MARINEWIND

Market Uptake Measures of Floating Offshore Wind Technology Systems (FOWTs)

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D2.2: Final social acceptance and environmental impact analysis

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EXECUTIVE SUMMARY

This document, **D2.2 – Final social acceptance and environmental analysis**, is a deliverable produced within the MARINEWIND project, which is funded by the European Union's Horizon Europe Framework Programme.

This deliverable presents the final results of the analysis of social acceptance and environmental impacts associated with the deployment of Floating Offshore Wind (FOW) in Europe, within the framework of the MARINEWIND project. Based on extensive stakeholder engagement, including co-creation workshops in the MARINEWIND Labs, surveys, and webinars, alongside a comparative review of national Maritime Spatial Planning (MSP) frameworks and Environmental Impact Assessments (EIAs), the study identifies key barriers and enablers for FOW development.

Social acceptance remains a critical challenge, often hindered by concerns over landscape alteration, conflicts with traditional sea uses (e.g., fisheries, tourism), and limited stakeholder involvement. Conversely, local economic benefits, job creation, and transparent governance are strong enablers. From the environmental perspective, the analysis highlights the need for harmonised EIA methodologies, improved data accessibility, and cumulative impacts assessments. Furthermore, the deliverable outlines best practices from both MARINEWIND countries, namely Spain and the UK, and Denmark to illustrate the value of integrated planning, early stakeholder engagement, and adaptive monitoring.

This deliverable reports the analysis carried out by the MARINEWIND consortium regarding social acceptance and environmental impacts over the entire project period, bringing further the work described in D2.1 [1]. Five chapters are included as follows:

- **Chapter 1** provides insights into the European policy framework guiding the sustainable deployment of FOW.
- **Chapter 2** analyses and compares data and results from the co-creation workshops realised in the MARINEWIND Labs, surveys and webinars.
- **Chapter 3** investigates the MSP measures in the five country Labs to identify best practices and enablers for the development of FOW. In fact, MSP has been recognised as an important tool to help solve conflicts with other uses of the sea, although one of the main problems [2] is that additional measures and policies need to be put in place, such as multi- or co-use, promoting ecosystem-based planning and enabling financial compensation, to minimize or mitigate spatial conflicts on project-specific levels [3].
- **Chapter 4** analyses the EIA processes in the five countries of the consortium, proposing a possible standardisation and related recommendations to overcome the traditionally fragmented and inaccessible nature of information contained in EIA processes for different European countries.
- **Chapter 5** proposes policy recommendations to enhance regulatory clarity, promote coexistence at sea, and foster a just and sustainable energy transition through FOW deployment.

1 INTRODUCTION

Integration and a holistic approach are crucial keywords related to the deployment of offshore renewable energy, in particular offshore wind. The integration of different policy and infrastructural interventions considers, on the one hand, the diverse stakeholder interests and needs, and on the other hand, various technological and logistical aspects.

These keywords are at the centre of the EU Ocean Pact, published on the 5th of June 2025 [4]. It is a strategic document outlining the intentions of the European Commission for the near future on ocean and marine-related issues. The approach consists in integrating all different policies which have implications in this field, hopefully leading up to an Ocean Act by 2027. Regarding offshore energy, the European Commission plans to:

- Develop an industrial maritime strategy to enforce EU industrial capabilities in manufacturing offshore energy technologies, including a strategy to make ports industrial clusters supporting the related value chain.
- Accelerate the installation of the marine renewable energy plants, tackling the issues of the necessary investments, the access to raw materials and the lack of skilled workforce.
- Couple the aforementioned goals with a strategy on coastal community development, to foster the economies and the resilience of these places, looking at new business models and climate adaptation interventions.
- Elaborate a unified ocean Research and Innovation (R&I) strategy going beyond the actual fragmentation of EU R&I initiatives, building a network of ocean technology testing sites, an ocean observation initiative and a digital twin ocean.

Regarding the enforcement of EU industrial capabilities, the European Commission published the Clean Industrial Deal on the 26th of February 2025 [5], covering weaknesses like the high energy prices, access to raw materials and skilled workforce. Furthermore, concerning the acceleration of marine renewable energy plants, the EU policy framework has included, over the years, different Renewable Energy Directives (REDs). RED III, approved by the European Parliament on the 12th of September 2023 [6], is the last directive on renewable energy and it sets a new target on EU renewable energy use by 2030, increasing it from 32% (set by RED II) to 45% (42.5% per each Member State).

There are different targets included in the directive. In particular, FOW could be supported by the target concerning the use of innovative technologies for the installation of new renewable capacity, which should constitute 5% of all installations. RED III also introduced accelerations in the permitting procedures, setting the maximum time for an authorisation between 1 and 3 years, depending on the kind of plant and area. There are exceptions related to offshore energy and connected to the complexities of the installation of plants in the sea or in the ocean.

In the so-called "acceleration areas", permit-granting should take at maximum 12 months for renewable energy projects, while the limit is set to 2 years for offshore renewables, with a potential

extension of a further 6 months for extraordinary and justified circumstances on the ground in both cases.
In a similar way, a longer deadline, with respect to other renewables, is set for the repowering of renewable energy plants. In the case of other renewables, the authorisation procedure could take no more than 6 months, while, in the case of offshore wind projects, no more than 12 months. When justified circumstances on the ground apply (e.g. safety reasons, impact on the grid, size or performance of the installation), Member States may extend both deadlines by an additional 6 months. Outside renewables acceleration areas, permit-granting deadlines are set to 2 years for renewable energy projects and 3 years for offshore renewable energy projects, 12 months for repowering renewable energy plants and 2 years for repowering offshore. All deadlines can be extended for justified circumstances on the grounds of 6 months for renewable energy projects and of 3 months for repowering projects.

According to the European Technology & Innovation Platform on Wind Energy (ETIP Wind) and the European Technology & Innovation Platform for Ocean Energy (ETIP Ocean), established as ETIPs of the EU Strategic Energy Technology Plan, these are the main aspects EU and national policymakers should focus on [7]:

- Market visibility;
- Marine Spatial Planning (MSP) and permitting;
- Public financing mechanisms;
- Grid development.

By mentioning market visibility, the two ETIPs intended an increasing commitment of the institutions to foster the development of offshore energy, which constitutes an important message for investors. The EU deployment targets go in this direction. All stakeholders are informed that the EU's ambitious targets imply an increase in offshore wind installations from 3 GW/year today to 15 GW/year by 2030. National institutions are asked to integrate these overall targets in their plans, particularly in their National Energy and Climate Plans (NECPs), as Portugal already did, providing the necessary certainty to investors and installers, at least regarding wave energy.

Additional measures aimed at improving market visibility include large volume tenders, which are necessary to give a boost to supply chain investments. For example, Germany and Denmark, in 2023, respectively closed and committed to open auctions for 7 and 6 GWs, fostering the creation of ecosystems of actors working together to develop national supply chains for offshore wind. For fixed offshore wind, tenders in Europe should be at least 1 GW. Increasing volumes would also help foster the development of less mature technologies, similar to the case of FOW. In that way, investors would know that governments are supporting the development and the adoption of these technologies and would do their part in accelerating their uptake.

The MSP is deemed as a crucial instrument, since it provides the basic conditions for investors and installers, stating the areas where offshore renewables will be developed, while streamlined permitting procedures would facilitate the commitment of private operators. The updates of the different MSPs should be built on a coordination among all stakeholders, ensuring a sustainable and fair sea use and preventing conflicts, while procedural simplification, like one-stop shops and digitalisation, should give new instruments for developing a local supply chain.

Concerning public financing, the ETIPs encourage policymakers to adopt schemes combining revenue support and investment aid. For offshore wind, two-sided Contracts for Difference (CfD) are considered the right form of revenue support since it helps to de-risk large projects, with governments paying and getting paid when the electricity price is, respectively, below or above a set CfD price. Non price-criteria ensure that projects bringing the highest value to the society are properly rewarded because of their commitments related to, for instance, environment, sustainability, R&I and cybersecurity. Also, Power Purchase Agreements (PPAs) can support projects ensuring long-term revenues.

The final, but not less important, recommendation of the ETIPs concerns the necessary grid development to collect and transport all the wind energy that should be produced by 2050. The offshore targets by that date require an offshore wind capacity amounting to 1.35 times the average load in Europe, as well as the need to reinforce grid infrastructures over Europe. Both public financing and reliable planning from system operators are crucial to provide the right conditions for an increase in European production of the necessary infrastructures and technologies, from cables to transformers and substations. Incentives should be allocated also for the development of grid optimisation solutions, allowing to manage more electricity without infrastructure additions, like flexible AC transmission systems, dynamic line rating and modular power flow control. The use of digital technologies is at the core of the optimisation effort.

However, financing and incentives are not sufficient without the development of adequate regulation and policies supporting the testing and the adoption of these new technologies. Policies should also adopt a holistic approach, going beyond separate offshore energy projects, with relative point-to-point grid connections. In fact, all projects should be conceived as parts of an overall offshore energy development plan, managing their connections to the onshore grids in an efficient way. For instance, more offshore wind plants can be managed as a unique energy island integrated with the onshore energy system via one connection point. As explained in MARINEWIND D1.1 – Analysis of policy and regulatory barriers and enablers [8], this kind of integrated plans paves the way to a new configuration in which "*large-scale deployment of offshore renewable energy will result in a gradual development of a meshed offshore network, which will connect several OWFs [Offshore Wind Farms] with several onshore bidding zones*" [9].

2 SOCIAL AND ENVIRONMENTAL HIGHLIGHTS FROM CO-CREATION WORKSHOPS, SURVEYS AND WEBINARS

This chapter analyses and compares data and results from the co-creation workshops realised in the MARINEWIND Labs, surveys and webinars, leveraging on the insights from a first assessment of the main barriers related to social acceptance and environmental impacts, reported in MARINEWIND D2.1 Analysis of social and environmental barriers and enablers [1]. The first analysis led to the identification of the following barriers: negative impact on tourism income; reduction in property values; conflict with fishing activities (e.g. reduction in fishing income; loss of employment in the fishing sector; increased costs for fishing activities, conflicts between fishing equipment and facilities); restrictions on recreational and sporting activities; impact on cultural heritage; negative perception of projects promoted by external entities; impacts on the sea-bed and fauna. On the other side the following factors were identified as favouring acceptance: positive gross added value; new activities related to tourism or boating; research and development activities related to marine energies and environmental monitoring; employment generation; development of the production supply chain; specialised training and education; synergies with other uses of the sea; development of communication platforms; reducing the cost of electricity; the potential role of FOW infrastructures as protected areas, increasing biodiversity, creating artificial reefs and encouraging aquaculture.

In this chapter, the Consortium enriches the analysis by integrating the results from all the co-creation workshops, the MARINEWIND survey and the webinars. These activities involved a wide range of stakeholders, including industry, academia, civil society, green innovation and public authorities, aiming at exploring barriers, as well as further understanding the social and environmental implications of FOW development through the experience and knowledge of the actors dealing with these aspects in daily life.

2.1 Co-creation workshops

MARINEWIND co-creation workshops involved a total number of 615 stakeholders across the Labs (Greece, Italy, Portugal, Spain, United Kingdom) and from five different categories, according to the Quintuple Helix approach (Figure 1):

1. Academia;
2. Civil society;
3. Green innovators;
4. Industry;
5. Public authorities.

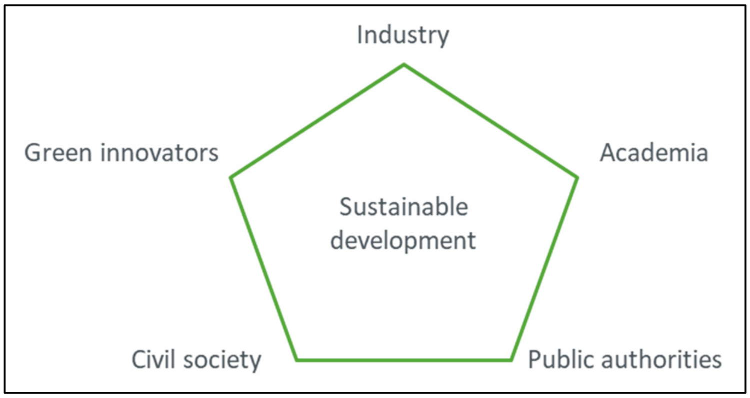

Figure 1 – Quintuple Helix: 5 macro-categories

In the framework of the co-creation workshops organised within the five MARINEWIND Labs, stakeholders were invited to identify the main barriers and enablers affecting the development of FOWs.

As a result of the fifteen co-creation workshops held in the MARINEWIND Labs, the following cross-cutting barriers – related to social acceptance, environmental and policy aspects - emerged:

Social acceptance

- Social acceptance of the Offshore Wind Farms (OWF): Lack of social acceptance amongst the local communities and key actors, including environmental and fishermen's associations, can cause significant delays in the construction phase, putting in jeopardy the economic viability of the projects. This opposition is often due to widespread misconceptions, a lack of proper and timely information on the implementation of the projects, and limited awareness regarding the potential benefits generated by the wind farms. This lack of awareness and clear information is, of course, worsened by the confusion generated by fake news. Besides, local communities are often sceptical about the actual distribution of the benefits among the inhabitants. Furthermore, social acceptance is hindered by a lack of transparency and public consultations in the licensing processes.
- FOW could damage the landscape and cultural heritage integrity: Offshore wind farms can have visual and aesthetic impacts, which may be a concern for coastal communities and tourism industries. Opposition to the alteration of landscapes or important cultural sites can be a significant barrier.
- Credibility of developers and public authorities: Concerns about transparency, integrity, and the capabilities of both developers and public authorities can hinder industry progress and social acceptance
- Lack of skilled workers: Shortage of trained professionals to meet the demands of the emerging offshore wind energy sector.

Environment

- Need to further investigate environmental impact: Environmental impacts related to FOW, particularly on marine ecosystems, needs to be further analysed due to the novelty of this technology. This aspect could also result in significant delays and costs (e.g., further environmental impact studies) for potential investors to invest in FOW.

Policy

- Lack of integrated Maritime Spatial Planning: The lack of a planning reconciling the interests of various sectors and eliminating possible conflicts is an important source of uncertainty. Marine spatial planning needs to be concise and specific to ensure good use and enhance stakeholder confidence in the development process and the coexistence with different activities in the sea. The lack of such planning is considered as a main barrier for investors as well.
- Lack of regulatory framework stability and offshore wind strategy: Regulatory uncertainties always affect the market's attractiveness for investors. Besides, these barriers can be worsened by a lack of governmental representation and effective decision-making in OWF projects, leading to frustration among stakeholders.
- Lack of smooth single authorisation procedure: Smooth and single permitting procedure would streamline the resolution of disputes that block the approval of projects for years. Often these procedures are complex, unclear and with a low level of digitalisation. As a result, these bottlenecks make permitting times longer and discourage investors.
- Unclear division of responsibilities identified a problem, for instance in southern countries like Italy, where different responsible public bodies with an unclear division of responsibilities are involved in granting FOW permits, further worsening the bureaucracy burden. This is an issue, in particular, among public and private entities regarding feasibility studies and preliminary analyses (e.g. of the seabed, with also risks of conflicts between national and local institutions, since the MSP limits regional powers.
- Conflicts among different sea uses: Offshore wind can be an obstacle for other uses of the sea and related sectors involved (first navigation, then landscape integrity and environmental protection, fishing both as a commercial and recreational and sporting activity, tourism). Furthermore, it could negatively impact tourism revenues and navigation. Ports are also asked to deal with logistical and administrative challenges to adapt their facilities to offshore wind operations. Sea-use conflicts can be worsened by a lack of transparency and collaboration between the fishing and renewable energy sectors, thus hindering dialogue and data sharing. As an example, according to the Italian Port Authority, FOW endangers the security of navigation and the number of planned projects for Offshore Wind Farms is too high to be able to coexist with the current navigation routes. Data from Italy showed that the Italian fishing sector is facing a major crisis, with a 35% decrease in the quantities of the fish caught and a 20% reduction of the employment rate, affecting the whole supply chain. In this context, FOW could further boost the negative effects of the crisis.
- Lack of tenders (with established criteria) to assign the maritime areas for wind farms produces unregulated race to apply for concession.
- Lack of knowledge, data, and best practice sharing.

On the other hand, stakeholders from the MARINEWIND Labs have identified the following main enablers:

Social acceptance

- Local supply chain development and job positions: Investing in FOW is not only crucial for meeting renewable energy targets but also for driving sustainable industrial growth. FOW projects can enable the creation of jobs, stimulate economic development, and contribute to reducing greenhouse gas emissions, bringing economic advantages for local enterprises of any direct participation in the supply chain. Furthermore, the production of wind energy can provide energy locally and guarantee stable and reduced electricity price, while the adaptation of existing infrastructures and the preventive investment in new infrastructures can bring new economic opportunities (e.g. ports adaptation).
- Information campaigns to raise public awareness about the benefits stemming from FOW, including health ones (e.g., air quality improvement) and safety of offshore wind energy could make local communities to have more informed opinions on FOW projects. Key actions to raise awareness about FOW project include workshops, lectures, and visits to offshore wind farms, allowing people to learn firsthand. In particular, it is important to raise awareness about the limited visual impact of FOW turbines if compared to the possible negative impact generated by not carrying out renewable installations. In addition, it is important to effectively communicate how investment in offshore wind energy can be translate into economic benefits and local employment.
- Energy communities: The integration of wind farms into the socio-economic fabric of the territories concerned can be an opportunity for more horizontal and bottom-up initiatives like energy communities, improving transparency, early engagement and community benefit sharing opportunities.
- Integrated development plan for offshore wind-ports and other sea uses: The integrated development of different sea activities can put together different economic opportunities in a sustainable way, both for the environment and for the long-term execution of these activities (e.g. preserving fish population). For example, the Italian Porth Authority suggested to reserve channels inside the offshore wind farms for navigation routes, which is an option that could be also considered for some types of fishing. This action would require a change in the general approach, replacing restrictive fishing measures with good regulation and management practices. The adoption of an integrated and co-existence approach of the maritime space would enable the promotion of other activities in the same space, including carbon capture, aquaculture, ocean monitoring and observation or environmental protection. In this context, the establishment of an ongoing dialogue with key stakeholders is crucial to co-develop new integrative models for FOW deployment.
- Stakeholder involvement: Engaging with industry stakeholders through consultations, advisory boards, and research collaborations can enhance government understanding of sector needs.
  Collaboration between academic institutions, private sector companies, manufacturers, and SMEs facilitates knowledge sharing, technology transfer, and innovation in the offshore wind sector.
  Legislative regulation of the participation of small investors, bringing as consequence shared responsibility and economic and social benefits, would help overcoming prejudices and concerns

by the civil society (e.g. Denmark). It is necessary to engage local community and stakeholders throughout all the phases of the project through awareness-raising campaigns, seminars, educational activities, roundtables to collect in advance their concerns and expectations while increase the social acceptance. Communities should be involved in decision-making and should be heard, taking the opportunities for public feedback. In case of divergent opinions, it is important to seek consensus-based solutions. This participatory process requires strong governance and commitment from all stakeholders, governmental involvement and support to overcome challenges and ensure project success.

- Workforce training: Workforce training and technology transfer are key elements to elevate domestic industrial capacity and competitiveness globally, while addressing the skill gap. In fact, by investing in educational programs tailored to the needs of the offshore wind energy sector, regions can cultivate a capable workforce to support industry growth. Instead of viewing the shortage of trained professionals as a drawback, stakeholders should recognise it as an opportunity to foster regional growth within the sector, attracting talent and stimulating economic development in the region.
- Compensation actions and redistribution of benefits: Fishing and tourism are important sectors for the five countries involved in MARINEWIND, and in general for all countries with sea. To counterbalance negative effects and opposition against the implementation of offshore wind projects, the co-design of compensatory measures for these sectors might be helpful.

Environment

- Wind farms hosting "protected areas", increasing biodiversity, creating artificial reefs and encouraging aquaculture. These areas would bring benefits to fishing, increasing the fish population and therefore the levels of catch in the neighbouring areas.
- Use of recyclable materials: There are interesting opportunities linked to the use of recyclable resins.

Policy

- Robust national regulatory framework is a key component to be ensured in order to accelerate offshore wind development.
- Policy support: Tailored support measures can act as enablers, such as dedicating specific funding for FOW projects and considering technology maturity in Administrative Strike Price (ASP) evaluations.
- Long-term EU and national policy on Offshore Wind sector: Education and training programmes for policymakers and regulators can improve awareness of the technical, economic, and environmental aspects of floating offshore wind energy. Furthermore, clear national planning in the long-term, as well as stable commitment and energy-related policies, both at national and EU levels, would provide a basic condition to foster investment and FOW development.
- Process clarity: Developers and authorities should be transparent in their processes and outcomes, which can enhance trust, together with clear permitting process in place.

- Data and knowledge sharing from consent to operational stages: Seamless data and knowledge sharing from consent stages to operational phases will facilitate smoother project execution, allowing for efficient problem-solving and innovation in floating offshore wind initiatives.

The following tables summarise the main cross-cutting barriers and enablers identified during the co-creation workshops.

Table 1: List of the main barriers to FOW deployment

Main barriers
Regulatory and authorization process uncertainty and criticalities.
Lack of proper MSP (in Italy and Greece, until recently).
Environmental impacts still to be further investigated
Unclear distribution of responsibilities among public and private entities.
The perception of FOW as an obstacle to the other uses of the sea.
Infrastructure not adequate for the implementation of FOW.

Table 2: List of the main enablers to FOW deployment

Main enablers
Working with private clients who require geophysical and geotechnical analyses.
Co-designing coexistence measures between wind farms and other uses of the sea.
Transforming wind farms into protected areas, increasing biodiversity.
Integrating wind farms into the local socio-economic fabric (e.g., creation of Energy Communities and local participation in the supply chain).
Increasing FOW social acceptability involving stakeholders and advertising benefits.
Opening the flexibility market to wind.
Clear supporting policies, based on long-term planning.
Investing in R&I involving industry.

The integration of diverse maritime activities emerged as an essential element to fully harness the wide range of benefits the sea offers — from navigation and tourism to food production and renewable energy — in a synergistic and sustainable manner. Through its multi-Lab analysis and stakeholder engagement efforts, MARINEWIND managed to identify key areas of conflict and lack of synergy - particularly involving offshore wind energy, fishing, and navigation, to inform future actions and policy-oriented interventions to accelerate FOW deployment in a more sustainable and holistic way.

2.2 Surveys

In the framework of the MARINEWIND Survey, which involved 540 participants across the five Labs, the main socio-economic and environmental barriers and enablers were further investigated. Drawing on the results presented in the D3.4 – MARINEWIND Survey analysis Report, this paragraph provides an insight into the main findings connected to the perception of the environmental impact and social awareness issues. First, the most relevant barriers identified by respondents include the impact of FOW on the loss of fishing grounds, as well as on the flexibility and operational capacity of fishers, particularly in terms of travel time, local employment, and decision-making. Respondents also highlighted the reduction of fishing areas due to turbine installation and the potential interference of subsea cables with fishing gear, along with the noise generated by these installations during construction, maintenance, and operation, which may affect coastal resorts and hotels. The impact on aquaculture is also considered significant. In contrast, the barriers that received the lowest importance ratings were the limitation or disruption of recreational boating and sports activities, and the potential reduction in real estate value. Among the countries surveyed, Spain and the United Kingdom are those that assign the highest importance to these impacts, while Greece and Italy are the ones that rate them the lowest.

Among the enablers evaluated, the one most consistently rated as important across all countries is the positive gross added value generated by floating offshore wind technology. This is followed closely by the potential for lowering electricity rates, which also ranks highly in all national contexts. Interestingly, in countries where pre-commercial floating wind farms already exist, such as the United Kingdom and Portugal, respondents place greater emphasis on the development of the FOW supply chain and on employment generation, including specialized training and education. In contrast, in countries like Italy and Spain, where the technology is still in earlier planning stages, greater importance is attributed to environmental co-benefits, particularly the creation of artificial reefs and marine protected areas.

In countries where floating wind technology is already being implemented, respondents highlighted the importance of apprenticeship and scholarship programmes, including training initiatives and educational contributions aimed at schools to promote awareness of climate change, sustainability, and renewable energy. In contrast, this strategy is not considered as relevant in the remaining countries. For Portugal and Greece, electricity discounts in the surrounding areas of FOW farms and improvements in internet speed are considered important. Meanwhile, in Spain and the United Kingdom, the most valued strategy is informing and involving the local community from the outset of the project, ensuring that both benefits and drawbacks are clearly communicated.

Overall, awareness of floating offshore wind technology among the general population is low across all countries. Surprisingly, Greece, despite being the country with the least technological deployment, showed a higher level of awareness compared to the others. In fact, the United Kingdom and Portugal, both with existing pilot projects, report the lowest percentages of high awareness.

Except for the United Kingdom, respondents in all countries generally believe that governments have not made sufficient efforts to raise citizen awareness about offshore wind and climate change. In Spain, responses are more evenly split between “yes” and “no,” suggesting that some initiatives have been undertaken, but they are not perceived as sufficient. In fact, most of the respondents considered it essential to involve local communities from the early stages of floating wind projects. However, a significant proportion also believes that the importance of this involvement depends on the level of engagement that the community itself is willing to assume. Among the different forms of community involvement, educational workshops and information sessions are considered the most effective across all countries. Hence, recommendation for awareness campaigns and educational outreach is key to bringing community along collaborative decision-making processes, which also receive substantial support.

More than 70% of respondents, regardless of the country, agreed that floating offshore wind turbines are a good solution for combating climate change and can be compatible with the surrounding environment and socioeconomic sectors. In particular, Italy stood out with the highest level of agreement, reaching 86%. The majority of respondents reported that their acceptance of FOW, their understanding of its potential socioeconomic and environmental impacts, and their overall awareness of these issues had increased over time.

Public and stakeholder support, including community engagement, is considered critical for several key aspects of OWF projects, including approval processes, financial backing, risk management, and long-term sustainability. Nevertheless, respondents did not view such support as equally crucial for achieving broader community approval (i.e., a social license to operate) or for guaranteeing that the economic advantages of these projects are shared with local populations.

Regarding the environmental impact of floating offshore wind, all countries surveyed considered it to be highly significant. Among the energy sources evaluated, tidal energy is perceived as the least important in comparison to floating offshore wind. This is likely due to limited public knowledge and the lack of commercial deployment of tidal technologies.

Respondents reported being aware of the environmental benefits of floating offshore wind turbines when compared to other energy sources. This awareness is particularly notable in relation to bottom-fixed offshore wind and onshore wind, as well as solar and nuclear energy. Interestingly, the perceived environmental advantage of FOW over coal is not as pronounced as it is over other technologies. Most respondents recognized the environmental benefits associated with floating offshore wind, especially in terms of the creation of protected fishing areas and artificial reefs. However, with the exception of the UK, the mitigation of climate change effects is not widely identified as one of the main benefits.

A majority of respondents believes that the FOW industry is highly committed to minimizing its environmental impact. Greece stood out as the country with the lowest percentage of respondents sharing this view, which is particularly notable given that it is also the country where the population is perceived to be most aware of environmental issues.

Respondents identified underwater noise and electromagnetic fields as the most significant environmental impacts, particularly during the operational phase of floating offshore wind farms. This is consistent with the fact that the operational phase represents the longest portion of a project's lifecycle.

The most widely recognised environmental benefits of FOW include the creation of protected fishing areas and artificial reefs. It is noteworthy that, except in the United Kingdom, the mitigation of climate change is not among the most frequently identified benefits. More than 90% of respondents considered is important to standardise procedures and criteria for EIAs, mitigation strategies, and compensation measures. In Portugal, this view is nearly unanimous, with 99% of respondents expressing agreement.

In countries with existing pilot wind farms, the most valued input for effective environmental impact assessments is better knowledge of deep-sea biodiversity. In contrast, in countries where floating wind has not yet been implemented, the most highly rated input is better knowledge of seabed characteristics.

2.3 Webinars

Within the MARINEWIND project, the Consortium organised a series of webinars targeting policymakers and relevant stakeholders, aiming at disseminating the main results to a wider audience, with the ultimate goal to foster the debate and generate more-informed policies to accelerate the uptake of FOW. Considering the relevance of the topics discussed, this section highlights the main aspects emerged from the webinars, which will be further detailed in D4.4 Webinar for policy makers and public authorities. In particular, during the MARINEWIND webinar "Shaping integrated policy frameworks for Floating Offshore Wind: Best Practices and Recommendations across Europe", held on the 18th of March 2025, the main issues on social acceptance and environmental impacts related to FOW were discussed, involving some of the MARINEWIND Consortium Partners, external experts and relevant stakeholders.

Considering the participation of Europêche, the Association of National Organisations of Fishing Enterprises in the European Union, in the MARINEWIND Consortium, the needs and challenges of this sector were considered in our work since the very beginning of the project. During the webinar, Europêche was invited to represent the fishery industry, explaining that the sector itself is not opposed to offshore wind farms. However, apart from MARINEWIND project, fisheries are often sidelined when it comes to renewable energy. Yet, when addressing climate change, the fishing industry should be seen as part of the solution, providing sustainably sourced animal protein with one of the lowest carbon footprints.

In fact, fishing grounds are shrinking as energy projects take priority and are prioritised close to shore. Therefore, fishing is often pushed further offshore, increasing its fuel consumption, emissions, and safety risks, given that fishing fleets are usually formed by small-scale ships. Fishing operations are disrupted and have to be concentrated in smaller areas, which risk to be over-used, rather than having a more balanced, lower- impact distribution across the sea.

All this is hindering the progress made by the EU fishing sector towards the Green Deal targets, especially considering that it has already reduced its emissions by almost 50%, nearly achieving the 55% target, five years ahead of schedule. Moreover, fleets are being modernised and improved to reduce the environmental impacts, adopting energy-efficient technologies, transitioning to lower emission fuels, improving gear selectivity to reduce bycatch, for instance.

When it comes to co-existence, the sector has already explored some solutions, such as the passive gear fishing. However, some activities may still not be fully compatible within the same space. Therefore, MSP is very important to strike a balance and the general approach to offshore wind development should be aligned with Article 2b of the Paris Agreement which, under the United Nations Framework Convention on Climate Change [10], calls for climate action that does not threaten food production. Future offshore wind projects, according to Europêche, should ensure navigation channels are wide enough to allow all fishing methods to operate safely.

Furthermore, Europêche brought some examples of best practices, such as the "Mariner Notices System" in the US, acting as an instrument to facilitating the communication between fisheries and wind developers, reducing gear conflicts and enhancing safety before and during the construction of offshore wind farms. It is a tool developed with an important contribution of the fisheries, and it brings benefits also for communication with other navigation types, like tourism. For the safety concerns, Emilia-Romagna region (Italy) was presented as a good example with structured consultations ensuring that wind projects involve coastal communities, including fishers. In the opinion of Europêche, these kinds of collaborative processes should be a standard practice in Europe.

The conflict between offshore renewable energy and fishing seems to be the more critical and difficult to deal with. Communication and involvement of all relevant stakeholders is crucial, in particular when dealing with conflicts on the uses of a resource, like the sea. Denmark has always been at the forefront of offshore wind development and implementation and its example could provide some ideas. During the MARINEWIND webinar, the Royal Danish Embassy in Italy was invited to give an overlook on the Danish model on offshore wind, also considering its mission to promote knowledge exchange between Italian and Danish stakeholders. Even if it is based on bottom-fixed offshore wind, and not on floating turbines, which implies different technology challenges and different conditions for supply chain, infrastructure development and ports, thus bringing concrete differences between the two markets, the Danish model can be inspiring also for FOW in Europe. In addition, Denmark met the EU deadlines on renewable energy by 2021. The main characteristics of the Danish model, which are relevant in the framework of this deliverable, could be summarised as follows:

- Focus on energy security, considering that Danish energy transition has been driven mainly by oil crisis and by the aim to become less dependent from abroad, and on the cost-competitiveness of renewable technologies.
- Crucial role of private companies at the core of the Danish model, which have been involved in multi-party and public-private agreements, also in virtue of the economic potential of wind in Denmark.
- Long-term policies and planning, which brought the first condition, policy stability, to be met to attract investors.
- One-Stop Shop approach applied to the communications among the institutions and the stakeholders.

The focus on technology cost-competitiveness and not on specific technologies also contributed to prevent political conflicts among parties supporting a technology against the other, as well as to ensuring continuity in policies.

Long-term policies include the Danish MSP, which is noteworthy, since it is precise, detailed and considers also co-existence of different sea uses. The 30% of the total sea area is allocated to renewable energy, mostly offshore wind. In fact, the sea area dedicated to offshore wind was doubled. Moreover, the Danish model is an important example of the collaboration between public and private subjects are the market dialogues, where industry and regulators get aligned. Besides, the Danish Energy Agency worked as a collector of requests and documents for all stakeholders (including ministries and system operators) involved in the development and installation of offshore wind turbines. It is the only interlocutor for Danish investors and renewable developers, easing the work for them, according to the One-Stop Shop approach. All documents are then shared with the Danish Maritime Authority.

At the base of the Danish model, speaking from an overall point of view, there is an approach keeping all actors and needs together, since all elements are strictly correlated and the workforce deployment, the stakeholder engagement and upskilling could be seen as a unique thing. Organisations are clustered and clusters are used to work on the alignment of interests, creating also the conditions for fruitful open knowledge sharing, defining standardised best solutions. Politics, local communities, industries, private companies, port authorities, fisheries, R&D and academia, are all part of the same goal and, at local level, the same approach is implemented, mainly aligning the interests of small and medium enterprises and major suppliers. The involvement of all relevant stakeholders focuses also on fostering specialisation, international competitiveness and cost efficiency.

This integrated and “ecosystem-oriented” approach has also been applied to the supply chain development, strictly linked with the Danish diffused ports and infrastructure sector. The Ports of Esbjerg and Odense are among the most important ones in Europe and they committed to nurture the offshore wind supply chain in the North Sea. Denmark managed to be a system-builder in the North Sea and that can be also very inspiring for the Mediterranean scenario, especially for countries such as Italy or France. In particular, the Port of Esbjerg is a very good example of local stakeholder involvement, driven by Business Esbjerg, the local industry association, that supports SMEs and other enterprises to create synergies with large companies and developers and contributes on workforce upskilling and reskilling programs. The creation of local industrial ecosystems is key for FOW, not only fixed technologies.

In the Danish case, the stakeholder involvement has also included fisheries, since the beginning, preventing the emergence of issues. The regulation framework has guided the developers needed to make good compromises and agreements with fisheries before the wind projects are connected to the grid, easing the engagement of fishermen and the co-existence of their activities within the wind farm areas. The Danish model shows that early dialogue is a good instrument to anticipate problems instead of facing them later, when it is more difficult to work them out.

The relationship between public-private partnerships and the R&D and academic communities have also been shaped according to the overall approach based on dialogue and engagement. This collaboration is key given that private-public partnerships always manage the testing facilities. The Ministry of Higher Education and Science paved the way but then, when it comes to the technicalities, the actors managed to work together efficiently.

The Danish model is based on integration and holistic approach, to ensure a use of the sea that is fair and able to generate value for all stakeholders and local communities. However, the sea is not just a resource to use, it is an ecosystem, part of the environment humankind lives in, not just exploits it.
During the webinar, representatives from the Renewables Grid Initiative and the Italian National Research Council (CNR) were invited to join a dialogue revolving around the need for an integrated approach in the planning of FOW, including social acceptance strategies, socio-economic externalities and environmental impact analysis. First, the need to keep the good environmental status of the sea as a key priority in the deployment of offshore wind has been highlighted. To this end, the MSP should consider environmental protection as an important aspect also to prevent conflicts and to enhance social acceptance.

France represents a good example in this regard, since its MSP update went through a meaningful stakeholder engagement process based on public debate, which is part of all infrastructure projects in France. In this case, it has foreseen the physical involvement of more than 20,000 people, the organisation of more than 400 events, and the collection of more than 30,000 feedback to overall MSP, looking at the different regions and sea basins. As a main outcome of this process, further areas for offshore wind were identified. However, concerning social acceptance and community engagement, defining the community is not straightforward when it comes to offshore wind. Therefore, all solutions need to be flexible and project-specific.

Besides, there is still a lack of clear and shared metrics and methodologies to assess the socio-economic aspects linked to offshore wind projects. It is not straightforward how to define the socio-economic benefits, how to create and measure them and assess if they are effective indicators. In this regard, SSE Renewables in the North of Scotland, for the development of Beatrice OWF (almost 600 MW), developed a very interesting process, starting by defining socio-economic benefits with the local community. SSE Renewables in Scotland invested more than £6 million for local priorities that were identified with local stakeholders. There are one-fits-all solutions.

According to CNR, the main socio-economic benefits linked with offshore wind projects include economic incentives, job creation and investments in local infrastructure. Denmark provides examples of best practices also on these aspects. Residents in Denmark near offshore wind projects are offered a greater share in profits. Other countries adopted similar schemes. In the Netherlands, local communities are incentivised from government to participate for 50% of the ownership in future wind projects. In Greece, the 3% of electricity from Offshore Wind farms returns to local communities in the form of extra funding to local administration or direct reduction of the electricity bills of the consumers.

However, MARINEWIND study identifies job opportunities as the best benefit, both during the construction and maintenance phases and in the view of the creation of a value chain, which paves the way to the creation of startups based on green technologies.

Regarding the environmental impact, it was highlighted that a proper and "future-proof" EIA requires international collaboration since the impacts could involve more countries (e.g. the ones sharing the same sea basin) and could also produce cumulative effects over the years. For that reason, the offshore wind projects that will be developed by 2030 need to be put in perspective considering also what will be developed by 2050. More projects over the decades will produce different impacts on the environment, modifying the impacts linked with older projects.

The experience of the international conventions of the North and the Baltic seas, working at the sea-basin level, shows that this kind of collaboration can help in defining guidelines. For instance, the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), which was created as a convention for the protection of the sea, has many different Working Groups tackling different aspects of offshore wind development with the contribution of representatives from all Member States. The Baltic Marine Environment Protection Commission, also known as the Helsinki Commission (HELCOM) is another good example. In the Mediterranean Sea, this kind of collaboration is at an early stage, but it can take advantage of the lessons learnt from the experience of the Northern European countries. Given that the Mediterranean offshore wind potential is linked to the new technology of floating turbines, it is important to start implementing to collect data and experience: the more we learn, the more we can reduce this precautional measures in developing projects, the more we can speed implementation up in a sustainable and fair way, with respect to the environment and the local communities.

This aspect is connected to the need of auctions including non-price criteria incentivising the environmental and social performances of the project, according to EU policies. Auctions should request applicants to propose something that goes beyond an EIA, beyond what developers are in any case obliged to. Auctions should be an opportunity to do the extra mile, for instance proposing something innovative that could concern mitigation measures or restoration of biodiversity and ecosystem. All the challenges and opportunities for FOW represented by MSP, policies and environmental impacts will be deepen in the upcoming chapters of this deliverable.

3 MARITIME SPATIAL PLANNING AND POLICIES FOR AN INTEGRATED OFFSHORE WIND DEVELOPMENT

This chapter presents an overview of the adopted MSP strategies in the five MARINEWIND Labs, pointing out the relevant aspects to identify barriers, enablers and best practices.

3.1 Greece

Since 2022, Greece has made significant progress in paving the way for offshore wind projects in its waters: areas suitable for medium and long-term OWF development have been identified through the implementation of an effective methodology. Firstly, Law 4964/2022 assigned the Hellenic

Hydrocarbons and Energy Resources Management Company (HEREMA) the exclusive responsibility of conducting technical studies to identify Organised Development Areas (ODAs) for offshore wind development.

In accordance with this law, the draft National Offshore Wind Farm Development Programme (NDP-OWF) was prepared in 2023 [11]. The draft NDP-OWF, including the relevant Strategic Environmental Impact Assessment (SEIA) study, was submitted to the competent authorities for approval in order to obtain legislative validity [12].

The determination of the potential OWF ODAs in the draft NDP-OWF is based on specific criteria and guidelines that take into account environmental, social and techno-economic factors; restrictions imposed by the relevant authorities; the compatibility of use and coexistence with other maritime activities; and the availability of interconnection capacity and transmission infrastructure, such as:

- National energy planning and objectives.
- Environmental and biodiversity protection planning.
- The existing Special Spatial Framework for Renewable Energy Sources (SSF-RES), and proposals from consultations with the Spatial Planning Directorate of the Hellenic Ministry of Environment and Energy.
- The opinions of the relevant public bodies and authorities to avoid conflicts with other maritime uses of Greek territory (e.g., national security, safe navigation and other activities, international best practices and approaches, and other conditions).

The above criteria and indications aim to identify potential OWF development areas that are highly likely to receive consent from the relevant authorities for the future location of offshore wind farms, to speed up the approval process for future OWF development projects. It is important to elaborate on the criteria considered in this programme, which are divided into three groups:

- Group A: exclusion criteria for avoiding areas for OWF project development.
- Group B: evaluation criteria for prioritising medium and long-term development areas (prioritisation criteria).
- Group C: Evaluation criteria for the further evaluation of areas applied in later phases.

The exclusion criteria restrict the location of offshore wind farms (OWFs) in certain areas. In fact, areas that are not suitable for OWF development are discouraged because it would be difficult to obtain consent from the relevant authorities or because they are unlikely to be approved due to non-compliance with the minimum technical conditions. The 20 exclusion criteria of Group A are based on:

- Restrictions imposed by competent bodies or authorities on areas for reasons of national security and restrictions imposed on other activities, given the current conditions, due to the difficulty of granting an OWF permit.
- The specific requirements of the Special Spatial Framework for Renewable Energy Sources (SSF-RES) for conflicting uses, and the obligation to comply with terms related to the development of the OWF.

- Technical limitations regarding bathymetry and wind speed may render an OWF project non-viable in terms of installation and operation.

After applying the aforementioned 20 exclusion criteria, the remaining areas (non-excluded areas) are large zones that could potentially be promoted for OWF projects. These zones are defined as areas that could be exploited for the establishment of OWFs in this programme. The potential exploitation zones are then evaluated using qualitative conditions considering different elements such as:

- Distances between islands, particularly where there is a high possibility of congestion from additional maritime activities in the area.
- Maps of maritime traffic density of passenger and commercial vessels.
- Preliminary opinions of the competent authorities on potential exploitable areas for FOW.
- The Ten-Year National Electricity System Development Programme for the period 2023-2032.
- Areas with high average wind speed and relatively regular bathymetry.
- Availability of sufficient total area to achieve at least 200 MW of installed capacity.

This qualitative evaluation involved institutional consultations and participatory dialogue with various stakeholders, including the Ministry of Environment and Energy, national port authorities, national grid operators and associations such as the Hellenic Wind Energy Association (HWEA), aiming at gathering technical opinions and strategic insights. The readiness of coastal communities, maritime operators, and local administrations for offshore investments was assessed through dialogue tables. Technical and participatory feedback was gathered on the compatibility of these investments with other maritime economic activities, as well as on the level of institutional support.

As a result, 23 potential de-risked Offshore Wind Farm Organised Areas Development (OWFODA) were identified and further evaluated to prioritise them as medium or long-term development areas. The following four evaluation criteria were applied to prioritise the identified potential OWFODA, considering international best practices and the prevailing conditions of the Greek marine area. Areas with medium-term potential are those that satisfied at least three of the following criteria:

1. Bathymetry: average water depth less than 350 meters.
2. Wind speed: mean wind speed > 9 m/s.
3. Grid connection available: onshore voltage stations within a radius of 50 kilometers.
4. Wind farm capacity: estimated installed capacity > 300 MW (considering 5 MW/km2 capacity density).

The medium-term development areas (until 2030–2032) comprise 10 potential OWFDA covering 978 km² with an estimated total capacity of 4.9 GW. The majority of these are suitable for floating offshore wind projects (7 out of 10 potential OWFDA). The long-term development areas (after 2030–2032) comprise 13 potential OWFODA, covering 1,381 km² and with an estimated total capacity of 6.9 GW. The majority of these are suitable for floating OWF projects (12 out of 13 potential OWFODA).

Additionally, an area has been designated for the development of pilot OWF projects: two potential OWFODA (Pilot 1 and 2), covering a total area of 353 km², for the selection of OWF installation areas that can accommodate fixed-structure OWF projects with a total capacity of up to 600 MW.

Figure 2 shows the OWFODAs as reported in the MARINEWIND WebGIS.

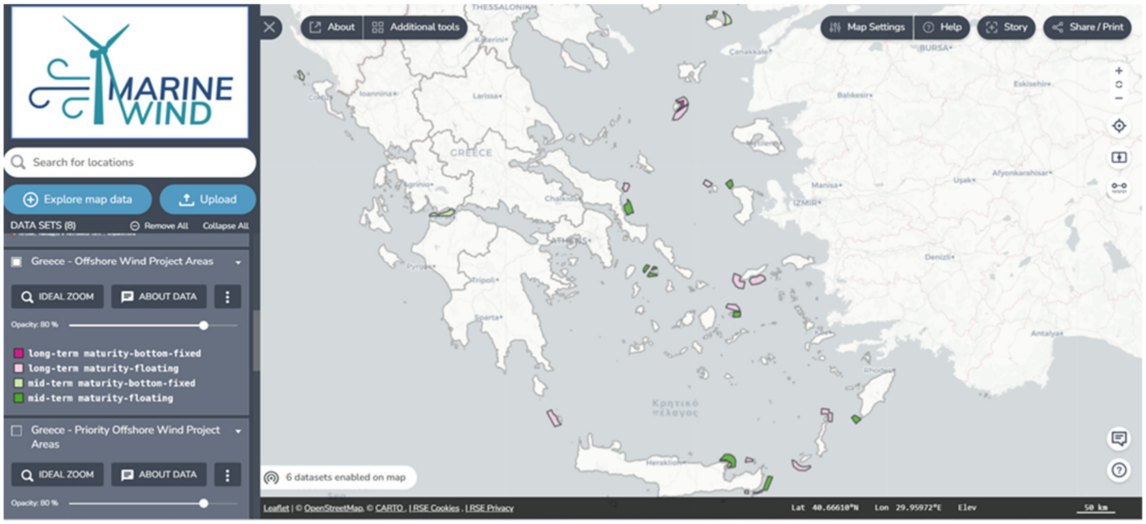

Figure 2 – Organised development areas for OWF (source: MARINEWIND WebGIS)

Greek MSP approval was announced only on the 16th of April 2025 by the Ministry of Environment and Energy [13]. It specifically incorporates a subset of six to ten ODAs that have been prioritised for development. These zones are designated on a spatial basis within the MSP and align with medium-term development targets up to 2030–32. The MSP officially maps six designated ODAs that are likely to be included in the initial tenders, including the pilot area near Thrace (Evros–Samothrace). It also establishes a framework for the progressive inclusion of up to 10 medium-term OWF zones (with an estimated capacity of ~4.9 GW) from the pool of twenty-five total identified areas as the planning process progresses.

3.2 Italy

Similarly to Greece, Italy missed the deadline set by the EU Directive (2014/89/EU) and did not adopt its MSP plan until the 25th of September 2024, with Decree No. 237 of the Ministry of Infrastructures and Transportation. The process began at the end of 2019 and saw the publication of a draft in August 2022, as part of the Strategic Environmental Impact Assessment (SEIA) process initiated for its approval. The Ministry of Infrastructure and Transport (MIT) has implemented the European Directive 2014/89/EU in Italy by drawing up three MSPs, one for each of the maritime areas into which Italian waters have been divided:

- Adriatic Sea;
- Ionian–Central Mediterranean Sea;
- Tyrrhenian and Western Mediterranean Sea.

These plans can be viewed on the dedicated portal created by the Ministry of Infrastructure and Transport [14] and a comprehensive map is reported in Figure 3. Each plan subdivides the marine space into planning units (PUs), assigning one or more prevailing uses to each, which are classified as "priority", "reserved", "limited" or "generic", based on the predominant activities in the area, such as energy production, fishing and transport, or environmental protection. PUs can have one to three prevailing uses (priority, reserved or limited) and may also include secondary uses. For PUs with a generic use, only secondary uses are defined as no prevailing use is foreseen. These uses were determined through the collection of data from various competent bodies. For instance, the Italian Institute for Environmental Protection and Research (ISPRA) and the Ministry of Environment and Energy Security (MASE) provided environmental information, and the Ministry of Agriculture, Food Sovereignty and Forestry (MASAF) provided data on fishing activity. These information layers made it possible to identify the prevailing activities and interests for each PU, providing a solid basis for subsequently defining the specific uses of maritime space. As the Italian MSP plan is a strategic document rather than an implementation one, it does not identify specific areas suitable for wind energy.

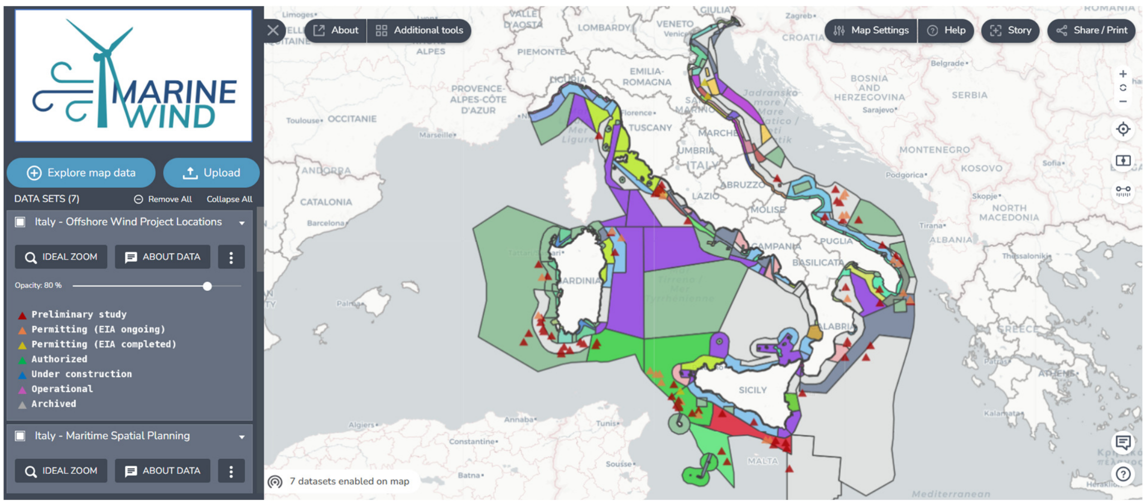

Figure 3 - MSP and OWF project locations map for Italy (source: MARINEWIND WebGIS)

However, given the delay in plan approval and the unclear regulatory framework, approximately two-thirds (17 out of 23) of floating wind farm projects, currently in the process of EIA, would be located in areas of the sea designated by Maritime Spatial Management Plans with defined priority uses other than energy [15]. The most common of these uses are "protection of the environment and natural resources", "fisheries", "maritime safety", "maritime transport and ports", and "landscape and cultural heritage". As these uses represent well-established, often regulated, strategic activities and interests, it is crucial to assess the compatibility of offshore wind installations with other competing uses of the sea. It is important to note that other additional 64 projects are currently undergoing EIA scoping (Figure 3), highlighting how a completely developer-led offshore wind development ends up being difficult to manage from an authorisation point of view.

3.3 Portugal

For the past decade, Portugal has been actively working to integrate offshore renewable energy into its MSP framework. The national MSP, known as PSOEM – *Plano de Situação do Ordenamento do Espaço Marítimo*, was initially approved by the Council of Ministers Resolution No. 203-A/2019, on the 30th of December 2019, providing a strategic vision for the sustainable use of maritime space, including pilot areas for the development of offshore renewables.

Nevertheless, by 2022/ 2023 the areas dedicated to the implementation of renewable energy projects in the PSOEM appeared to fall short when considering the number of requests submitted by developers. In addition, the established polygons were destinated for pilot projects and therefore the designation of specific areas for commercial projects was lacking.

As a result, in 2023, the Portuguese authorities commenced an Offshore Renewable Energy Allocation Plan by public initiative (PAER - *Plano de Afetação para Energias Renováveis Offshore*), with the purpose of revising the PSOEM. Initially, the proposed areas were planned for developing 10 GW of offshore renewables until 2030, through a phased, concurrent process. However, the government has recognised that the target was too ambitious and should be revised. The Allocation Plan underwent a Strategic Environmental Assessment (SEA) and a public consultation phase (through December 2023), having garnered approximately 150 comments. Authorities incorporated the public feedback and prepared the final version of the PAER in December 2024.

In parallel, Portugal's strategy for offshore renewable energy was further reinforced through the revised National Energy and Climate Plan (PNEC 2030), adopted via Council of Ministers Resolution No. 149/2024, on the 30th of October 2024. This revision raised the national target for renewable energy's share in gross final energy consumption to 51% and confirmed a trajectory toward climate neutrality by 2045. Offshore wind energy, especially FOW was reaffirmed as a critical element of the energy mix, capitalizing on higher and more consistent wind resources at sea. The PNEC 2030 emphasized the strategic use of Portugal's extensive maritime space not only to meet climate targets but also to drive industrial development and attract long-term investment. It also confirmed the target of 2 GW of installed offshore wind capacity by 2030, as a first step toward the broader goal of reaching 10 GW in the years ahead.

Following the approval of the revised PNEC, a major milestone was achieved in 2024 with the adoption of the PAER and its integration into the PSOEM, formalized by Council of Ministers Resolution No. 19/2025, issued on the 7th of February 2025. This plan formally integrated FOW into the MSP framework and defined specific areas allocated for its development (Figure 4). As a result of the public consultation and the SEA, the PAER defines priority areas for offshore renewable energy, balancing energy targets with environmental protection, fishing activity, and other maritime uses. It also aligns with Portugal's climate and energy goals, notably the ambition to reach 2 GW of installed offshore wind capacity by 2030, as set out in the government's roadmap - the PNEC2030.

In addition, following recent indications enabled by the European Union Net Zero Industry Act [16] (NZIA), the Portuguese Government has mandated the creation of a Working Group, formed to work towards the Permitting and Licensing of Renewable Energy Projects – *Estratégia de Missão para as Energias Renováveis* [17]. The aim is to establish a One-Stop-Shop, centralizing all procedures and ensuring faster and transparent licensing workflows. This infrastructure is expected to develop procedures towards the attribution of grid connection for new renewable energy projects, operationalise environmental permitting and to advance sectorial plans for sandboxes (i.e., areas implemented to accelerate renewable energies projects).

Co-funded by the European Union

Despite this progress, key regulatory procedures are still under development. The Portuguese administration is currently preparing the regulatory framework for the authorization process of offshore wind projects, which includes licensing procedures, environmental assessment requirements, and coordination between national agencies. In parallel, the government is expected to publish guidelines and rules for upcoming auctions, which will determine how access to maritime space and grid connection is granted to developers.

Recent political instability has led to delays in finalising and publishing key regulatory instruments for Portugal's first offshore wind auction. Still, a government order issued in April 2025, - Order nº 4752/2025 - established a centralised, sequential development model for offshore wind deployment in Portugal, aligning with the national climate and energy goals set out in the PNEC 2030. The order established two critical deadlines:

- **July 2025**: Submission of a comprehensive proposal detailing the operationalisation of the first offshore wind tender procedure.
- **October 2025**: Finalisation of the auction rules and framework.

This development represents a crucial step toward launching competitive tenders for offshore wind area allocation, aiming to bring greater clarity and predictability to developers and investors, while supporting Portugal's broader ambitions for offshore renewable energy deployment.

Through these developments, particularly due to its early adoption of MSP tools, commitment to stakeholder engagement, and experience with demonstration projects, Portugal is recognised as a proactive player in offshore renewable energy. The country stands as a reference for integrating renewable energy into MSP through structured planning, though the ongoing challenge remains in the timely execution of supporting policies and auction mechanisms.

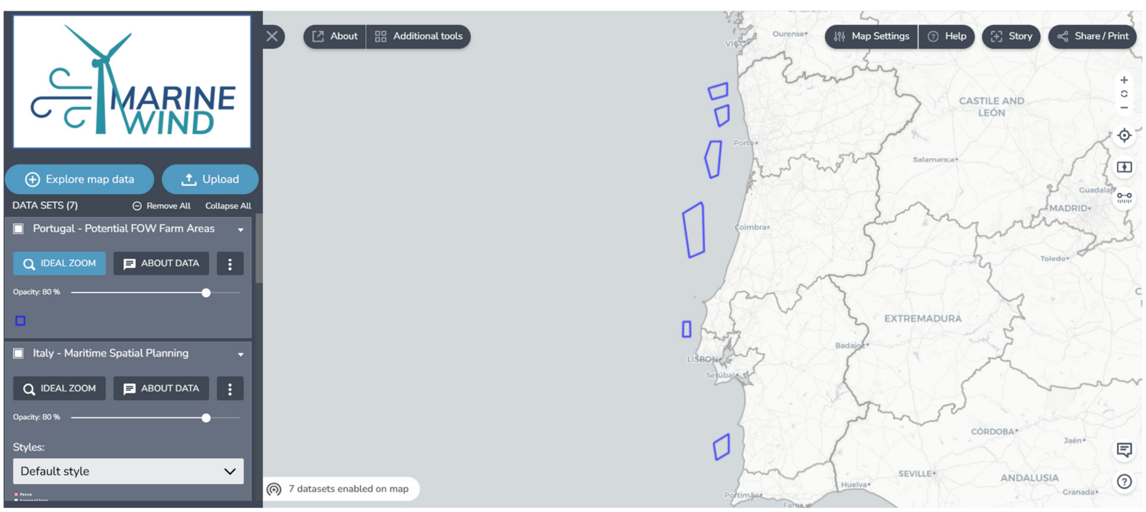

Figure 4 – Potential Floating OWF areas (source: MARINEWIND WebGIS)

3.4 Spain

In Spain, offshore wind is covered by the ZAPs - *Zonas de Alto Potencial* (High Potential Areas), which are included in the POEMs (Spanish acronym for MSP). MSP does not replace sectoral authorizations or EIA procedures. The POEMs have a validity of six years, with mid-term reviews planned. ZAPs are not exclusive zones and other areas may also be developed if compatibility with existing uses and with the environmental criteria are demonstrated. In case of use conflicts, priority is given to ZAPs. A total number of 20 ZAPs have been established until now.

A major regulatory update was implemented with the adoption of Royal Decree 962/2024, of the 24th of September 2024, which established a comprehensive legal framework to produce electricity from offshore renewable sources in Spain, superseding the previous regime under Royal Decree 1028/2007 and aligning the Spanish framework with recent EU directives and strategic objectives for marine renewable energy. This new regulation introduced significant measures addressing socio-economic aspects of offshore wind development, including:

- Inclusion of socio-economic and environmental non-price criteria in competitive procedures (Article 14.1). According to Article 14.1, non-economic criteria (e.g. socio-economic impact, environmental performance, compatibility with other sea uses, employment impact, and contribution to local industry) may account for up to 30% of the total evaluation score in the competitive allocation process.
- Public dialogue phase (Article 10). Stakeholders and project promoters are encouraged to work together in a public dialogue process to integrate improvements to the offshore wind project in order to enhance synergy with other maritime sectors and to maximize positive externalities in affected regions.
- Assessment of socio-economic impacts (Article 13.2(c)). Criteria related to socio-economic impacts of projects developing offshore wind are explicitly listed, covering, for instance, impact on local employment, interaction with fisheries, contribution to regional economic development, and involvement of SMEs and local value chains.
- Transparent publication of documentation and results (Article 18). All relevant information, including public dialogue outcomes, competition results, and project progress, must be available on the website of the Ministry for the Ecological Transition and the Demographic Challenge, ensuring accountability and transparency.

Concerning the environmental regulation, environmental evaluation of POEMs was completed in 2022 and the Royal Decree 962/2024, adopted in September 2024, consolidated and clarified the administrative and permitting procedures for marine renewables, with no specific environmental framework for floating wind. Under current legislation, all offshore wind projects, including floating wind, are subject to individual EIAs as regulated by Law 21/2013, taking into account the specific impacts of each project.

Regarding floating offshore wind projects in Spain, numerous developers have submitted preliminary documentation for environmental and administrative processing, particularly under the procedures outlined in Law 21/2013 on EIA. These submissions are currently in the voluntary or scoping phase of the EIA process, which is allowed prior to formal project initiation and does not imply any formal authorisation. Under the new regulatory framework established by Royal Decree 962/2024, offshore wind auctions are a mandatory prerequisite for granting site exclusivity, grid access, and subsequent project authorisation. As of now, no auctions have been held, and therefore no project can enter the formal permitting phase under this new framework.

The only exception is the GOFIO project (50 MW, Canary Islands), which began its permitting process before the 2021 moratorium and is being evaluated under the previous regulatory regime. Consequently, any project has received a positive Environmental Impact Statement or advanced to the authorisation stage under the current framework. In summary, while developers are allowed to initiate early-stage environmental consultations, no project can proceed to formal permitting or receive authorisation until auctions are conducted.

However, Spain currently hosts two operational offshore testing platforms that support several FOW pilot projects focused on technological innovation and environmental assessment, while a third platform is under development, and a fourth has been announced:

- Biscay Marine Energy Platform, Basque Country (BiMEP) is the operational testing platform off the coast of Armintza. It is a public test site for offshore renewable technologies. In September 2023, the DemoSATH project began operations here. This 2 MW floating wind prototype, developed by Saitec Offshore Technologies, RWE, and Kansai Electric, is the first floating wind turbine connected to the grid in Spain and it tests technical performance and environmental integration.
- Oceanic Platform of the Canary Islands (PLOCAN) is the operational platform located in Gran Canaria. It supports testing of marine energy technologies. X1 Wind deployed its X30 floating wind prototype here. Although now completed, this project provided valuable data for assessing environmental and operational conditions of floating structures.
- Catalonia's Offshore Energy Test Platform (PLEMCAT) is planned to be built off the Bay of Roses (16–24 km offshore) and it will be led by IREC (Catalonia Institute for Energy Research). It is intended to support R&D, environmental monitoring, and coexistence studies. Activities are expected to begin before the end of 2025. Projects linked to PLEMCAT include:
  - HiveWind (Hive Wind Energy, S.L.) – floating wind demonstration project currently in development phase.
  - Esteyco – engineering firm selected to test a floating prototype at the site.
  - X1 Wind – expected to participate in future testing at PLEMCAT, following previous deployment at PLOCAN.
- A new experimental floating wind platform is planned 10 km offshore from the Port of A Coruña, promoted by the Galician Regional Government (*Xunta de Galicia*) in collaboration with *Red Eléctrica* and the Port Authority of A Coruña.

The adoption of Royal Decree 962/2024 marks a major step forward in establishing a comprehensive regulatory framework for offshore wind in Spain. However, several key regulatory instruments are still pending before the first offshore wind auction can be launched:

- A ministerial order is required to approve the auction rules and detailed evaluation criteria, including technical, economic, and non-price components (such as socio-economic and environmental impact, which may account for up to 30% of the total score).
- A second ministerial order is necessary to formally initiate the competitive procedure, specifying the designated areas, installed capacity, and auction calendar.
- The tariff and remuneration regime, which will define the economic conditions for awarded projects (linked to Royal Decree 960/2020), is currently under revision.
- The Coastal Concession Regime (*Reglamento General de Costas*) is also being revised to better accommodate the specific needs of offshore wind infrastructure, particularly FOW, which require anchoring systems and dynamic cabling.

Although no specific changes have been made to environmental regulations for offshore wind, the procedures established by Law 21/2013 on Environmental Assessment remain fully applicable to all projects. This is expected and consistent with current practice, as no new environmental framework has been introduced for offshore wind. This regulatory progress reflects Spain's commitment to launching its first offshore wind auction in alignment with the POEMs (approved via Royal Decree 150/2023) and the objectives set out in the Offshore Wind Roadmap. However, full implementation depends on the adoption of these forthcoming legal instruments.

3.5 United Kingdom

In the UK, the MSP includes provisions for offshore wind, part of the authorisation process through the Marine Management Organisation (MMO), and it involves a competitive auction system for seabed leases managed by The Crown Estate. The auction process includes:

- Socio-economic benefits as non-price criteria.
- New guidelines for compensation measures to affected communities and stakeholders.
- Enhanced frameworks and methodologies for managing conflicts between different sea uses and for assessing the potential synergies among them.
- The implementation of fees aimed at supporting local socio-economic development.

The marine plans in the UK do not include the spatial allocation of offshore wind areas and strongly focus on spatial conflict resolution measures. In the comparative study [3], that considers England, Denmark and the Netherlands, three strategies are highlighted:

1. Relocating conflicting sea uses, which could mean actively moving activities or, more passively, could imply the moving of other activities elsewhere.
2. Minimising conflicts, which implies the adoption of measures to ease a co-habitation of different sea uses (e.g. Setting turbine position in such a way to allow the movements of fishing ships in the same area or reducing the intensity of rotation during bird migration periods).
3. Mitigating negative impacts, which focuses on non-spatial consequences of offshore wind installation, introducing, for instance, compensatory measures for potential impacts on other activities' businesses.

The first two strategies focus on conflicts related to spatial physical-technical aspects, the third one on financial-administrative aspects. Each country adopts a combination of these strategies depending on the institutional capacity, which, according to the researchers of the University of Groningen, refers to "the availability of established systems of policy instruments, procedures, techniques, ideas and values, but also how these features work in practice". The institutional capacity is determined by financial and legal constraints and by other assets.

- Knowledge resources: the necessary knowledge to develop a plan for the uses of sea space.
- Relational resources: the stakeholder network and the power relations inside it.
- Mobilisation capacity: the ability to use knowledge and networks to implement conflict resolution measures.

All these elements foster and or limit the so-called institutional space, "the discretionary freedom of actors within established formal and informal norms or procedures". This flexibility is important considering that not all potential future spatial conflicts can be foreseen and put into norms, given the increasing use of the sea in Europe. In fact, one of the main conclusions of the study of the University of Groningen is that spatial conflict resolution measures, in most cases, pertain to specific project level, adopting to specific circumstances, rather than the abstract plan level. In all the three studied cases, Denmark, the Netherlands and the UK, institutions include potential conflicts in plans, but they mostly focus on minimisation and mitigation rather than relocation depending on established space reservations.

As the British MSP does not pre-allocate areas to specific activities, passive relocation is implied in sector or project specific requirements in the permitting procedures (e.g. renewable energy developments cannot co-exist with other uses). The UK still has enough usable sea areas where passive relocation can move with no top-down indication.

Minimisation strategies are adopted to optimise the use of the sea. In the UK, the lack of pre-allocation areas limits co-use opportunities to the first activity to arrive, with dynamic activities, those not tied to a specific area and easily relocatable, being at a disadvantage, particularly in sectors like fishing and tourism. The potential co-use of a sea area in the UK is determined by the project proposals, which get more support if "optimise the use of space and incorporate the opportunities for co-existence and cooperation with existing activities" (e.g. burial of cables, good design of infrastructure). This is a clear example of managing space conflicts at the level of permitting, rather than at the plan level.

The following explicit mitigation measures have been adopted in the UK:

- Financial compensations for negative impacts on the environment and other businesses (like in the Netherlands).
- Imposing alternative windfarm installation methods, for instance, to abate noise to protect marine mammals, and reduce the impact on the seabed.
- Other types of compensations (e.g. building artificial reefs for biodiversity).

The UK also integrates non-price criteria into seabed lease auctions managed by The Crown Estate, including socio-economic benefits, environmental performance, and stakeholder engagement. Compensation mechanisms, such as artificial reef creation and financial support for affected sectors, are increasingly embedded in project planning.

3.6 Best practices in other countries

The International Energy Agency – Wind Technology Collaboration Program (IEA WIND TCP) [18] reports that, in some EU countries, legal appeals by local communities against wind energy developments can take years to resolve. These delays could often be avoided through earlier and more meaningful community involvement during the project planning phase, as well as by offering local populations the opportunity to participate in investments, such as through energy cooperatives. Notable examples that can be drawn from countries beyond the MARINEWIND Consortium include:

- In the Netherlands, a great effort is made to increase social participation and support. The aim is that local communities engage in 50% of the ownership of new wind projects because of the long lead times of wind projects, participation is still limited.
- In Germany, the project AR4Wind [19] aims at increasing the overall acceptance of wind turbines by a realistic experience of planned projects. Therefore, the development and use of mobile Augmented Reality (mAR) technologies in public participation processes is proposed as a solution. To achieve a high level of acceptance, the project envisages an agile and user-centred approach on a workable mAR visualisation system to be used in public participation processes with intensive integration of real demonstration scenarios using mobile phones and tablets. In addition, Germany plans to fund costs for the planning and permitting phase for onshore wind farms to be erected by local communities according to the Renewable Energy Act (EEG 2023).
- In Denmark, residents near projects are offered a greater share in profits.
- In Finland, social acceptance is generally high and local municipalities with larger amounts of wind power get considerable economic benefits from property tax contributions. Revamping the compensation mechanism to also include landowners along transmission lines is in process. Additionally, the requirements for EIA and new requirements related to end-of-life activities, such as dismantling the turbines, will be clarified.
- In France, as already pointed out in this chapter, there was a massive stakeholder engagement during the preparation of the national MSP (*Document stratégique de façade DSF* for 4 sea basins [20]), adopted in 2022. In 2024, the new National Strategy for the Sea and Coasts for the period 2024-2030 was adopted. And, with the aim of integrating new offshore renewable energy and biodiversity protection areas into maritime spatial management plans, following the law for the acceleration of renewable energy, a public consultation "*La mer en débat*" was held between November 2023 and April 2024. To date, a web public concertation is in place while, at the same time, various bodies will be consulted under the Environment Code, as well as neighbouring countries. All the feedback gathered during these various consultations will be processed in order to further develop the draft coastal strategies, which are expected to be adopted in autumn 2025. All the latest information on offshore wind power in France is available on a website, which is updated by the Directorate-General for Energy and Climate (Direction Générale de l'Énergie du climat - DGEC) [21].

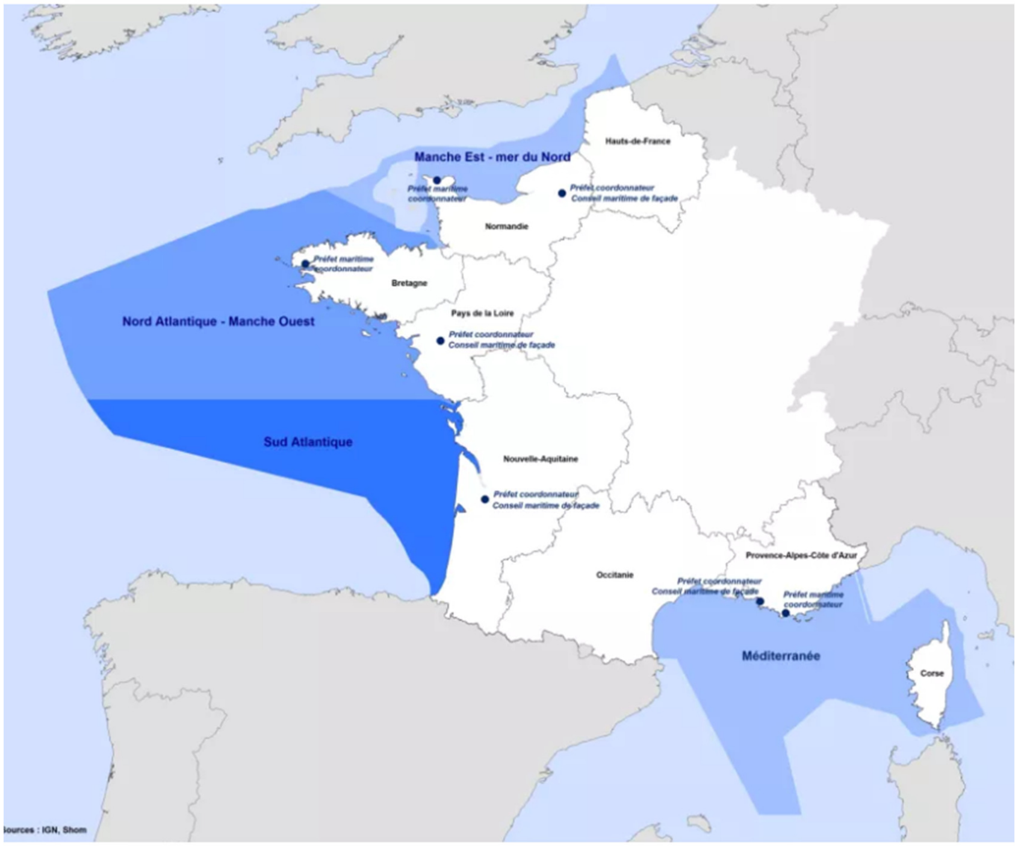

Figure 5 – The 4 sea basins of the French MSP

Regarding the MSP policies in the Netherlands and Denmark, a comparative study by the University of Groningen [3], identifies three key strategies: relocation, minimisation, and mitigation. In the Netherlands, institutions proactively define potential co-uses of marine areas and incorporate them into offshore wind permitting procedures by including non-price criteria, thereby supporting projects that foster coexistence and reduce spatial conflicts. Active relocation measures, such as assigning alternative fishing areas, are used only in limited cases. Mitigation strategies include financial compensation not only to address negative impacts but also to support sectoral transitions, such as helping fisheries adopt more sustainable practices; compensation for other affected industries; and the requirement to use alternative installation techniques that reduce noise, protect marine mammals, and minimise disturbance to the seabed. In Denmark, MSP designates areas for specific uses without necessarily prohibiting other activities, allowing for a flexible "multi-use" model unless conflicts become too significant. However, sector-specific regulations, particularly those concerning environmental and biodiversity protection, may impose stricter limitations. Mitigation and compensation measures in Denmark are assessed on a project-specific basis, mainly through EIA.

4 EXAMINATION OF ENVIRONMENTAL IMPACTS ASSESSMENT ANALYSES AT COUNTRY LEVEL

The purpose of analysing EIAs at the country level is to gather valuable and detailed information from the Consortium Partners, overcoming its currently fragmentation and unavailability at EU level because it is collected in national databases that are not easily accessible. To complement the analysis, an overview of recent strategies adopted for the EIA and social acceptance of wind energy developments in countries which are outside the MARINEWIND Consortium but in which the wind energy sector is significant, is presented.

The wind farms selected for the present analysis are, when possible, at different development stages and allowed the collection of information on the actual environmental impact of the installations, thus suggesting effective best practices and assessing their relative relevance. When relevant, information and data from bottom fixed farms are included in the analysis.

The analysis aims at: i) identifying methodologies and tools used within the EIAs (e.g. available data included in previous studies and in the technical or scientific literature, available numerical or reduced order models, ad hoc in situ analyses); ii) classify available data; iii) collecting qualitative and quantitative outputs of EIAs (e.g. *kg of fuel used, dB of underwater radiated noise, abundance of a selected species* etc); iv) identifying mitigation and compensation measures.

Based on the information collected by the Consortium Partners and related to the selected wind farms (see the forms in chapter 7 - Annex 1), a list of topics which are considered in the EIAs is identified. For each topic of interest, the present analysis shows the main findings and identifies commonalities among different countries. In addition, the analysis at country level allows to derive general recommendations and best practices.

It is important to emphasise that an additional output of EIAs is the accurate biological, chemical and geological characterisation of large marine areas, contributing to the increase of knowledge. Wind farms are, to all intents and purposes, distributed observation systems that can contribute significantly to the Digital Ocean.

Within the Consortium countries, Greece and the UK stand out as peculiar cases for different reasons. Due to the different maturity of the offshore wind sector, EIAs in the UK are guided by strategic frameworks and regulatory standards. The methodologies used are not specific to individual offshore wind farms but represent general approaches applicable across UK waters. In detail, the UK adopts the Project Design Envelope (PDE) approach, also known as Rochdale Envelope, a planning and EIA concept that allows developers to propose a project with defined parameters for flexibility while still ensuring a thorough assessment of potential environmental impacts. It balances the need for flexibility (within prescribed constraints) during the development of a project with the requirement to assess its potential environmental effects. The permitting agency then uses the PDE approach to assess the worst-case impacts on key receptors (e.g., marine mammals, fish, benthic habitats, commercial fisheries), focusing on the design parameters that represent the greatest potential impact to each resource,referred to as the Maximum Design Scenario (MDS); this is actively applied in current projects such as East Anglia 1 and East Anglia 2 [22].

Regarding monitoring and data, the Offshore Wind Evidence and Change Programme (OWEC) is a UK-wide initiative led by the Crown Estate [23]. It has funded over 35 research projects to date to address critical knowledge gaps about the environmental impacts, consenting processes and benefits of offshore wind farms. The programme focuses on benthic, marine mammal, and ornithology receptors, as well as the impacts of offshore wind on marine ecosystems. Among the others, it supports the Ecological Consequences of Offshore Wind research programme (ECOWind), which remains central to the UK's environmental strategy and has three main objectives: 1) understand how interactions between species are affected by offshore wind, and what this means for populations; 2) enhance marine observations through innovative technology to inform understanding of the effects of offshore wind on marine life; 3) use the knowledge gained from these first two objectives to inform marine policy and management, including net gain and marine environmental restoration [24].
Additionally, environmental data and evidence generated through UK offshore wind projects are made publicly available via the **Marine Data Exchange (MDE)**, a repository managed by The Crown Estate. The MDE supports transparency, reproducibility, and cross-sector collaboration by providing access to survey data, monitoring reports, and geospatial information. This open-access platform complements strategic programmes like OWEC and ECOWind, enabling evidence-based planning and cumulative impact assessments.

On the other hand, although Greece does not yet have any plants in the planning stage it is actively advancing its offshore wind energy sector, with a strong emphasis on environmental considerations. A key component of this development is the SEIA [12] conducted by the Hellenic Hydrocarbons and HEREMA. Based on the SEIA report and the National OWF Development Programme [11] the methodology followed for selecting the potential OWF development areas can be summarised in three main sections:

1. Strategic EIA methodology;
2. Identification of environmental objectives and evaluation criteria;
3. Area exclusion criteria for the development of (F)OWTs projects.

Therefore, information from Greece is taken from this strategic plan (details can be found in chapter 7 – Annex 1).

4.1 Collected EIAS for the different labs across Europe

The following Table 3 shows the wind farms considered within the present analysis. Concerning the development stage, the selected plants are categorised as follows:

1. Planned: the wind farm has been planned for an assigned area, but the EIA has not been presented to the competent authority yet.
2. EIA ongoing: the EIA has been presented and is currently under examination by the competent authority.

3. EIA approved/Integrations requested: the competent authority has approved the EIA or has requested additional information.
4. In operation/under construction: the wind farm has received the final EIA approval and is in the operational or construction phase.

Table 3: List of Wind farms considered in the analysis

Wind Farm	Country	Type	Development stage
7SeasMed	Sicily Channel, Italy	Floating	EIA approved
Tyrrhenian Wind Energy	Central Tyrrhenian, Italy	Floating	EIA ongoing
Barium Bay	Southern Adriatic, Italy	Floating	EIA Approved
WindFloat Atlantic	Portugal	Floating	In operation
Biscay Marine Energy Platform	Spain	Platform	In operation
Tramuntana Offshore Wind Farm	Spain	Floating	EIA approved
PLEMCAT	Spain	Platform	EIA approved
Outer Dowsing	Lincolnshire Coast, UK	Bottom-fixed	EIA ongoing
Dogger Bank	North Sea, UK	Bottom-fixed	Under Construction
Moray West	Scotland, UK	Bottom-fixed	EIA Approved
Sheringham Shoal Extension	Norfolk, UK	Bottom-fixed	Planned
Berwick Bank	Scotland, UK	Bottom-fixed	Planned
Stromar Floating Wind Farm	Scotland, UK	Floating	In scoping
Gwynt Glas Floating Wind Farm	Celtic Sea, UK	Floating	Preferred Bidder
Equinor Floating Wind Project	Celtic Sea, UK	Floating	Preferred Bidder

4.2 Analyses of different impacts included in the EIAs

4.2.1 Emissions into the atmosphere

Concerning this aspect, most EIAs lack consistent information, making cross-country comparisons difficult. The collected data shows a general absence of compensation strategies, with most emphasis placed on mitigation. Italy and Greece recognise that an increase in direct and indirect emissions of air pollutants is expected during the construction and operation phases of FOW projects. For two of the wind farms planned in Italy, the fuel consumption for installation, operation and decommissioning is accounted for based on the available data on supporting vessels and the estimation of each activity duration. The estimate of the impact of emissions is based on the equivalence between marine diesel consumption and the produced NOx, SOx, PM10, CO2 and the proposed mitigation strategies rely on the use of alternative fuels and/or hybrid/electric engines. Very detailed quantitative information is provided from Italy, but not uniformly for all projects. Similarly, UK approach is based on vessels activity logs and fuel consumption models. In Portugal and Spain this aspect is not considered.

Recommendations that can be derived:

As only Italy and UK deal explicitly with this aspect, it is not possible to deduce cross-country recommendations concerning this topic. As a general comment, it can be concluded that the increase of polluting emissions into the atmosphere due to the operations related to offshore wind farms is recognised as a critically impacting factor that must be carefully quantified and analysed to identify effective mitigation strategies.

4.2.2 Acoustic Emissions

Across Italy, Portugal, Spain, UK and Greece, the EIAs' treatment of acoustic emissions in OWF projects reveals several shared patterns. Every country's assessment flags underwater noise - in general, and from piling, vessel traffic and construction - as a stressor on marine life. The methodologies adopted to assess the acoustic emissions heavily rely on literature data (not necessarily related to the actual installation site). In Italy and UK, noise emissions from the wind turbines and due to the supporting vessels are usually estimated by numerical models (e.g. Pile-Driving Source Model and Marine Operations Noise Model developed by JASCO Applied Science coupled with BELLHOP propagation model). Differently, PT and SP perform acoustic measurements during some of the farm life-phases.

Quantitatively, for all countries, the indicators of noise levels are expressed in terms of Sound Pressure Levels (SPL) at specific distance from the wind turbines and/or from the farm. In this respect, Italy offers source-specific data (e.g., acoustic emissions levels for pile driving, cable burial, turbine and vessels). UK focuses mainly on piling, whilst Portugal and Spain remain at a more general level, discussing "construction noise" or "underwater noise" broadly, without breaking out decibel metrics or individual sources.

All five countries, regardless of detail, recommend very similar mitigation measures: temporal restrictions to avoid breeding seasons, active monitoring and shut-down thresholds when mammals are detected, bubble-curtain or cofferdam systems around pile-driving sites, soft-start piling procedures to ramp noise gradually.

A specific case is represented by Greece, where FOW farms are not yet in the authorisation phases. Two specific Environmental Objectives are mentioned in the EIAs methodologies (reduce emissions of underwater and airborne noise and vibrations, avoid exposure to levels of environmental noise and vibrations that exceed permissible limits). In addition, it is recognised that, during the construction phase, an increase in airborne and underwater noise emissions is expected.

Recommendations that can be derived:

- **Standardise acoustic metrics** adopting consistent indicators (e.g. SPL at standard distances) to enable cross-project comparison.
- **Baseline monitoring**: conduct pre-construction surveys to establish ambient noise levels and key species presence.
- **Source-specific modelling**: model individual noise sources (pile driving, cable laying, turbine operation, vessels) with propagation tools (e.g. Bellhop) to predict zone-of-influence.
- **Define and implement a mitigation hierarchy**: avoid piling in sensitive seasons; minimise noise via bubble curtains and low-energy hammers; offset any residual impacts with habitat enhancement or relocation assistance for affected species.
- **Active monitoring and adaptive management during operation**: deploy real-time measurement systems and visual observers; establish shutdown thresholds when marine mammals enter exclusion zones.
- **Equipment selection**: choose low-noise vessels (e.g. "Silent-E" certified) and quiet pile-driving technologies (vibratory or drilled piles where feasible).
- **Stakeholder engagement and transparency**: share acoustic data and mitigation performance with regulators, local communities, and NGOs to build trust and inform future best practices.

4.2.3 Electromagnetic Field Emissions (EMF)

Only Italy and Spain include the electromagnetic emission from cables in the EIAs. Where available, the estimate of the EMF magnitude is based on numerical modelling and/or measurements available from literature for other sites. In Italy, the projects proponents estimate the electromagnetic field generated by buried cables to be much smaller (and rapidly decreasing with the distance from the source) than the natural geomagnetic field in the Mediterranean Sea. There is no mention of the EMF impact of dynamic (floating) cables. Portugal and Greece omit EMF risk analysis. Both Italy and Spain indicate common mitigation measures to be undertaken at the design phase. Burial depth is the most common strategy: from 0.4–0.5 m in some Italian projects up to 1.5–2 m in Spain's Tramuntana farm. In addition, cable construction features - three-core XLPE/EPR insulation, spiral-wound conductors to cancel opposing magnetic fields, steel armouring - are mentioned.

Recommendations that can be derived:

- **Standardise EMF metrics**: for instance, report both magnetic and electric field strengths at standard distances from buried and unburied cables.
- **Baseline and follow-up monitoring**: pre-installation surveys of ambient EM levels; follow with in-situ spot measurements post-commissioning to validate model predictions.
- **Cable burial**: target a minimum burial depth of 1 m for inter-array cables and 1.5–2 m for export lines, adapting to seabed conditions.
- **Cable design for field cancellation**: spiral-wound, three-core configurations and high-grade XLPE or EPR insulation to minimise stray fields.

- **Buffer zones for sensitive species**: where EMF-sensitive fauna (e.g. sharks, rays) are present, maintain exclusion corridors or increase burial depth around critical habitats.

4.2.4 Waste production

This topic is considered only in the EIAs collected from Italy, where an estimation of the waste of steel, iron, composite and concrete is provided only for the floating 7SeasMed wind farm, based on a direct correlation between the installed capacity of the wind turbines and the amount of end-of-life waste material, extrapolated from studies on offshore wind farms. Differently, for the Barium Bay wind farm (IT), the impact of an onshore farm is provided, considering the balance between soil excavated quantities and backfilled volume. For all the Italian proposed wind farm, the mitigation strategy to reduce waste production is based on a circular economy approach. In details, planned preventive maintenance, repowering (upgrading components rather than replacing entire systems), recertification and reconditioning are envisaged as the more effective mitigation measures. Targeting a material recyclability rate of about 90–95% is considered the most promising way to dramatically reduce waste production.

Recommendations that can be derived:

- **Standardise waste tracking in EIAs**: mandatory inclusion of detailed waste volume estimates across all phases, not just design or construction.
- **Boost recycling capacity**: given the high recyclability targets, investments in specialised recycling facilities for composite blades and offshore-specific materials are essential.
- **Incentivise Circular Design**: National policies should reward developers using high-recyclability materials and modular, easy-to-disassemble designs.
- **Cross-project learning**: considering the limited number of deployed floating offshore wind farms, encourage sharing of waste data and lessons learned across wind farm projects to continuously improve planning and mitigation strategies.

4.2.5 Seabed characterisation and protection

All countries recognise the importance of seabed characterisation as a fundamental requirement for determining wind farm location, the type and placement of anchors, and the routing of submarine cables.

In general, there is a clear need for specific in situ geomorphological and geophysical surveys, complemented by laboratory testing. Geomorphological studies are typically conducted using oceanographic vessels equipped with multibeam echosounders, side-scan sonar, sub-bottom profilers, magnetometers, sparkers, and Remotely Operated Vehicles (ROVs). Geophysical studies involve core drilling to assess soil characteristics and sediment samples are often collected using devices such as the Van Veen grab. These are followed by laboratory analyses, particularly grain size distribution tests, to further understand sediment composition. The United Kingdom emphasises the importance of also estimating sediment displacement volumes as part of seabed assessments.

Regarding mitigation strategies, Italian EIAs prioritise the selection of optimal anchoring systems. It is recommended to use taut or semi-taut polyester moorings and pole anchors, which provide precise positioning with minimal environmental impact, as these systems are designed to be completely buried and thus reduce the seabed footprint.

Portugal and the UK offer specific guidance on cable routing and seabed protection, including the following best practices:

- bury submarine cables to the maximum feasible depth, up to -20 m (Z.H.);
- minimise trench dimensions for onshore cable routes;
- reuse excavated materials whenever possible;
- dispose of surplus material appropriately;
- select cable routes and burial methods that minimise seabed disturbance and reduce sediment resuspension.

Spain provides general recommendations regarding wind farm siting, advising the avoidance of rocky seabeds to reduce impacts on sensitive habitats. Installations should maintain a minimum distance of 100 meters from significant geological features. In specific cases, such as the BIMEP project, mooring area reshaping is suggested to further mitigate impacts.

The Greek Strategic Environmental Assessment highlights the need to preserve both the quantity and quality of soils, maintain the physicochemical properties of the seabed and soil, and minimise the permanent occupation or sealing of the seabed.

Recommendations that can be derived:

It is not possible to provide a cross-country analysis because MARINEWIND partner countries have focused their studies on different aspects. However, it emerged that there is an urgent need to quantify what can be considered an acceptable minimum impact on the seabed in terms of sediment displacement volume and permanent occupation of the seabed.

4.2.6 Characterisation and protection of AVIFAUNA

The protection of birds and bats is an issue that all countries pay close attention to. Ad hoc studies with seasonal observations and acoustic measurements are carried out during the farm design phase to monitor routes and identify species. In addition, to constantly monitoring migration routes and the species involved, annual censuses of nesting colonies and analysis of electromagnetic field impacts on bird populations are carried out during the operational phase.

With reference to bats, ultrasound detector (e.g. BATLOGGER) are installed on the turbine that allows the automatic sampling identification of almost all chiropters during each sampling event. Remote access to data allows to, as reported by Portugal, identify animals' diversity and activity (per unit of time) in the project area. Usually during this monitoring activity complementary environmental parameters such as air temperature, humidity, wind speed and direction and visibility are acquired.

In Scotland, NatureScot developed the Marine Ornithology guidance to support EIA and Habitats Regulations Assessment (HRA) processes. This is a suite of eleven guidance notes highlighting the steps to take, processes to follow, as well as tools and methods to use and where to find them when carrying out an impact assessment for ornithology for an offshore wind farm. Guidance includes the recommended parameters to provide consistent and comparable results for all Scottish projects to be assessed for an individual project and cumulatively with other projects.

Mitigation strategies include continuous monitoring during operation using cameras and radar systems, while other systems use visual deterrents, such as painting one of the three blades black. It is also recommended to adjust installation activities (e.g., noise-producing) outside of migration or breeding periods efforts to minimize interference with nesting sites during operations. On the other hand, the restoration strategy adopted by the Berwick Bank farm (Scotland) is to provide artificial nesting structures.

It is worth noting that, although the BIMEP area has been proposed for designation as an important Bird Area (IBA) due to its ecological significance, FOW are in operation.
In the Greek Strategic EIA, specific objectives aimed at protecting biodiversity including birds are mentioned (see section 3.3). Moreover, it is also recognised that a significant impact to the birdlife during the operation phase is expected.

Recommendations that can be derived:

- **Perform continuous monitoring** across the whole lifecycle of the wind farm.
- **Collect and share data** gathered across studies after having defined a standardization
- **Develop specific guidance for developers**, based on EU or national regulations, to assess the impact on birds during EIA process.

4.2.7 Characterisation and protection of marine flora and fauna

The protection of marine flora and fauna is a key consideration across all countries involved in OWF development. Environmental assessments span the entire life cycle of these projects and typically include studies on benthic communities (both flora and fauna), fish populations, and marine mammals. In Spain, particular attention is given to interactions with marine protected areas and associated biodiversity.

A range of methodologies, largely consistent across countries, is employed for species identification and environmental monitoring. These include:

- Literature reviews and analysis of existing data.
- In situ visual surveys using ROVs.
- Passive acoustic monitoring with hydrophones to detect marine mammal activity.
- Active acoustic surveys using buoys to assess fish populations.
- Seabed sampling for benthic analysis.

Predictive models based on collected data are used to estimate environmental impacts. In Spain, for example, the interaction of the PLEMCAT park with marine biodiversity corridors has been assessed through compatibility analyses with Natura 2000 zones and nearby protected areas. Regarding marine flora, Italian EIAs focus on identifying and protecting *Posidonia oceanica* meadows and mapping coralligenous habitats using predictive models and field observations. Spanish EIAs also consider coralligenous habitats. In the UK, assessments under the Habitats Regulations, known as Habitats Regulations Assessments, are conducted to determine whether a project might significantly affect designated features of European sites. This approach has been applied, for instance, to the Stromar Floating Wind Farm in Scotland.

Country-specific focus areas and outputs:

- Italy emphasises the need to optimise cable routes and installation methods to minimise disturbance to seabed flora.
- Portugal prioritises identifying species, their spatial distribution, abundance, and relationships with environmental variables such as temperature and depth.

Special attention is given to marine mammals. Around the WindFloat Atlantic project, *Delphinus delphis* (common dolphin) is the most frequently sighted species, followed by the minke whale and harbour porpoise. Spain's assessments aim to identify all vulnerable species and provide quantitative data. At the SP-Biscay Marine Energy Platform, benthic communities are identified as sensitive using the AZTI Biotic Index, which evaluates the quality of soft-bottom benthic macroinvertebrate communities. Common dolphins are consistently observed around Spanish OWFs. UK assessments also focus on species-specific presence and behaviour, using baseline data for impact modelling.

The following mitigation strategies have been identified:

- Italy recommends techniques such as controlled horizontal drilling, modular cast iron shells for cable protection, and surgical trenching.
- Spain emphasises careful cable route design to avoid key habitats and suggests scheduling noise-generating activities outside of migration or breeding periods. It also promotes best practices for biofouling management, including routine maintenance and inspections to prevent the spread of invasive species.
- UK supports the use of exclusion zones, embedded mitigation planning, and adaptive management strategies.

Both Spain and the UK have implemented adaptive monitoring programmes for operational farms to assess and mitigate long-term impacts on benthic habitats and ichthyofauna. Italy also proposes ecological restoration measures, such as replanting algal forests and creating artificial reefs using stones or concrete mats to protect cables and enhance biodiversity.

Even if Greece is at an earlier stage, with FOW not yet in the authorisation phase, its EIA methodologies and the National OWF Development Programme outline five key environmental objectives:

1. Protection and conservation of biodiversity (species and ecosystems);

2. Preservation of the distribution and abundance of marine species in line with local environmental conditions;
3. Management and protection of nationally and internationally significant protected areas;
4. Prevention of habitat fragmentation and obstruction of movement routes for birds and marine organisms;
5. Safeguarding seabed integrity to maintain ecosystem structure and function.

Proposed FOW sites in Greece are generally located more than 2 km from Absolute Nature Protection Areas and Key Biodiversity Areas, and mostly outside the national Natura 2000 network.

Recommendations that can be derived:

- **Perform a continuous monitoring** across the whole lifecycle of the wind farm to identify changes in fish populations or behaviour and the status of benthic communities; Consider the development of specific biodiversity sensors.
- **Adopt adaptive design and management**.
- **Study the interaction** with protected and sensitive areas.
- **Define standards** and indices to quantify impact on marine flora and fauna (i.e. ATZI index etc.)

4.2.8 Water quality

This topic is not addressed explicitly in the Italian and UK EIAs, although some recommendations for mitigating this type of impact are included in those for the protection of the seabed and benthic flora. On the contrary, Portugal and Spain pay attention to water quality performing predictive estimation during planning and monitoring, installation and operation phases. Portugal performed Conductivity Temperature Depth (CTD) in different defined areas, especially around the WindFloat Atlantic farm, casting to measure temperature, and salinity across a depth gradient, water sampling to check for turbidity, oil and greases from the surfaces to 90 meters of depth and the presence of polycyclic aromatic hydrocarbons (PAHs) on the sea surface and down to 50 meters. Results suggest inexistence of impacts on water quality caused by the wind farm. However, it is recommended to adopt spill prevention measures on vessels that support farm's operations and equip them with containment kits.

Spanish EIAs refer to the Marine Strategy Framework Directive to evaluate the status of marine waters at farm location and in the surrounding areas. Results for farm in operation (BIMEP) show a good water status. The Park Tramuntana's EIA addressed the impact of Horizontal Directional Drilling (HDD) and Jetting during the construction phase and of the mooring line movement during operation. Results of the analyses evidenced an increase of temporary turbidity near HDD exit point and cable trenches (max ~40 mg/L, lasting 2–5 hours), a limited sediment deposition in trench area (~3 cm near trench, <1 cm beyond 60 meters) which is recognised to be less significant than natural events like storms or trawling, a very localized impact during operation (<1% of project area, sediment plume dissipates within 25 meters). Notwithstanding the expected low impact, it is recommended to comply with the environmental requirements outlined in the MSFD, to plan continuous monitoring during construction and periodic monitoring of water quality during operation, to avoid areas with high contamination risk. Moreover, it is suggested to use temporary casing at HDD exit points to contain and recycle bentonite clays, to perform numerical modelling to predict and manage sediment plumes and to optimize mooring line design to minimize seabed disturbance.

The Greek Strategic EIA includes both minimising water pollution and the quantitative degradation of water resources. According to Greek analyses, it is expected to have low negative impact during construction and decommission phase, no impact during operation phase and low required water consumption during the production of equipment phase.

Recommendations that can be derived:

- **Continuous monitoring of the water column** in the farm area and in the closest marine areas.
- **Define standards and protocols** for monitoring campaigns.

4.2.9 Hydrodynamic interference

Spanish EIAs include hydrodynamic studies, considered essential to ensure that offshore structures do not disrupt water flow in ways that could affect marine ecosystems, nutrient cycles or navigation safety, relying primarily on wave and current measurements and oceanographic models to address these concerns, with proposed solutions including the selection of installation sites that minimise interference with natural hydrodynamics, continuous monitoring to detect any significant alteration of currents or wave propagation, and the design of floating platforms with anchoring systems adapted to local hydrodynamic conditions to prevent interference; in parallel, Greece, through its Strategic EIA, requires the avoidance of permanent changes in hydrographic conditions.

Recommendations that can be derived:
As only Spain deals explicitly with this aspect, it is not possible to deduce cross-country recommendations concerning this topic.

4.3 Best practices

Based on an analysis of the EIAs previously presented and the strategic frameworks and regulatory standards already in force in the UK, it is possible to suggest a series of best practices:

- The use of PDE and MDS approach for flexible project design as done in the UK and in some EU and non-EU countries (e.g. US).
- The continuous monitoring of all environmental parameters throughout the farm's lifetime, as applied in Spanish and Portuguese plants currently in operation.
- The definition of strategic monitoring frameworks (e.g. ECOWind, OWEC) that standardise data acquisition and analyses and ensure **FAIR** (Findable, Accessible, Interoperable, Reusable) data availability.
- Integration of ecosystem-based approaches and CIA (Cumulative Impact assessment) as implemented in the UK.
- The inclusion of non-price criteria in auction design to reward projects that deliver broader societal and environmental value.

- The implementation of mitigation and compensation measures, including artificial reefs, seasonal restrictions, and stakeholder compensation, tailored to local contexts.

4.4 Identification of further needs

Despite the existence of frameworks and regulations, there are still some gaps that need to be filled even in the UK, especially with reference to the several aspects highlighted below:

- Definition of standard metrics and indicators (e.g. SPL levels, emissions, habitat disturbance) for the relevant outputs of EIA analyses, as well as to enable cross-project comparison and cumulative impact assessment.
- Quantification of what can be considered an acceptable minimum impact on marine ecosystems.
- Set quantitative limits for each output.
- Standardisation of spatial data and monitoring protocol, such as the use of open-access platforms (e.g., the MDE - Marine Data Exchange) to promote transparency, reproducibility and stakeholder collaboration.
- Development of sensors for biodiversity quantification.
- Enhanced modelling of climate change interactions.
- Broader adoption of Marine Net Gain principles to ensure offshore wind contributes positively to biodiversity and ecosystem services.
- Embedding adaptive management strategies that allow for real-time monitoring and responsive mitigation during operations.

Moreover, different marine areas present unique environmental challenges and considerations for offshore wind development. These variations are due to differences in ecological sensitivity, existing marine activities, seabed conditions, etc. and the availability of infrastructure. For example in the UK, key region specific issues that should be addressed in EIAs are:

- North Sea (including Moray Firth and Aberdeenshire Coast): Legacy oil and gas infrastructure, grid connectivity constraints, and cumulative impacts from overlapping marine activities.
- West and North-West of Scotland (Hebrides, Orkney, Shetland): Harsh weather conditions, complex seabed morphology, and high biodiversity sensitivity requiring detailed habitat mapping.
- Celtic Sea (South Wales and South-West England): Emerging floating wind hub with port infrastructure development needs, marine spatial planning challenges, and stakeholder coordination.

4.5 Analysis of the EIA strategies in other countries

In this section, an overview of strategies adopted for the EIA and social acceptance of wind energy developments in countries outside the MARINEWIND Consortium is presented. The focus is on those countries where wind energy plays a significant role in national energy planning. The objective of such analysis is to contextualise international practices beyond the Consortium's scope, highlighting regulatory frameworks, assessment protocols, and mitigation measures adopted in regions with mature or rapidly expanding wind energy sectors. This comparative analysis aims to identify commonalities and divergences in EIA approaches, offering insights that may inform or complement the practices within the MARINEWIND initiative. The information here is gathered from the IEA WIND TCP Annual Reports for 2022 and 2023 [18].

Denmark

- *Strategic screening of offshore wind potential (2022-2025)*: the Danish Energy Agency has allocated resources for a strategic environmental screening of offshore wind in Danish waters between 2022 and 2025. The aim is to collect the necessary environmental data, including the cumulative impacts of offshore wind energy, and to support the long-term planning and decision-making of large-scale offshore wind in Denmark.

Netherlands

- *Research on environmental impact*: the project BeWild (Biodiversity Enhanced Wind Farm development, Integrated Monitoring & Inspection and Localised Design) aims to make sustainable ecological and economic expansion of offshore wind energy possible harmonizing it with other stakeholders such as shipping, fishery and nature which are often not welcome in offshore wind farms because of potential disturbance of the turbines. This is done through an integral data collection and analysis approach during wind farm inspections, using robotic vehicles like Uncrewed Surface Vessel (USVs) and ROVs and creating an eco-friendly environment. The project will result in a monitoring system for e-DNA samples, cable detection sensor, biodiversity enhancing low-cost scour protection and integrated sensing capabilities in USV/ROV.
- Red obstacle lighting on wind turbines at nighttime is experienced as a nuisance for people living in those areas. One of the solutions is approach detection, which switches the light on when an aircraft is near a wind turbine. The transponder-based system is cheaper than the radar-based and will probably become the preferred solution. This research is performed on onshore wind farms but is applicable also offshore.
- The ecological impact of offshore wind is increasing as the number of wind turbines will grow rapidly in the coming decades. Therefore, ecological requirements are implemented in the Dutch offshore wind tenders. This also includes research assignments into the ecological effects of offshore wind, ways to mitigate the adverse effects or even nature-enhancing measures.

5 CONCLUSIONS AND FINAL RECOMMENDATIONS

The findings of the study of social and environmental impacts carried out within the MARINEWIND project, including insights from co-creation labs, surveys, and webinars, align closely with the recommendations and strategic directions of other institutions and stakeholders involved in offshore wind development.

With regard to social acceptability, a comprehensive understanding and acceptance of offshore wind farms by local communities remains limited. While MSP represents a necessary initial step to manage spatial conflicts, it is insufficient on its own. Additional policy measures are required at multiple institutional levels to address and mediate these conflicts effectively.

Different countries have adopted varying approaches to the spatial implementation of offshore wind energy. These range from designating exclusive zones for wind development, to allowing multi-use areas without exclusive allocations. Although zoning exclusively for wind energy, which is the approach adopted in Denmark for fixed-bottom offshore wind, has proven effective in some contexts, it is nonetheless essential to complement MSP with broader strategies to manage spatial interactions, support co-location of activities, and implement mitigation measures.
The involvement of multiple administrative bodies in the permitting process can complicate both the efficiency of decision-making and the enforcement of conflict mitigation measures. The success of such processes is closely linked to the institutional capacity of the governing authorities.

Among potential conflicts, interactions with the fisheries sector emerge as the most pressing issue. This is likely exacerbated by the structural challenges currently facing the sector, including the need for technological upgrades and the ongoing decline in fish stocks.

The MARINEWIND project made a concerted effort across the five countries under investigation to promote transparency, encourage dialogue with local stakeholders and share information throughout the strategic, planning, and permitting phases. However, the perception that national governments have not invested sufficiently in public awareness campaigns around offshore wind or climate change still remains. Moreover, mechanisms to ensure that local communities benefit from offshore wind development are still largely lacking.

The ongoing public consultation for the MSP revision in France stands out as a noteworthy example of best practice in participatory governance to guide future actions to maximise social acceptance. However, it is equally critical that each offshore wind project be evaluated on a case-by-case basis, applying flexible, site-specific solutions, thus requiring the development of harmonised and transparent methodologies for assessing socio-economic impacts, supported by measurable indicators and parameters.

The picture emerging from the analysis of EIAs shows a substantial lack of a common framework, not only across different countries under investigation but, in some cases, also within the same country. There is a clear lack of shared metrics and indices to provide quantitative assessments of impact magnitude, thereby limiting the ability of policymakers and regulators to apply objective criteria. Existing strategies and guidelines tend to offer qualitative recommendations only. Furthermore, EIAs for different plants sometimes focus on analysing different potential impacts on the marine environment. Nonetheless, several key areas of environmental assessment are commonly addressed across countries, including acoustic emissions, seabed characterisation, marine flora and fauna, and migratory avifauna. For these topics, despite the absence of formal standardisation, the applied methodologies and mitigation measures are broadly similar across different projects.

Drawing on best practices from the United Kingdom, there is a pressing need to establish a robust regulatory framework at both regional and national levels, informed by conservation strategies and, in the case of EU countries, the Marine Strategy Framework Directive. Despite these gaps, the reviewed documentation generally contains high-quality analyses and valuable data. The assessments carried out during planning, along with continuous environmental monitoring during operation, provide critical insights into marine ecosystems, many of which remain poorly understood, particularly in deeper waters. A wide array of sensors and monitoring technologies, including ROVs, has been deployed. There is also an identified need for new instruments to measure and quantify marine biodiversity.

To ensure that collected environmental data are effectively utilised, standardised monitoring protocols should be adopted, and dedicated data repositories should be established, adhering to the FAIR (Findable, Accessible, Interoperable, Reusable) principles. Once again, the UK's structured approach to long-term monitoring (e.g. OWEC, ECOWind) offers a useful model. Some critical aspects, such as cumulative impact assessment, are still absent from several EIAs, particularly in Southern European contexts. Conversely, the interaction between offshore wind farms and nearby marine protected areas or ecologically sensitive zones must be addressed systematically in all assessments. Ultimately, it is recommended that the "do no harm" principle be progressively reinterpreted toward a "Net Gain" approach for marine biodiversity, potentially extending this concept to include ecosystem services as well.

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7 ANNEX 1 – EIA DATA COLLECTED FROM MARINEWIND CONSORTIUM

7.1 Greece

Greece is actively advancing its offshore wind energy sector, with a strong emphasis on environmental considerations. A key component of this development is the SEIA conducted by the Hellenic Hydrocarbons and HEREMA. In November 2023, HEREMA released the SEIA for public consultation which was approved in October 2024. Based on the SEIA report [12] and the National OWF Development Programme [11] the methodology followed for selecting the potential OWF development areas can be summarized in three main sections:

1. Strategic EIA Methodology
2. Identification of Environmental Objectives and Evaluation Criteria
3. Area Exclusion Criteria for the development of (F)OWTs projects

The first two sections describe the methodology for the assessment, evaluation and mitigation of impacts on the environment, while the last section includes selected criteria for the exclusion of the areas for the development of (F)OWTs projects.

7.1.1 Strategic Environmental Impact Assessment Methodology

This section describes the methodology applied for the assessment and evaluation of the potential significant environmental impacts of the SEIA Program in accordance with the specifications of Directive 2001/42 and the harmonized national legislation (107017/2006). Additionally, the methodology of the EU guides and available relevant international bibliography and experience in corresponding sectoral Programs. The SEIA methodology includes the following steps:

Step 1: Identification of the Environmental Parameters under consideration based on Directive 2001/42/EK., the Environmental Objectives (EOs) that are considered important for ensuring the integration of the environmental and climate dimension in the implementation stages of the Program, as well as the relevant Evaluation Criteria that include a series of guiding questions regarding whether and to what extent the set EOs of the Program are achieved. In this step, the correlation of the Program with the defined EOs is also carried out to identify the environmental parameters where significant impacts are expected.

Step 2: Assessment and evaluation of the potential significant environmental impacts at the level of the Program interventions in relation to the EOs that have been set, taking into account their time prioritization (medium-term and long-term), the location and the available technical characteristics of the OWF projects (seating technology, installation depths, installed capacity). The process is carried out through the guiding questions and concerns all the stages of implementation of the Program (Research, Construction, Operation and Decommissioning of the OWF projects).

Step 3: Assessment and evaluation of the potential significant Transboundary Environmental impacts of the Program, which, given the nature of the projects/activities of the Program, concern Biodiversity, Water and Marine uses/activities.

7.1.2 Identification of Environmental Objectives and Evaluation Criteria

The following table presents the environmental and social parameters examined within the framework of the SEIA, as well as the corresponding Environmental Objectives and Assessment Criteria per parameter examined, which were based on:

- the EU and national medium-term and long-term objectives for Energy and Climate,
- the objectives of the Marine Strategy Directive 2008/56/EK and the harmonized national legislation (L. 3983/2011, as applicable) concerning the prevention, protection and conservation of the marine environment,
- the environmental objectives and the corresponding assessment criteria of the EU Classification Regulation 2020/852 concerning the compliance of programs/projects with the Do No Significant Harm (DNSH) Principle and the relevant EU guidance (2021/C 58/01), and
- Socio-economic criteria, such as the economic viability of projects, the prevention and enhancement of social cohesion, the promotion of research and innovation, as well as the direct and indirect impacts on society.

Parameter	Environmental Objectives	Assessment
Climate – Climate change	**EOC1**: Reducing GHG emissions. **EOC2**: Increasing the share of RES in the energy mix by 2030 and contributing to achieving a climate-neutral economy by 2050. **EOC3**: Limiting energy consumption from conventional production sources. **EOC4**: Addressing the impacts of climate change and protecting against climate-related risks of accidents/disasters.	• With the implementation of the (F)OWT projects/activities, a reduction in GHG emissions from electricity generation at national and EU level is expected by a maximum of approximately 21,049.32 $ktCO^2$/year by 2030 and 26,407.32 $ktCO^2$/year from 2030 onwards. • Furthermore, the implementation of the Program will positively contribute to the goals of the National Energy and Climate Plan (NECP) with the implementation of (F)OWT projects with an estimated maximum available installed capacity of 5.5GW by 2030 and 6.9GW after 2030. • Low increase of the GHG emissions during the construction and operation phase of the project. • Low risk of accidents/disasters.
Biodiversity – Flora - Fauna	**EOB1**: Protection and conservation of biodiversity (species, ecosystems). **EOB2**: Protection, conservation and management of Protected Areas and protected species of national and international interest. **EOB3**: Protection and conservation of the distribution and abundance of marine species in accordance with the prevailing physiographic, geographical and climatic conditions. **EOB4**: Avoiding fragmentation of habitats and avoiding placing barriers on movement routes of birds and marine organisms. **EOB5**: Protection of the integrity of the seabed to ensure the structure and functioning of ecosystems.	• Existence of important flora and fauna species. • The Program interventions are located offshore at average depths greater than -60m and concern mostly FOW projects. • The proposed potential FOWs are located at a significant distance (>2km) from Absolute Nature Protection Areas, Nature Protection Areas and Key Biodiversity Areas. The potential FOW are also located for the most part outside the protected areas of the national Natura 2000 Network, occupying only 0.38% of the total area of these protected areas and 0.56% of the country's marine waters. • Low and medium potential negative impacts during construction and decommission of FOW. • Significant impact on birdlife during the operation phase. • Positive impact may arise from fishing restrictions in marine biodiversity.
Water	**EOW1**: Minimizing water pollution (maintain and improve the quality of inland and marine waters). **EOW2**: Avoid permanent changes in hydrographic conditions. **EOW3**: Minimizing the quantitative degradation of water resources.	• Low and medium negative impact during construction and decommission phase due to excavations. (lower in case of floating technologies) • No impact during the operation phase. • Low required water consumption during the production of equipment phase.

Soil	**EOS1**: Preserving the quantity and quality of soil. **EOS2**: Protecting and maintaining the physicochemical characteristics of the seabed and soil. **EOS3**: Minimizing the permanent occupation/sealing of soil and seabed.	• The permanent occupation of the seabed concerns mainly fixed-based Offshore Wind projects and is estimated at a maximum of approximately 636.5km2 (total area of potential OWFs fixed-base projects) since the projects will not cover all of the individual OWFs but a small subset of them given their nature.
Landscape	**EOL1**: Protection and preservation of the quality and diversity of the natural landscape. **EOL2**: Upgrading/promoting the aesthetics of the landscape.	• The Program's interventions are located offshore and at a distance greater than 1,852m from the coastline. • According to the available relevant literature (Campaign for the Protection of Rural Wales, 1999 in ScottishPowerRenewables, 2020) significant impacts of a permanent nature arise in the zone of 0--7.5km from the coastline (Major impact due to proximity; Capable of dominating landscape).
Air quality	**EOA1**: Reduction of air pollutant emissions into the atmosphere.	• The Program's interventions are expected to contribute to the reduction of air pollutant emissions from conventional power generation sources in the medium and long term. These emissions, indicatively in 2019, amounted to approximately 29,800t SOx, 39,300 NOx, 1,710t PM, 1.35t Pb. • During the construction and operation phase of the (F)OWT projects, an increase in direct and indirect emissions of air pollutants is expected, which with the implementation of appropriate measures as proposed for Climate-Climate Change will be of low intensity, cumulative and fully reversible.
Noise	**EON1**: Reduce emissions of underwater and airborne noise and vibrations. **EON2**: Avoid exposure to levels of environmental noise and vibrations that exceed permissible limits.	• The Program's interventions are expected to indirectly contribute to the reduction of airborne noise emissions from conventional power generation sources in the medium and long term. • During the construction phase of the (F)OWT projects, an increase in airborne and underwater noise emissions is expected from the maritime and road transport of construction materials and equipment, as well as from dredging and excavation works at the project sites.
Population – Socioeconomic environment	**EOP1**: Sustainable use and protection of the resources on which existing maritime economic and social activities depend. **EOP2**: Strengthening the energy supply system, especially in the island area.	• The nominated potential (F)OWTs were selected following extensive consultation with relevant bodies to ensure the minimization of potential impacts on the socio-economic environment in the Program implementation area. • The proposed interventions of the Program will contribute to strengthening the energy supply and infrastructure of the Hellenic Electricity Transmission System.

	EOP3: Combating poverty and eliminating social exclusion, with emphasis on combating energy poverty. **EOP4**: Increasing employment and training in innovative technologies at a national and regional level. **EOP5**: Transition to a circular economy including waste prevention and recycling. **EOP6**: Developing synergies with other sectors of the Blue Economy and contributing to the reduction of their environmental and climate footprint.	• During the construction and decommissioning phase of the (F)OWT projects, there may be a burden mainly on the existing port infrastructure for the needs of servicing operational vessels. • During the construction, operation and decommissioning of the projects, waste reduction practices will be implemented.
Human health – Quality of life	**EOH1**: Protection and improvement of public health and quality of life of the population. **EOH2**: Minimization of public health risks (pandemic) and accidents.	• The nominated potential (F)OWTs were selected following extensive consultation with relevant stakeholders (Hellenic Defense Forces, Ministry of Defense, Ministry of National Defense) to ensure that the potential impact on the safety of navigation and accident prevention/avoidance of accidents in the Program area is minimized. • The implementation of the National OWF programmed interventions will contribute positively to the mitigation of energy poverty, while the installation of early warning/forecasting systems for extreme weather events will contribute to the avoidance/prevention of accidents/disasters in coastal and inland areas. • During the construction, operation and decommissioning of the projects, best practices will be implemented to reduce the noise, air pollutant emissions generated to minimize potential impacts on sensitive receivers.
Marine Uses and Land Uses – Tangible Assets	**EOML1**: Avoidance of conflicts with other maritime uses and land uses. **EOML2**: Protection and improvement of the value of material assets in the intervention areas. **EOML3**: Maintenance, improvement and effective use of existing infrastructure.	• During the construction and decommissioning phase of the OWF projects, an increase in noise and air pollutant emissions from the transport of construction materials and equipment by sea and road is expected, as well as an increase in maritime traffic in the OWF projects. The potential impacts on its marine uses will be of low to moderate intensity and fully reversible after the construction phase of the projects. • During the construction and dismantling phase of the OWF projects, there may be a strain on the existing port infrastructure for the needs of operational vessels. The suitability of the port infrastructure closest to the projects will be investigated to ensure that these pressures on port infrastructure are minimized.

Cultural Heritage	**EOCH1**: Preservation and protection of elements of cultural heritage. **EOCH2**: Highlighting elements of cultural and historical interest.	• The nominated potential (F)OWTs are located, after extensive consultation with relevant stakeholders, more than 1.85km from declared maritime archaeological sites and more than 10km from UNESCO World Heritage Sites. In addition, the potential OWFs shall be located more than 300m from wreck sites as notified by competent bodies. • The potential impacts on the cultural environment will be minor and fully reversible at the end of the construction phase of the projects.

7.1.3 Area Exclusion Criteria for the development of (F)OW projects.

This section describes the exclusion criteria to determine available areas for developing (F)OW projects.

Criterion 1: Areas of Absolute Nature Protection and Nature Protection (paragraphs 1 and 2 of Article 19 of Law 1650/1986). The location of wind turbines within these areas is prohibited. The distance of wind turbines from them is determined in accordance with an approved Special Environmental Study (SES) or relevant Presidential Decree (PD) (Article 21 of Law 1650/1986) or relevant Joint Ministerial Decision (JMD) (Law 3044/2002).

Criterion 2: Cores of National Parks, Declared Natural Monuments, and Aesthetic Forests (not included under Criterion 1). The siting of wind turbines within the core zones of National Parks, designated Natural Monuments, and Aesthetic Forests is not permitted. Minimum setback distances from the boundaries of these areas may vary and are typically defined in an approved NRP, relevant PD, or JMD.

Criterion 3: RAMSAR Wetlands. Wind turbines may not be installed within wetlands designated under the Ramsar Convention, making these areas ineligible for FOW development. There is no legally mandated buffer zone; instead, the appropriate distance from Ramsar wetlands is evaluated on a case-by-case basis during the Approval of Environmental Terms as part of the EIA process.

Criterion 4: Priority Habitats within Natura 2000 Sites. This includes habitats such as *Posidonia oceanica* meadows located in areas designated as Sites of Community Importance under the Natura 2000 network, in accordance with European Commission Decision 2006/613/EC (OJ L 259, 21.9.2006, p. 1). These priority habitats are considered exclusion zones for the development of (F)OW projects.

7.2 United Kingdom

EIAs in the UK are guided by strategic frameworks and regulatory standards. The methodologies used are not specific to individual offshore wind farms but represent general approaches applicable across UK waters.

Key methodologies and tools include:

- SEIA and EIA
- Numerical and reduced-order models for hydrodynamics, sediment transport, and noise propagation
- Site-specific data collection and stakeholder consultation
- Multi-criteria analysis and ecosystem-based approaches
- Use of Project Design Envelope (PDE) and Maximum Design Scenarios (MDS)

Recent developments include the integration of cumulative effects frameworks, ecosystem-based monitoring, and strategic data sharing initiatives such as ECOWind and OWEC.

Relevant legislations and Policy frameworks include:

- UK EIA Regulations (2017)
- Marine Works (EIA) Regulations
- Conservation of Habitats and Species Regulations (2017)
- Marine (Scotland) Act 2010
- Wildlife and Countryside Act 1981
- Nature Conservation (Scotland) Act 2004

Specific to Scotland, there have been some updates this year (2025) below:

- Draft updated Sectoral Marine Plan for offshore wind energy (2025): Updates to the spatial planning framework for ScotWind and INTOG leasing rounds [25].
- NatureScot Marine Ornithology guidance (2 hat supports EIA and HRA processes for offshore wind, with a focus on marine birds and cumulative impacts.

Specific to Wales developments:

- The Welsh offshore wind action plan (2025): A national strategy to maximise the benefits of offshore wind in the Celtic Sea, including streamlined planning, port investment, and floating wind innovation [26].

Data classification encompasses experimental data, such as in situ surveys (e.g., hydrophones, sediment cores), numerical data from model simulations for noise, hydrodynamics, and ecological interactions, as well as literature-based data from historical studies and scientific research.

In terms of outputs, Environmental Statements (ES) are submitted under Section 36 of the Electricity Act 1989 and Marine Licensing frameworks. Quantitative indicators include underwater noise levels, emissions, waste volumes, and biodiversity metrics.

There are mitigation and compensation measures that will be bespoke for the various requirements. These include mitigations linked to seasonal restrictions, acoustic deterrents, cable burial, hybrid vessels, and compensation for initiatives such as artificial reefs, habitat restoration, and seabird collision reduction.

Some case studies are included below, along with the types of analysis used and further information relevant to each wind farm. We have included fixed-bottom wind farms as more advanced and established in terms of the availability of data. Note that some of the best practices are:

- The use of PDE and MDS for flexible project design
- Strategic monitoring frameworks (e.g. ECOWind, OWEC)
- Integration of ecosystem-based approaches and CIA

Name of the Farm and Location	Type of Environmental Analysis/Topic	Methodologies	Outputs and Quantitative Indicators	Mitigation Strategies	Compensation Strategies	Other Info
Outer Dowsing (Lincolnshire Coast, UK) – In Examination (2025)	Underwater Noise	JOMOPANS-ECHO, RANDI 3.1, EMODnet bathymetry	SPLrms 229 dB @1m, SPLpk 248 dB	Seasonal piling windows, acoustic deterrents	N/A	Uses PDE and MDS
Dogger Bank (North Sea) – Under Construction	Emissions	Vessel activity logs, fuel consumption models	CO_2: 327,000 tons over 30 years	Hybrid support vessels	N/A	Largest OWF globally
Moray West (Scotland) – Approved	Marine Mammals	Hydrophones, visual surveys	Species-specific presence and behaviour	Real-time monitoring, exclusion zones	N/A	Uses the Marine Scotland Licensing Manual
Sheringham Shoal Extension (Norfolk) – In Planning	Seabed Disturbance	Multibeam sonar, sub-bottom profiling	Sediment displacement volumes	Trenching minimisation, cable routing	N/A	Applies Rochdale Envelope
Berwick Bank (Scotland) – In Planning	Avifauna	Radar, visual surveys, acoustic ID	Migratory route mapping	Blade painting, radar deterrents	Artificial nesting structures	OWEC-aligned monitoring
Stromar Floating Wind Farm (Scotland) – In Scoping (2024)	Marine mammals, seabirds, and benthic habitats	EIA scoping, HRA screening, site-specific surveys	Baseline data for impact modelling	Embedded mitigation planning, adaptive management	TBD	1 GW capacity; Ørsted, BlueFloat, Renantis JV
Gwynt Glas Floating Wind Farm (Celtic Sea) – Preferred Bidder (2025)	Seabed disturbance, port infrastructure, socio-economic impact	Strategic EIA planning, port impact assessments	1.5 GW capacity; port selection data	Port upgrades, local workforce training	TBD	EDF Renewables UK & ESB JV

Equinor Floating Wind Project (Celtic Sea) – Preferred Bidder (2025)	Grid connection, marine spatial planning, cumulative impacts	NESO-aligned grid planning, CIA frameworks	1.5 GW capacity; grid integration strategy	Strategic siting, phased deployment	TBD	Equinor-led; Crown Estate Round 5

In terms of future needs, several aspects are highlighted below:

- Standardisation of spatial data and monitoring protocols
- Enhanced modelling of climate change interactions
- Broader adoption of Marine Net Gain principles

Different marine areas around the UK present unique environmental challenges and considerations for offshore wind development. These variations are due to differences in ecological sensitivity, existing marine activities, seabed conditions, and the availability of infrastructure. We summarised key region-specific issues that should be addressed in EIAs:

- North Sea (including Moray Firth and Aberdeenshire Coast): Legacy oil and gas infrastructure, grid connectivity constraints, and cumulative impacts from overlapping marine activities.
- West and North-West of Scotland (Hebrides, Orkney, Shetland): Harsh weather conditions, complex seabed morphology, and high biodiversity sensitivity requiring detailed habitat mapping.
- Celtic Sea (South Wales and South-West England): Emerging floating wind hub with port infrastructure development needs, marine spatial planning challenges, and stakeholder coordination.

Define key indicators and their relative weight (possible input to webGIS)

- SPL levels (dB)
- Emissions (CO_2, NO_x, SO_x)
- Waste volumes (kT)
- Species presence and abundance
- Habitat disturbance area (km^2)

7.3 Portugal

WindFloat Atlantic (WFA), Viana do Castelo, Portugal (Operational)					
Type of environmental analysis/Topic	**Methodologies**	**Outputs and quantitative indicators**	**Mitigation strategies**	**Compensation strategies**	**Other info**
Water Quality (Pre-installation and Operation phases)	Sampling at Control and Impact areas. CTD casting. Water sampling at different depths: • Turbidity – surface, -25m, -50m, -75m, -90m • PAHs and Oils + Greases – surface, -50m	Temperature, and salinity across a depth gradient. Turbidity, oils and greases. Results suggest inexistence of impacts on water quality caused by the wind farm.	Adopt spill prevention measures on vessels; equip them with containment kits.	None	Recommended to pay attention to geoarchaeological data on coastal evolution.
Acoustic emissions: (Pre-installation and Operation phases)	Sampling occurred during the spring and autumn 2018 (pre-installation), Autumn 2020 and spring 2021(Operation) At the turbines area 2 hydrophones: 1) – 43 m and 2) - 85 m from seabed	• SPL (Sound Pressure Level) • 1/3 Octave bands • PSD (Power Spectrum Density) • Relevant statistics • AIS data. Delphinid species are less sensitive to lower frequencies, therefore less susceptible to noise emitted from the turbines. Baleen whales are more sensitive to	Monitoring only; no significant mitigation applied.	None	Information collected from the Strategic Environmental Assessment (SEA) for the inclusion of new areas for offshore wind, the PAER.

		lower frequencies and have greater potential to detect the noise emitted from the turbines.			
Marine mammals (Pre-installation and Operation phases)	Project phases: Pre-installation and Operation Surveys in control and Impact areas: a) Visual surveys with MMOs+ b) PAM	Species id, spatial distribution, abundance and relation with environmental patterns: temperature, depth. *Delphinus delphis* (common dolphin) led in sightings, followed by the Minke whale and harbour porpoise. Porpoises and other cetaceans showed more frequent and longer stays at EA6 (Control Area; lower bathymetry) and EA1 (Impact Area, Greater bathymetry). Porpoises more frequent in the operational phase. Other cetaceans more frequent in the pre-installation phase.	Monitoring only; no significant mitigation applied.	None	Information collected from the recently approved SEA for the inclusion of new areas for offshore wind, the Allocation Plan for Renewable Energy Offshore, the PAER.
Marine Birds **(Pre-installation and Operation phases)**	Visual surveys and radar detector installed on the turbines	Flight paths, behaviour, altitudes. Species diversity. Radar data to complement visual surveys.	Monitoring only; no significant mitigation applied.	None	Results are not public.

Bats **(Pre-installation and Operation phases)**	Ultrasound detector (e.g. BATLOGGER) installed on the turbine. Automatic sampling Identification of (almost) all chiropters during each sampling event. Remote access to data.	Animals diversity and activity (per unit of time) in the project area Complementary environmental parameters – air temperature, humidity, wind speed and direction, visibility	Monitoring only; no mitigation applied.	None	Results are not public.
Biofouling/ Artificial Reef Effects (Operation)	Photograph, video and in situ sampling by divers at 1m, 5m, 10m depths on selected turbine columns (1/year, 5 years, autumn). CTD data and water parameters.	Species richness, abundance, coverage, biofouling thickness, video/photo documentation, physic-chemical parameters.	Limit sampling to safe conditions; repeat sampling under consistent seasonal windows. Visibility and sea-state precautions.	None	Sampling must follow Beaufort ≤ 3 sea state conditions for safety and visibility.
Fish Communities (Operation)	Trawl surveys and octopus pots	Biodiversity, abundance, community distribution biodiversity indexes, among others.			These surveys are an independent initiative of the developer; the results are not public.
Benthic Communities/ Seabed Integrity	NA	NA	Bury cable to max feasible depth (-20m), minimize trench size, reuse excavated material, select low-impact route, limit seabed work.		If any studies were made the results are not public
Cultural Heritage	Archaeological surveys, geophysical/geotechnical data interpretation, continuous onshore/offshore monitoring, emergency protocols, and pre/post	Reports of archaeological finds, conservation state, mitigation actions, visual records, adjusted cable routes to avoid heritage.	Extensive measures: route adjustment, in situ conservation, archaeological monitoring, emergency halt protocol, submerged repositories, georeferencing anomalies.	Preservation or relocation of artefacts.	Maintenance activities involving seabed must be pre-approved by cultural heritage authority.

	excavation documentation.				
Socio-economy	Several initiatives have been put into practice by the developer, such as receiving internships from local schools, collaboration in university projects and the construction of an interpretation centre for the community, etc. Dissemination materials (leaflets, digital media), creation of complaint logbook, yearly reporting, stakeholder engagement sessions	Public outreach coverage; feedback logs; number of contacts logged; annual reports; impact on local perception and awareness.	Dissemination before operation. Stakeholder dialogue to disseminate project objectives and characteristics, including local fishermen, tour operators, and environmental organizations before the wind farm starts operation. Complaint handling process. Information accessibility ensured.	Monetary compensations have been paid to the fishermen, both local and regional fishermen.	The results are not public.

7.4 Spain

Biscay Marine Energy Platform (BIMEP) - In operation					
Type of environmental analysis/Topic	**Methodologies (**)**	**Outputs and quantitative indicators**	**Mitigation strategies**	**Compensation strategies**	**Other info**
Hydrodynamic	Wave and current profiler installation	Mean surface current speed is 10-20 cm/s with a predominant northeast-southwest (NE-SW) direction. The mean wave energy flux is 21.4 kW/m, originating from a 50° northwest (NW) direction. Tides in the area are semidiurnal, with a range varying from 1.5 m to 4 m.	Specific installation locations were selected to minimize interference with natural water dynamics. Continuous monitoring ensures that operations do not significantly alter currents or wave propagation.	N/A	Hydrodynamic studies are crucial to ensure that the structures do not disrupt water flow, which could affect marine ecosystems or navigation safety.
Water Quality	Evaluation based on the Water Framework Directive (Directive 2000/60/EC).	The physic-chemical status of water bodies in the BIMEP area is classified as "very good."	Compliance with the environmental requirements outlined in the Directive. Periodic monitoring of water quality ensures that operations do not degrade it.	N/A	Essential for maintaining ecosystem health and ensuring that marine activities do not pollute or alter water conditions.
Sediments	Geomorphology and sedimentology studies.	Two-thirds of the BIMEP area is located over sedimentary or mixed rock-sand sediments with low organic content and high grain size. One-third of the area is over a rocky seabed.	Rocky bottom areas were avoided to reduce impacts on sensitive habitats. Structures were installed at least 100 m away from significant geological features.	N/A	

		Nearshore zones feature two paleochannels filled with sand-gravel sediments.	One mooring area was reshaped to avoid impacts on geological structures.		
Benthos	Monitoring of benthic communities using drag sampling and visual inspections with ROVs (Remotely Operated Vehicles).	Benthic communities are identified as sensitive to alterations, as evaluated using the AZTI Biotic Index.	An adaptive monitoring program has been implemented to assess and mitigate long-term impacts on benthic habitats.	N/A	
Ictiofauna	Active acoustics using buoys to monitor fish populations.	There is limited specific data available on fish populations in the BIMEP area.	Implementation of a monitoring program to gather data on ichthyofauna and assess potential impacts over time.	N/A	
Marine birds	Annual census of nesting colonies and analysis of electromagnetic field impacts on bird populations.	Three main species identified in the BIMEP area: European storm petrel (*Hydrobates pelagicus*), European shag (*Phalacrocorax aristotelis*), and yellow-legged gull (*Larus michahellis*).	Efforts to minimize interference with nesting sites during operations.	N/A	The BIMEP area has been proposed for designation as an Important Bird Area (IBA) due to its ecological significance.
Marine mammals	Passive acoustic monitoring of underwater sounds and marine mammal activity.	The short-beaked common dolphin (*Delphinus delphis*) is a common species in the area.	Reduction of noise-generating activities during sensitive periods, such as installation phases.	N/A	
Fisheries	Assessment of economic activities in the area.	The primary economic activity involves 11-14 artisanal fishing vessels, which annually capture over 14,000 kg of more than 10 small pelagic and bottom fish species.	Consultation with stakeholders from the fishing sector to minimize conflicts.	Economic compensation to the fishing sector for the loss of access to the area due to BIMEP activities.	

		Recreational fishing is also significant, with over 20 small leisure vessels in operation during favourable weather.			
Cultural and archaeological values	Visual inspections with ROVs to identify underwater archaeological resources.	Presence of archaeological features has been documented, requiring careful planning of installation activities.	Avoidance of areas containing significant archaeological resources.	N/A	
Protected species and areas	Assessment of conservation status and compliance with designated protected areas.	Identification of key protected habitats and species that may be affected by project activities.	Careful alignment of project activities to avoid disturbances to designated areas.	N/A	Conservation priorities guide operational planning.
Landscape	Characterization of the coastline landscape near BIMEP.	The shoreline near BIMEP is listed as an area of special interest for its marine landscape value.		N/A	
Socioeconomic	Broad assessment of economic and social impacts on local communities.	The project impacts fisheries, tourism, and local businesses, requiring integrated management solutions.	Promoting coexistence between the energy platform and traditional economic activities.	Establishment of a research and development facility in Arminza to foster collaboration and economic benefits.	Socioeconomic evaluations ensure the project benefits outweigh the costs for affected communities.
Tramuntana Offshore Wind Farm – EIA approve					
Type of environmental analysis/Topic	**Methodologies (**)**	**Outputs and quantitative indicators**	**Mitigation strategies**	**Compensation strategies**	**Other info**
Water turbidity and sedimentation	Construction phase 1. HDD 2. Jetting Operation phase	Temporary turbidity increases near HDD exit point and cable trenches (max ~40 mg/L, lasting 2–5 hours).	Use temporary casing at HDD exit points to contain and recycle bentonite clays.	N/A	Sediment effects modelled as less significant than natural events like storms or trawling.

	1. Movement of turbine mooring lines	- Limited sediment deposition in trench area (~3 cm near trench, <1 cm beyond 60 m). - Operation impact localized (<1% of project area, sediment plume dissipates within 25 m).	Numerical modelling (MOHID) to predict and manage sediment plumes. Optimize mooring line designs to minimize seabed disturbance.		
Underwater noise	Passive Acoustic Monitoring (PAM), vessel noise studies. Operation phase: Literature review, experience from Hywind Tampen and others.	Construction phase noise from vessels (164–188 dB re 1 µPa at source) and cable-laying equipment. No pile-driving noise (a major contributor in fixed offshore projects). Operation phase: turbine noise (low frequency: 25–125 Hz) reaching 120 dB at 2 km, below disturbance thresholds for key species.	Use modern, low-noise vessels (e.g., Silent-E certified). Monitor acoustic levels and cetacean activity (hydrophones and visual censuses).	N/A	Cetaceans (e.g., bottlenose dolphins) and turtles assessed for sensitivity. No high-energy impulsive noise during construction.
EMF	Biot–Savart numerical modelling. Literature review.	Magnetic field (B): Max ~90 µT (inter-array cables); ~5 µT (export cables). Electric fields (E): Zero outside cable shielding. Limited detection by sensitive species (e.g., eels, loggerhead turtles). Localized impact: ~10,000 m^2 footprint (~1% of project area).	Cable burial (1.5–2 m) and protective armour minimize EMF. Monitoring EMF levels and behavioural patterns of affected species (cetaceans, turtles).	N/A	EMF impact localized to areas near cables; effects on navigation or migratory species deemed low.
Marine Circulation and	Literature review, data analysis.	Impacts on nutrient flow and water circulation considered	No specific mitigation measures required;	N/A	Focused on ensuring hydrodynamic integrity; project aligns with minimal

Nutrient Distribution		negligible due to project design and positioning.	monitoring to confirm findings during operation.		interference in marine currents and nutrient cycles.
Proliferation of invasive species	Literature review.	No significant effects expected due to environmental management practices and monitoring.	Adherence to best practices for biofouling management on turbines and infrastructure.	N/A	Routine maintenance and inspections aim to limit potential vectors for invasive species.
PLEMCAT Platform – EIA approve					
Type of environmental analysis/Topic	**Methodologies [**]**	**Outputs and quantitative indicators**	**Mitigation strategies**	**Compensation strategies**	**Other info**
Hydrodynamic	Evaluation through oceanographic models and measurement of currents and waves.	Mean current speed and wave characteristics tailored for safe anchoring of floating platforms. Bathymetry considered between 50 and 750 m.	Design of floating platforms with anchoring systems adapted to hydrodynamic conditions to avoid interference.	N/A	
Water Quality	Analysis based on the Water Framework Directive.	Water quality classified as suitable for the project, respecting sensitive areas like seagrass meadows.	Continuous monitoring of discharges during construction and operation. Avoidance of areas with high contamination risks.	N/A	
Sediments	Bathymetry, geomorphology, and seabed lithology studies.	Seabed primarily composed of sand and mud, suitable for catenary anchoring systems.	Minimization of sediment disturbance during anchoring and cable installation. Use of non-invasive techniques where possible.	N/A	
Benthos	Assessment of benthic communities through visual inspections (ROV) and	Identification of vulnerable species, such as deep coral habitats.	Cable route design to avoid key habitats.	N/A	

	focused studies on sensitive areas.		Adaptive monitoring program in place.		
Marine Fauna (Fish, Marine Mammals, and Birds)	Acoustic monitoring for mammals, bird censuses, and fish behavior studies.	Common dolphin and migratory birds frequently observed in the area. Identification of critical migratory routes.	Adjust installation activities (noise-producing) outside of migration or breeding periods.	N/A	Assessment of the park's interaction with marine biodiversity corridors.
Fisheries and Socioeconomic Activities	Assessment of impacts on local fishing activities.	Limited impact by including areas already protected or restricted for fishing.	Consultation and collaboration with fishing communities to minimize conflicts.	Economic compensation for affected sectors.	Potential benefits for fish stock recovery by reducing fishing in restricted areas.
Protected Areas and Biodiversity	Compatibility analysis with Natura 2000 zones and nearby protected spaces.	Avoidance of critical areas such as ZECs and ZEPAs. Compliance with legal requirements for protected areas.	Route and design adapted to avoid interference with protected areas.	N/A	
Landscape and Navigation	Assessment of visual impact and effects on navigation routes.	Reduced visibility by locating the project more than 8 km from the coast. Minimal impact on maritime traffic routes.	Placement in areas distant from key maritime corridors and prominent coastal views.	N/A	Park design optimized to minimize visual and landscape impacts.

7.5 Italy

7SEASMED WIND FARM – SICILY					
Type of analysis	**Methodologies ()****	**Outputs and quantitative indicators**	**Mitigation strategies**	**Compensation strategies**	**Other info**
Emissions into the atmosphere (on/off *): **a) Fuel consumption** **b) Dusts (onshore)**	Available data on supporting vessels and estimation of number of hours and days for: installation at sea, operation, decommission	Marine diesel consumption: 4.5 ton/day Total: 3506 ton NOx: 253133 kg; SOx: 35060 kg PM10: 3751 kg; CO2: 11000 ton 345 ton/year; 10350 ton for 30 years NOx: 747270 kg; SOx: 103500 kg PM10: 11075 kg; CO2: 327000 ton	Use of alternative fuels, hybrid/electric engines	–	–
Acoustic emissions: **• Piling for anchor**	Available literature data	SPLrms 229 dB @1 m SPLpk @1 m 248 dB	Acoustic deterrent, physical barriers (nets), avoid breeding periods, active monitoring and stopping, appropriate hammer type, pile material and size, blow characteristics	–	–
• Cable burial (vessels for positioning and trenching)	North Hoyle Farm (Wales) hydrophone data	123 dB @160 m Leq: 178 dB @1 m (same level of a dredger)	–	–	–
• Aero-generator and floating platform (operational phase)	Geo-acoustic map for the seabed: EMODNET bathymetry/geology, Copernicus (CMEMS2020) for water column characterization: T, salinity, sound speed (Hywind DEMO + models for scaling and propagation)	Max 123 dB re 1µPa at 300 m Prevalent 85–100 dB	–	–	–
• Vessels	Available models (Jomopans-ECHO, RANDI	116–132 dB for shipping traffic Prevalent 110–120 dB	–	–	–

	3.1, EMODNET shipping service)				
Electromagnetic emissions of cables	Available data: data sheets and data from wind farms in the North Sea	Electromagnetic field at 50 Hz, decreasing very fast	Medium or high voltage spiral wound cables to cancel the magnetic field, insulating materials (XLPE; EPR)	–	–
Waste production	Design Data	For 5 GW plant: 1600 kT waste (steel, iron, composite, concrete) 7SeasMED: Waste: 80 kT	Circular economy: reduction of resource use, maintenance and repair, planned preventive maintenance, repower, recertification, reconditioning 90–95% recyclable material	–	–
Seabed characterization	Ad hoc in situ studies based on new data acquisition. Geomorphological: oceanographic vessel with multibeam echosounder, sidescan sonar, sub-bottom profiler Geophysical: Core drilling for soil characterization	Positioning farm, anchoring and laying the cable duct	Taut or semi-taut polyester mooring Use of pole anchoring: point anchors, low ground occupancy, completely underground	–	–
Characterisation of marine flora and fauna	Posidonia: ad hoc in situ samples Fauna: hydrophones, ROV observations	Cable position and methodology	TOC-controlled horizontal drilling to lay a counter pipe Modular cast iron shells to protect the cable Surgical trenching	Ecological restoration by replanting algal forests Artificial reefs with stones or concrete mats to protect cables and	–

				attract biodiversity	
Migratory Avifauna	Ad hoc studies with seasonal observations, acoustic measurements to identify species	Identification of migratory routes, frequency, and species	Cameras and radar systems, visual deterrents, color one of the three blades black	–	–
TYRRHENIAN WIND ENERGY – CIVITAVECCHIA (28 FWTS, 13.5 NM FROM THE COAST					
Type of analysis	**Methodologies ()****	**Outputs and quantitative indicators**	**Mitigation strategies**	**Compensation strategies**	**Other info**
Emissions into the atmosphere (on/off *): **a) Fuel consumption** **b) Dusts (onshore)**	Installation at sea (=decommission), Operation, Decommission	NA	NA	–	–
Acoustic emissions: **• Piling for anchor**	Available literature data	SPLrms 229 dB @1 m SPLpk @1 m 248 dB	Acoustic deterrent, physical barriers (nets), avoid breeding periods, active monitoring and stopping, appropriate hammer type, pile material and size, blow characteristics	–	–
• Cable burial (vessels for positioning and trenching)	North Hoyle Farm (Wales) hydrophone data	123 dB @160 m Leq: 178 dB @1 m (same level of a dredger)	–	–	–
• Aero-generator and floating platform (operational phase)	Seabed Geo-physics characterization: GEBCO 2021 Grid	Max 123 dB re 1µPa at 300 m Prevalent 105 dB	–	–	–

	Geo-acoustic map for the seabed: EMODNET bathymetry/geology, World Ocean Atlas's Database (NOAA-World Ocean Atlas 2018, based on World Ocean Database) for water column characterization: T, salinity, sound speed (Hywind DEMO + models for scaling and propagation)				
• **Vessels**	Available models (Jomopans-ECHO, RANDI 3.1, EMODNET shipping service)	Medium level sound: 125 dB for shipping traffic	–	–	–
Electromagnetic emissions of cables	Numerical approach: Matlab code Literature review	NA	Helicoid cables Burying depth: 0.4–0.5 m below the seabed	–	–
Waste production	NA	NA	Circular economy: reduction of resource use, maintenance and repair, planned preventive maintenance, repower, recertification, reconditioning 90–95% recyclable material	–	–
Seabed characterization	1) Ad hoc in situ studies under the supervision of	Positioning farm, anchoring and laying the cable duct	Taut or semi-taut polyester mooring	–	–

	Conisma: Oceanographic vessel with multibeam echosounder, side scan sonar, sub-bottom profiler, magnetometer, sparker, and ROV 2) Laboratory test: Grain size analyses on 9 sediment samples collected using a modified 5L Van Veen Grab		Use of pole anchoring: point anchors, low ground occupancy, completely underground		
Characterisation of marine flora and fauna	Posidonia: ad hoc in situ samples, ROV Mapping of coralligenous habitat (predictive models + in situ observations) Fauna: hydrophones, ROV observations, EUFAMA platform data	Cable position and methodology	TOC-controlled horizontal drilling to lay a counter pipe Modular cast iron shells to protect the cable Surgical trenching	Ecological restoration by replanting algal forests Artificial reefs with stones or concrete mats to protect cables and attract biodiversity	–
Migratory Avifauna	Ad hoc studies with seasonal observations, acoustic measurements to identify species	Identification of migratory routes, frequency, and species	Cameras and radar systems, visual deterrents, color one of the three blades black	–	–
BARIUM BAY – SOUTHERN ADRIATIC SEA (74 FWTS, 1,110 MW, 21.6–27 NM FROM THE COAST)					

Type of analysis	Methodologies ()**	Outputs and quantitative indicators	Mitigation strategies	Compensation strategies	Other info
Emissions into the atmosphere (on/off *): **a) Fuel consumption** **b) Dusts (onshore)**	Installation at sea (=decommission), Operation, Decommission	Marine diesel consumption Estimated impact on global warming: 30 t CO_2eq/GWh (vs. 456 t CO_2eq/GWh for combined cycle natural gas plant)	Use of alternative fuels, hybrid/electric engines	–	–
Acoustic emissions: **• Piling for anchor**	Source levels: Literature data: Norro et al. Study of Wind Farm Belwind (Blighbank, Belgium) Pile-driving source model (PDSM) by JASCO (MacGillivray 2014, construction phase) Data from Kinkardine wind farm (operational phase) Noise propagation: MONM-Bellhop by JASCO	At 750 m: Min Lpk = 179 dB re 1 µPa Max Lpk = 194 dB re 1 µPa	Use of bubble curtains to reduce underwater noise propagation	–	–
• Cable burial (vessels for positioning and trenching)	NA	NA	–	–	–
• Aero-generator and mooring system (operational phase)	1) Hywind Scotland (Burns et al. 2022) 2) Kinkardine (Risch et al. 2023)	Energy emitted at frequencies < 1 kHz 162.5–167.2 dB re 1 µPa²m² (depending on wind speed, JASCO evaluation)	–	–	–
• Vessels	Hydrophone data: 4 stations 1) SEApro Software	Low-frequency component 48 kHz 122.2–123.8 dB	–	–	–

	(qualitative analysis) 2) dBWav and VSLM (Virtual Sound Level Meter) software (quantitative analysis)				
Electromagnetic emissions of cables	Evaluated	Magnetic induction: 3 µT at 5.8 m and 10 µT at ~3 m Lower than Mediterranean geomagnetic field (~20 µT ± 5 µT)	66 kV AC submarine cables (three-core, XLPE insulation, steel armor) Ensure compliance with regulations and maintain distance from sensitive areas	–	–
Waste production	Design Data	Onshore works: Excavation: 67,459.6 m³ Backfill: 36,695.9 m³ Surplus: 30,763.7 m³ Removed asphalt: 681.9 m³ Removed topsoil: 809.0 m³ Surplus to be disposed of at authorized landfills	Circular economy: reduction of resource use, maintenance and repair, planned preventive maintenance, repower, recertification, reconditioning 90–95% recyclable material	–	–
Seabed characterization	1) Ad hoc in situ studies under Conisma supervision: Oceanographic vessel with multibeam echosounder, side scan sonar (SSS), sub-bottom profiler (SBP), ROV, CPT 2) Laboratory test: sediment characterization	Positioning farm, anchoring and laying the cable duct	Taut or semi-taut polyester mooring Use of pole anchoring: point anchors, low ground occupancy, completely underground	–	–
Characterisation of marine flora and fauna	Posidonia: ad hoc in situ samples, ROV Mapping of coralligenous habitat	Cable position and methodology	TOC-controlled horizontal drilling to lay a counter pipe Modular cast iron shells to	Ecological restoration by replanting algal forests	–

	(predictive models + in situ observations) Fauna: hydrophones, ROV observations, EUFAMA platform data		protect the cable Surgical trenching	Artificial reefs with stones or concrete mats to protect cables and attract biodiversity	
Migratory Avifauna	Ad hoc studies with seasonal observations, acoustic measurements to identify species	Identification of migratory routes, frequency, and species	Cameras and radar systems, visual deterrents, color one of the three blades black	–	–
Social Acceptance	Territorial and Environmental Enhancement	Adaptation/improvement of the Adriatic cycle path Creation of landing places for “Metromare” maritime mobility Integration of the project into the “seascape”	–	–	–
	Awareness and Training (Green Economy)	Memorandum of Understanding with Legambiente Puglia Virtual reality video of the park “Energy Talks” and “Agorà Energia” School meetings Explanatory animation on offshore wind farms	–	–	–
	Research and Specific Training	Marine laboratory and observatory on the offshore platform Energy-dedicated courses in higher technical institutes MoU with Jonian Dolphin for marine research Agreements with other research institutes	–	–	–
	Promotion of Creativity and Arts	Artistic installations on wind turbines MoU with Pigment (public art) Short film competition on climate change	–	–	–
	Citizen Involvement	Dedicated events (in addition to Energy Talks and Agorà Energia)	–	–	–
	Environmental Education in Schools	Projects on calculating the carbon footprint Regional network of “green schools”	–	–	–

		Exhibitions and exhibits on environmental and energy themes			
	Combating Marine Litter	Involvement of local fishermen in "fishing for litter" projects with Legambiente	–	–	–
	Specific Training (Employment)	Creation of ~6,000 jobs Training activities for local production sector	–	–	–
	Artistic Installations and Land Art	Redefining wind farms as part of the landscape through artistic interventions	–	–	–
	Innovative Business Model	Creation of social and environmental value MoUs with INARCH, Legambiente, Pigment, universities Shared vision among stakeholders	–	–	–
	Coastal Experiential Stations	Interactive multimedia totems to "see" and "hear" the wind farm along the coast Collaboration with local authorities Idea competition with IN/ARCH	–	–	–
	Tourist Accessibility of the Park	Catamaran tours Fishing tourism Use of offshore substation as observation point and underwater aquarium	–	–	–