
- **Germany: Blue mussels, seaweed farming and offshore wind energy.**
- **Netherlands: Offshore seaweed and floating solar/ or offshore wind energy.**
- **Denmark: Offshore wind and tourism.**
- **Greece: Tourism and fish aquaculture.**

Beyond technological strides, UNITED has explored the legal, regulatory, and insurance dimensions while also examining the environmental and socio-economic impacts.

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This Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement no 862915

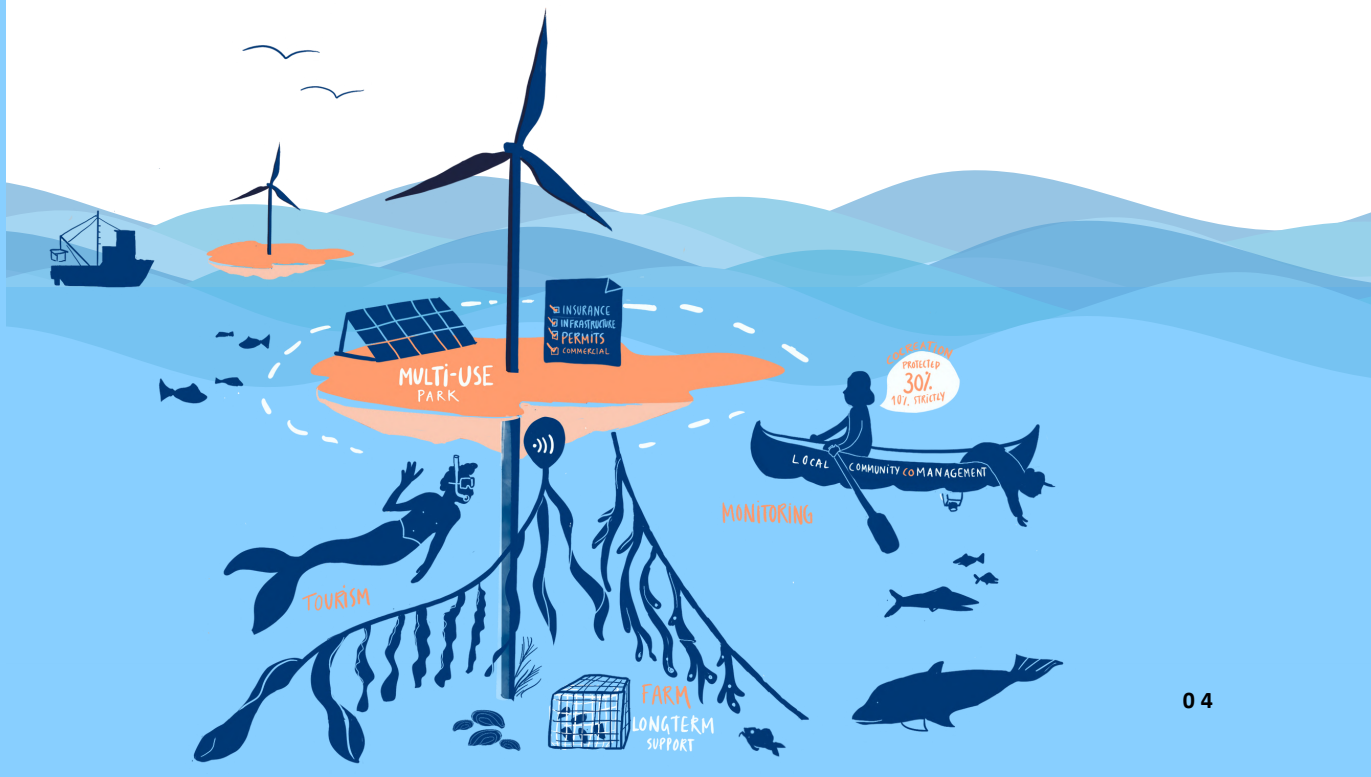
WHY THE OCEAN MULTI-USE COMMERCIALISATION ROADMAP?

The Ocean Multi-Use Commercialisation Roadmap filters UNITED's insights, providing a **compass for scaling multi-use** initiatives. This resource is not only valuable for innovators and industry actors but also essential for policymakers to grasp the enablers for widespread multi-use adoption.

The roadmap presents a selection of **recommendations** derived from the project's pilots and highlights **practical examples** that can guide future multi-use initiatives organised by relevant topics. The recommendations aim to support the future adoption and expansion of multi-use, not only in the pilot project locations but also in broader contexts.

It is vital to emphasise that advocating for scale-up is not the primary objective. Instead, the roadmap promotes the **wider adoption of a multi-use system thinking** that can foster synergies among sectors, leading to increased socio-economic benefits. Additionally, it encourages **synergies between nature and economic activities,** creating greater social and economic value compared to single-use approaches.

Learn more about the multi-use concept from the Ocean Multi-Use Action Plan 2018.



PILOTS OVERVIEW

GERMAN PILOT

The German pilot project involved installing and operating an offshore demonstration aquaculture farm, focusing on mussels (Mytilus edulis) and macroalgae (Saccharina latissima). This farm was established at the FINO3 research platform, located in the German North Sea, approximately 80 km west of Sylt Island. While FINO3 itself does not generate wind energy, its pile construction shares similarities with offshore wind turbines.

TECHNOLOGY READINESS LEVEL (TRL)

The TRL of the German Pilot was assessed at **TRL 5** at the beginning of the project. This corresponds to the stage where the technology has been validated in a relevant environment, particularly in an industrially relevant setting in the context of key enabling technologies, which, in the case of the German pilot, was the near-shore site in the Baltic Sea. While certain individual activities, such as those at the near-shore aquaculture farm, are already operational and have achieved a TRL of 9, their successful adaptation and implementation in the more challenging offshore environment necessitate complex logistical and technical adjustments. This transition to the offshore environment represented the primary focus for **advancing the overall pilot technology from TRL 5 to 7.**

1. **Pre-operational Phase:** Initial tests were conducted in near-shore waters to evaluate the resilience of various equipment and materials against factors like biofouling, wave action, tides, currents, storms, salinity, and corrosion. These tests took place at the Kiel Marine Farm, an existing commercial aquaculture facility in the Baltic Sea.

2. **Operational Phase:** Following the near-shore testing, the mussel and macroalgae longline aquaculture system was set up at the offshore site, FINO3. The project utilized the best-performing materials and equipment identified during the near-shore tests. To ensure the economical and safe operation of the offshore facility, an automated data collection and remote monitoring system was implemented at the FINO3 site. This technology was essential due to the high costs and limited accessibility associated with offshore locations, which are often subjected to harsh weather conditions. A sampling of mussels and algae occurred during maintenance, and additional samples of both were taken prior to decommissioning. The mussels in this extreme offshore location exhibited growth with a meat content slightly higher than the average North Sea mussel. Algae also showed promising growth rates. Further sampling and growth experiments are necessary to assess the market potential for reliable algae and mussel aquaculture.

3. **Post-operational phase:** Decommissioning was carried out using several boats over two sea missions. The strain of harsh weather conditions on the algae and mussel systems was evident. Nonetheless, these systems performed very well, demonstrating the feasibility of long-term installation of aquaculture equipment in a far remote, high-energy environment. Unfortunately, the monitoring system (including the lander and winch system) suffered critical damage, resulting in data loss. However, the implementation of backup systems proved valuable, ensuring basic data collection throughout the project's duration.

Commercialisation potential:

Kiel Marine Farm is the first open-water marine aquaculture for mussels and algae in the German Baltic Sea, with blue mussels as its main product. As a small company, the farm focuses on the regional organic niche market. Customers are willing to pay up to 12 EUR/kg for the local aquaculture product, compared to national prices of 1-3 EUR/kg. This higher price point is achievable due to a close connection with customers and the effective 'branding' and 'storytelling' of the product and the farm itself, especially in the context of a space-efficient multi-use and link to renewable energy. The primary customers, in order of importance, are local restaurants, local resellers, and end customers. The mussels are exclusively sold within a 100 km radius of their cultivation area, allowing the farm to operate as a 'direct seller' and currently bypass the need for a costly packaging facility.

The German pilot is moving forward with its commercialization efforts in the follow-up project ULTFRAMS, where it aims to assess production capacities and explore more efficient and reliable techniques for harvesting and transporting mussels, oysters, and algae.

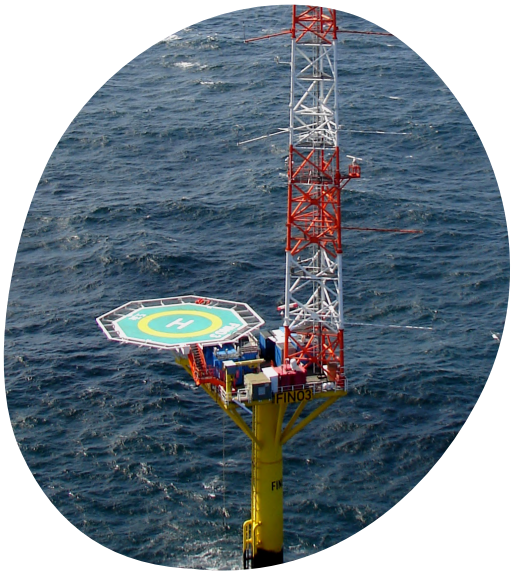


Image 2 FINO 3 offshore research platform at the German pilot site

BELGIAN PILOT

The Belgian Pilot, situated in the Belgian part of the North Sea (BPNS) within the offshore wind farm of Belwind located 49 kilometres offshore, featured an innovative combination of three key activities: offshore wind energy, European flat oyster aquaculture, oyster reef restoration, and seaweed cultivation. Several activities took place, including the development of scour protection materials and the establishment of grow-out systems for oysters and seaweed.

1) **Restored Oyster Reefs:** The pilot aimed to restore native flat oyster reefs, utilizing the hard substrate used for wind turbine foundation scour protection. This environment, free from bottom fishing activities, provided an ideal setting for oyster larvae to settle, initiating natural reef development. The coexistence of aquaculture and reef restoration was a symbiotic relationship, where aquaculture provided initial stock for reef development, and established reefs offered oyster larvae for aquaculture.

2) **Seaweed Cultivation:** The offshore wind farm offered a secure space for seaweed cultivation. The environment's characteristics, including lower temperature, reduced turbidity, and less fouling, offset the challenges of strong currents and waves. This approach enhanced ecosystem services, such as nutrient removal, and promoted biodiversity.

TECHNOLOGY READINESS LEVEL (TRL)

The pilot began with a technology readiness level (TRL) of 5. After repeated nearshore testing, the pilot demonstrated a system prototype for low-trophic aquaculture in an offshore wind farm site, achieving TRL 7 by the end of the project.

1. **Pre-operational Phase:** During this phase, a variety of aquaculture systems were tested at a nearshore site, focusing on different equipment and substrates for flat oyster and sugar kelp cultivation, along with nature-inclusive scour protection. The evaluation of these tests enabled the selection of the most efficient cultivation practices. This chosen configuration was later applied during the operational phase at the offshore site. The Belgian pilot is specifically located within the Belgian part of the North Sea, within the Belwind Offshore Wind Farm (OWF). Flat oyster aquaculture, restoration, and seaweed cultivation underwent testing in the pre-operational phase at the Westdiep nearshore site, situated five kilometres off the Nieuwpoort coast. The results from these tests informed the design and refinement of aquaculture systems intended for deployment in the offshore operational phase.

2. **Operational Phase:** The operational phase took place offshore and was determined based on the specific requirements for flat oyster and sugar kelp growth. Following a procedure similar to that of the German pilot, the technical components of the aquaculture system were procured off the shelf and customized to suit the environmental conditions of the target site. Implementation was carried out in collaboration with a specialized company that has previously installed similar anchors and longlines worldwide, including for commercial purposes. The installation of oyster restoration structures occurred in the summer of 2021, followed by the installation of aquaculture longlines in the spring of 2022.

- **Cultivation of sugar kelp** (Saccharina latissima) under offshore conditions proved possible, demonstrated by the successful growth over the period from mid-December to mid-May. The trials succeeded in demonstrating that even under harsh offshore conditions, the juvenile sugar kelp can attach sufficiently and grow into macroscopic thalli. However, installation, monitoring and harvesting are strongly weather-dependent, and delays were experienced throughout the cultivation trials, resulting in lower yields than anticipated. Fouling on cultivation structures was observed to be significantly lower compared to the nearshore site. Simultaneously, successful growth was observed until a higher depth (3m) at the offshore location in comparison to nearshore (1m). Yields averaged about 0.8 kg m-1 cultivation substrate with maximum yields of 1.8 kg m-1 cultivation substrate observed in the first meter of cultivation depth. Due to the usage of net cultivation structures (4x2m, 20 x 20 cm mesh size), a substrate length of 16 m per m backbone length is reached, resulting in an average 12.8 kg m-1 backbone length.
- **Cultivation of native oysters** (Ostrea edulis) was also successful in terms of promising survival and growth in a harsh offshore environment. Of the four different cultivation techniques tested, the metal frames containing SEAPA baskets performed the best when considering structural integrity, biofouling accumulation, and capacity. The SEAPA baskets have a cylindrical design and are oriented horizontally. This encourages a tumbling motion, which seems to control internal biofouling accumulation but may also cause oysters to grow thicker, more rounded shells. It is unclear whether this shell morphology would have an effect on marketability.

3. **Post-operational Phase**: This phase of the project coincides with the beginning of the Ocean Mission ULTFARMS project, which will continue the Belgian pilot's investigation into multi-use. Therefore, only limited decommissioning has taken place for the time being. This includes the removal of oyster cultivation structures and seaweed nets from the long lines. The end of the ULTFARMS project will include the full decommissioning of the Belgian pilot infrastructure, including the low-trophic aquaculture longlines for oyster and seaweed cultivation, screw anchors, and restoration tables. The Belgian pilot partners, Ghent University, Parkwind and Jan de Nul developed a detailed method statement for the full decommissioning in 2026 at the end of the ULTFARMS project.

Commercialisation potential:

To achieve breakeven for this multi-use combination, significant cost reductions are essential, with a particular focus on:

- Distance to the harbour, required boat size, and fuel usage: Future projects should prioritise optimising operational efficiency, including the sharing of boats and staff resources.
- Development and installation of screw anchors: As production scales up in future projects, the costs associated with screw anchors are expected to decrease.

Moreover, the effective oyster grow-out designs may influence oyster shell morphology and underscore the importance of structural considerations in future endeavours. Delays due to the weather-dependent installation, monitoring, and harvesting should also be taken into consideration in the operational timelines of future be taken i

More information on the decommissioning procedures can be found in UNITED Deliverable 7.6 *Development and implementation of a decommissioning procedure.*

Image 3: Belgian pilot seaweed harvest

DANISH PILOT

The Danish pilot project at the Middlegrunden wind farm near Copenhagen combines offshore wind energy production with tourism. Visitors can enjoy guided boat tours to the wind farm and even climb the 60-meter turbine towers, with the chance to enter the nacelle on clear days, offering a beautiful view.

TECHNOLOGY READINESS LEVEL

At the outset of the UNITED project, the Danish pilot was categorised as having a **TRL of 6.** Over the course of the project, the pilot evolved into a commercially sound business with a **TRL of 9.** This was mainly due to the expansion of the tour program both on-site and virtually, the establishment of a safety and security framework and the training of new tour guides.

1. **Pre-operational:** Middelgrunden wind farm was established on a natural reef with water depths ranging from 3 to 6 meters, 3.5 km outside of Copenhagen harbour, in the fall of 2000. It is a city landmark visible from Copenhagen and surrounding beaches. The wind farm consists of 20 turbines, each with a rated capacity of 2 MW. The maximum height of the wingtip is 102 meters. The wind farm is owned 50% by HOFOR (local energy and water supply) and 50% by the **Middelgrunden Wind Turbine Cooperative, which has 8,553 members**. At the time it was built, Middelgrunden was the largest wind farm in the world based on cooperative ownership.

2. **Operational:** In the framework of the UNITED project, the Danish pilot expanded the existing tourism activities and created new attractions. The expansion of tourism activities was achieved by attracting new target groups and becoming part of the tourism offering in Copenhagen and its region. The attraction of local and international groups was achieved through the development of virtual visits, engaging with divers' associations, and introducing more boat companies to promote the visit to the turbines. Nevertheless, the number of boat tours has fluctuated, dropping during the COVID-19-related travel restrictions and rising in 2022 to reach 75 annual trips, generating a turnover of 102,000 EUR.

3. **Post-operational:** The Middelgrunden wind farm is approaching the end of its operational lifespan. To address this, the cooperative responsible for managing it is actively pursuing repowering rights. Their aim is to replace the ageing turbines with more advanced and efficient models while retaining the existing infrastructure and spatial layout. If the state grants a new lease, the turbines are slated for refurbishment by 2026, which will prolong their operational life by an additional 25 years.

Commercialisation Potential:

The interest in the Danish offshore wind and tourism multi-use initiative is driven by a global increase in awareness and demand for sustainable and educational tourism experiences. Moreover, the promotional efforts by the UNITED project, boat operators' websites and articles in high-profile publications, such as Bloomberg, have been instrumental in inspiring visitors. Individuals who have participated in tours have often become ambassadors, bringing new groups and furthering awareness.

The Danish pilot suggests that the keys to unlocking this potential for commercialising multi-use tours that combine the appeal of offshore wind farms with marine tourism appear to be effective marketing, ensuring an adequate supply of trained guides, and managing the logistical challenges posed by boat scheduling and the seasonality of tours and fluctuating visitor numbers.

During the UNITED project, the frequency of "open house" events was increased to annual occurrences due to the surge in interest, and additional guides have been trained to accommodate the growing number of visitors. Investment in specialised boats from 2024 is also set to boost the capacity for tour groups significantly. Additionally, introducing innovations like virtual visits and engaging with local associations can broaden the appeal and access to this multi-user concept.

Image 4 Impressions from the UNITED pilot at the Middelgrunden Wind Farm in Denmark

GREEK PILOT

The Greek pilot brings together fish aquaculture farming and diving expeditions. The KASTELORIZO AQUACULTURE operates an aquaculture farm on floating facilities in the marine area near the Natura 2000 islet Patroklos, which is located 850 meters from the mainland. Planet Blue is a local diving centre based in Lavrio, Greece, 60km south of Athens, offering diving tours for groups and individuals. The fish and shellfish produced at the site are sold in Greece and abroad, including in seven restaurants owned by KASTELORIZO. Several synergies have been derived from this multi-use activity, including new touristic activity, scuba diving at an aquaculture site, cost minimization by sharing the existing aquaculture and diving equipment (Underwater Remote Operating Vehicles, diving gear, and expertise), as well as increased wider societal acceptance of aquaculture farm and its products.

TECHNOLOGY READINESS LEVEL:

At the beginning of the pilot project, the TRL of the Greek pilot multi-use case was 3-5 (i.e., the multi-use case has been conceptualized, and the individual elements have been proven, but the multi-use case needs testing and demonstration in the relevant environment). **The pilot reached its aspired TRL of 7-8** (demonstration in an operational environment, also referred to as pre-or first-of-a-kind commercial demonstration) by the end of the project. This progress was achieved through a series of enhancements, including the introduction of scuba diving, boat tours, professional diving, internet connectivity, power supply improvements, and the deployment of sensor devices. This progress has brought the Greek pilot to a mature and promising stage with integrated systems and optimized operations.

1. **Pre-operational phase:** The fish farming unit was already established and in operation at TRL 9 at the beginning of the project. Planet Blue Diving Centre also already had a business providing underwater remote operating vehicles for aquaculture, including mapping the underwater landscape of aquaculture sites or conducting inspections or repairs of aquaculture infrastructure placed in great depths. In addition, Planet Blue offers diving expeditions for cleaning up waste in the aquaculture area.

2. **Operational phase:** This phase included the development and testing of a business plan for real-life scuba-diving expeditions in the pilot site, as well as assessing the shared cost reduction. Moreover, monitoring was conducted through cameras that were installed at the cages to monitor fish behaviour and to track any stress indicators during the scuba-diving expeditions.

Furthermore, environmental parameters have been monitored at the aquaculture site with the use of multi-probe sensors. The Temperature, Dissolved Oxygen, Current, pH, Turbidity, Chlorophyll, Nitrate, and Ammonium have been monitored, not only to establish the environmental footprint of the aquaculture site but also to track any disturbance to environmental parameters from the multi-use (e.g., Ammonium rise might be an indicator of stress in fish). The deployment of cameras and the development of algorithms offered continuous estimation of fish average weight and other production indicators. The calculation of average weight instead of manual sampling can reduce physical damage and stress on the fish. Data on fish behaviour from remote monitoring can also ensure optimal feeding, leading to reduced costs and environmental footprint because of minimized feed loss.

3. **Post-operational:** The pilot will continue its operation after the conclusion of the UNITED project. Therefore, no decommissioning is foreseen at the moment. KASTELORIZO holds an aquaculture license, which is valid until 2030. Current plans include renewing the license after 2030, which would also enable a continuation of the multi-use business.

Commercialisation:

The Greek pilot used innovative marketing strategies to boost both activities. Key initiatives included a QR code hunt with prizes, and educational videos with quizzes. The pilot also considered rebranding aquaculture products to better highlight sustainable practices and the link to the local diving clubs, and a 'sustainable multi-use badge' on restaurant menus, where the fish from the aquaculture side is served. Future strategies should focus on diversifying marketing channels, balancing online and offline tactics, and maintaining adaptability to unforeseen disruptions like COVID-19. The pilot's success in integrating tourism and sustainable aquaculture can also provide a model for promoting undermarketed fish species and sustainable local seafood consumption in the future.

Image 5 Impressions from the UNITED pilot at the Patroklos pilot site in Greece

DUTCH PILOT

The two multi-use scenarios have been explored in the framework of the UNITED pilot in the Netherlands:

1. **Offshore wind and solar energy generation; and**
2. **Offshore wind and seaweed farming.**

While floating solar installations are typically deployed nearshore or in lakes, this pilot marked the first attempt to test these technologies offshore. The primary objective was to build a robust business case for offshore floating solar energy generation. This involved conducting comprehensive assessments of the feasibility, economic viability, and technical aspects of offshore solar installations. Furthermore, the project explored the potential for integrating offshore floating solar with existing wind farm operations. This integration presents an exciting opportunity to leverage synergies in monitoring and maintenance activities, maximizing the efficiency and performance of both energy sources. However, several significant barriers and challenges still need to be addressed and overcome in this pioneering venture. These challenges include issues related to insurance coverage, connection cables to the mainland grid, and regulatory frameworks governing offshore solar installations.

1. **Pre-operational phase:** several small-scale pilots have taken place in the North Sea Farmers test areas prior to the UNITED pilot.

2. **Operational Phase:** Two seaweed cultivation systems were operational at the Offshore Test Site for the second cultivation season. One system experienced damage due to a storm but was repaired. Seaweed quality degraded due to high temperatures, but the harvest test was successful. Testing of an automated seaweed harvest machine was conducted. Efforts were also made to define the legal and contractual framework for offshore integrated wind and solar energy projects within the Dutch Exclusive Economic Zone. Activities around the floating offshore solar farm of Oceans of Energy included weekly inspections, structural work, and ecological monitoring. The solar farm withstood severe storms, demonstrating its resilience. DNV verified the technology's feasibility for operating in high wave and harsh offshore conditions.
A cost-effective and lightweight data buoy, the OTS Buoy, was designed and procured. The OTS Buoy was installed in July 2023 to monitor various parameters, including water conditions, forces on the system/anchor chain, and atmospheric data. Data collected by the OTS Buoy is visu monitors various parameters, i

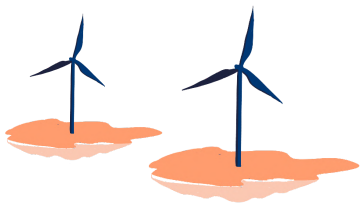
3. **Post Operational Phase:** Several installations, including the offshore seaweed cultivation systems and OTS Buoy, have been decommissioned at the end of 2023.

Image 6: Dutch pilot seaweed

MARKET ANALYSIS & POTENTIAL

MARKET ANALYSIS OVERVIEW - UNITED ECONOMIC SECTORS

Offshore renewable energy



European Union (EU) Member States have agreed on ambitious long-term goals for the deployment of offshore renewable energy, ranging from **109-112 GW by 2030, 215-248 GW by 2040, and 281-354 GW by 2050.**

The **North Sea and Baltic Sea** basins show the most potential, which has been supported by the high-level policy agreements (Tables 2 and 3), followed by the Atlantic Sea. Due to the presence of wave energy, the Atlantic and North Sea are also good candidates for combined hybrid energy solutions such as the one demonstrated by the **EU-SCORES project.**[2]

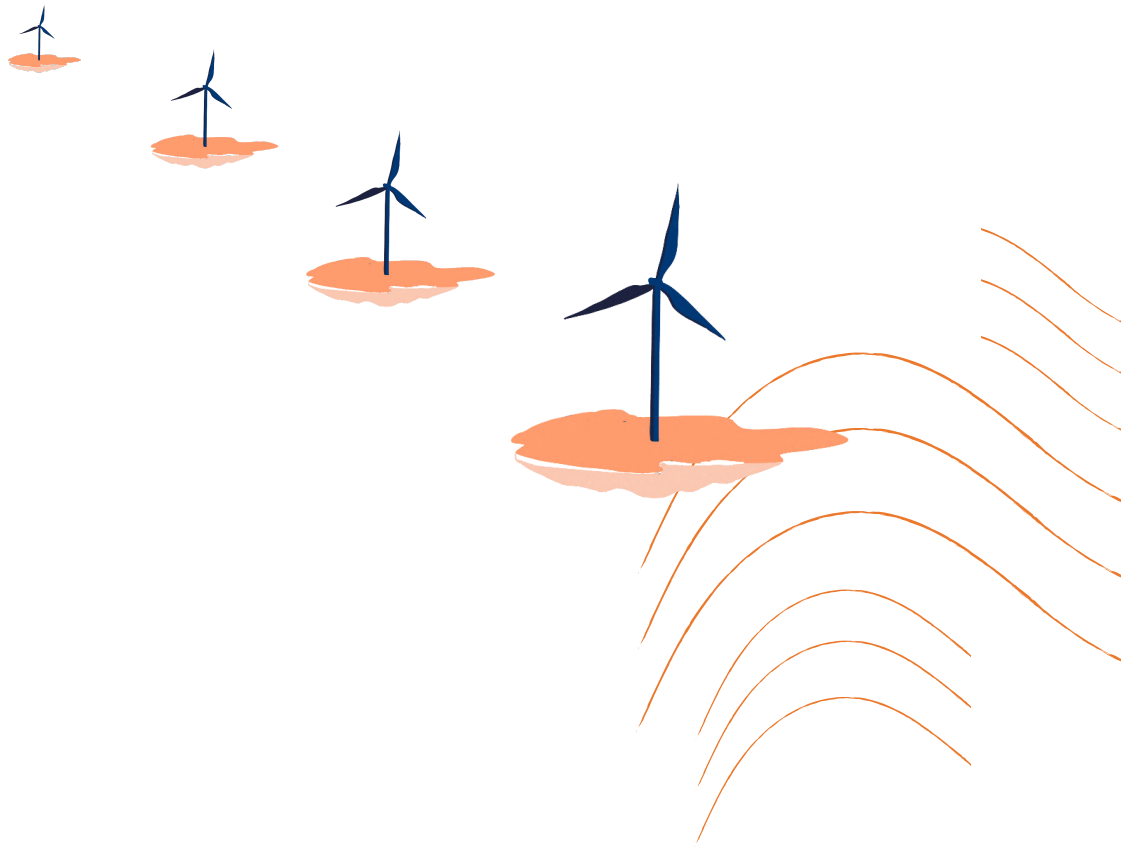
Nevertheless, ensuring the social and environmental sustainability of offshore renewable energy development remains a challenge. To meet these targets, annual deployment rates will have to increase significantly, putting additional pressure on the European seas.
On the other hand, offshore wind **permitting procedures and their length vary significantly** across the Member States, slowing the rollout of offshore renewable energy.
While the concept of spatial efficiency and co-using sea space is **often encouraged on the policy level,** the multi-use between offshore renewables and other uses is not yet common practice.

The established wind energy sector can lead the way in integrating multiple activities in wind farms. The offshore wind industry often operates in different countries holding extensive expertise in marine ecology and biodiversity, e.g., from EIA processes, that can be utilised to site, design, and conduct robust multi-use pilot projects.

Learn more about combining different types of renewables offshore from the EU SCORES project

Table 2 Non-binding agreement on the goals for offshore renewable energy generation for the Northern Seas Offshore Grids -NSOG priority offshore grid corridor countries [1]

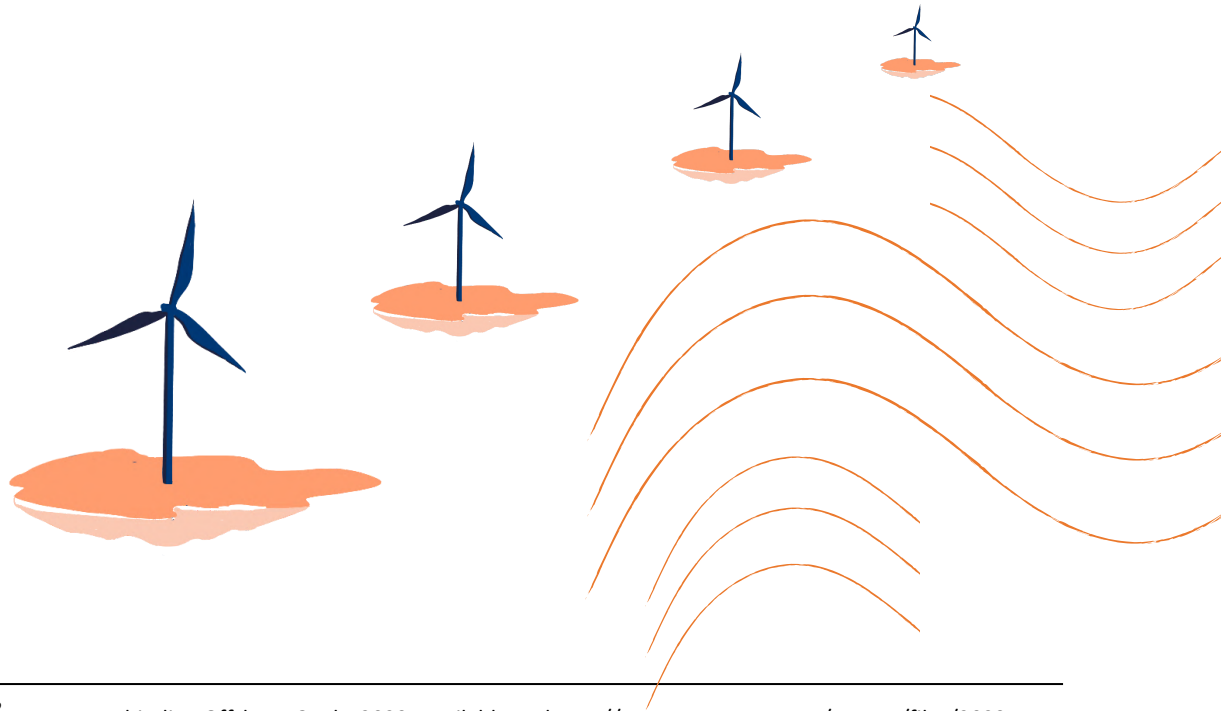
MEMBER STATE	GOAL 2030 (GW)	GOAL 2040 (GW)	GOAL 2050 (GW)
Belgium	6	8	8
Denmark	5.3	19.3	35
Germany	26.4	60	66
Ireland	4.5	13	20
France	2.1	4.6 - 8	4.6 - 17
Netherlands	16	30 - 50	38 - 72



[1] NSOG Non-binding Offshore Goals. 2023. Available at: https://energy.ec.europa.eu/system/files/2023-01/NSOG_non-binding_offshore_goals_final.pdf

Table 3 Non-binding agreement on the goals for offshore renewable energy generation for the High-Level Group Offshore Wind Working Group -BEMIP priority offshore grid corridor (2022)[2]

MEMBER STATE	GOAL 2030 (GW)	GOAL 2040 (GW)	GOAL 2050 (GW)
Denmark	7.9	7.9	7.9
Germany	4.1	4.1	4.1
Estonia	1	3.5	7
Latvia	0.4	0.4	0.4
Lithuania	1.4	2.8	4.5
Poland	5.9	10.9	10.9
Finland	1	5	12
Sweden	0.7	-	-
Total for BEMIP priority offshore grid corridor	**22.5**	**34.6**	**46.8**



[2] BEMIP Non-binding Offshore Goals. 2023. Available at: https://energy.ec.europa.eu/system/files/2023-01/BEMIP_non-binding_offshore_goals_final.pdf

VALUE PROPOSITION FOR MULTI-USE IN THE OFFSHORE RENEWABLES SECTOR

Multi-use initiatives enhance the **green image and corporate social responsibility** of the offshore renewables sector, which must secure its place in increasingly congested seas. By promoting better **local integration** and generating more **socio-economic benefits** for local communities, offshore renewables projects gain **wider acceptance**.

KEY RISKS

Multi-use initiatives should not hinder the progress of offshore renewables, which are already facing challenges in achieving their set targets in many countries.

KEY ENABLER FOR THE OFFSHORE RENEWABLES MULTI-USE MARKET ENTRY

- **Identifying zones for different types of suitable multi-use projects** in existing and future renewable energy farms,
- **Streamlining permits and adopting the non-financial tendering criteria** that integrate the multi-use concept,
- **Clarifying insurance** regulations and developing **government-backed insurance** funds for multi-use projects. See Maripark concept in the Netherlands and Belgium.
- **Ongoing funding support** for multi-use pilots to allow enough time not only for the technology testing but also for measuring impacts and testing business models.

OPPORTUNITIES

- **Maximise Local Socio-economic Benefits:** Utilise economic models for identifying areas and specific multi-use combinations that can yield the most local socio-economic benefits, thereby enhancing their appeal to local communities and potential investors.
- **Cultivating Wind Farms as Cultural Attractions:** Develop a comprehensive market ecosystem around wind farms to enhance their cultural acceptance and transform them into attractions similar to historic windmills. This approach particularly applies to multi-use combinations involving tourism.
- **Innovative Funding for Non-Economically Driven Multi-Use Initiatives:** Create innovative funding mechanisms tailored to multi-use projects that may not yield direct economic benefits, such as those integrating ecosystem restoration and blue corridors within wind farms.
- **Integration of Multi-Use Concepts in Offshore Energy Island Developments:** Implement multi-use concepts within offshore energy island developments, e.g., Dogger Bank Wind Farm.
- **Enhancing Research and Monitoring Access:** Encourage offshore wind farm operators to grant access to their sites for research and monitoring purposes related to multi-use pilot projects. Collaboratively develop site access guidelines with government authorities, researchers, and academics to facilitate this cooperation.

OFFSHORE WIND MULTI-USE VISION 2030

112 GW OF OFFSHORE WIND CAPACITY integrated with sustainable food provision and nature conservation, while preserving spatial resources for future use.

2030

- FIRST LARGE-SCALE, LONG TO MEDIUM-TERM COMMERCIAL MULTI-USE PROJECT REACHES THE BREAK-EVEN POINT
- MULTI-USE INTEGRATED INTO OFFSHORE ENERGY ISLANDS CONCEPTS
- WELL DEVELOPED MARKET ECOSYSTEM ARROUND WIND FARMS
- UNITED BUSINESS MODELS REPLICATED IN OTHER AREAS
- CLEAR REGULATORY FRAMEWORK AND INCENTIVES
- FINANCIAL INCENTIVES: FOR MULTI-USE FOR DEMONSTRATION
- MULTI-USE ZONES IDENTIFIED IN EXISTING AND FUTURE WIND FARMS

2024

MARKET ANALYSIS OVERVIEW – UNITED ECONOMIC SECTORS

Aquaculture market analysis

Aquaculture Policy Push in the EU

The sustainable development of aquaculture is one of the main objectives of the EU **Common Fisheries Policy.** It is also reflected in the **Strategic Guidelines for a more sustainable EU aquaculture** and the **EU Algae** Initiative. Aquaculture production is recognised by the **European Green Deal** as a source of **"low carbon" protein for food and feed.**

Aquaculture Trends

The EU seafood market is heavily dependent on imports to meet its consumption needs. In 2021, imports accounted for 72% of the total seafood supply [3], and 29% of EU consumption came from farmed products [4]. The development of sustainable EU aquaculture offshore plays a key role in meeting the increasing demand for sustainable protein and improving the EU's seafood self-sufficiency. In 2020, the EU aquaculture sector employed around **57,000 people working for approx. 14,000 enterprises.** The enterprises are primarily small, close to the shore, and family-owned.

In terms of volume of aquaculture production per category of species, **more than half is shellfish [5]**, while **marine fish account for around 20%**. The vast majority of EU production is for mussels, trout, seabream, oysters, seabass, carp and clams. More recently, **Integrated Multi-Trophic Aquaculture (IMTA)** has emerged as a space-efficient and environmentally friendly approach. However, to date, the development has mainly relied on a couple of EU research and innovation funded initiatives. In 2020, the 27 EU Member States produced **430.748 tonnes of mussels**, mainly from aquaculture (94% of the total). **Spain** is by far the main producer (47% of the EU production in 2020), followed by **France, Italy, the Netherlands, Denmark, Greece and Ireland**. **Belgium**, on the other hand, has no mussel aquaculture production but is a major mussel consumer. There is, therefore, still much **potential for further growth** and diversification in terms of producing countries and species farmed.

More recently, there has been a substantial focus on **seaweed farming** in Europe. The EU considers seaweed farming to be a **key pillar of its Blue Bioeconomy Strategy**. There are currently **several seaweed startups** in Europe, but production volumes are just in the hundreds of tons and are growing only slowly.

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3 INTRAFISH. 2023. Available at: https://www.intrafish.com/markets/european-union-hits-record-low-levels-of-seafood-self-sufficiency-as-dependence-on-imports-grows/2-1-1330537

4 EUMOFA. 2023. Available at: https://www.eumofa.eu/documents/20178/566349/EFM2023_EN.pdf/95612366-79d2-a4d1-218b-8089c8e7508c?t=1699352554122

5 CINEA 2023. EU aquaculture sector: Socioeconomic development (2008-2020)

Seaweed as an EU Strategic Blue Economy Opportunity

Seaweed can provide raw materials for a wide range of applications due to its diverse composition. Whether red, green or brown, seaweed has a **multitude of different uses**, depending on the species. A variety of seaweed products are already on the market with **competitive value propositions and prices**, as well as significant displacement value of conventional ingredients such as imported soy. Current main markets, including seaweed for **human consumption and hydrocolloids**, are growing steadily, so any new markets will have to compete for biomass with these established supply chains. For instance, methane-reducing additives in ruminant animal feeds represent a totally novel market. This emphasises the **need for significantly increased primary production of seaweed.**

Cost of Cultivated Seaweed Biomass Production as a Key Constraint

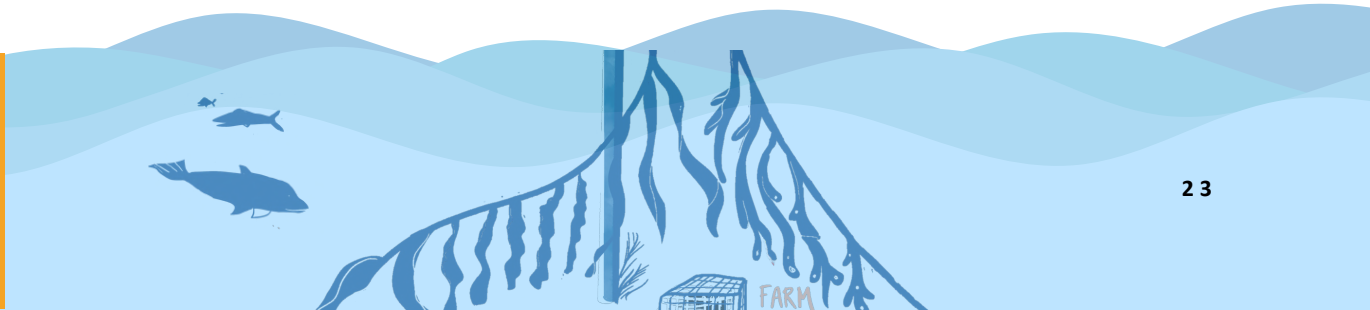
Currently, most of the EU seaweed comes from wild harvested bio-mass and is not cultivated, therefore making it cheaper (e.g. Ireland, which is mostly wild harvest).

The high price of seaweed-derived compounds and the cost of cultivated biomass production are significant constraints for seaweed products market entry. The more the application competes with commodity or commodity-derived products (for example, plastics or construction materials), the greater the pricing challenge. To address very competitive price challenges, bring down the cost of production, and prevent seaweed-based products from remaining a speciality niche, **market-stimulating mechanisms such as subsidies (e.g. a basic payment scheme for farmers, similar to the Common Agricultural Policy) could be introduced.**

Multi-use as an Opportunity for Scaling up Aquaculture Offshore

In response to limited space near the shore, the utilization of further offshore areas for scaling up aquaculture within wind farms has been piloted not only in the UNITED project but also in several subsequent initiatives, including **Mission Ocean ULTFARMS and OLAMUR**. These projects aim to establish commercially viable low-trophic aquaculture production in more demanding offshore environments located within offshore wind farms.

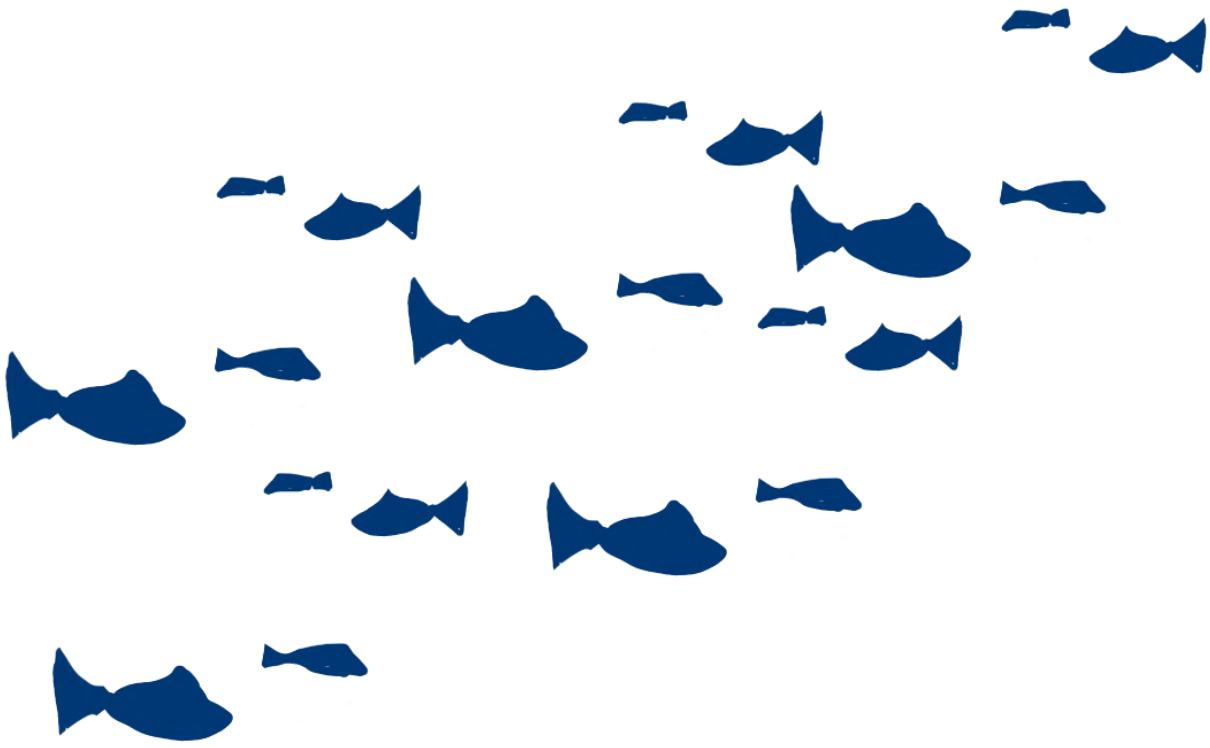
Of all the markets assessed in the World Bank Global Seaweed New and Emerging Markets Report 2023, biostimulants, animal feed additives and pet food markets were identified as the most promising short-term emerging market opportunities for seaweed.



Justifying the 'green premium' via Life Cycle Assessment

Multi-use seaweed-based product developers hope to justify a green premium. However, there is a need for a **Life Cycle Assessment to verify sustainability claims** and to **inform the decision making of policymakers and investors**. Seaweed cultivation offshore has the potential to provide significant ecosystem services – such as blue carbon, bioremediation (e.g. nutrient uptake, pollution mitigation and improvement of water quality), and biodiversity – and the associated potential to improve the business case of developing seaweed-based value chains. Still, monetising these will require the further development of **harmonised certification methodologies and credit schemes**, along with **robust monitoring, reporting and verification [6].**

The SeaMark project will perform a life cycle assessment (LCA) of 12 innovative price-competitive products that encompass the entire value chain, while quantifying ecosystem services provided by seaweed cultivation. This will contribute to a growing body of evidence justifying EU-wide frameworks for both LCA, and quantification and monetisation of ecosystem services.



6 World Bank. 2023. Global Seaweed New and Emerging Markets Report 2023.

VALUE PROPOSITION FOR MULTI-USE IN THE OFFSHORE AQUACULTURE SECTOR

- Multi-use projects with offshore renewables offer the potential for scaling up offshore aquaculture operations and achieving cost savings through combined logistics and operations.
- Sourcing renewable energy for the aquaculture farm locally, such as from wave or solar energy, can reduce costs and enhance the environmental credentials of the aquaculture products, potentially creating a premium product (e.g. certified carbon negative seafood).
- Combining aquaculture with tourism activities such as boat tasting tours or diving can help with the acceptance of the farm due to more local socio-economic benefits, and ensure better promotion and acceptance of its products.

KEY RISKS

- Limited financial capacity of aquaculture farmers to take on the associated risks and liabilities of multi-use projects, especially in the case of combination with offshore renewables.
- Limited 'soft skills' such as marketing, branding and customer service to build a premium product.
- Limited involvement of aquaculture farmers in marine and coastal planning processes. More pilot investigation needed to improve the technology readiness level for a safe scaleup in harsh offshore conditions

KEY ENABLER FOR THE OFFSHORE AQUACULTURE MULTI-USE MARKET ENTRY

- Aquaculture farmers active involvement in the planning process to raise awareness about the benefits of multi-use and discuss possible business scenarios.
- Provision of financial support to aquaculture farmers to test the technologies offshore and test different business models supporting value-added applications of sustainable aquaculture products.
- Integration of sustainable aquaculture as a government requirement in new projects, such as including multi-use as a non-financial tendering criterion or a permit condition.

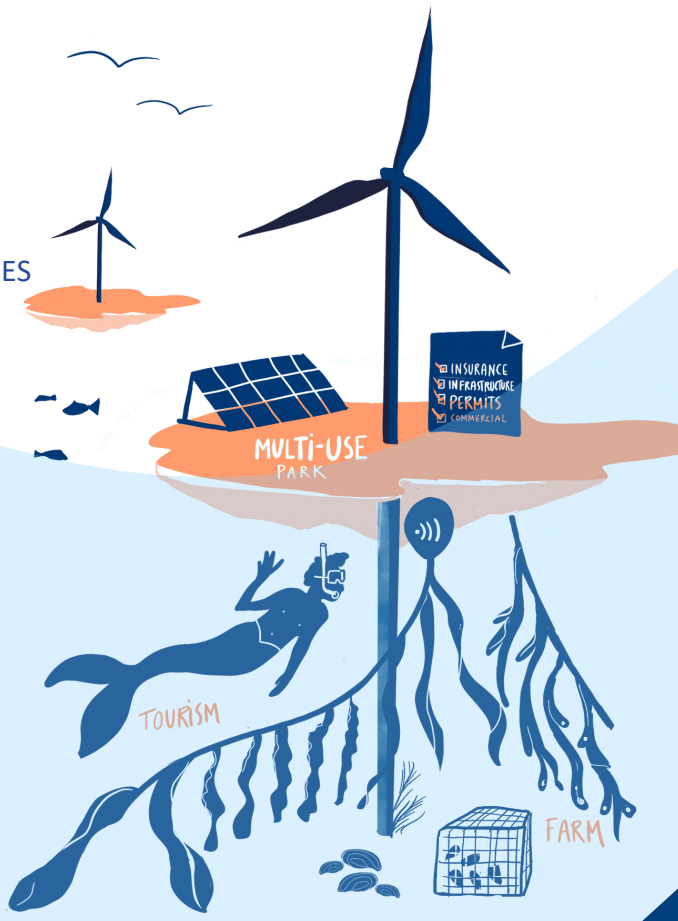
MARKET ANALYSIS AND POTENTIAL

MARINE AQUACULTURE MULTI-USE VISION 2030

Sustainable seafood production was successfully scaled up through collaboration with offshore renewables, and the integration of coastal tourism and local culture has decisively shifted consumer preferences towards greater emphasis on sustainable seafood choices.

2030

- FIRST LARGE-SCALE, LONG TO MEDIUM-TERM COMMERCIAL AQUACULTURE MULTI-USE PROJECT REACHES THE BREAK-EVEN POINT
- EXPANDED MARKET AND CONSUMER PREFERENCES FOR LOW TROPHIC SPECIES (E.G. SMALL OR INVASIVE SPECIES)
- PREMIUM MULTI-USE PRODUCS AND CERTIFICATIONS DEVELOPED
- CLEAR REGULATORY FRAMEWORK AND INCENTIVES
- UNITED BUSINESS MODELS FOR OFFSHORE AQUACULTURE REPLICATED IN OTHER AREAS
- ONGOING FUNDING SUPPORT PROVIDED TO FARMERS FOR OFFSHORE MULTI-USE DEMONSTRATION
- AQUACULTURE AND NATURE RESTORATION MULTI-USE ZONES IDENTIFIED IN MSP (E.G. IN EXISTING AND FUTURE WIND FARMS)



2024

MARKET ANALYSIS OVERVIEW – UNITED ECONOMIC SECTORS

Tourism market analysis

EU coastal areas are amongst the most preferred touristic destinations for European and international travellers, making coastal and maritime tourism the **biggest, growing sector of the EU Blue Economy** in terms of Gross Value Added and employment. Coastal tourism comprises recreational activities taking place in the proximity of the sea (such as swimming, sunbathing, coastal walks, and wildlife watching) as well as those taking place in the maritime area, including nautical sports (e.g. sailing, scuba diving, cruising, etc.).

Over half of the EU bed capacity is concentrated in coastal regions. For the economy of many coastal EU Member States, tourism generates a significant portion of the national revenue. It has a wide-ranging impact on economic growth, employment and social development. Tourism is particularly significant for **Southern European** countries, such as Spain, Portugal, Italy, Malta and Greece. At the same time, coastal tourism is characterised by **high seasonality**, with demand concentrated in a limited number of months, usually July and August. Dealing with seasonality is, in fact, one of the key policy issues in tourism [7].

Although there is still a large market for mass sun and beach tourism, travellers are increasingly seeking unique sustainable experiences, especially in Western Europe. Pure leisure tourism is in decline. The choice of holiday destination is increasingly influenced by **ethics, moral values, concerns about the coastal environment and its ecosystems, including biodiversity protection and a desire to positively impact local communities**. This is especially the case for Generation Y or millennial travellers. Travellers are eager to avoid crowds and look for more remote destinations, which means that these destinations are not expected to remain remote for long.

VALUE PROPOSITION FOR MULTI-USE IN THE TOURISM SECTOR

- The multi-use tourism model offers a diversified portfolio of experiences, which helps mitigate seasonal fluctuations and drives economic growth in rural areas by leveraging local attractions and activities.

7 EUROSTAT. 2023. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Tourism_statistics_-_seasonality_at_regional_level#The_regions_with_the_highest_seasonality_are_coastal_regions

VALUE PROPOSITION FOR MULTI-USE IN THE TOURISM SECTOR

- The multi-use tourism model offers a diversified portfolio of experiences, which helps mitigate seasonal fluctuations and drives economic growth in rural areas by leveraging local attractions and activities.

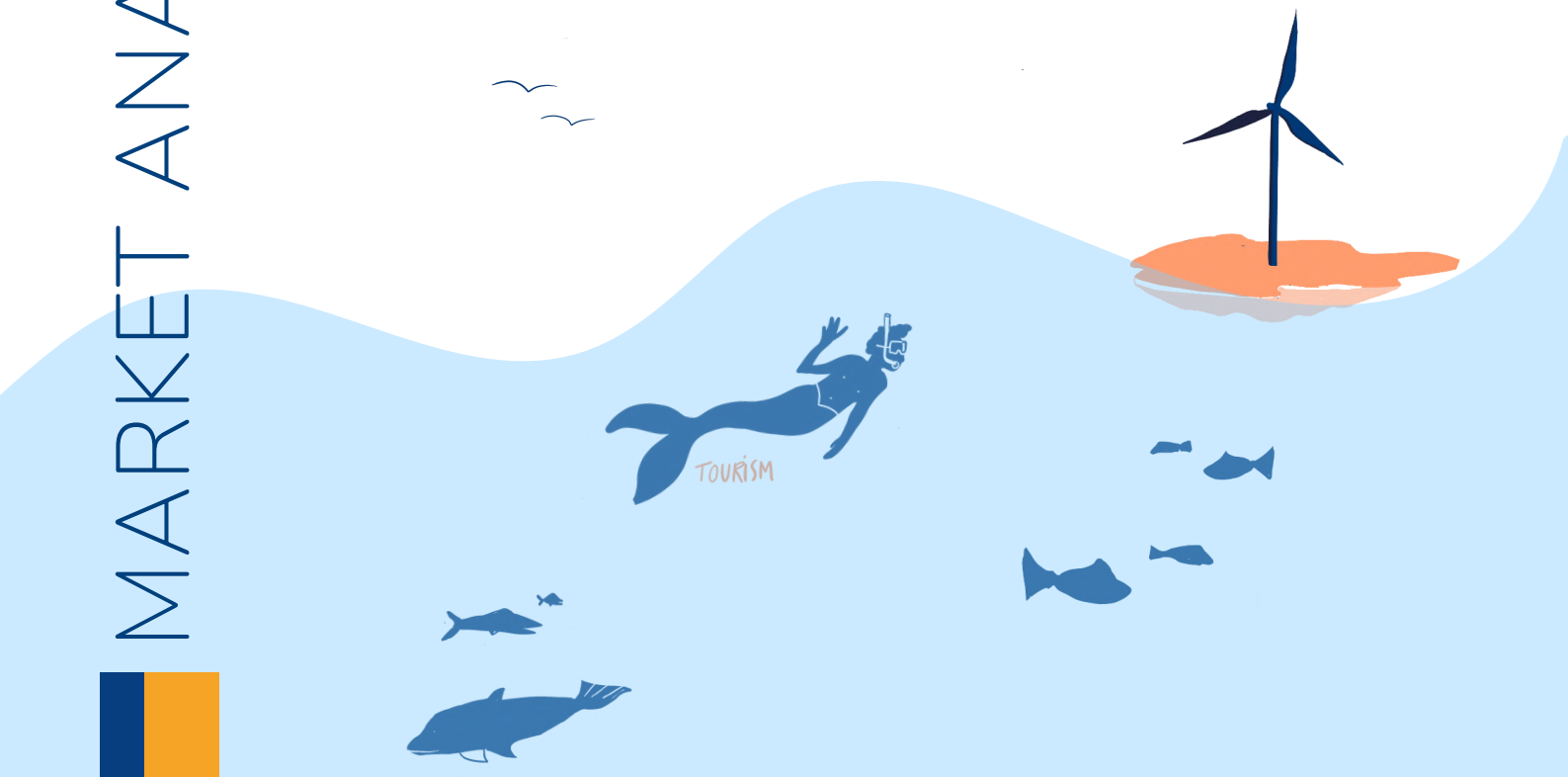
KEY RISKS

- Tourism multi-use should not intended to promote mass tourism, which can strain local resources and infrastructure. To mitigate this, multi-use strategies must be carefully and selectively applied, tailored to each locale's specific re-quirements and capacities

KEY ENABLER FOR THE OFFSHORE AQUACULTURE MULTI-USE MARKET ENTRY

• Raising awareness about the potential benefits of combining tourism with other sectors:

- Incorporate the concept of tourism multi-use into official tourism policies and strategies to increase its visibility and provide incentives for exploring these opportunities.
- Create appealing yet financially sustainable business showcases that connect tourism with the cultural values of the region. For instance, the 'Taste the Atlantic' initiative, an integral component of the Wild Atlantic Way, is dedicated to promoting Ireland's rich seafood culinary heritage. It emphasizes sustainable practices and the use of locally sourced, high-quality ingredients, demonstrating how regional culture, particularly gastronomy, can be employed to enrich tourism offerings and promote sustainability. These collective efforts have effectively attracted tourists to Ireland's coastal regions, significantly contributing to the economic development of the western coast.



MARKET ANALYSIS AND POTENTIAL

TOURISM MULTI-USE VISION 2030

European coastal tourism, interwoven with diverse sectors, offers local communities and travellers a diverse range of sustainable experiences, effectively mitigating seasonality and driving rural economic growth.

2030

- MORE LOCAL SOCIO-ECONOMIC BENEFITS DERIVED FROM THE BLUE ECONOMY VIA TOURISM MULTI-USE
- TOURISM MULTI-USE LINKS BLUE ECONOMY SECTORS TO LOCAL CULTURE AND VALUES
- TOURISM MULTI-USE WELL INTEGRATED INTO THE MARKET FOR SUSTAINABLE ADVENTURE AND RETREAT
- UNITED BUSINESS MODELS FROM DENMARK AND GREECE REPLICATED IN OTHER AREAS
- CLEAR REGULATORY FRAMEWORK AND INCENTIVES FOR INTEGRATION OF TOURISM IN OTHER SECTORS
- FINANCIAL INCENTIVES: FOR MULTI-USE THAT CAN BOOST THE ECONOMY IN RURAL REGIONS
- MSP AND COASTAL DEVELOPMENT PLANS IDENTIFIED ARES FOR TOURISM MULTI-USE WITH MOST SOCIO-ECONOMIC POTENTIAL

2024

MARKET ANALYSIS OVERVIEW – UNITED PILOTS

German pilot

Fisheries and the cultivation of aquatic organisms have a long tradition in Germany. Aquaculture production leans toward **land-based systems** combining different types of production, such as renewable energy like biogas, fish and plant production. Aquaculture makes a minor contribution to the annual food production in Germany.
Offshore aquaculture is still to be developed in Germany. The German maritime spatial plan for the Exclusive Economic Zone (EEZ) does not currently allocate specific areas for aquaculture. However, it does **encourage the development of offshore aquaculture when integrated with other off-shore infrastructures**, such as wind farms. As of the end of 2023, **authorities are actively engaged in studying multi-use approaches** and exploring how they can be integrated into future planning rounds.

According to aggregated data for the Federal States of Lower Saxony and Schleswig Holstein (federal states with access to the North Sea coast), there are approx. 3000 ha of areas are designated for mussel fishing, and up to 500 ha are used for mussel spat production in aquaculture; in total, 12 fishing vessels with special permission for fishing mussels are distributed among 10 companies for a total of approximately 50 direct employees.

The **German offshore wind sector** had 24,400 employees in 2018. Sales have been estimated at a level of around 8.1 billion euros, and in the same year, 2018, the direct gross value added in Germany amounted to 1.9 billion euros. The largest share of direct employees (14.5%) is working in the turbine manufacturing industry.

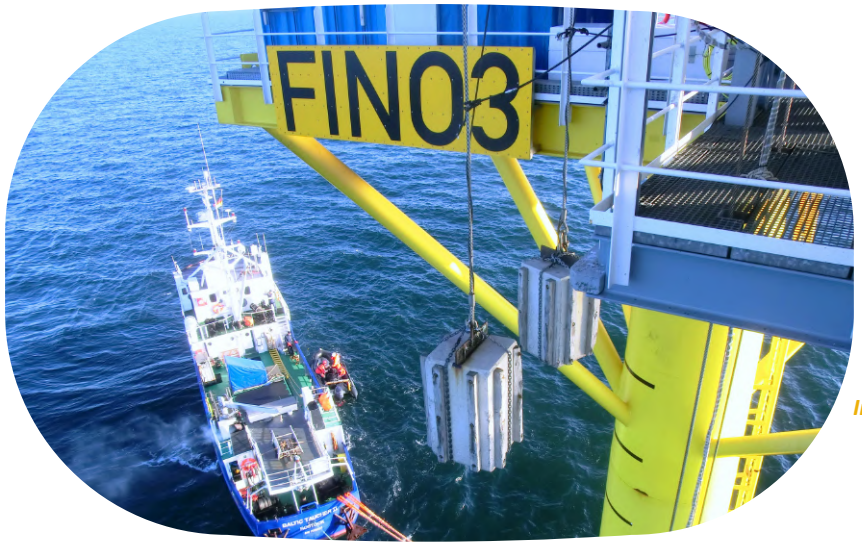


Image 7: German pilot- FINO 3 platform

MARKET ANALYSIS OVERVIEW – UNITED PILOTS

Belgian pilot

Seaweed production in Belgium is currently limited, primarily involving startups. Only three onshore companies are involved in algae (micro and macro) production. Among companies focused on macroalgae (seaweed) exclusively, annual turnover is estimated at 0.164 million EUR, employing 101 individuals.

Oyster production is relatively new, with two companies located near the pilot site in Ostend. One company operates on an 8 to 9-hectare farm, producing flat oysters (10% of total) and common cupped oysters (90% of total) with an estimated annual output of about 30 tons (subject to weather conditions). The second company operates three aquaculture lines, producing around 10 tons per year. The second company is looking to expand its production to 30 plots, each with four aquaculture lines. Therefore, the country's total oyster production could reach around 50 tons per year.

Belgium features **56 offshore wind turbines** with a total installed capacity of 171 MW and an estimated annual production of 550 GWh. The electricity generated serves around 160,000 Belgian households. OWF revenues amount to roughly 30 EUR per MWh, supplemented by a governmental subsidy of 107 EUR per MWh, resulting in annual revenues of approximately 75 million EUR.

Image 8: Impressions from the Belgian pilot

MARKET ANALYSIS OVERVIEW – UNITED PILOTS

Dutch pilot

The Netherlands have a **well-developed shellfish aquaculture** industry focusing mainly on mussel farming. Traditional bottom culture is carried out on 4,000-hectare (ha) culture plots in the Wadden Sea in the north and 2,250-ha plots in the Oosterschelde in the southwest. There is a policy framework for monitoring, research and evaluation.

The Netherlands's goal is to reach approximately **21 GW of offshore wind farms in operation by around 2030**, which would supply 16% of the country's total energy and cover 75% of current electricity consumption. This commitment offers significant economic opportunities, with a substantial domestic market supporting the growth of the Dutch offshore and wind sector.

The country is currently still on a path to having **4.5 GW of operational offshore wind turbines by 2023**, as outlined in the Energy Agreement for Sustainable Growth. This capacity is meant to contribute 3.3% of the nation's total energy supply.

Image 9: Impression from the Dutch pilot

MARKET ANALYSIS OVERVIEW – UNITED PILOTS

Danish pilot

In Copenhagen, a prominent tourist destination, there were 3.19 million visitors in 2019, ranking it **73rd among the world's most popular cities**. Tourism activities generated 7.7 billion EUR (2018), equivalent to 2.5% of Denmark's GDP, with Copenhagen contributing an estimated 847 million EUR (2018).

Denmark boasts **341 offshore wind turbines** with a total installed capacity of 855 MW. The Middelgrunden wind farm, with a capacity of 40 MW, represents 4.7% of Denmark's offshore wind capacity. Annual offshore wind energy production is approximately 100 GWh, and electricity is sold on the Nord Pool market. The profit from electricity sales is anticipated to increase, reaching an estimated 5.4 million EUR per year as electricity prices are expected to rise.

Image 10: Impression from the Danish pilot

MARKET ANALYSIS OVERVIEW – UNITED PILOTS

Greek pilot

Greek marine aquaculture started in the early 1980s, and by 2018, it ranked **2nd in volume and value among the EU Member States in fish farming**. Nonetheless, the aquaculture sector faced challenges due to **economic, regulatory, and bureaucratic obstacles**, as well as social **acceptability issues for coastal aquaculture.**

Greece boasts a vast coastline, numerous islands, and archaeological sites, making it an **attractive destination for scuba diving.** Greece's tourism, is rebounding strongly post-pandemic with a 15.2% increase in travel receipts and a 17.3% rise in tourist numbers in 2023 compared to the previous year, indicating a robust recovery and opportunities for growth. The government has facilitated dive tourism by revising regulations and easing restrictions since 2005. Recreational divers in Greece are typically well-educated men aged 31-50, with a monthly income between 1,201-1,500 euros. Multi-use offer combining diving around sustainable fish farms with educational components aligns with current market interests, especially among **new generations seeking diverse, educational, and adventurous tourism options.** There is a trend towards exploring uncharted destinations, with travellers looking for unique, immersive experiences. There is a significant **interest in nature tourism**, contributing to overall wellness and featuring innovative outdoor activities.

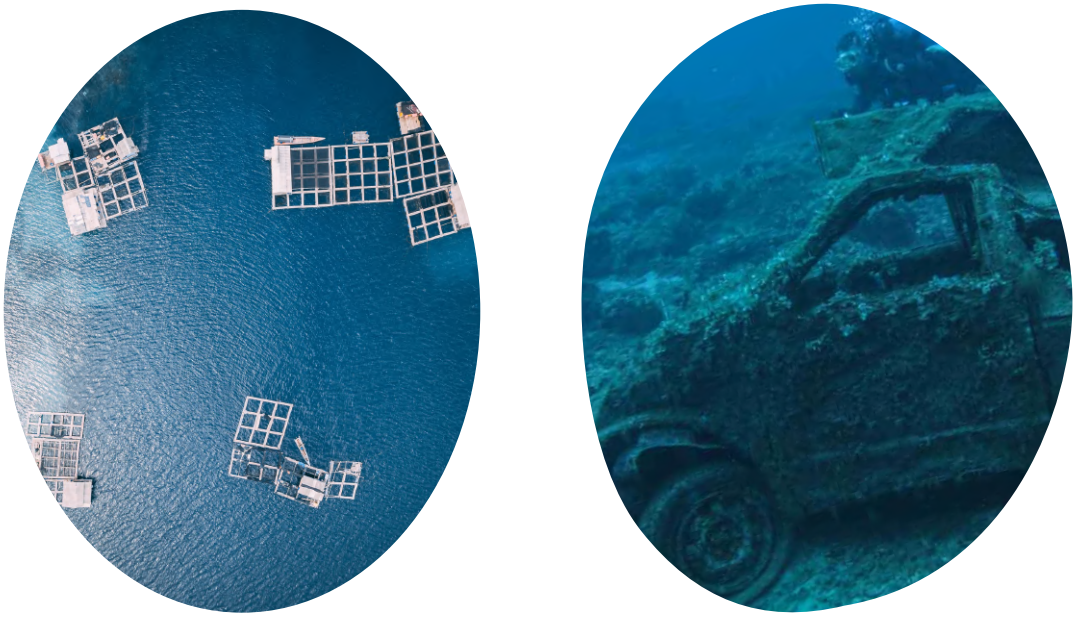


Image 11: Impression from the Greek pilot

REGULATORY & POLICY FRAMEWORK

POLICY AND REGULATION

Navigating the complex regulatory environment is crucial for successful commercialisation. The growth of offshore renewable energy, particularly wind farms, has amplified the need for better sea space management in European waters. Conflicts arise with other marine uses, such as shipping and fisheries, while new activities like sustainable food production seek space within wind farm areas. The concept of multi-use at sea is recognized in many Maritime Spatial Plans across the EU, but practical implementation lags. Table 4 below presents the overview of key regulatory challenges identified in each of the UNITED pilot countries.

Maritime spatial planning (MSP) offers options to stimulate multi-use projects (Belgian and Dutch MSP). While legal complexity and overlapping powers of the authorities seem to hinder the establishment of commercial-scale multi-use projects, MSP can be seen as a driver to start multi-use.

The manner in which the MSP is organized can also have more direct financial implications on a project level. Namely, the Belgian and German MSPs allocate specific uses (e.g. wind, aquaculture) to specific zones and use inflexible safety zones. The Dutch MSP allows for much more flexibility with respect to allowing non-priority uses within several zones of a priority use, such as energy production. In addition, safety zones are flexible in the Dutch MSP, allowing for additional non-priority use to access zones with different priorities. While the latter approach ensures easier adaptation to innovation, it also holds more unknown variables, which translate to more potential risks for insurers. The easier it is to engage in multi-use – especially with respect to mobile activities – in a particular area, the more difficult it is to assess which types and sizes of risks will be introduced in the area and which cumulative risks this can create.

Table 4 Overview of regulatory challenges per pilot (adapted from Marijn et al. 2023)

PILOT	COVERAGE OF MU IN THE MARITIME POLICY	COVERAGE OF MU IN MSP	CHALLENGES / ASPECTS IMPACTING COMMERCIALISATION
BE			Exotic species issue
DE			The development of combining renewable energy production and sustainable food production is still in an experimental phase
NL			Opportunity maps, joint initiatives
DK			No unified application procedure
GR			No MSP adopted yet

Legend:

Green – covered
Blue – some considerations present
Orange – not covered

It is important to take into account different governance approaches between different countries. We can synthesise multi-use in the pilots in a number of governance models:

1. Control, strict planning and regulation which allows MU only within pre-defined zones;
2. Flexibility and adaptive management in which the exact location and modalities of MU are to be defined within larger zones according to a bottom up process and depending on innovation; and
3. "Hybrid" model which culminates the characteristics of the first two models into one at different governance levels.

Governance takes place at several levels, such as the central authority level, the regional, sectorial and/or local authority level. Governance is present even at the level of the established private operator with significant power or leverage to (dis)allow any additional multi-use activity.

	FIXED structures activity Wind farms, aquaculture	Mobile activity Fisheries, shipping, tourism
Model 1 BE, DE	Predefined zones, strict procedure, top down	Strictly regulated, prohibited within zones with fixed structures
Model 2 BE, GR	Flexibility within zones, adaptive procedure, bottom up, innovation driven	Flexible applications of safety distances, opens options to operate within zones with fixed structures
Model 3 DK	Predefined zones, strict procedure, top down	Flexible applications of co-use, opens options to operate with fixed structures

Figure 1 Governance framework schemes in the Netherlands, Germany, Belgium, Denmark and Greece (adapted from Marijn et al. 2023)

Learn more about policy and regulation from the UNITED Case specific report on legal aspects and insurance issues. 2023.

SCAN ME

Key recommendations for the EU level policy

MSP Directive Update

The revision of the Maritime Spatial Planning (MSP) Directive should provide more specific guidance on offshore multi-use. These updates should incorporate key principles for multi-use, drawing from the research projects and best practices implemented by Member States. The revised Directive should emphasise a space-efficient approach that promotes integration and a systems-based solution. Rather than focusing on economic agglomeration, the EU should adopt a holistic approach that ensures better integration of crucial priorities, including nature protection, food security, and energy sustainability.

Mainstreaming Multi-Use in Sectoral Policies

The concept of ocean multi-use intersects with multiple sectors and cross-cutting policies. As such, it should gain greater visibility across relevant EU sectoral policies and regulations, such as the European Tourism Strategy and the EU Nature Restoration Law. This higher level integration of multi-use in EU policies will promote coherence in the application of multi-use practices and principles throughout the EU.

Integrate the topic of multi-use in ongoing foras

such as the Blue Forum or MSP Global, as well as in the relevant sea basin level fora such as the North Sea Political Cooperation on offshore wind.

Key recommendations for the National level policy

Comprehensive legal framework for multi-use, and inter-administrative cooperation:

For multi-use to thrive, both a legal framework and incentives for profitability are essential. The urgent development of a legal framework and improved cooperation between administrations are crucial for realizing MU's potential. The concept of a 'one-stop shop' for administration remains challenging to achieve in practice. Lowering the administrative burden might positively impact the rentability of MU projects. At present (rather low) rentability plays a role in the slow emergence of MU in European seas.

Integration of Multi-use in Maritime Spatial Plans

e.g. Area Passport in the NL and in the relevant sectoral plans and policies. Identification of multi-use zones and regulations.

Integration of multi-use in the tendering criteria of offshore wind

Development of experimentation zones

with reduced legal requirements could promote innovation and results of such projects would build the evidence base and confidence of planners, regulators and developers for future MU implementation

EXAMPLE: MariPark Concept

The concept of MariPark, a sustainable and nature-inclusive business park at sea, has been developed in the framework of the North Sea Community of Practice and eMSP project led by the Dutch government. The aim of the MariPark is to reduce costs and risks for multi-use developers by identifying a suitable area for and developing an offshore wind farm (OWF) use combination park, including physical infrastructure and governance support before 2030. The infrastructure aspect focuses on providing anchors, using buoys to mark the boundaries of multi-use areas, providing docking facilities, floating harbours, working areas, drones for monitoring, and shared use of ships, as well as shared services like security, safety, and insurance.

The governance aspects focus on providing permits for the entire area so that developers can easily access permits for their activities through a one-stop-shop process. However, such approaches should not encourage excessive clustering at sea, and the suggested flexibility should not compromise the order, long-term planning, and certainty that marine spatial planning aims to provide.

EXAMPLE: Area Passport and non-financial tendering criteria

A noteworthy example aimed at promoting multi-use (MU) is found in the Netherlands, where a concept called "area passports" is being implemented to guide multi-use within offshore wind farms. Within these wind farms, an indicative zonation designates specific zones for priority and non-priority uses. In this context, non-priority uses are permitted in the zones primarily allocated for renewable energy production. This allows various activities to apply for permits to develop within the wind farm without requiring formal authorisation from wind farm operators. It's essential to clarify that this form of MU is envisioned specifically for "new" offshore wind farms, not for existing ones. In the Dutch part of the North Sea, an offshore renewable energy installation zone has been introduced to optimise the coexistence of both traditional mobile activities and new fixed installation activities, thus reserving an area for future use by these installations.

The Dutch Offshore Wind Energy Act incorporates four permit allocation methods, which include a comparative assessment. Under the comparative assessment, additional ranking criteria may be introduced through ministerial regulation. These criteria can be location-specific or serve a one-time role based on additional social considerations, particularly

concerning innovation, such as nature, aquaculture, fisheries, safety, or shipping. For example, the licensing scheme and tender process for Hollandse Kust (north) and Hollandse Kust (west) Site VI introduced a criterion aimed at promoting innovations that facilitate the integration of future wind farms into the Dutch energy system. Additionally, an expert committee overseeing the tender for the Hollandse Kust (west) Site VI included "contribution to the ecology of the North Sea" as a criterion within the comparative assessment. Applications were evaluated based on the following criteria:

1. The financial offer's amount.
2. Certainty of the wind farm's completion, considering the knowledge and experience of the involved parties and the financial guarantees provided by the parent company(s).
3. Contribution of the wind farm to the energy supply.
4. Contribution to the ecology of the North Sea.

This ecological criterion was further divided into two components:

1. Encouragement of investments to support the naturally occurring biodiversity, including species, populations, and habitats, in the Dutch North Sea.
2. Promotion of innovation and the development of solutions to benefit the naturally occurring biodiversity in the Dutch North Sea from the wind farm at Site VI and future Dutch offshore wind farms.

See all UNITED Policy Briefs

SCAN ME

INSURANCE

In the risk assessment conducted for the UNITED pilots in 2021, the inadequate insurance policy was ranked the top risk for the multi-use undertaking, jeopardising its commercial viability.

While the existing insurance policies may be sufficient for the added use, altering existing policies or getting a new one may be needed in some cases. Several factors can affect the price of the novel policy, including the unknowns and risks associated with the novelty of multi-use, the imbalance between parties involved and market corrections. The following recommendations are based on the general findings of the UNITED pilots, many of whom have gone through processes for obtaining insurance.

Recommendations for the multi-use innovators:

1. **Avoid Overlapping Insurance** by assessing existing policies for sufficient coverage before taking out novel insurance.

2. **Risk Assessment and Novelty of multi-use:**
   - Insurance fees are influenced by the inherent risks in the offshore project.
   - Projects located near vulnerable areas or those that involve food or feed production in high-traffic zones can increase risks.
   - The transformation of research projects into commercial endeavours can raise insurance fees.
   - Lack of historical data due to the novelty of multi-use leads to higher fees.

3. **Provide a detailed Project Description**, including risk assessment, consequences, mitigation measures, and impact analysis for insurers to create a meaningful risk matrix.

4. **Staff Training and Equipment Security:**
   - Demonstrate that all project partners have well trained staff and secure equipment.
   - Collaborate with experienced subcontractors to reduce risks.

5. **Risk Reduction Strategies:**
   - Detail how the project plans to reduce damage in case of risk materialisation, including equipment testing and risk scenario simulations.
   - Employ technologies like remote operated vehicles (ROVs) and weather stations for timely incident logging and risk reduction.

6. **Ensure clear Visibility and Marking** of multi-use projects with visible buoys to reduce the risk of collisions.

7. **Flexibility and Delay Considerations:**
   - Consider flexible starting dates for insurance policies or overestimating project duration to accommodate potential delays.

8. **Addressing Imbalance** Between multi-use Parties:
   - When MU projects are deployed in areas already occupied by others, cost-sharing mechanisms or coordination to minimise risks can help distribute insurance costs fairlys

9. Have a clear **Contractual Waiver of Recourse** among project parties to avoid claims above the insured limit.

10. **Consider Market-Driven Factors** for insurance policy like limits, deductibles, and coverage options to strike the right balance between risk and cost.

Recommendations for insurers:

1. Flexible Assessment of Permit Requirements: Insurers should be adaptable in assessing permit requirements, considering the specific project context. While detailed requirements offer clarity, they should also account for the latest scientific methods and flexibility where necessary to avoid undesirable outcomes.

2. ISO Standards for Reassurance: ISO standards related to fisheries and aquaculture can provide insurers with reassurance when adhered to. These standards offer flexibility and can be adapted or partially complied with to suit the project's needs.

3. Risk Assessment Data Sharing: Insurers can collaborate with multi-use pioneers to collect and share data on the project, enhancing their understanding of multi-use risks and potentially lowering insurance fees.

4. Incentives for Low Loss Ratios: Insurers can consider offering bonuses for low loss ratios or premium reductions for claim-free years as incentives to multi-use users for responsible risk management.

Recommendations for regulators:

1. Standardisation of Permit Requirements: Regulators should consider standardising permit requirements, balancing clarity with the flexibility to adapt to specific project needs. The use of ISO standards can be advantageous for reassurance.

2. Consideration of Scientific Methods: Ensure permit requirements are based on the best and most recent scientific methods to reduce the risk of harm and ensure compliance with environmental and safety standards.

3. Adaptable Marine Spatial Plan to allow for innovation: When planning Maritime Spatial Planning (MSP), regulators should balance flexibility and predictability. While flexibility allows for innovation, it should be structured to minimise unknown variables and potential risks for insurers.

4. Incentivise Collaboration: Encourage collaborative initiatives between multi-use partners from the beginning, allowing them to design projects that minimise risks and avoid MU conflicts.

Recommendations for policy makers:

1. Government-backed Insurance Funds: Consider the creation of government-backed insurance funds to assist in insuring against multi-use-related risks, especially for damages from natural disasters or unforeseen events. Such funding can make multi-use projects more financially viable.

2. Private Insurance Incentives: Promote private insurance incentives like those for agricultural crop loss due to natural disasters. This can stimulate multi-use initiatives and help cover the loss of production and profits.

3. Pooling Insurance: Encourage multi-use users to pool insurance to lower fees, potentially through the establishment of insurance funds for multi-use projects.

4. Leverage European Maritime Fund: Explore the potential for the European Maritime, Fisheries, and Aquaculture Fund (EMFAF) to support insurance schemes for aquaculture and damages from natural disasters in the context of multi-use. Advocate for the use of the fund in subsidising multi-use insurance.

EXAMPLE: Insurance policies used in UNITED Belgian pilot

Partners of the Belgian pilot took out a novel insurance policy for both insurance of assets and liability. University Gent is the principal insured party. As University Gent is a public institution the policy was obtained via a tendering procedure. There is a financial cap for the liability poli-cy, set at 10 million euros, as was the minimum demand of the concession holder of the wind farm. In a distinct contract with the wind farm operator, each party ensured it would waive recourse to one another beyond the cap of 10 million euros. Every alteration to the project must be communicated to the insurer accompanied by a method statement and simulation of the impact of the change. Given that the pilot is taking place in a wind farm that is already in concession, there was little leeway for the additional MU user to negotiate with the concession holder on the necessary terms and guarantees required by the concession holder. When novel maritime areas are taken into use for wind farms, this imbal-ance between parties will likely repeat itself when concessions are granted for wind farms and other MU users once again need to deal directly with the already present wind farm concession holder.

Key lessons learned for future multi-use endeavours

- Anticipate and address potential imbalances between parties, particularly when new users enter established maritime areas with existing concession holders
- Establish clear communication channels and mechanisms for negotiating terms and guarantees with concession holders
- Define financial caps for liability policies, setting parameters for waiving recourse beyond these caps, and providing a structured process for communicating project alterations to insurers in multi-use insurance arrangements, especially in situations where established stakeholders are involved.

Learn more about insurance issues from the UNITED full D6.2 and D6.3 reports online

SCAN ME

TOWARDS VIABLE BUSINESS MODELS AND INVESTMENT STRATEGIES

This chapter presents the key recommendations from the assessment of various business models and investment strategies tailored to each multi-use combination covered in UNITED project. It draws insights from the experiences of UNITED pilots and encompasses a spectrum of approaches such as public-private partnerships, joint ventures, and stakeholder collaborations. The chapter explains the factors influencing project profitability for each multi-use combination, including project duration and scale, product and service development, intellectual property considerations, and key recommendations for cost savings.

The sections below provide key recommendations for addressing key actors, indicated by the following symbol:

OFFSHORE RENEWABLES AND AQUACULTURE

The economic analysis and business model canvas has been developed for the multi-use combination of offshore renewables and aquaculture across three pilots within the UNITED project, spanning Germany, Belgium and the Netherlands. Drawing upon the key learnings derived from each pilot, the following chapter presents several key factors that can affect the commercialisation of this multi-use activity.

Duration of the project

Duration can affect profitability of the offshore renewables and aquaculture multi-use project. In assessing the business models for offshore wind and blue mussels (Mytilus edulis) aquaculture multi-use pilot project in the German North Sea, it became evident that profitability in the short term, particularly within a four-year project duration, remains a challenge. Given the substantial initial investment costs involved, the feasibility and profitability are more likely to be realized over the medium to long term e.g. beyond 5 year duration.

ENCOURAGE MEDIUM TO LONG TERM MULTI-USE PROJECTS DURATION TO ENHANCE FINANCIAL VIABILITY

Policymakers

SYNCHRONISE THE ANTICIPATED OPERATIONAL LIFETIMES OF THE ECONOMIC ACTIVITIES, PARTICULARLY FIXED INSTALLATIONS, ENGAGED IN MULTI-USE

DEVELOP COORDINATED EXIT STRATEGIES AT THE PROJECT'S INCEPTION: OUTLINE HOW ONE BUSINESS CAN EXIT OR DECOMMISSION WHILE MINIMIZING DISRUPTION TO THE OTHER.

This may include a phased decommissioning approach or transitioning responsibilities. Consider insurance policies tailored to the specific risks such as business interruption insurance or policies that cover the costs of decommissioning.

Developers

Size of the multi-use project

Size is another critical factor influencing profitability. Economies of scale come into play, with a key milestone termed the 'break-even point.' The UNITED analysis (see QR code below) reveals that smaller setups, such as the one at German pilot FINO3, harvesting 12,750 kg mussels annually at a price per kg of €2, operate at a loss. In contrast, larger theoretical setups, like the one at the Nordergründe wind park, harvesting 2,380,000 kg annually at a price per kg of only €1, exceed the break-even point when investment costs are not considered [7]. The break-even point is contingent upon various factors, including investment and operating costs, as well as market mussel prices.

DEVELOPMENT OF LARGER OFFSHORE AQUACULTURE SETUPS IS NECESSARY TO REACH OR EXCEED THE BREAK-EVEN POINT

Policymakers, Planners, Developers, NGOs, Academia

See UNITED Deliverable 1.3 Business Analysis of UNITED pilots

SCAN ME

[7] Machbarkeitsstudie: Offshore-Aquakultur am Standort der Forschungsplattform FINO3 -Teil 1. Geisler, R., Schulz, C., Michl, S.C., Strothotte, E. 2018

Product development and market positioning

Product development and market positioning should focus on the premium products using mussels and seaweed cultivated in the offshore wind farm, to achieve higher prices and reach the break-even point sooner. These premium products could be positioned in the market as high-quality, sustainably-sourced options for the discerning market that value sustainability, health-consciousness, and premium quality. Examples could include gourmet mussel varieties, specialized seaweed-based food products, or unique health supplements derived from seaweed. Offshore multi-use can be emphasized as the unique selling points of the products, promoted for their contribution to low spatial and environmental impacts, carbon-fixing proper-ties, and contribution to water purification. Recognized sustainability certifications, such as the Aquaculture and Marine Stewardship Council (ASC, MSC) for mussels and various organic or sustainable certifications for seaweed, can significantly enhance the marketability of products.

EXPLORE PREMIUM PRODUCT AND SUSTAINABILITY CERTIFICATIONS DEVELOPMENT BASED ON THE LOW SPATIAL IMPACT OF MULTI-USE AND WHERE APPLICABLE ALSO ON LOW TROPHIC AQUACULTURE

Developers, Certification bodies, Academia

Cost savings by sharing resources and processes

Cost savings by sharing resources and processes is evident based on the available data from the German, Belgian and Dutch pilots, there are opportunities for cost savings by sharing resources and processes, such as transportation, monitoring, maintenance work, land-based and offshore facilities, staff training, and insurance premiums. Drawing from insights gained from the Dutch pilot on offshore solar and seaweed multi-use, a seaweed farm if combined with a solar energy generation could potentially benefit from the locally supplied electricity. These cost savings and benefits are particularly significant for the aquaculture segment. The financial benefits of multi-use may not be substantial enough to incentivize participation from the offshore wind sector, primarily due to concerns about potential negative impacts on their core operations. Thus, for the OWF, non-monetary benefits may play a bigger role.

INCENTIVISE THE OWF SECTOR IN A REGULATORY OR FINANCIAL SENSE TO VENTURE INTO MULTI-USE

Policy makers, Planners

Non-financial benefits

Non-financial benefits become especially evident in cases where nature inclusive design has been applied or nature restoration activities take place such as the case in UNITED Belgian pilot. Moreover, 'regenerative aquaculture' offshore can potentially bring in several environmental benefits - seaweed have carbon fixing properties while shellfish purify the water. Both algae and mussel do also not need to be fed, so no input of nutrients is needed to grow mussels and algae.

PROMOTE NON-FINANCIAL BENEFITS OF MULTI-USE, SUCH AS ENHANCED OPERATIONAL RESILIENCE AND ENVIRONMENTAL STEWARDSHIP, TO ENGAGE THE OFFSHORE WIND SECTOR EFFECTIVELY

Policy makers, planners

Investment strategies

Investment strategies still heavily rely on the public funding and private donations. So far, only partial investments have flown from the offshore wind developers for the research projects. The three pilots of UNITED focus on the renewable energy and aquaculture will take next steps in the framework of UNITED follow up project ULTFARMS and Amazon funded project in the Netherlands. For more actual investments from the industry, a clear regulatory requirement or incentive must exist such as the tendering criteria for certain suitable zones. Passive fishing and farming in wind farms could be supported in the framework of the Common Fishery Policy also as a way to support the transition to a more sustainable/environmentally friendly fishing gears.

While the aquaculture farmers are the ones to benefit the most their current financial capacity in many of the EU countries is low for such offshore endeavours. As the risk of loss of production due to bad weather is very high in these early stages of offshore multi-use, they will remain to rely on the public support for such developments, thus countries where sustainable local seafood scaleup is a priority may need to financially step in. Collaborative funding across countries and regions could also be an option identifying the suitable sites with transferable environment across the regions where the evidence collected can be required to feed into several planning processes. This could allow for the better alignment of the future multi-use related policy and regulation in the region, esp. relevant for the projects and industries that operate across borders. Collaborative funding between private and public funders should be further explored e.g. Amazon has recently donated into the Dutch pilot to support the development of a first commercial seaweed farm in the offshore wind farm.

For the nature restoration within offshore wind farms there are no business opportunities apart from corporate social responsibility. Thus these initiatives may need to rely on innovative ways of funding such as 'adopt a marine animal' programs [8], following similar initiatives for other species. Funding via the universities and research institutes for education and research – they can derive indirect benefits from technology development that can be sold elsewhere in the form of an IP technology transfer or consulting services

PROMOTE NON-FINANCIAL BENEFITS OF MULTI-USE, SUCH AS ENHANCED OPERATIONAL RESILIENCE AND ENVIRONMENTAL STEWARDSHIP, TO ENGAGE THE OFFSHORE WIND SECTOR EFFECTIVELY

Policy makers, planners

KEY MILESTONES TOWARDS REALISING BUSINESS OPPORTUNITIES

2025

Successful establishment of a business model that capitalises on the minimal spatial footprint of multi-use for the development of premium, certified sustainable product. e.g. demonstrated by the ULTFARMS and OLAMUR projects.

2026

Completion of a pilot scheme exploring innovative funding streams for multi-use initiatives, especially those with indirect economic benefits, including ecosystem restoration and the integration of blue corridors in wind farms.

2028

Achievement of the first large-scale commercial multi-use project with an annual mussel har-vest exceeding 2,000 tons, reaching financial break-even in the medium to long term.

2030

Successful integration of multi-use concepts within offshore energy island developments, with Dogger Bank Wind Farm as a reference case.

[8] More info available at: https://support.wwf.org.uk/adopt-a-marine-animal

OFFSHORE WIND AND TOURISM

Based on insights from the Danish pilot in UNITED, the commercial effectiveness of offshore wind and tourism multi-use combination predominantly relies on several key factors listed in this chapter.

Project location

The coastal and maritime spatial plans can have an important role in mapping the areas where this combination can bring the most socio-economic benefits to the region e.g. rural areas in a need of an economic boost. Moreover, on the project level, the break-even point is influenced by the distance to the shore. The farther the wind farm, the longer the tour, and consequently, the higher the tour cost to cover fuel and personnel time. Moreover, to maintain tourists' interest during the long ride, additional activities need to be offered, affecting the overall cost.

BOAT RIDES TO WIND FARMS LOCATED FAR OFFSHORE, EXTENDING BEYOND TWO HOURS, MAY POSE CHALLENGES IN MAINTAINING TOURISTS' ATTENTION AND COULD BECOME PROHIBITIVELY EXPENSIVE WHEN COMPENSATING FOR FUEL AND HUMAN RESOURCE COSTS

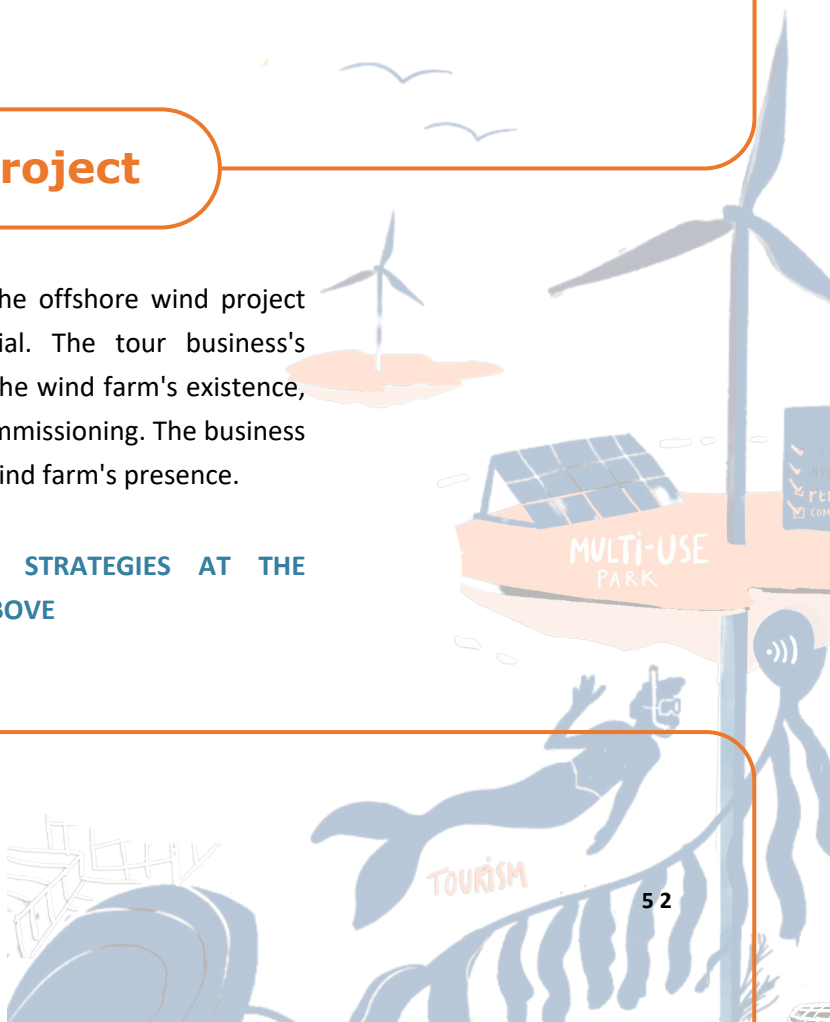
Developers

Duration of the project

Aligning the operational life of the offshore wind project with the boat tours is essential. The tour business's sustainability is closely linked to the wind farm's existence, as it can cease to exist after decommissioning. The business plan for the tours hinges on the wind farm's presence.

DEVELOP COORDINATED EXIT STRATEGIES AT THE PROJECT'S INCEPTION. SEE 5.1 ABOVE

Developers



Seasonality

Tours are highly weather-dependent and are more frequent during warm, dry summer months. This seasonality can be synchronized with offshore wind farm maintenance to prevent conflicts. For example, maintenance can be scheduled during the colder winter months. However, any boat accessing the turbines requires calm seas. In the case of UNITED Middelgrunden pilot, boat tours have also fluctuated due to the covid restrictions, reaching 75 annual trips in 2022, generating a turnover of 102,000 EUR, a big jump compared to the two previous years affected by covid restrictions.

Promotion and marketing positioning

Precisely targeting the right market segment, including those with a keen interest in offshore engineering and renewables, holds paramount importance. This primarily involves engaging with universities, offshore developers, and potential investors in offshore wind projects. The recent success of the Danish pilot can be largely attributed to the UNITED project's effective communication strategies. These strategies include promoting tours through QR code virtual tours integrated into museums and prominent landmarks throughout the city, featuring in journal articles, and gaining television coverage. This heightened exposure has proven instrumental in attracting an increasing number of tourists, particularly from the academic, wind development, and corporate retreat sectors.

Additionally, the adoption of green-certified boats can augment the eco-friendly aspect of these tours, effectively appealing to sustainability-conscious tourists, mirroring the positive outcome observed in the Danish pilot. While this multi-use combination may not be suitable for large-scale expansion at a single location, its broader adoption across diverse locations should be explored. Rather than limiting tours to one wind farm, many wind farms, especially those located in rural areas, should consider allowing tours to raise awareness and maximize the local socio-economic benefits accrued.

COLLABORATE WITH LOCAL TOURISM BOARDS, MUSEUMS AND EDUCATION PROVIDERS TO FORM SUITABLE TOUR CURRICULA AND PROMOTE IT

Developers

Cooperative ownership

Cooperative ownership should be considered as it can facilitate tour creation or other offshore wind related tourism or recreational activities. As seen in the case of the Danish pilot, it brings significant economic benefits to local communities.

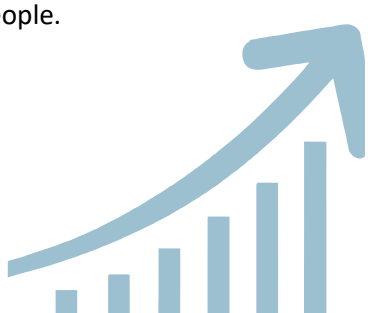
SEE PAGE 13 FOR AN EXAMPLE OF COOPERATIVE OWNERSHIP IN MIDDELGRUNDEN WIND FARM, WHICH WAS PARAMOUNT IN FORMING AND PROMOTING THIS MULTI-USE

Non-financial benefits

Non-financial benefits, including raising awareness about the importance of offshore renewables, offering an additional source of recreation, serving as a regional landmark, and a source of pride, have been evident in the Middelgrunden farm's case. This combination can be particularly beneficial for rural regions in need of an economic boost.

Investment strategies

Offshore wind developers can play a pivotal role in securing local benefits, for instance, by contributing to community funds. Governments should take the responsibility of equitably distributing these funds. Currently, tours are organized through small investments from boat tour companies and cooperatives. Enhancing the visibility of these business opportunities in local strategies and coastal plans is essential to ensure government support for sustainable aware-ness-raising activities, potentially through community funds or to support small-scale, sustainable tourism businesses. Offshore wind-related tourism can receive financial backing by positioning itself as educational tourism, fostering collaborations with universities for excursions and partnering with offshore renewable companies for corporate re-treats. Government entities responsible for education and tourism should actively participate in distributing funds to support this initiative, as it has the potential to enhance the image of and interest in the engineering sector. This is particularly significant in addressing the low interest in studying engineering in northern Europe among young people.



KEY MILESTONES TOWARDS REALISING BUSINESS OPPORTUNITIES

2024

Widespread adoption of economic models to pinpoint areas with the greatest potential for maximizing local socio-economic benefits in multi-use combinations.

2025

Successful replication of existing business models (e.g., inspired by the UNITED pilot, such as the cooperativeorganized Middelgrunden wind farm tours) in various locations

2026

Establishment of a comprehensive market ecosystem centered around wind farms, transform-ing them into cultural attractions, akin to the status enjoyed by traditional windmills

TOURISM AND AQUACULTURE

Based on insights from the Greek pilot in UNITED, the commercial effectiveness of aquaculture and tourism multi-use combination predominantly relies on several key factors listed in this chapter.

Project location

The break-even point for profitability is affected by the farm's distance from the shore. Farms located farther from the shore are more challenging and expensive to reach. Rural regions can benefit significantly from this venture.

Developers

Marketing link to culture and purpose

In addition to sustainable volunteering activities such as underwater litter collection, culinary experiences like tasting and developing products, and joint cooking at the restaurant using collected items, exploratory dives with specific themes should be considered. These offerings align with the experiential tourism interests of the Y and Z generations.

Branding

Incorporate branding directly onto aquaculture product packaging, featuring images of divers and providing QR codes for tours. Integrate branding in restaurant menus where the fish is served, with virtual aquaculture farm diving tours and phrases like "Check out where the fish is from" or "Come dive with us and meet the famer”.

Skills dependent

Success in this multi-use venture relies heavily on the marketing and soft skills of aquaculture farmers, including customer relations, service and tour guiding, adventure development, marketing, branding, and premium product development. Establishing relationships with the local tourism board, agencies, conferences, research universities focused on marine science, maritime museums, and aquariums is crucial.

Non-financial benefits

This multi-use endeavor also provides non-financial benefits, especially in raising awareness about sustainable aqua-culture and influencing seafood preferences toward more sustainable low-trophic species like small fishes, seaweed, and shellfish.

Investment strategies

Government sustainable fishery incentives have primarily funded the development of this activity, as they support the transition in fisheries and offer an alternative income source for farmers. For instance, a German pilot aquaculture farm diversified its income by offering tours to its close-to-shore aquaculture facility and providing educational tours to schools during the COVID-19 pandemic when restaurant orders were low. These educational tours played a crucial role in sustaining the business.

To further stimulate ongoing growth and progress in the industry, government financial investments remain essential. These investments can manifest as subsidies and grants extended to sustainable aquaculture farms, serving as vital incentives for industry expansion. Moreover, supporting value-added applications of sustainable aquaculture products through financial aid, technical assistance, and market insights will encourage product diversification, expand the range of offerings derived from seaweed and shellfish, and enhance the industry's overall competitiveness.

KEY MILESTONES TOWARDS REALISING BUSINESS OPPORTUNITIES

2025

Growth in the market for low trophic species driven by increased demand for aquaculture products, like small fish and invasive species, influenced by tourism and leisure activities e.g. Round Goby project in the Baltic Sea.

2026

Diversified tourism offerings, leading to enhanced local socio-economic benefits in rural regions.

FUTURE PILOT ACTIONS TO PROMOTE MULTI-USE COMMERCIALISATION

To advance the development and commercialization of multi-use projects, several critical steps should be taken:

ENHANCE COMMERCIAL READINESS: SUPPORT DEMONSTRATION PROJECTS THAT FOCUS ON ENHANCING THE COMMERCIAL READINESS OF MULTI-USE INITIATIVES, INCLUDING COMPREHENSIVE BUSINESS CASE DEVELOPMENT TO SHOWCASE THE BENEFITS AND POTENTIAL FOR SCALE-UP

Policy makers

LONG-TERM ENVIRONMENTAL IMPACT ASSESSMENT: IMPLEMENT LONG-TERM MONITORING AND MEASUREMENT OF ENVIRONMENTAL IMPACTS POST-IMPLEMENTATION TO ENSURE SUSTAINABILITY AND PROVIDE VALUABLE DATA FOR FUTURE PROJECTS

Planners, Regulators, Developers

UTILIZE OFFSHORE DEMONSTRATION ZONES: DEVELOP NEW OFFSHORE DEMONSTRATION ZONES AND LEVERAGE EXISTING ONES TO PILOT MULTI-USE PROJECTS EFFECTIVELY. NOTABLE EXAMPLES INCLUDE THE NORTH SEA FARMERS OFFSHORE TEST SITE, WHICH SERVES AS AN INCUBATOR FOR START-UPS AND SCALE-UPS IN THE FIELD

NGOs, Academia, Developers

ESTABLISH DATA SHARING PLATFORMS: CREATE SEA BASIN-WIDE DATA SHARING PLATFORMS AND PROTOCOLS SPECIFICALLY DESIGNED FOR MULTI-USE-RELATED DATA. THIS INCLUDES INFORMATION ON IMPACTS, RISKS, AND COMPREHENSIVE LISTS OF TECHNOLOGY AND INSURANCE PROVIDERS TO FACILITATE INFORMED DECISION-MAKING AND COLLABORATION

Policymakers, Planners, Developers, NGOs, Academia

STAKEHOLDER ENGAGEMENT, CAPACITY BUILDING AND COMMUNITY BENEFITS

Stakeholder engagement plays an important role both in building constituency on the maritime spatial planning level as well as during the inception of an offshore multi-use project. Multi-use projects have the potential for positive social and economic impacts, such as job creation, community development, and enhanced sustainability, if planned carefully and in collaboration with stakeholders whose needs and ideas can help to design the project.

UNITED project has demonstrated that strategic stakeholder engagement and awareness-raising campaigns are important in improving understanding of the multi-use concept and opportunities it provides, generating interest of relevant actors, and building local support.

Establish Ongoing Forums at Sea Basin and National Levels

At the national and sub-national levels, creating continuous forums is essential for fostering exchanges, not only among government bodies but also as informal platforms for sectors to learn from one another. These forums pro-mote a deeper understanding of each other's needs, operations, and functions—crucial prerequisites for meaningful negotiations and trade-off discussions. The governments have a vital role in facilitating these dialogues and guiding user representation for cultivating an environment where sector interests are balanced, enabling the development of multi-use projects.

Examples of such dialogues include Working Groups and Communities of Practice, such as the Dutch North Sea Community of Practice (CoP), Belgium Multi-Use Vision Working Group, and Ireland's ORE Seafood Working Group, as well as the UK's FLOWW group and guidance (currently undergoing updates). These dialogues promote the collective exchange of knowledge and discussion about multi-use business cases, incentives, and risk mitigation strategies, among various stakeholders, including government bodies, industry representatives, research institutions, and environmental organizations. This collective effort accelerates the development of multi-use projects and contributes to shaping and adapting relevant policies and regulations to accommodate the evolving needs of multi-use initiatives.

Policymakers

Develop User Representation Guidance

Government involvement is essential in guiding and facilitating the establishment of user representation structures within multi-use projects, such as sectoral liaisons, to resolve conflicts early and encourage multi-use. This ensures that the voices and interests of different stakeholders, such as fishing communities, energy companies, and environmental groups, are heard and considered during project planning and decision-making.

Policymakers, Planners

Promote Multidisciplinary Learning

Multi-use projects require multidisciplinary skills and expertise for their development and operation. Encouraging ongoing sector-to-sector exchange is crucial for mutual learning. Additionally, mainstreaming the topic of multi-use into relevant curricula, offshore training programs, and certifications is imperative.

Policymakers, Academia

Encourage the Community-Centric Engagement for Maximised Benefits

Early and comprehensive engagement with communities not only ensures project acceptance but also secures long-term, ongoing benefits for these communities. In the Danish pilot of UNITED, the wind farm's visually appealing layout was co-designed with local communities, fostering a sense of ownership and turning the wind farm into a regional landmark. This engagement also led to partial cooperative ownership of the wind farm and motivated cooperative-organized boat tours, contributing funds to the local economy. This approach can be especially relevant for rural regions seeking an economic boost, as it attracts tourists to these areas. Opportunities like fish farm diving experiences or linking offshore wind with attractions like the Wild Atlantic Way can diversity sustainable tourism offer and provide essential infrastructure and coastal access for both locals and tourists.

Planners, multi-use innovators, NGOs

KEY STAKEHOLDER ENGAGEMENT RECOMMENDATIONS FROM UNITED FOR FUTURE MULTI-USE INNOVATORS

Clearly Explain Multi-Use: Ocean multi-use is complex and not widely understood; provide clear and comprehensive explanations to stimulate interest. Utilize diverse communication methods, such as videos, social media, and presentations, adapting your message format to your audience.

Craft a Compelling Narrative: Develop a strong knowledge base and narrative to engage stakeholders effectively and provide relevant information about the project. Have your data and experiences ready to share, and make the purpose of their involvement clear from the start.

Target Specific Outreach: Identify and focus on key stakeholders who are genuinely interested in your project, refining your outreach as you gain familiarity with the project's context and the stakeholder environment.

Showcase Tangibility: Organize tours and site visits to demonstrate the technical challenges and opportunities in real-world settings.

Engage with Local Culture: Engage with local cultural heritage stakeholders (museums, academics, associations…) to get to know the local specificities and discuss all together with local inhabitants how to fit in (e.g. organize a collaborative social event). Even only choosing collectively the name of the site and some of its features can boost the local feeling of ownership and involvement and maximise local socio-economic benefits.

Host In-Person Events: Organize at least one in-person event involving various stakeholders, including public representatives and non-experts, to raise awareness, gather input, and foster collaboration. Make these events interactive, attractive, and well-organized.

Be Ready to Address Specific Challenges: Prepare to address challenges related to different sectors collaborating, including differences in knowledge, interests, technical complexities, and legal/administrative processes. Consider aligning historically opposing sectors through slow, long-term dialogue and highlighting mutual benefits.

Multi-Use Innovators

See the full report D5.5 Recommendations for Successful Stakeholder Involvement in Multi-Use Projects

SCAN ME

SCALABILITY AND REPLICABILITY

THERE IS THE POTENTIAL FOR SCALING UP AND REPLICATING THE MULTI-USE SOLUTIONS BEYOND THE UNITED PILOT PROJECTS.

Each EU Sea Basin presents a unique combination of environmental and socio-economic conditions, thus having different potential for multi-use combinations. The level of advancement of maritime spatial planning, and the integration of multi-use in relevant policies and regulation also differs across regions, as well as the experience with multi-use demo projects and related knowledge exchange foras.

BALTIC SEA

NORTH SEA

MEDITERRANEAN

BALTIC SEA

In the Baltic Sea, multi-use is also mainly driven by offshore renewable energy targets. Moreover, extractive aquaculture development is also being increasingly considered as a means to combat eutrophication and reduce dependence on seafood imports. However, due to low salinity and the issue of visual impact in coastal areas, siting for aquaculture is a challenge. Combination with the OWF sector is seen as a potential opportunity that can reduce the costs of developing aquaculture further offshore where there may be more suitable areas. Coastal tourism is also an important economic sector in the Baltic, although it has a short season (mainly summer). Tourism combined with offshore wind (e.g. boat tours for OWF sightseeing), provides additional and innovative tourism opportunities that could potentially sustain tourism sector all year round.

Key opportunity: Offshore wind and nature restoration / regenerative aquaculture (COOLBlue project), as well as tourism multi-use that can give economic boost to the rural regions and extend the tourism season

- Integrate the topic of multi-use into the existing discussion foras incl HELCOM VASAB for the sea basin wide principles
- Identify where and what type of MU may make sense – and integrate in future rounds of MSP
- Regional test sites and data sharing protocols – esp. given the fact that regulatory environment is so diverse and future projects are to span across borders
- Use the combination with tourism to attract and educate about sustainable aquaculture and facilitate wider acceptance of aquaculture products and promote fishing species that are more sustainable to eat (small fishes, invasive species, etc.) e.g. RoundGoby

NORTH SEA

The North Sea offers particularly good conditions for renewable energy generation, including offshore wind, wave and tide as energy sources, which is reflected in the ambitious renewable energy policies of the North Sea EU Member States. A combination of these energy sectors, either in the vicinity or as part of the offshore energy island, with the purpose of maximal energy generation from the resources at the given sea space, is some-thing that developers are increasingly considering. Given the large number of offshore renewable energy projects in the North Sea, conflict with and displacement of fisheries are critical issues for consideration, as well as nature protection priorities. Salinity and water quality in the North Sea provide suitable conditions for aquaculture development. Many of the North Sea countries also state development goals for aquaculture as part of their maritime policies also as a means for transition to more sustainable fishing. Multi-use with offshore renewables is seen as an opportunity for moving aquaculture offshore and scaling it up. However, rough sea conditions still present an eminent challenge for the development of technological solutions that would enable this MU. Tourism activities within offshore wind farms have already been established in many counters (i.e. renewable energy museums and visitor centres, boat tours, etc.).

Key opportunity: Integration of multi-use concepts into offshore energy island concepts
Integrate multi-use in offshore energy islands concepts – e.g. Dogger Bank Wind Farm
Existing foras can facilitate the development of the sea basin wide multi-use principles
Officialise, integrate multi-use principles in the North Sea Agreement North Sea given its long standing experience in multi-use and existing structures and foras to drive the way for the uptake on the EU level when it comes to the offshore wind

Key opportunity: Integration of multi-use concepts into offshore energy island concepts

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- Officialise, integrate multi-use principles in the North Sea Agreement
- North Sea given its long standing experience in multi-use and existing structures and foras to drive the way for the uptake on the EU level when it comes to the offshore wind

MEDITERRANEAN

Mediterranean Sea is one of the most popular tourism destinations in Europe and worldwide. The continuous growth of tourism is informing the diversification of the sector while local fishing communities and fishers see the increasing demand as an opportunity to have an alternative source of income. Fishers are using their boats to engage tourists in sustainable fishing, a touristic activity which is normally referred to as 'pescatourism. Environmental protection and conservation combination with fishing, tourism helped diversify these uses. Combinations of aquaculture and environmental protection (Natura 2000), that refer to a small-scale community based environmentally friendly seaweed and shellfish production, are also present and are deriving eminent benefits. Aquaculture is also an eminent traditional coastal sector (especially in Greece and Italy), often combined with tourism and environmental protection. Finally, many of the Mediterranean countries now also have offshore renewable energies on their agendas thus many of the offshore renewables multi-use examples from the North Sea and Baltic may provide useful learnings for this basin in the future.

Key opportunity: sustainable tourism diversification through aquaculture and fisheries.

- Develop MSP and acknowledge multi-use concept as a useful sustainable tourism diversification model and for com-bating seasonality in tourism policies
- Consider socio-economics in mapping and zonation of maritime spatial plans to highlight where the multi-use concept could provide an economic boost to the rural regions, thus providing incentives for its development in these zones.
- Develop human and food safety protocols for combining aquaculture and tourism
- Use it to attract and educate people about sustainable aquaculture and facilitate wider acceptance of aquaculture products and promote fishing species that are more sustainable to eat (small fishes, invasive species, etc.)

SCALABILITY AND REPLICABILITY

	SCALABILITY	REPLICABILITY
Offshore Wind Farms and Tourism (boat tours) Evidence base: DK pilot	**LIMITED** It is not meant to be at a large scale but rather to be considered as a suitable option in areas of need for an economic boost or to aid the acceptance of offshore wind projects by providing more local socio-economic benefits via tourism.	**YES** Replicability potential in all countries with existing or offshore wind farms planned to be built in the coming years. However, the replicability depends on: -Distance to shore: if too far too much time and fuel needed. -Technology used: Climbing the turbine may also not be possible given that the new turbines have an elevator for up to 2 people instead of the ladder. Thus only from the boat site seeing or visiting the platform may only be feasible in new turbines.
Offshore Wind Farms and Aquaculture (low trophic) Evidence base: BE, NL and DE pilots	**YES** Can help scaling up sustainable food generation offshore. The challenge in scalability can be the conflict with fisheries, thus considering the impact on and role of fisheries in the widespread development of this multi-use would be of utmost importance.	**YES** This concept is highly replicable to the sea basins with the existing and planned offshore renewable energy farms. The maritime spatial planning processes have an important role in the identification of suitable zones for aquaculture within the existing and planned renewable energy farms. The replicability may be stalled in some areas due to the conflict with fisheries or technology issues related to the harsh offshore conditions.
Wind Farms and Nature Restoration Evidence base: BE pilot	**YES** Expansion of this concept to a wider scale can be recommended based on the local specificities and potentially beneficial in situation where the wind facts can support the creation of blue corridors aiding the connectivity of species and migratory corridors for species. However, careful assessment of possible impacts is advised. The models developed in UNITED e.g. Brecht et al. 2023 can aid with this work.	**YES** In general, the application of the nature inclusive design of offshore wind farms and nature restoration actions in and around safety zones can be recommended. However, given that there are space specificities, concrete contributions to the nature should be evident and the potential impact on the exclusion of other users should be taken into consideration from the socio-economic perspective.
Fish aquaculture and tourism Evidence base: GR pilot	**LIMITED** Not meant to be at the large scale but rather to be considered as a suitable option in areas of a need for tourism diversification, or to aid the acceptance of aquaculture project by providing more local socio-economic benefits via tourism. Existing intensity of tourism should be taken into consideration when deciding on the development of this multi-use.	**YES (but with conditions)** Replicability potential in all countries with existing or planned aquaculture farms. However, the replicability depends on: • Distance to shore: if too far too much time and fuel needed. • Local needs in terms of tourism diversification and existing intensity

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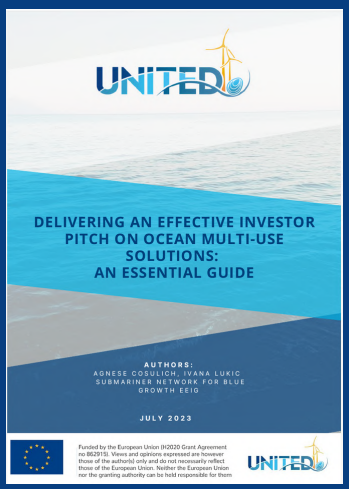
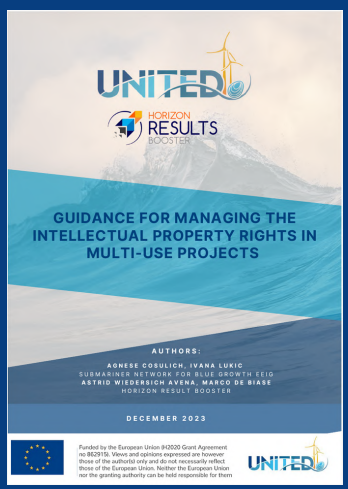


Guidance for Managing the Intellectual Property Rights in Multi-Use Projects



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