DELIVERABLE 9.3

FINAL REPORT ON ECOSYSTEM BUILDING AND STAKEHOLDERS EMPOWERMENT

Work Package 9

Dissemination and Exploitation

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Abstract	This deliverable reviews the degree to which societal and stakeholder engagement addressed acceptance of the activities and outcomes generated by the UNITED project, crucial for future adoption and scalability of developed solutions. It examines public and industry interactions through local outreach efforts conducted by project pilots. The report outlines the extent of outreach with various groups, the establishment of

	collaborations and stakeholder ecosystems, and outlines strategies for sustaining these developments in the future.
Keywords	Stakeholder Engagement; Community of Practice; Multi-Use Acceptance
Change Log	Resubmission 1 – change in cover page and introduction tables, reference to consumer profiles and product analysis conducted under business case scenarios with major outcomes summarised and deliverables referenced to limit duplication

1. TABLE OF CONTENTS

2. EXECUTIVE SUMMARY

This deliverable focuses on the acceptance and viewpoints of society at large and wider stakeholder groups for the activities and products developed within the UNITED project. These are the foundation of successful future uptake and scaling of the solutions and multi-use combinations developed and enhanced throughout this work. In order to determine the degree to which such activities and combinations are accepted by the public as consumers of the outputs and also by industry, localities, and relevant intermediaries, the local outreach activities conducted by the pilots themselves as well as supporting information found in literature is presented within this deliverable to give an overview of the directed activities achieved by the pilots and the current landscape at play. Here we denote the degree to which outreach with different groups was achieved, to what degree collaborations and stakeholder ecosystems could be developed, and how these developments will be carried on into the future.

3. STAKEHOLDER INTERACTIONS AND ECOSYSTEM BUILDING

3.1. Objective

The objective of this deliverable is to summarise the degree to which the pilots, particularly in the context of the multi-use or co-location solutions they have implemented, have been able to engage with and develop an ecosystem of stakeholders within their locality or beyond. Developing an ecosystem of stakeholders within the context of multi-use at sea, particularly in marine cases such as combining offshore wind with aquaculture, involves a strategic and collaborative approach to bring together diverse parties with a vested interest in the sustainable development of marine resources. A majority of these efforts have been realised in the UNITED project's social pillar work package, but the full extent of interactions with different groups spreads across all project work packages and includes aspects on governances, economics, and commercialisation, as well as general outreach to the public and presentation of overarching project outputs. Within this deliverable we seek to highlight the key achievements in the various work packages and pilots efforts to increase the visibility, potential, and solutions to marine multi-use and summarise the overall ecosystem of stakeholders engaged with. We use the term stakeholder ecosystem to refer to the interlinkages and interactions between the different groups and types of stakeholder groups engaged with throughout the project. This accounts for the primary requirements in identifying and engaging with such a group.

In the context of multi-use initiatives at sea, the process of developing an ecosystem of stakeholders begins with the identification and categorization of various parties directly involved in, influenced by, or exerting influence on such activities. These stakeholders encompass a diverse range, including offshore wind developers, aquaculture companies, environmental organizations, regulatory bodies, local communities, tourism operators, researchers, and governmental agencies. Once stakeholders are identified, a critical step involves mapping their respective needs, interests, and priorities. For instance, while offshore wind developers may prioritize energy production optimization alongside environmental impact mitigation, aquaculture companies may focus on ensuring sustainable production and profitability. Understanding these divergent needs facilitates the identification of common ground and potential areas for collaboration and what roles they can play in interacting with a directed pilot project and in supporting the growth of multi-use solutions. Effective communication channels play a pivotal role in fostering collaboration among stakeholders. This entails establishing inclusive and transparent platforms, such as regular meetings, workshops, forums, online platforms, or stakeholder advisory groups, where stakeholders can share information, exchange ideas, and contribute to decision-making processes. Building trust and relationships among stakeholders is paramount for successful collaboration and key in defining the ecosystem of stakeholders. Creating an environment characterized by openness, mutual respect, and understanding of diverse perspectives lays the foundation for effective partnerships. Moreover, facilitating networking opportunities and establishing personal connections further strengthens relationships and fosters a sense of shared purpose. Encouraging interconnections and synergies among stakeholders is essential for maximizing the potential of multi-use initiatives at sea. For instance, integrating offshore wind farms with aquaculture installations can yield mutual benefits, such as infrastructure sharing and ecosystem services enhancement. Aligning stakeholders' objectives with broader sustainability goals is imperative for achieving consensus and driving progress. This necessitates ongoing dialogue, compromise, and a commitment to balancing economic, environmental, and social considerations. Continuous monitoring and evaluation of stakeholder engagement processes are essential for assessing effectiveness, identifying challenges, and adapting strategies as needed. By soliciting input from stakeholders and tracking progress towards shared objectives, feedback mechanisms facilitate iterative improvement and contribute to the achievement of sustainable marine development goals. In summary, developing an ecosystem of stakeholders within the context of multi-use initiatives at sea entails creating a collaborative framework that fosters engagement, facilitates communication and collaboration, and promotes synergies among diverse stakeholders.

3.2. Process and Approach

The methodology employed for this process is elaborated in several other project deliverables. The aim is to provide a concise overview of the approach and groundwork laid before engaging with stakeholder groups during the implementation of the UNITED project. Additionally, the aspirations and desired outcomes of this development of stakeholder ecosystem are outlined in section 4.4. Stakeholder engagement stands as a central strategic objective

for UNITED. This objective is accomplished through a transparent and accountable approach to involving stakeholders. The UNITED Stakeholder Engagement Framework exemplifies UNITED's dedication to accountable and transparent stakeholder engagement. Influenced by the International Association for Public Participation (IAP2) spectrum, this framework provides a structured approach. The IAP2 spectrum, a globally recognized framework, assists organizations in determining the appropriate level of involvement needed to fulfil the objectives of various stakeholder activities. In developing a collaborative and mutually beneficial ecosystem of stakeholders, the full breadth of this approach is considered in the UNITED project and different elements are enacted through the activities executed. For example, the information packets, policy briefs, and deliverables are geared towards informing interested parties, while the development and execution of communities of practice and practitioner workshops embodied the consultation, involvement, and collaboration elements within this framework.

Figure 1: Stakeholder spectrum as applied in UNITED and based on IAP2

	Inform	Consult	Involve	Collaborate	Empower
Characteristics	One-way engagement	Limited two-way engagement; we ask questions, stakeholders respond.	Two-way or multi-way engagement; learning on all sides, stakeholders and UNITED act independently, UNITED is decision maker.	Two-way or multi-way engagement, joint decision making and actions.	Decisions delegated to stakeholders; stakeholders play a role of governance.
Stakeholder participation goal	To provide stakeholders with balanced and objective information to help them understand the process, proposed solutions and outcomes.	To obtain stakeholder input on analysis, proposed solutions and outcomes.	To work directly with stakeholders throughout the process to ensure public issues and concerns are consistently understood and considered.	To partner with stakeholders in the process, including the development of alternatives and the identification of the performed solution.	To place final decision making in the hands of the public.
Our promise to stakeholders	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and provide feedback on how stakeholder input influenced the decision.	We will work with you so that your concerns and issues can be directly reflected in the alternatives developed and provide feedback on how stakeholder input influenced the decision.	We will look to you for direct advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.
Example of engagement tools	• Factsheets • Email bulletins • Media releases	• Public analysis and advice • Focus groups	• Workshops	• Consensus building	• Delegated decisions

	• Dedicated project web pages on the UNITED website • Written reports	• Surveys • Public meetings • Meetings with selected stakeholders • Webinars and other online forums	• Consultative committees (e.g. SAB)	• Participatory decision making • Partnerships	

The stakeholder ecosystem envisioned for the UNITED project aimed to transcend traditional formats of informing and consulting, aspiring instead to reach for more engaged involvement and collaboration. In order to move beyond the basis of informing and consulting levels, required actively engage the community throughout the decision-making process, acknowledging their input and concerns. While decisions ultimately remained within the purview of the organization or department, the goal was to ensure that community perspectives were considered and integrated in the decision making process whenever possible. This level of engagement is particularly suitable for issues where community members have a vested interest, though they may not be highly contentious or far-reaching in impact. For collaborations, the focus shifted towards genuine partnership and power-sharing between stakeholders. Here, the promise extends to incorporating community advice and recommendations "to the maximum extent possible," signalling a commitment to interactive processes and genuine two-way dialogue. While ultimate decision-making authority still rests with the organization or department, there is a substantially greater degree of community input and influence. However, establishing the necessary trust and ensuring meaningful engagement can be resource-intensive and time-consuming efforts. This proves exceptionally difficult in a short timed project, and therefore existing networks and relationships that had been developed within the pilot working groups and direct participants was relied upon as an initial starting pointing to then be broadened and elaborated upon with the other pilot groups as well as additional actors in regional and industry specific settings. The collaborative level is especially well-suited for addressing controversial issues and navigating complex problems, offering opportunities for in-depth exploration and resolution. Nevertheless, there are inherent risks associated with this level of participation. If stakeholders perceive that their input has not been adequately considered or if consensus cannot be reached, it can erode trust and undermine future relationships. Thus, successful collaboration requires robust and interactive processes that allow for thorough examination of issues and foster genuine dialogue among all parties involved.

In the context of stakeholder management and mobilization, it's essential to adopt a comprehensive understanding of stakeholders that extends beyond internal parties directly affected by Pilots. While these include subcontractors, project partners, shareholders, and owners, UNITED recognizes the need to consider a broader array of stakeholders to achieve its overarching goal of demonstrating the feasibility of offshore multi-use for future sectoral developments. This multifaceted understanding of stakeholders poses a significant challenge within the UNITED project, necessitating the formulation of robust management strategies as foundational elements for stakeholder engagement and stakeholder ecosystem development. Bourne et al. (2005) emphasized the importance for project managers to engage not only with supportive "tame" stakeholders but also with those who may hold opposing views or priorities. Given the dynamic nature of power structures, maintaining active communication systems becomes essential (Bourne et al., 2005). Understanding and managing stakeholder influence can help mitigate the risk of adversarial parties disrupting project progress. Moreover, leveraging stakeholder influence can serve as a subtle positive catalyst for project success. The participatory approach to stakeholder management within UNITED seeks to garner support from diverse interest groups by appealing to their intrinsic motivations and values as reflected in the different formats of engagement listed in figure one above and encompassed in the overall outreach and stakeholder engagement plans. Given that social systems are subject to continuous change, stakeholder analysis is an iterative process that will evolved throughout the stages of the UNITED project, rather than one isolated analytical step. An iterative process was used to compile the stakeholder list and formulate strategies. As new information was gained (purposefully or opportunistically), stakeholder information was updated and stakeholder strategy actions revised, in order to ensure the most suitable approach.

In order to ensure a good coherence of stakeholder engagement within the pilots, specific to their multi-use approach, each pilot nominated a single interlocutor to be responsible for stakeholder contacts and activities. More specifically, these persons were in charge of regularly updating the stakeholder register to inform on specific groups or entities being engaged with through pilot activities, outreach, and collaborations. Additionally they served as contact liaison for engaging stakeholders for the different activities they could be solicited for (interviews, workshops, etc.), following up with these solicitations. They have also coordinated activities that involve external stakeholders in the Pilot, ensuring said process is as efficient as possible and fits into the framework for stakeholder engagement for the project. These interlocutors were also trained through the societal and social engagement arm of the project and specialists through a series of training demonstrations and received support in developing and executing interactions and events while also coordinating with the general project outreach and communication activities to make use of the resources available in terms of material development, presentations, and coordination of efforts to engage with large groups at external events, congresses, and workshops.

At the onset of the UNITED project, these interlocutors and the pilots as a whole, including relevant partners and participants, were brought together to outline prospective ambitions for stakeholder ecosystem building and to what degree and in what capacities such activities would take place. The general guidelines, training, and actions plans developed for each pilot were crafted in consultation with all partners and the communication and outreach arm of the project to have a timeline and plan generated for each of the pilot cases. Detailed information on these can be found in the WP5 deliverables and the overall approach is detailed in the UNITED deliverable 5.1. When engaging stakeholders, it is imperative to adhere to ethical principles and procedures outlined in the ethics deliverables 11.1 and 11.2 of the UNITED project. As the project involves interactions with research participants through interviews and workshops, personal data collection is inevitable. To ensure transparency, UNITED follows prescribed ethical principles and informed consent procedures mandated by the EC. These ethical principles under Horizon 2020 for research participation encompass various facets, particularly for the stakeholder ecosystem developments including proportionality of questions posed during interviews and surveys should align with project aims and an underlying right to privacy, denoting information that is collected is treated confidentially to maintain privacy, in line with GDPR requirements and ethical guidelines. This was critical for the work undertaken as sometimes in the workshops and engagement sessions, personal viewpoints or conflicting results were produced and the anonymisation and careful handling of such elements was required in order to ensure the trust and collaborations developed within the project were safeguarded and maintained. These principles guide communication, dissemination activities, recruitment, community building, and data gathering processes throughout the project. Additionally, safety and protection guidelines are upheld to ensure robust ethical standards for all project activities.

To ensure this and maintain good standing and openness with the ecosystem of stakeholders, UNITED followed an informed consent procedure before participation with stakeholders in interviews or workshops. In this procedure the participant is informed with information about the project aims and how the data will be processed through a consent form. These guidelines along with key support and engagement strategies are provided in details for the project partners and also external entities seeking to develop and engage in such a processes as well. These WP5 deliverables have been made public and the information within serves as a readily available starting point for other actors and initiatives to draw from in terms of best practices and a baselines for engagement and stakeholder development in other projects in multi-use.

Aside from the pilot and multi-use solution specific approach used to engage with societal actors and specific stakeholder groups to develop these stakeholder ecosystems, project wide initiatives, including workshops, congresses, and general dissemination activities also underpinned these efforts across UNITED. These included internal communication among numerous partners, specific communication with local communities involved in demonstration pilots, and engagement with external entities spanning from local to international scales. The communication WP and arm of the project identified pathways for both internal and external stakeholders, crucial for ensuring effective consortium operations and external communication. In this pathway plan, detailed in the final communication plan of Deliverable 9.2 of the UNITED project, continuous dialogue with authorities and relevant stakeholders has been initiated early on and will persist throughout the project to facilitate smooth pilot implementation and uptake of project outcomes. These stakeholders are grouped into broader categories for engagement at local, regional, national, European, and international levels. The initial communication plan evolved and

expanded as new stakeholder groups emerge and project activities generate additional communication priorities. The stakeholder groups identified, categorized, and prioritized to engage with outside of the project involved determining the level of these actors, whether at the local, regional, national, European, or international scale, as they represent key target audience members. Furthermore, a preliminary outline of materials and topics of interest were generated for these stakeholder groups and geared towards the degree of interaction and collaboration foreseen through various activity points. As the project advanced, particularly through stakeholder workshops and engagement sessions, these materials and topics were expanded upon and updated to reflect new developments, with the final results being detailed in the final communication plan as well as a number of the other WP9 deliverables focusing on the workshops and outcomes from general and targeted stakeholder and ecosystem interactions.

Regarding training activities, Internal workshops concentrated on addressing the needs of UNITED pilots and any deficiencies in certain areas such as stakeholder engagement and economic assessment application. These internal workshops aimed to enhance knowledge and ensure alignment among relevant partners that were part of the key stakeholder ecosystem, meaning the most active and highly engaged actors which were paramount to the design, deployment, operation, and functioning of the pilots. External workshops focused on transferring knowledge from the UNITED project to stakeholders and other projects. The proposed topics are tentative and address knowledge gaps identified within the MUSES project and across UNITED pilots. Recorded learning material accompanied each training and user workshop in order to provide lasting materials for the participants and engage a larger potential group. This material included briefing documents sent to participants beforehand, as well as recorded lectures, presentations, and interviews with experts. Dissemination of this material occurred via the project website, social media, partner networks, and relevant associations, with consideration given to sharing on learning platforms such as UDEMY and MASTERCLASS. Dissemination webinars were also conducted to share project results with a wider audience and foster collaboration, such activities leaned more into the inform and consult categorisations seen in Figure 1, however this did allow for a manner through which additional stakeholders whom were not directly approached or engaged with through the pilot to become aware of the work being undertaken and to join in on future stakeholder workshops and engagement sessions. These webinars featured speakers from other projects, industry representatives, and public policy experts, and were designed in collaboration with these stakeholder as well, identifying the knowledge gaps or barriers to implementing the target multi-use activities and raising awareness and need for betterment of solutions in technological, policy, social, or economic mechanisms to further the mutli-use adoption. The inclusion of such co-organisers and external members in the webinars was pursued as to ensure maximum outreach and collaboration, engaging with other networks and broadening the outreach pool.

Community workshops were a pivotal aspect of the UNITED project, spanning from January 2021 to March 2023. These workshops served as crucial platforms for engaging with relevant stakeholders, with the primary objective being knowledge transfer and fostering ownership of project outputs. These events were strategically designed to accommodate different stakeholder needs, often combining elements of training workshops and user workshops. Such a comprehensive approach aimed to maximize impact while minimizing logistical challenges, resulting in at least five workshops held throughout the project's duration. To ensure broad outreach and significant engagement, workshops were often organized in conjunction with major conferences or symposiums, such as Better Off Blue or Aquaculture Europe. By leveraging existing gatherings, UNITED could effectively reach a wider audience and stimulate collaboration across sectors. Advance notifications, circulated at least two months ahead, allowed participants to plan accordingly and ensured maximum attendance. Promotion efforts were multifaceted, encompassing social media platforms, newsletters, project websites, and personalized invitations, all conducted in compliance with GDPR regulations.

The establishment of an advisory board and community of practice facilitated ongoing engagement with stakeholders, enhancing the project's relevance and impact. These initiatives were instrumental in gauging interest, gathering input, and fostering collaboration beyond the project's duration. Central to this was the UNITED website, which functioned as an information hub and collaborative platform for multi-use initiatives. Evaluation of communication activities was integral to assessing their effectiveness in disseminating accurate information about multi-use concepts. Indicators such as website traffic, newsletter subscriptions, social media engagement metrics, and feedback from workshop participants provided valuable insights into the reach and impact of communication

strategies; all documented and discussed in additional detail within the Final Communication and Dissemination plan under WP 9, UNITED Deliverable 9.2.

The success in developing stakeholder ecosystems and identification of relevant actors fostered collaboration throughout and hopefully beyond the project's lifespan. Engagement activities such as workshops, interviews, and webinars were instrumental in gathering interest and initial ideas for this community. The project initially connected with the existing Dutch Community of Practice (COP), expanding its scope to engage with other regional European Seas. Outreach efforts included targeted webinars and group meetings, leveraging momentum and connections developed during the project. The culmination of these efforts resulted in the creation of a standalone COP, serving as a legacy element of the project. The UNITED website played a pivotal role in facilitating community formation, serving as an information hub and platform for collaboration. Partners contributed by suggesting suitable community members and supporting outreach efforts. The network utilized existing initiatives such as the Stakeholder Advisory Board, Dutch COP, and Regional Waters initiatives to realize the vision of multi-use.

3.3. Multi-Use Acceptance

Currently, the acceptance of Multi-Use at sea in the European domain varies across different stakeholders and regions. While there is growing recognition of the potential benefits of Multi-Use, such as optimizing marine space and resources, enhancing sustainability, and promoting economic growth, there are also challenges and varying levels of acceptance. The full spectrum of the stakeholders encompassing the stakeholder ecosystems for each of the UNITED pilots are detailed in Deliverable 5.1, however the spectrum and degree of acceptance are reflected upon briefly here. Within the context of government and regulatory bodies, European governments and regulatory bodies have shown increasing interest in Multi-Use initiatives as a means to achieve multiple policy objectives, including the Blue Growth Strategy, the EU Biodiversity Strategy, and the European Green Deal. However, acceptance varies depending on specific national policies, regulatory frameworks, and local contexts. Despite the extent of which European Directives and funding of such projects seems to underpin the support and general acceptance of multi-use activities and initiatives as a positive and welcome development, as noted in Ciravegna et. al, 2024 which uses the case of the UNITED project as foundation for addresses the costs and roadblocks to further implementation, the inconsistency and sometimes oppositional requirements in national and regional applications speaks to a different story. This can be the case of national and regional policy needing to catch-up to national and supra-national policy, objectives, and aims, however, it can also speak to divergent viewpoints on the acceptance and rational behind multi-use. In this regard the acceptance and facilitation of multi-use, as discussed by UNITED and Ciravegna et al 2024, relies on a landscape of multi-use governance that has evolved significantly, with several countries adopting diverse frameworks, often influenced by recent maritime spatial plans. While such plans offer avenues for multi-use projects, challenges persist due to national legal complexities and overlapping authorities, hindering the establishment of full-scale installations or co-location of offshore activities. Overcoming these hurdles requires substantial investments, so while an overall accepting and positive viewpoint may be communicated in the stakeholder group, additional efforts are required in order to bring in line the challenges faced in practical applications with ambitions.

In the context of industry and business, certain sectors within the maritime industry, such as offshore wind energy and aquaculture, have been early adopters of Multi-Use practices, recognizing the potential for synergies and cost efficiencies. However, broader acceptance among industry stakeholders may require further incentives, policy support, and demonstration of economic viability. Early adopters from the energy sectors can be readily seen as engaged and positive in the acceptance of such synergies and pushing forward with multi-use application t sea, this is reflected in the composition of the partner group within UNITED, including larger offshore wind operators and full logistical food production chain members as well, and additionally with those whom have engaged in the communities of practice as well as the workshops and information seminars. Several well established sector actors have been seen moving in collaborative manners, through the work executed within UNITED, through other initiatives and working groups, and also in a broader spectrum as well by van den Burg et. all 2020, Przedrzymirska et al 2021, Ciravegna et al 2024. Environmental and conservation groups, often prioritize biodiversity conservation and ecosystem protection over industry and traditional economic developments also recognize the potential benefits of Multi-Use in minimizing environmental impacts and promoting sustainable resource use. This is counterbalanced about potential negative ecological consequences and advocate for cautious implementation and

rigorous monitoring. The use of multi-use to consolidate activities and increase the pressures exerted on marine areas which can often already be under considerable exploitation is a validated concern espoused by these groups. A required balance of not using multi-use concepts to greenwash certain offshore activities to make them look more environmentally friendly and beneficial, while at the same time increasing pressures and extractive forced on oceans and seas is a notable concern which causes differentials in the acceptance and acceptability of such multi-use solutions and roll-outs. The discourse between environmental groups, universities, society, and policy will be of grave importance to the overall acceptance of such multi-use as the legal and practical frameworks on implementing Multi-use will undoubtedly have large repercussions for overall acceptance thereof as touched upon in Giannopoulos, 2023 revision of offshore energy and European environmental law. As researchers and academics play a crucial role in advancing knowledge and understanding of Multi-Use practices, there is growing interest in interdisciplinary research and collaboration to assess the environmental, social, and economic implications of Multi-Use, as well as to develop best practices and guidelines.

Local communities must also and most importantly be considered in the acceptance of Multi-Use initiatives; local communities depends on factors such as perceived economic benefits, social impacts, and involvement in decision-making processes. Community engagement and consultation are essential for building trust, addressing concerns, and ensuring local acceptance. Overall, while there is growing recognition of the potential of Multi-Use at sea in the European domain, widespread acceptance and implementation require continued efforts to address regulatory barriers, promote stakeholder engagement, demonstrate economic viability, and ensure environmental sustainability. Collaboration among stakeholders, knowledge sharing, and pilot projects are key mechanisms for advancing acceptance and adoption of Multi-Use practices. During the UNITED survey of 27 external stakeholders that were reached, regarding content, they acknowledged UNITED's strong technical and scientific credibility in the approach the project adopted to the multi-use solution proposed. In terms of engagement, the majority felt their voices were heard, leading to satisfaction with their participation. However, most respondents in were already familiar with the concept of Multi-use and recognized its relevance for sustainability without much discussion. This indicated that the groups interacted with are likely not a fully representative cross section of the stakeholder at play within the field. The challenge for the subsequent and future engagement is to capture and work with other stakeholders, especially decision-makers and single-use experts and operators, to a higher degree and particularly those whom are perhaps not aware of or already positive and accepting of multi-use as a concept. This would allow for a gathering of more diverse feedback, which would be beneficial for ongoing stakeholder activities for multi-use and to facilitate broader dissemination of project outcomes. Local stakeholders from the pilot areas participated as well, albeit with some imbalance, notably with the German pilot being well-represented. Many of those whom were engaged with at this local level of stakeholder ecosystem development were positive, interested, and engaged with the project and overall ambitions on multi-use. While there is an overall positive trend on acceptance of multi-use, the difficulties in effectively and safely implemented such activities, among other roadblocks and barriers require additional efforts from a wider array of actors to better enable and facilitate the adoption and implementation of such activities at larger scales to full realise the potential it has to offer.

4. STAKEHOLDER ECOSYSTEM REALISED

4.1. German Pilot

The offshore research platform FINO3, operated by FuE-Zentrum, served as a valuable reference for offshore wind farm operators and turbine manufacturers in the North Sea region. With its windmill monopile construction, similar to offshore turbines, and its extensive history of scientific research, FINO3 was well-positioned to host a demonstration project for offshore wind and aquaculture. The objectives of such a project included reducing technological, financial, health, safety, and environmental risks associated with multi-stakeholder engagement through various means and channel, as well as accelerating the acceptance of multi-use concepts by North Sea industries. This involved developing a comprehensive data management system, investigating interactions between target culture species and the offshore environment, and improving the information base for future regulations and permissions. Additionally, the project aimed to demonstrate societal acceptance and benefits, explore business models and cooperative ownership opportunities, and enhance the social and environmental image of involved businesses. Collaboration among stakeholders were envisioned to shared costs, improved financial yield for investors, and the potential for eco-label certification. The project also provided opportunities for small and medium-sized companies and EU institutions to demonstrate their capabilities under realistic conditions and contribute to the development of reference guidelines. The primary stakeholder groups whom have been engaged with through the work completed in the UNITED project German pilot include those listed below. These actors have been brought into contact with the pilot either through workshops, through permitting and legal requirements, or discussions and collaboration on joint deigns and operation of activities.

- Offshore wind sector
- Aquaculture suppliers
- Commercial aquaculture producer
- Insurance companies
- Regional and Local Authorities
- Educational institutions at multiple levels

During the initial phase of the German pilot project, an online socioeconomic workshop was conducted in November 2022 to categorize social impacts. This workshop brought together a diverse group of stakeholders from various sectors, including offshore wind energy, regional agriculture, the DG for Maritime Affairs and Fisheries European Commission, as well as experts from marine ecology, food technology, and engineering disciplines. Following this initial discussion, further refinement of the identified social impacts occurred during the consortium's General Assembly in February 2023, where partners met in person to conduct a detailed analysis. Through collaborative efforts, several significant social impacts emerged. A primary concern identified was the impact on employment, training, and re-skilling initiatives in the region, particularly affecting the local population residing within a radius of up to 20 kilometers from the landing port. Additionally, there was heightened concern regarding the increased risk of offshore accidents due to the concurrent operations of multiple teams, primarily affecting offshore workers, with a ranking of medium to high importance. Medium-importance impacts included the establishment of new processing facilities, leading to job opportunities for the local workforce. Furthermore, the expansion of training and education facilities attracted more individuals to the area, impacting both local residents and professionals. The automation of shipping operations offshore necessitated upskilling of existing workers and attracted new professionals, influencing the existing offshore professional community and relevant students. Another significant impact was the potential exclusion of other uses within the wind farm area, which could hinder activities related to shipping and fishing. Finally, the provision of alternative income sources for fishers transitioning out of the industry ranked as a medium to low level of importance in the assessment of social impacts. These key social and synergistic effects were related to the stakeholder ecosystem through a series of workshops, one-on-one discussions with relevant boards and authorities, as well as through a number of outreach activities as discussed in section 4.2.

The outreach efforts conducted by the German Pilot team resulted in several social synergy effects, with implications extending to future multi-use projects and generating acceptance and interest within the general public. Online workshops covering topics such as Safety & Logistics and Technology Transfer played a pivotal role in attracting the interest of both attendees and external experts. These workshops not only garnered attention for the project but also elicited valuable input from external experts, enriching the insights of the German Pilot and

contributing to the broader objectives of the UNITED project. The diverse tasks undertaken within the German Pilot also sparked interest in educational settings, particularly in school projects. A significant collaboration was initiated between the German Pilot team and a local Club of Rome school, yielding mutual benefits. Students were provided with opportunities to engage in hands-on scientific practices related to the highly relevant and rapidly evolving topic of multi-use in the marine sector. The FuE team also gained fresh perspectives and insights into potential enhancements for algae cultivation at the nearshore site, including aspects such as grow-out substrates, seeding techniques, and yield optimization. Furthermore, engagements with politicians and key stakeholders revealed additional social synergies. Discussions with policymakers laid the groundwork for key outcomes, such as the potential for job creation within the aquaculture sector, to be realized within German waters. Additionally, ongoing exploration is underway to restructure the maritime spatial plan to elevate the concept of multi-use to a higher level, reflecting a commitment to optimizing resource allocation and fostering sustainable practices in the aquatic environment. While these outcomes are not solely attributed to the activities of the German Pilot, the progress demonstrated, data generated, and body of evidence produced through the execution of the pilot's activities have garnered additional interest from the authorities with whom they have collaborated. This has also contributed to furthering multi-use initiatives in Germany, where there is a significant need for proof-of-concept applications and data supporting the benefits and feasibility of these activities. A full description of the stakeholder workshops, communication and dissemination activities, as well as the outreach conducted by the pilot is detailed in the Deliverables 9.2, 5.1, 5.4.

By interacting early with stakeholders and society at large, future consumers can be created. Hence, interaction on different levels was of very high importance. The pilot was thus represented in different conferences such as Aquaculture Europe or the Wind Energy Conference. Talks and presentations were also given to other consortia of projects, and the general public was reached by opening the daily business for reporters and filmmakers from regional and national television broadcasting stations and newspapers. Even across the German borders, a broadcasting crew from the Swiss national television reported on the outcomes of the German pilot. To get into more interaction with the different stakeholders, workshops on national and international levels were held. These dealt with the different aspects not only of the German pilot but also of the United Project at large. Many connections to governmental and permitting agencies were built during the pilot implementation, paving the way for future projects and potential commercial usage, these include connections to offshore suppliers, shipping companies, and the wind energy sector, all major stakeholders, were also established.

4.2. Dutch Pilot

The North Sea Innovation Lab serves as an independent test site for various innovations, including seaweed cultivation, floating solar panels, and renewable energy projects, all with a focus on co-use within offshore wind farms. In the context of the UNITED project, specific parcels within this test location were utilized for deploying seaweed cultivation lines by The Seaweed Company and floating solar panel arrays by Oceans of Energy. These pilot deployments were strategically positioned to simulate conditions akin to offshore wind farms in the same region, serving as crucial proof of concept for their designs and operations. Located 12 kilometers off the coast of The Hague – Scheveningen, the North Sea Farmers Offshore Test Site boasts technical specifications such as a 600 ha area, water depth of approximately 18-20 meters, and official demarcation. The Dutch pilot within this site aimed to achieve four key demonstration objectives, showcasing the combined functionality of offshore wind developments, floating solar energy production, and seaweed farming in various configurations. While not situated within an offshore wind-farm installation, the extensive testing of seaweed and floating solar panels in this exposed North Sea site has provided valuable data and insights for future combinations, demonstrating synergies that could benefit all three activities when integrated into one operational site. The testing of floating solar panel arrays aimed to demonstrate economic feasibility, reduce technical risks, define legal and contractual frameworks, and establish safe operational plans for commercial roll-out. Similarly, the deployment of monitoring buoys and seaweed grow-out systems aimed to demonstrate the economic feasibility of integrating aquaculture within offshore wind farms, including the development of safe operational plans and legal frameworks. Furthermore, the co-location of floating solar and seaweed aquaculture sought to highlight synergies between these sectors and explore additional aspects such as technical feasibility of energy and communications connections, operational feasibility of using solar power systems as energy hubs for aquaculture, and the impact on aquaculture business cases when

combined with solar power. The core participants in the Dutch pilot activities and considerations included the project members participating in the project listed below (

- Stichting Noordzeeboerderij/North Sea Farm Foundation: non-profit organization aimed at realizing sea-weed industry in The Netherlands
- The Seaweed Company (TSC): commercial seaweed company cultivating certified seaweed
- Oceans of Energy BV (OOE): first company to design, develop and build floating solar systems that can withstand robust, offshore conditions
- TNO: supports with research on floating solar energy offshore and provides modelling outputs
- Ventolines BV: service provider of onshore wind and solar and offshore wind projects
- Vattenfall: Wind farm operator that is interested in impacts of logistics, governance and insurance in multi-use activities in offshore wind farms.
- Governmental permitting and planning agencies related to offshore energy and aquaculture
- Search & rescue, Commercial shipping, Fishing
- The Dutch Community of Practice – in particular groups on Marine Spatial planning, Seaweed mariculture, and the development of offshore renewable energies

For the core group of stakeholder, the acceptance of multi-use and the applicability in the Dutch coastal zone relied on the societal impacts and social dimensions of such applications. The assessment of impacts revealed several significant findings within the UNITED project. Notably, the activities undertaken within the project led to the creation of new employment opportunities across various levels, both directly within the pilot activities and within the supply chain. While currently at a smaller pilot scale, these opportunities are expected to expand with the development and roll-out of commercially viable projects, offering significant economic prospects for the fisheries sector and the local community. Furthermore, the integration of solar energy with wind energy contributed to a more balanced and secure energy production system, enhancing energy security within the region and increasing the potential of the region's total green energy production portfolio. Additionally, the multi-use approach enhanced food security and reduced the carbon footprint by increasing the production of nutritious food resources, particularly from lower trophic levels. This approach also improved land use efficiency by combining multiple activities, thereby reducing the occupation of land space and avoiding the utilization of nature-sensitive areas such as those designated under Natura 2000.

Moreover, the multi-use approach helped alleviate political pressures by bolstering local energy and food production security, reducing dependency on other countries for energy and food supplies, and enhancing political stability. By leveraging the same electricity grid for both solar and wind energy, capacity utilization was maximized, leading to cost savings that could be redirected towards other projects, thereby increasing the acceptability of multi-use options compared to single-use wind farms. The development of offshore activities increased education and awareness about offshore environments and the sea, fostering a more informed and engaged community. However, the presence of the wind farm restricted navigation for fishers and sailors through the area, leading to reduced acceptance of the project among these stakeholders. Overall, the preliminary assessment highlighted the project's potential to generate positive economic, environmental, and educational outcomes, while also identifying challenges posed by navigation restrictions within the wind farm area.

In developing and validating these synergies and engaging with the stakeholder ecosystem as a whole, the Dutch pilot was uniquely positioned to take advantage of an already existing, operating, and multi-faceted community of practice. This group is known as the North Sea Community of Practice[1] and has been operating for a number of years. It is a body which consists of a number of commercial, NGO, governmental, research, and commercial actors which has a number of sub groups which discuss specialised topics of relevance. This is done through a wide array of activities such as online meeting, group presentations, congresses and more. This group also has significant influence and power as it has, across its many functioning sub groups, produced a number of unified positions from Dutch sectors on the current status, needs, and projected development of said sectors, and has a number of initiatives surrounding multi-use, marine spatial planning, and furtherance of these ideas within the Dutch EEZ. Through collaboration and participation in a number of these groups the Dutch pilot actors have uncovered several

[1] https://kennisdelen.rvo.nl/groups/view/244e11b4-4982-410f-ab62-eb94b7e23d51/community-of-practice-noordzee

significant social synergies, each contributing to the overall success of the multi-use approach and fostering a more sustainable coexistence within the North Sea environment. A primary synergy involved the efficient use of space, minimizing the spatial footprint of individual activities through strategic integration planning. This approach ensured equitable access to the North Sea for all stakeholders while promoting sustainability. Such a need for equal access and the representation of all the varied interests is a recurrent theme and point of discussion within the North Sea CoP. Collaborative integration efforts had the potential to enhance social acceptance and awareness within the community, showcasing the feasibility of coexistence and sustainable practices. This contributed to a more positive perception of the project among stakeholders and the broader public. Emphasizing collective outreach and communication efforts, the project highlighted the importance of unified visions and shared ownership of design. By collaborating on communication activities, the pilot initiatives effectively conveyed their objectives and benefits to a wider audience, amplifying their impact and reach. These social synergies optimized resource utilization, promoted environmental sustainability, and underscored the significance of community engagement and awareness-building in successful multi-use practices within the North Sea.

The progress and contributions to the North Sea CoP by the partners within the UNTIED project has seen one of the most marked benefits across the applications in the project. From the realised benefits and power of such an organisation, the creation of additional CoPs across other regions has been underscored and is a key element in future projects and initiatives. The follow-up project of UNITED, ULTFARMS, aims to develop a similar approach for bringing together these wide arrays of stakeholders into such an interlinked ecosystem of stakeholder through the development of local Communities of Practice in future works. Additionally, Steins et al. 2021 underpins that achieving multi-use, while reliant on technology and innovative solutions, is faced with the more sever challenge of bringing the needs and requirements from a wider body and collective of stakeholders than is realised in more common single-use developments. Through the creation of such integrated stakeholder ecosystems within a Community of Practice, a non-political learning environment, where different sectors can learn and share with one another to develop synergies and action-oriented plans for co-use and co-development is key to overcoming said challenges.

4.3. Belgian Pilot

The activities undertaken in the Belgian pilot of UNITED focused on deploying Low-Trophic Aquaculture within active offshore wind farms and restoring native flat oyster reefs for human consumption. Two distinct locations were utilized for these activities: the primary site was within the Belwind wind farm, located 46 km offshore with an average depth of 25-30 meters, while the secondary site, Westdiep, situated 5 km off the coast near Nieuwpoort, Belgium, served as a nearshore testing ground. Building upon the EDULIS offshore mussel aquaculture pilot project conducted from September 2016 to 2019, the activities within UNITED leveraged previous experience with offshore longline systems and bivalve aquaculture at the Belwind wind farm. The primary objective of the pilot was to assess wind farms as suitable locations for restoring native flat oyster reefs and cultivating flat oysters for human consumption. Sub-objectives included identifying appropriate areas for reef restoration, demonstrating the development of scour protection to support oyster reef formation, validating longline designs for offshore oyster production, identifying suitable seed collectors and grow-out systems, developing remote monitoring systems for oyster growth, and optimizing communication and scheduling between activities. Additionally, a secondary objective focused on comparing the growth of seaweed offshore and nearshore to assess suitability and growth potential for different varieties. This involved utilizing the same longlines used for oyster activities to attach seeded ropes with various seaweed species, with the aim of exploring morphological and nutritional characteristics influenced by environmental dynamics. For the stakeholder ecosystem development within the Belgian pilot, the following core groups were considered:

- 4SEA consisting of 4 environmental NGOs: WWF, Natuurpunt, Greenpeace, Bond Beter Leefmilieu
- Fishery Industry Sector - including fishing and auctioneers
- Regional and local authorities, including permitting and licensing
- Port authorities
- Local recreational companies, e.g. sailing clubs
- Wind farm operators

In communicating and engaging with the stakeholder ecosystem within the Belgian pilot, the focus was primarily focused on the degree to which aquaculture could be integrated within offshore wind farms and the incorporation of oyster restoration and aquaculture within such offshore multi-use systems. This was achieved through a series of workshops and stakeholder engagement events which have served as the basis for the formation of a Belgian Community of Practice. This CoP will be further enhanced in the follow-up project ULTFARMS, and expanded to include interactions with the Dutch CoP. To explore the social impacts relevant to scaling and deploying such combined systems in Belgian waters, the Belgian Pilot conducted a number of workshops focused on the socioeconomics of multi-use and relevance to various stakeholders. These workshops included representatives from diverse fields and institutions, including research institutes, aquaculture, fisheries, food sectors, commercial actors spanning the blue economy spectrum, public organizations, and tourism entities.

Four scenarios were deliberated, each involving the combination of wind farms with various activities: seaweed culture, oyster aquaculture, oysters' restoration, and a combination of all three activities within wind farms. Within the wind farm and seaweed scenario, several social impacts were identified and assessed for their significance. High importance was accorded to impacts related to research and knowledge building, job creation, sustainable food production, concerns about unfair competition, and the optimization of offshore wind farms. Additionally, medium importance was assigned to impacts such as the development of new culinary experiences and job-related risks, while the impact on nature and biodiversity restoration was deemed to have low importance. In the wind farm and oyster culture scenario, certain social impacts were also evaluated for their significance. High importance was attributed to factors such as local oysters being considered a luxury product, potential negative perceptions of wind parks due to increased offshore activities, and increased costs for both wind farm and aquaculture operations. Medium importance impacts included pride in sourcing food locally, cultural heritage potential for tourism, and concerns about the impact of aquaculture on small fisheries. Regarding the wind farms and oyster reef restoration scenario, impacts of high importance included increased social acceptance of wind parks due to their combination with nature restoration efforts and enhanced resilience to climate change. Concerns about potential environmental harm from structural aspects, maintenance, and decommissioning were also highlighted. Finally, in the integrated scenario encompassing all activities, reducing conflicts of use and developing knowledge through integrated activities were deemed of highest importance, while impacts from the previous scenarios were also considered but ranked lower in comparison. This integrated approach aimed to maximize the utility of the marine zone and promote co-ownership of applications at sea. Such workshops and interventions between varied groups of stakeholders within the overall project stakeholder ecosystem is key in order to account for the varying viewpoints and prioritisation of impacts and effects from multi-use.

A full and detailed description of the format and interactions across these workshops and outreach events can be found in the WP9 and 5 deliverables related to workshops and communication and outreach activities. However, what is critical to realise in the case of the Belgian stakeholder interactions is that a fully integrated multi-use scenario involving all three activities in the wind farm, most impacts were regarded as highly acceptable, including increased employment and the development of new tourism opportunities, however, negative outcomes such as the privatization of sea areas and high product pricing were considered undesirable. Furthermore, the benefits of developing such workshops and interactions between a myriad of stakeholders was seen as very beneficial and require din order to share information, developments, and to catalyse coordination, co-development, and co-management of the limited EEZ in Belgium. This was denoted as a potentially driving force underpinning the requirement of close collaboration and further development of multi-use within Belgian waters, simply the very limited amount of uniquely exploitable space to be had and the large ambitions and demands being placed on these water by a wide and varied cast of stakeholders.

When considering the demands and needs from engagement and coordination of stakeholders in an upscaling and commercialisation scenario, numerous promising opportunities emerge. Integrating aquaculture activities within wind farms unlocks significant space within the Belgian sector of the North Sea for alternative uses. This surplus space could accommodate various activities, such as professional and recreational fishing, leisure navigation, and sailing. Space allocation often triggers conflicts, as aquaculture projects typically prefer nearshore areas for easier maintenance and protection from the elements. Co-locating aquaculture within wind farms could mitigate these conflicts over space use, benefiting the local population and fishermen. Furthermore, expanding multi-use activities would require the recruitment of additional personnel, including technicians, engineers, and marine experts. These professionals would play crucial roles in the year-round maintenance and monitoring of the multi-

use project. Moreover, the emergence of new locally-sourced products offers opportunities to enhance tourism, a significant source of income and activity during the summer along the Belgian coast. These factors, combined with the development of a community identity centered around local and sustainable seafood production, can provide a fresh source of protein aligning with the region's sustainability objectives. Additionally, the overall attractiveness of the coast stands to benefit from multi-use initiatives. Anticipated effective communication and increased visibility regarding the Belgian coast and the North Sea could enhance job opportunities, attracting an active population and fostering economic growth and community vitality. Residents of the region can take pride in living in an area where sustainability is genuinely prioritized. Witnessing innovation and the development of sustainable activities within wind farms reflects a commitment to environmentally responsible practices. This shift from traditional activities to alternative practices can instil a sense of pride and progress within the community, fostering a shared ownership of the new operational approach. Overall, a positive and hopeful outlook on multi-use was found throughout the stakeholder pool in the Belgian case. A keenly identified need to develop a more structural and adept ecosystem for stakeholder engagement, perhaps in the formation of a stand-alone Community of Practice reflecting that already present in the Dutch case.

4.4. Danish Pilot

The Danish pilot project explores the concept of multi-use involving tourism and Offshore Wind Farms (OWF), capitalizing on the shared sea space and joint infrastructure and activities developing upon the cooperative-owned OWF Middelgrunden Wind near Copenhagen which has occasionally hosted visits by students, companies, and enthusiasts interested in offshore wind, including boat trips and turbine climbing events every two years. The primary objectives of the Danish pilot were to expand and enhance existing multi-use concepts, particularly tourism to OWF. This involved increasing the TRL level to 7 or higher, expanding tourism activities related to OWF, and integrating OWF tourism into the broader tourism offerings of Copenhagen and the region. Additionally, the pilot aimed to serve as a demonstrator for improved multi-use information technology and physical facilities, advising on health and safety practices, regulations, safety measures, and demonstrating the operability and profitability of the multi-use solution. Throughout the UNITED project, the operation of tours to the wind turbine has been further developed, expanding synergies between OWF and tourism. Activities such as sightseeing boat tours combined with angling have been explored, broadening the range of offerings in the region. Special designs for platforms around the turbines, catering to divers, local fishers, and offshore restaurants, have also been investigated. Beyond tourism, the project has identified additional benefits, including engaging boat tour operators in OWF-related monitoring activities, enhancing onshore visits to OWF information centers and museums, installing telescopes for OWF observation, organizing helicopter flights or virtual reality experiences, and conducting educational tours to increase local knowledge about green energy. In addition to the project objectives, the pilot has supported the development of viable business models and capacity building for local tourism operators. It aimed to mainstream such solutions in local development policies and broader OWF project development guidance, exploring their transferability to other regions and Member States within the EU. This entailed developing general business models and guidance for cost-benefit analysis to support the financial viability of future multi-use developments. Within the context of these efforts, key actors and stakeholders to be engaged with included:

- Engagement of local intermediaries and clusters such as tourist boards and local councils will be crucial as these can have a strong role in initiating and supporting the long-term functioning of this multi-use, mainly by identifying opportunities, facilitating cooperation and promoting MUCL concepts.
- Boat and diving tour operators - one of the aims of this pilot is to empower the sector by gathering relevant tourism stakeholders and maintaining a network of local tour operators.
- Angling and diving associations.
- Local museums, exhibition and information centers.
- Other intermediaries incl. State of Green.
- Organizing visits for professionals.
- All the visitors participating in the guided tours

In Denmark, offshore wind farms enjoy widespread support and high societal acceptability, alleviating concerns for developers and operators in the country. However, the commercial implementation of large-scale multi-use concepts presents complexities for offshore wind developers, notably in terms of potential interference with ongoing operations and maintenance activities, posing safety and operational challenges. Consequently, the

commercialization of such multi-use concepts may present more hurdles than benefits for offshore wind developers. Among the positive impacts with high acceptability, two outcomes stand out. Firstly, the potential for job creation, particularly for guides and boat operators, holds significant promise, especially at the local level. Additionally, raising awareness about wind energy, targeting diverse audiences such as foreign tourists, professionals, and students, is seen as a valuable outcome of the initiative. Conversely, three impacts were viewed less favorably, all categorized as negative impacts with undesirable outcomes despite their high importance. One such impact is the decrease in energy production resulting from halting turbines for one hour to accommodate visitor groups. This reduction directly affects wind park operations and poses additional risks, especially for boat operators navigating near turbines. Such risks can negatively influence social opinions of both activities, particularly as accidents, although not expected to be common, could draw significant attention and impact perceptions. The absence of emergency medical care facilities aboard boats and within turbine structures further compounds safety concerns, adding a layer of vulnerability to visitor and boat operator experiences.

The project partners and key stakeholders have identified five social impacts, all deemed highly significant. Firstly, the creation of employment opportunities for guides and boat operators is considered crucial at the local level, albeit less so nationally. Furthermore, there is substantial potential to enhance public awareness about wind energy, benefiting both local residents and communities on a regional and broader scale. Prior to the UNITED project, tourism activities at the Danish site included educational tours for school and business groups from outside Denmark, demonstrating an interest in learning more about offshore facilities. The integration of an educational program and online tours through UNITED's efforts promises to broaden engagement, education, and acceptance across diverse communities and provide a model for other wind developments. However, it's worth noting that visiting the turbines entails a temporary decrease in energy production, as each group of 18 people requires the turbine to be stopped for one hour. In general, the physical visits to the wind turbines and the online virtual tours developed through the project have been met with a positive response. Stakeholders from various backgrounds have shown significant interest and appreciation for the project's outreach efforts and activities. Notably, there has been a notable increase in the number of visitors opting for boat tours and turbine-climbing experiences, which can be attributed to heightened project visibility and strategic partnerships with local museums and blue growth initiatives. These collaborations have expanded the project's reach and impact, attracting a diverse audience including businesses, educational institutions, schools, and general tourists. The operators of the wind turbines have welcomed this diversity, recognizing it as a positive development. The increased interest in tours and educational resources offered by the project benefits both the tourism and wind energy sectors. Developer groups have also scheduled tours for their employees and stakeholders, acknowledging the value of firsthand exposure to offshore wind operations. Moreover, the virtual tours and media content created as part of the project have garnered explicit endorsement and validation for offshore wind energy. Participants engaging with these interactive experiences have gained insight into the significance and benefits of harnessing offshore wind energy, contributing to the broader discourse on sustainable energy solutions. The project's comprehensive approach to outreach and education has not only sparked enthusiasm among visitors but has also bolstered the positive perception of offshore wind energy as a viable and impactful renewable energy source.

4.5. Greek Pilot

Operating in the marine area adjacent to the islet "Patroklos," KASTELORIZO AQUACULTURE SA manages a fish-farming unit on floating facilities, positioned just 850 meters off the coast. Annually, the aquaculture operation yields 230 tons of marine Mediterranean fish. This locale garners substantial tourist interest, with many visitors exploring the coasts of Patroklos islet, particularly during the summer, often via private boats. Notably, the seabed holds considerable touristic allure, featuring attractions like an underwater stolen cars cemetery near the mainland coast, as well as numerous shipwrecks and ancient artifacts, making Scuba-diving activities popular. Given the coexistence of aquaculture and tourism activities in this shared marine space, various objectives and prospective activities have been identified including the implementation of advanced technologies to enhance aquaculture production efficiency, including monitoring parameters such as salinity, water quality, and fish behaviour. The development of monitoring and management technologies to coordinate the operations of touristic diving boats and recreational activities with the activities at the aquaculture site. Additionally, providing support for management and planning decisions regarding the expansion of the aquaculture unit to ensure it does not disrupt current touristic activities. Also, exploring business development opportunities and cost minimization by integrating

activities from both sectors. Possible scenarios include organizing diving expeditions to the aquaculture units as a recreational attraction for divers or utilizing special equipment (ROVs) from diving centers to assist aquaculture activities during emergencies or risky procedures. To achieve such aims and development of tourism with fish aquaculture a number of relevant stakeholder groups had been identified:

- Kastelorizo SA Aquaculture.
- Planet Blue diving center.
- Local ministry office.
- Local community.
- Tourists – scuba-divers.
- Local chamber of commerce or offices of tourism.

The Greek pilot and its partners undertook an assessment to gauge the level of acceptability for each social impact and the acceptability and response of the various stakeholder groups. Notably, impacts with a high level of acceptability were observed, particularly concerning the generation of higher revenues for the local population. The presence of aquaculture activities attracted other marine life, thereby drawing visitors and fostering the development of diving activities, restaurants, hotels, and other ventures. This influx of economic activity contributes to increased revenue for the local community and enhances the quality of life without the negative implications associated with mass tourism, as visitor numbers are capped at 16 per day at the aquaculture site. Additionally, positive outcomes include heightened education and awareness regarding environmental protection in the area, facilitated by initiatives such as videos and testimonies, along with an improved diving experience. The increase attention to the protection and preservation of natural capital and protect species was vastly important to stakeholder at all levels. Conversely, negative impacts with undesirable outcomes were also identified. These include challenges related to the production of aquaculture fish, which face resistance from Greek consumers due to a negative perception of aquaculture and a preference for wild-caught fish over farmed alternatives. Furthermore, the increase in local tourism is not universally appreciated by the local population, indicating a potential source of tension within the community. The identification of these challenges and perceptions was key in order to address them and bring awareness to the benefits of such collaborations and address negative perceptions in an open manner.

Through the engagement undertaken within UNITED, a number of stakeholder groups, notably some with whom interactions and information exchange on multi-use is difficult were realised. Within the framework of our multi-use project, tourists exploring the area encounter several significant advantages. Initially, they gain a heightened awareness of ongoing environmental conservation efforts in the region, acquiring valuable insights into the importance of preserving the marine ecosystem. Additionally, tourists have the opportunity to familiarize themselves with the intricacies of fish farming operations. This interaction serves as an educational platform, dispelling misconceptions and misunderstandings regarding the potential negative impacts of aquaculture. It enables visitors to recognize the role of responsible aquaculture in addressing concerns related to overfishing. Lastly, tourists derive enjoyment from participating in scuba diving expeditions within our diverse marine environment. This not only offers them an immersive experience but also cultivates a deeper connection with the abundant aquatic life flourishing in the area. These benefits were mutually appreciated by the local authorities as well as the SMEs and educative programmes with whom the pilot engaged and collaborated with.

5. PRODUCT AND CONSUMER ANALYSIS

In this chapter, we provide a synthesis of the work undertaken in Work Package Three (WP3) related to the development of business cases, commercial positioning, and the exploration of various multi-use configurations. Our efforts have focused on the commercial viability and strategic positioning of innovative pilot outputs, including seaweed cultivation, oyster farming, and mussel production. The product resultant from commercial activities is the activity itself, therefore we do not focus on these outcomes but rather tangibles and consumables from the rest of the range of product outputs. Throughout WP3, we have developed business cases and plans for these configurations, analysing their potential to create sustainable and profitable opportunities. This chapter will build upon the findings from previous deliverables, offering an integrated overview of the commercial insights gained and their implications for the project's strategic objectives.

We will reference and elaborate on conclusions drawn in previous deliverables, providing detailed assessments of each pilot's market potential, scalability, and economic feasibility. By contextualizing these findings within the broader scope of multi-use development, we aim to present a cohesive narrative that highlights the commercial prospects and challenges associated with these innovative marine ventures.

Our evaluation has highlighted a range of positive environmental, social, and economic impacts resulting from the multi-use configurations explored within the project. In Greece, the primary benefit of the collaboration is enhanced local acceptance of aquaculture operations. Integrating activities like scuba diving tours with aquaculture can help mitigate opposition by increasing transparency about the industry's practices and potential environmental impacts. Although there are limited direct financial gains from this integration, the positive social impact is significant, as it can enhance the diving experience and promote a better understanding of aquaculture. Conversely, the Danish pilot demonstrates substantial benefits for the local economy through the use of existing offshore wind farm (OWF) infrastructure. The collaboration has spurred increased tourism, with visitors specifically traveling to see the OWF. This has led to additional economic activity for local businesses, such as hotels and boat operators, and has provided the pilot with valuable exposure through increased public engagement. While financial gains for the companies involved remain confidential, the overall economic benefit to the community is evident.

The integration of OWF with marine aquaculture is gaining traction, especially in the North Sea, where space constraints and competing uses pose significant challenges. Multi-use strategies, facilitated through Marine Spatial Planning, present a promising solution for optimizing marine resources in this area. However, a deeper understanding of the potential socio-ecological impacts and user conflicts is necessary to support the successful implementation of these multi-use scenarios. UNITED pilots in the North Sea demonstrate several positive environmental, social, and economic impacts from combining OWFs with aquaculture, particularly mussels and seaweed. Key benefits include more efficient marine space utilization, local food production, greenhouse gas (GHG) reduction, and habitat improvement. OWFs can significantly reduce CO2 emissions by replacing fossil fuels, while seaweed and mussel aquaculture can contribute to carbon sequestration and serve as renewable resources for various industries, such as medicine and cosmetics. Although carbon sequestration currently represents an additional benefit, it could become a future revenue source if scientifically validated and quantifiable. Another noteworthy impact is the potential for added value creation and local food production. Offshore operations can supply high-value seaweed and mussels, which, when promoted as sustainable and nutritious local food, can enhance economic opportunities and reduce reliance on imported seafood. This could lead to job creation and support local communities by providing a healthy, locally sourced food option. Conducted within the unused space of OWFs, these activities are unlikely to interfere with wind energy operations, thereby reducing marine space usage and alleviating pressure on marine ecosystems. This is one of the key products of the project that is noted as a consumable which is of interest to determine the degree to which consumers would be able to use these. In the context of the work and project, the consumers would be commercial actors whom would by, process, and develop higher value products from the outputs of such ventures. Despite the promising potential of these integrated activities to deliver value and bolster local food production, the viability of transforming this potential into sustainable business models remains uncertain. This topic is explored in D 3.4, where the practical implications and scalability of these initiatives within the broader Blue Bioeconomy context. And is summarised below.

5.1. Consumers and Markets for Pilot outputs if scaled

In Deliverable 3.4, we delve into the diverse roles and interactions of stakeholders involved in the project pilots, utilizing the Quadruple Helix Model as a guiding framework. This model extends traditional business frameworks by incorporating four key stakeholder groups—producers, consumers, networkers, and government entities—each contributing uniquely to the innovation ecosystem. By examining these groups within the context of our project pilots, we gain valuable insights into how multi-use marine initiatives can foster collaborative synergies and drive sustainable development.

The Quadruple Helix Model in the Context of Project Pilots

1. Producers: This group includes the primary actors involved in the production of goods and services within the multi-use configurations, such as aquaculture farmers and offshore wind farm operators. Their role is crucial in shaping the technical and operational aspects of the pilots, and their capacity to innovate directly influences the feasibility and success of integrating diverse activities, such as seaweed cultivation or eco-tourism, within the same marine space. This is often the role of the UNITED project pilot partners in generating raw materials to then be taken up or sold for additional value to be generated later in the chain of production cycles.
2. Consumers: Representing the end-users and beneficiaries of the multi-use outputs, consumers play a pivotal role in determining the market viability of the products and services offered. In the context of our pilots, this includes not only local communities benefiting from increased access to fresh seafood and renewable energy but also tourists and recreational users engaging in activities like diving and educational tours. Understanding consumer preferences and behaviors is essential for designing value propositions that resonate with diverse market segments. Often the consumers of the products developed would be other companies and entities whom would either packages and retail the produced goods and food-stuff, or use them as raw inputs to higher value product generation. The consumers are therefore commercial entities looking to interact with bulk purchases. This is especially evident and important in larger and scaled productions where quantities would easily exceed small scale direct to end consumer chains.
3. Networkers: This category encompasses intermediaries and facilitators, such as research institutions, NGOs, and industry associations, who bridge the gap between producers, consumers, and policy-makers. Their role is instrumental in promoting knowledge exchange, fostering innovation networks, and advocating for supportive policies and frameworks. In the project pilots, networkers have been pivotal in facilitating stakeholder collaboration, conducting impact assessments, and disseminating best practices across sectors and regions.
4. Government Entities: Government and regulatory bodies influence the legal and policy environment in which multi-use projects operate. Their involvement is critical in establishing supportive regulatory frameworks, providing funding opportunities, and ensuring compliance with environmental and safety standards. For the pilots, government entities have played a key role in enabling Marine Spatial Planning and promoting sustainable development goals that align with the broader socio-economic objectives of the region.

Application to Business Models and Frameworks

By integrating the Quadruple Helix Model into the analysis of project pilots, we can better understand the complex interplay of stakeholders and their collective impact on business model development. This holistic approach allows us to identify synergies and potential conflicts, optimize resource use, and create innovative, inclusive business frameworks that address both economic and societal needs. Throughout deliverable 3.4, specific case studies and insights from the pilots, demonstrating how each stakeholder group has contributed to the evolution of business models and frameworks in the context of multi-use marine projects. These examples will illustrate the practical application of the Quadruple Helix Model, highlighting best practices and lessons learned that can inform future initiatives in the Blue Economy. This is done for the consortium partners and in consideration of the external entities whom would have vested interested in playing roles not present in the UNITED consortium. Below we look at the cross-over and major outcomes from the three most evident outputs of the project, seaweed, mussels, and oysters as products for consumption. There are details on the wind sector and offshore renewable energy

developments within D3.3 and D3.4, however the energy production component, while a combined benefit in the project, was not one of the key developments resultant from the body of work and pilots.

5.2. Seaweed Production

Seaweed, or macroalgae, has a long history of cultivation in Asia, while in Europe, its commercial production has gained traction only in the past two decades. The North Sea seaweed industry is still in its early stages but is experiencing steady growth. With over 10,000 species of seaweed categorized into brown, green, and red varieties, Europe currently farms several species such as sugar kelp, sea lettuce, and dulse. However, the majority of seaweed production in Europe is still harvested from the wild, with only a small percentage cultivated through dedicated farming operations. As seaweed production scales up in the Netherlands and across Europe, its potential consumer base is expected to expand significantly. The primary consumers of large-scale seaweed production are likely to be larger corporations that package seaweed for end-use consumption or utilize it to create higher-value products, including cosmetics, pharmaceuticals, nutraceuticals, and bio-packaging. Companies involved in producing creams, medicines, and other specialized products are particularly well-positioned to benefit from a steady supply of sustainably farmed seaweed.

The European seaweed industry, particularly in the North Sea and related project countries (Belgium, Netherlands, and Germany), is still in its early stages but is showing promising growth potential. In 2018, the European seaweed market for human consumption was valued at approximately $1.02 billion, representing 10% of the global market share. The Netherlands an Belgium, with openness to diverse culinary influences, including Asian cuisine, and strong reputation for agricultural efficiency and water management, is well-positioned to capitalize on this expanding market. This makes the country an ideal location for seaweed innovation and collaboration. Projections indicate that the European seaweed market could reach as much as €9.3 billion by 2030, driven by its diverse applications in food, animal feed, pharmaceuticals, cosmetics, biofertilizers, biofuels, and ecosystem services. With appropriate development, European producers could capture up to 30% of this market, highlighting the vast potential for local production to meet growing demand.

Operational expenditure analysis from UNITED Dutch pilot partner, The Seaweed Company, underscores the significant potential for economies of scale in seaweed production. Increasing the number of cultivation systems can dramatically reduce production costs, making European seaweed more competitive against lower-cost Asian imports. For example, operating five cultivation systems results in a cost of €11.30 per kilogram of wet weight (WW), while operating 20 systems brings the cost down to €4.03 per kg/WW, and 500 systems reduce it further to just €1.52 per kg/WW. Achieving such scale efficiencies is critical for the European seaweed industry to thrive on a global scale. The potential for expansion in both the Dutch and Belgian markets is substantial. In Belgium, current production data are limited, and much of the information available is derived from broader European datasets, indicating that while the sector is still nascent, there is room for significant growth. Differences between macroalgae (seaweed) and microalgae production highlight distinct commercial applications, with macroalgae being used predominantly in food, cosmetics, and pharmaceuticals, while microalgae find their primary use in biofuel production and aquaculture feed. The Belgian market, despite its smaller scale, is supported by a political push towards sustainable growth, as reflected in the EU Bioeconomy Strategy and national policies encouraging multi-use activities within offshore wind farms (OWFs).

However, the industry faces several competitive challenges. Prices for locally cultivated North Sea seaweed are currently higher than those for Asian imports, which limits its economic viability on a large scale. In this case the consumers of these outputs would need incentives; to capture significant market share, European producers must reduce production costs and emphasize the unique properties of locally grown seaweed, such as sustainability and traceability, to justify a premium price. Overcoming these challenges will depend on targeted interventions, such as subsidies, technological innovation, and regulatory support, to enhance the competitiveness of European seaweed on the global stage. A significant barrier to market growth is consumer unfamiliarity with seaweed. Many consumers are unsure about how to prepare, store, and incorporate seaweed into their diets. Issues such as perceived high cost, limited availability, and unclear preparation instructions further deter adoption. Retailers also struggle to categorize seaweed products effectively, leading to confusion about where to find them in stores. Addressing these barriers requires innovative marketing strategies to increase consumer awareness and acceptance. Emphasizing the nutritional benefits of seaweed, providing clear usage instructions, and positioning it as a sustainable and versatile food source are crucial steps in building consumer demand.

As the seaweed industry in Europe matures, aligning production capacity with market demand and ensuring the availability of high-quality, cost-competitive products will be essential. Continued research into the ecological impacts and scalability of seaweed farming, along with targeted investments in infrastructure and technology, will be key to unlocking the full potential of this emerging sector. Strategic partnerships across the value chain, from cultivation to end-product manufacturing, will be vital in realizing the economic and environmental benefits of seaweed production at scale. By focusing on sustainable growth, job creation, and the development of innovative, high-value products, the European seaweed industry can position itself as a leader in the global market.

The sustainability of seaweed farming is contingent on balancing production intensity with the carrying capacity of the marine ecosystem. In the North Sea, plans are underway to assess the feasibility of large-scale seaweed production, potentially covering several hundred square kilometers. This growth could foster substantial economic opportunities, with the European seaweed industry projected to create up to 85,000 full-time equivalent (FTE) jobs by 2030. This includes roles in hatcheries, farming, processing, and distribution, as well as indirect employment in logistics and marketing. Realizing the full economic potential of the seaweed industry will depend on increasing production volumes, expanding European market share, and integrating Dutch businesses into the value chain. With a projected market size of €9.3 billion annually across various applications, including food, animal feed, pharmaceuticals, and biostimulants, the seaweed industry offers a promising avenue for economic development and job creation in the Netherlands and beyond.

5.2.1. Consumer Summary

Despite the growing production of seaweed in Europe, consumers often prefer imported varieties over locally grown options. Several factors contribute to this trend, including concerns about price, availability, familiarity, and perceived quality. One of the primary challenges is price sensitivity. European-grown seaweed tends to be more expensive compared to imported varieties, particularly those from Asia. The higher costs of production in Europe, which include labor, regulatory compliance, and the relatively small scale of current operations, result in a higher price point. For many consumers, cost is a critical factor in purchasing decisions, and the higher price of European seaweed can deter them from choosing it, even if they recognize the potential sustainability benefits of supporting local producers. Availability also plays a significant role. Imported seaweed products, especially those from Asia, are well-established and widely available in supermarkets and specialty stores. They occupy substantial shelf space and are easy for consumers to find. In contrast, European seaweed is less visible, as distribution channels are still developing. This limited market presence reduces consumer exposure and makes it difficult for local products to compete effectively.

Another obstacle is consumer familiarity and preference. While Asian seaweed varieties, such as nori and wakame, are well-known and widely used in popular dishes like sushi and salads, European varieties such as sugar kelp and dulse are less recognized. This unfamiliarity can affect consumer confidence and willingness to experiment with these products. Additionally, there may be perceived differences in taste, texture, and culinary versatility, leading consumers to favor the flavors and forms they are already comfortable with. Perceptions of quality and origin also influence consumer choices. Asian countries like Japan, South Korea, and China are seen as traditional and expert producers of seaweed, which can create a bias against European-grown varieties. This perception is often linked to cultural associations and beliefs about the authenticity and quality of the product. Convincing consumers to view European seaweed as equally high-quality and authentic requires significant effort in altering these ingrained perceptions. Furthermore, there is a lack of effective marketing and educational initiatives around European seaweed. Many consumers are unaware of the environmental and health benefits of locally grown seaweed or its potential uses beyond traditional Asian cuisine. Without targeted efforts to educate consumers on these aspects and to demonstrate how to incorporate European seaweed into their diets, it is challenging to shift existing preferences and habits.

Overcoming these barriers will require a strategic approach that addresses cost reduction, improves market presence, and enhances consumer education. By effectively communicating the unique qualities and benefits of European seaweed and promoting its versatility and sustainability, producers can better position their products to compete in the global market and encourage greater local consumption.

5.3. Bivalve Production

In the context of this analysis, oysters and mussels are grouped into a single consumer category due to their substantial overlap in market characteristics and consumer preferences. Both shellfish species share similar production methods, culinary applications, and face comparable challenges and opportunities in the marketplace. Consequently, separating these products would result in repetitive content and redundant insights. The consumer profile for oysters and mussels typically includes individuals and businesses with a preference for sustainable seafood options, often in the context of premium dining experiences or niche culinary markets. However, roadblocks such as fluctuating supply, high production costs, and consumer misconceptions about shellfish farming practices can hinder broader market penetration. Benefits of expanding this consumer base include promoting local aquaculture, reducing seafood imports, and supporting coastal economies. Detailed information on consumer behavior, market dynamics, and potential strategies for overcoming these challenges is discussed extensively in Deliverables 3.3 and 3.4.

The bivalve aquaculture sector in the North Sea, particularly for mussels and oysters, presents a complex landscape shaped by regional characteristics and market dynamics. In Belgium, the aquaculture industry is relatively small but steadily growing, encompassing the production of various species of fish, crustaceans, and mollusks. Most of Belgium's aquaculture occurs on land, with the exception of oyster production along the coast, where favorable North Sea conditions support the cultivation of both flat and cupped oysters. Despite its modest scale, the sector shows potential for expansion. Recent data indicate that Belgium produced approximately 200 tons of aquaculture products in 2019, valued at 1.3 million EUR. However, this figure encompasses all aquaculture production and not solely oysters. Two companies in Ostend currently dominate Belgian oyster production, collectively yielding around 50 tons annually. Plans for expansion, such as the upscaling of production plots, signal a promising trajectory for the sector, although it remains constrained by limited market presence and competition with imported products.

In Germany, aquaculture is similarly fragmented, characterized by small-scale, family-owned businesses. The sector's primary focus is on mussel cultivation, which traditionally occurs in nearshore sites within the protected Wadden Sea National Park. Here, mussel spat is produced and then relocated to designated areas in the North Sea, where it grows to harvestable size over several years. This method is part of the traditional mussel fishery, which uses bottom trawling techniques. Despite the constraints of operating within protected areas and the competition with other maritime activities like tourism and shipping, German mussel aquaculture has experienced gradual growth. However, spatial expansion of mussel production is limited due to the environmental restrictions of the Wadden Sea National Parks. As a result, further growth in the sector will likely necessitate a move towards offshore cultivation, which is currently experimental and dependent on multi-use arrangements with offshore wind farms (OWFs).

The consumer market for bivalves in Europe, particularly in the North Sea region, is driven by a growing demand for sustainable seafood options. However, both Belgian and German producers face significant roadblocks in meeting this demand. High production costs, limited scale, and stringent environmental regulations make it difficult to compete with imported bivalves, which are often less expensive and more readily available. Additionally, consumer awareness and preferences play a crucial role. Many consumers are more familiar with imported varieties and may not perceive local products as offering superior quality or sustainability. This perception, combined with limited marketing and distribution channels, restricts the market reach of locally produced bivalves. Despite these challenges, there is considerable potential for growth in the bivalve aquaculture sector in the North Sea, driven by technological innovations and the development of new business models focused on sustainability and regionality. For instance, offshore aquaculture systems that integrate mussels with other species, such as seaweed, could provide important ecosystem services, enhance economic stability through diversified incomes, and increase social acceptance of aquaculture practices. However, realizing this potential will require strategic collaboration between aquaculture and wind energy sectors, as well as supportive policies that facilitate multi-use of marine areas. Although large-scale commercial viability of offshore bivalve production remains a long-term goal, the ongoing pilot projects and research efforts in both Belgium and Germany are crucial steps towards building a resilient and sustainable aquaculture industry in the region.

The consumer base for farmed mussels and oysters in Europe primarily consists of larger businesses such as wholesalers, restaurants, food processors, and retailers who purchase these bivalves in bulk. These businesses often use

mussels and oysters as raw materials for creating higher-value products such as pre-packaged seafood dishes, gourmet offerings, or processed items like smoked or marinated shellfish. Despite the potential market opportunities, several limitations affect the expansion of the bivalve market in Europe. One significant limitation is the consistency and reliability of supply. Large businesses require a steady and predictable volume of high-quality product to meet consumer demand and maintain profitability. Fluctuations in production due to environmental factors, such as changes in water temperature, pollution, or harmful algal blooms, can disrupt the supply chain and make it challenging for European producers to compete with more established markets like those in Asia or North America, where production scales are larger and more stable.

Another barrier to market expansion is the stringent regulatory environment in Europe, which can make scaling up production a slow and costly process. For businesses looking to source bivalves for resale, ensuring compliance with health and safety standards, traceability, and sustainability certifications is essential. While these regulations protect consumer health and promote sustainable practices, they also increase the cost and complexity of production, making it difficult for smaller European producers to achieve the economies of scale necessary to compete with international suppliers. The needs of these larger business consumers go beyond just product availability. They require assurances of consistent quality, compliance with food safety standards, and the ability to meet specific certification requirements, such as organic or Marine Stewardship Council (MSC) labels. Additionally, there is a growing demand for transparency regarding the environmental and social impacts of aquaculture practices. Businesses increasingly seek suppliers who can demonstrate sustainable and ethical farming practices, as this aligns with consumer expectations and regulatory trends toward more responsible sourcing.

To expand the market, European producers must focus on meeting these business consumers' needs through innovations in production technology and improvements in supply chain management. Developing more resilient aquaculture systems that can withstand environmental variability, investing in advanced processing and packaging technologies to extend shelf life, and improving logistical networks to ensure timely delivery are critical strategies for gaining a foothold in the competitive bivalve market. Furthermore, enhancing communication and marketing efforts to promote the unique qualities of European mussels and oysters—such as their sustainability, local origin, and premium taste—can help differentiate these products and attract more business consumers willing to pay a premium for high-quality, responsibly sourced seafood. By addressing these limitations and focusing on the specific needs of their business consumers, European bivalve producers can better position themselves to capture a larger share of the market and support the growth of the aquaculture industry in the region.

5.3.1. Consumer Summary

The bivalve aquaculture industry in the North Sea, particularly focusing on mussels and oysters, is growing but faces significant challenges and opportunities in meeting the needs of its consumer base. In Belgium, oyster production is limited and primarily concentrated among a few coastal companies, while in Germany, mussel farming is carried out within the protected Wadden Sea National Park. Despite the small scale and traditional practices, both countries are exploring ways to expand into offshore areas, though this remains in an experimental phase due to environmental and logistical challenges. International competition, primarily from Asian and North American markets, continues to pose a significant threat, as these regions often provide lower prices and a more stable supply. The primary consumers of farmed mussels and oysters in Europe are large-scale businesses such as wholesalers, food processors, and upscale restaurants, who purchase these products in bulk for resale or as ingredients in value-added products. These businesses require a consistent supply of high-quality bivalves, compliance with food safety standards, and certifications that guarantee sustainable and ethical production practices. However, the fluctuating supply due to environmental conditions, high production costs, and stringent regulatory frameworks make it challenging for European producers to meet these demands consistently.

One of the key strategies for European producers to gain a competitive edge is to market locally produced bivalves as environmentally friendly alternatives that help reduce total carbon emissions. Promoting the benefits of choosing European mussels and oysters—such as reduced transportation emissions and the support of local ecosystems—can attract environmentally conscious consumers and businesses. This approach can position European bivalves as a premium, sustainable choice, aligning with growing consumer and corporate commitments to reducing their carbon footprint and supporting local food systems.

To further support the growth and stability of the sector, governmental subsidies and policies are essential. These could include financial incentives for producers to adopt innovative, sustainable farming practices, subsidies to offset the higher production costs, and promotional campaigns to raise awareness about the benefits of consuming locally sourced bivalves. Such support would not only help European producers compete with cheaper imports but also strengthen local production, enhance food security, and contribute to regional economic development. By aligning production capabilities with the needs of their business consumers and leveraging governmental support, European bivalve producers can better position themselves in the competitive global market. Focusing on sustainability, food security, and regional economic resilience, the industry can attract more businesses willing to invest in locally produced, high-quality mussels and oysters, ultimately helping to secure a more sustainable future for the sector.

6. SUMMARY AND SYNTHESIS

The overall engagement and stakeholder ecosystem building processes developed withing WP5 and implemented through the various workshops and initiatives across all 5 of the UNITED pilots was evaluated to be a success across the project. While various groups delved to a greater or lesser degree into these activities, some overarching benefits and recommendations have been formed. The incorporation of diverse activities within a multi-use framework holds promise for generating substantial economic benefits while effectively managing societal costs. This integration not only enhances overall economic efficiency but also frequently results in reduced financial expenditures. From a business perspective, multi-use environments can offer greater financial rewards compared to single-use scenarios situated in separate marine areas. Furthermore, multi-use arrangements may enable activities that would be economically unfeasible in single-use contexts. For example, certain touristic activities thrive within multi-use settings, leveraging the presence of other coexisting activities for their viability. Boat tours in wind farms or diving excursions around fish farms are prime examples, benefiting from the diverse marine life attracted to these combined environments, including iconic species like marine mammals. Overall there was a benefit perceived and realised to varying extents from many of the actors involved in the multi-use projects. Ranging from environmental, social, societal, or economic elements, all of the stakeholder groups engaged with across the pilots agreed to the benefits of integrating multiple activities at sea.

In the decision-making process, policymakers and stakeholders must consider the economic impacts when evaluating the societal value of various multi-use options. To ensure a comprehensive assessment of all relevant impacts, a structured and sequential approach was developed and implemented in collaboration with pilot leads and other consortium partners directly involved in the pilot projects. Multi-use scenarios, when contrasted with single-use approaches, have the capacity to yield net societal benefits across various dimensions, encompassing cultural enrichment, social equity, and community empowerment. The specific nature of these advantages varies depending on the contextual factors and the nature of the envisaged multi-use applications. Rooted deeply in sustainable development principles, multi-use concepts hold promise in empowering coastal communities, fostering interdisciplinary collaboration and innovation, and accommodating traditional or cultural practices related to the sea, such as certain forms of fishing or recreational pursuits. However, discerning the extent to which multi-use arrangements outperform or provide additional benefits compared to singular use activities is not always straightforward, particularly in offshore settings where societal benefits materialize on land within regional municipalities, while tangible differences in co-location versus single use are evident at sea. A crucial determinant in this assessment lies in the potential to augment overall activities within a given domain. The interactions with the various stakeholder groups has demonstrated resilience and adaptability in addressing social benefits and considerations at both pilot and scaled levels. Often drawing inputs from stakeholder workshops and broader consultations, consensus on scaled multi-use features is reached, with a focus not only on pilot scales but also on future developments and deployments.

A key aspect for future developments and bridging sectorial and interest divides is the development of overarching communities of practice for he marine environment. As reflected in the success of collaboration and ease at which multiple actors can be engaged with in meaningful and beneficial way through the Dutch Community of Practice, and the future deployment of similar initiatives at regional levels in future works and projects, such an approach can be seen as a way forward. But institutionalising stakeholder communities, the ability and opportunity for cross-sectorial engagement and collaborations is clear, as is the ability to more easily and concretely interact with policy and decision makers at multiple levels, ranging form local to transnational.

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