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At the Frontier

Guidelines for Unlocking the Offshore Wind Energy Potential in Central and Eastern Europe

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The geopolitical shifts following Russia's invasion of Ukraine have underscored the urgency of accelerating renewable energy deployment across the European Union (EU). Central to this transition is the increased investment in offshore wind energy, recognized for its reliability, scalability, and critical role in achieving the EU's energy and climate security objectives. This handbook aims to provide comprehensive guidelines for accelerating the deployment of offshore wind energy projects in the Black Sea region, with a specific focus on Bulgaria and Romania, as well as the experience of Croatia and Poland. It offers a detailed analysis of the regulatory framework required to attract investment and streamline project approval, emphasising the need for coherent policies that align with EU directives. The handbook addresses the environmental challenges of balancing marine ecosystem conservation with wind energy development, advocating for meticulous spatial planning and community engagement. Infrastructure readiness is another area of focus, with recommendations for port and grid enhancements, adoption of digital solutions, and strategic maritime spatial planning to support large-scale offshore wind deployment.

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ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic area
ACROPO	Competent Authority for the Regulation of Offshore Petroleum Operations in the Black Sea
ANRE	Romanian Energy Regulatory Agency
BLUECEE	Project "Strengthening Policy and Governance Capacity for Blue Energy in Central and Eastern Europe"
CAPEX	Capital Expenditures
CEE	Central and Eastern Europe
CEF	Connecting Europe Facility
CfD(s)	Contract(s) for Difference
DEA	Danish Energy Agency
EC	European Commission
EEA	Exclusive Economic Area
EEG	Renewable Energy Sources Act
EEZ	Exclusive Economic Zone
EIA(s)	Environmental Impact Assessment(s)
ENTSO-E	European Network of Transmission System Operators
EPG	Energy Policy Group
ESG	Environmental, social and governance (ESG) investment strategies
EU	European Union
EUR	Euro
GW	Gigawatt(s)
HEP DSO	HEP Distribution System Operator
HERA	Croatian Energy Regulatory Agency
HOPS	Croatian Transmission System Operator
HROTE	Croatian Energy Market Operator
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
km	Kilometres
km^2	Square kilometres
kV	Kilovolt(s)
LCOE	Levelized Cost of Electricity
LCRs	Local content requirements
m/s	Meters per second
MFF	Multiannual Financial Framework
MP(s)	Member(s) of Parliament
MPA(s)	Marine protected area(s)
MSFD	Marine Strategy Framework Directive
MSP	Maritime Spatial Planning
MW	Megawatt(s)
MWh	Megawatt-hour(s)

NECP	National Energy and Climate Plan
NGO	Non-Governmental Organization(s)
NRRP	National Recovery and Resilience Plan
O&M	Operation and Maintenance
ONDP	Offshore Network Development Plans
OWF	Offshore wind farm
PLN	Polish zloty
PPP(s)	Public-private partnership(s)
PV	Photovoltaic(s)
RED	Renewable Energy Directive
RES	Renewable Energy Source(s)
SEA	Strategic Environmental Assessment Directive
SOVs	Service operation vessels
TSO	Transmission System Operator
TWh	Terawatt-hour(s)
TYNDP	Ten-Year Network Development Plan
UNESCO	United Nations Educational, Scientific and Cultural Organization
W/m^2	Watt(s) per square meter
WACC	Weighted Average Cost of Capital

EXECUTIVE SUMMARY

The geopolitical shifts following Russia's invasion of Ukraine have underscored the urgency of accelerating renewable energy deployment across the European Union (EU). Central to this transition is the increased investment in offshore wind energy, recognized for its reliability, scalability, and crucial role in achieving the EU's energy and climate security objectives. The European Offshore Renewable Energy Strategy, adopted in November 2020, has prompted EU member states to set ambitious targets for offshore wind energy deployment and enhance regional cooperation on cross-border infrastructure projects.

Offshore wind energy holds significant potential for the Black Sea region, particularly for EU members Bulgaria and Romania. Embracing offshore wind in this region offers two primary benefits: reducing dependence on fossil fuel imports and fostering sustainable economic growth for coastal areas. As Europe strives towards climate neutrality by 2050, the Black Sea is poised to become a pivotal arena for offshore wind, providing energy security and supporting large-scale industrial decarbonization and economic revitalization.

Regulatory set-up

The establishment of a robust regulatory framework is fundamental to the successful deployment of offshore wind energy projects in the Black Sea region. Although Bulgaria and Romania have made progress in establishing their renewable energy legislation, significant gaps remain that need to be urgently addressed to attract investment and streamline project implementation. Developing coherent policies that align with EU directives and standards is imperative. National governments should integrate offshore wind energy targets into their strategic documents, create comprehensive roadmaps with clear timelines, and allocate dedicated budgets for research and innovation in offshore wind technologies' adaptation. Additionally, setting up an interdisciplinary one-stop shop permitting process is crucial.

Aligning onshore and offshore grid planning with offshore wind site development and establishing clear compensation rules for investors in grid infrastructure will further enhance regulatory efficiency. Legal frameworks should also include mechanisms for continuous monitoring and evaluation to ensure that policies remain relevant and adaptive to technological advancements and market dynamics. Encouraging public-private partnerships and fostering collaboration between governmental agencies, industry stakeholders, and local communities will be essential in overcoming regulatory hurdles and facilitating smooth project execution.

Maritime spatial planning

In the context of Central and Eastern Europe, maritime spatial planning (MSP) is key to unlocking the region's offshore wind energy potential. MSP provides a structured framework for balancing environmental, economic and social considerations in maritime zones, ensuring that offshore wind development is sustainable and efficient. However, progress in the region is uneven; Croatia has yet to adopt an MSP, and Romania and Bulgaria have not designated specific areas for offshore wind in their existing plans. The implementation of MSP in CEE countries is crucial to designate appropriate zones for offshore wind energy, minimise environmental impacts and resolve conflicts between different marine users. By integrating relevant EU policies and fostering cross-border cooperation, MSP can streamline the development of offshore wind infrastructure, enhance environmental protection and support the region's energy transition. Furthermore, the involvement of different stakeholders throughout the MSP process is essential to achieve social acceptance and regulatory clarity, ultimately contributing to the resilient and sustainable growth of the offshore wind sector in CEE.

Environmental co-existence

Balancing environmental conservation with offshore wind project development is a critical challenge. Ensuring that the deployment of offshore wind energy is harmonious with marine ecosystems requires meticulous spatial planning and adherence to best practices. This includes integrating offshore wind deployment areas into maritime spatial plans and developing strategies for the coexistence of wind energy projects with other maritime activities, such as fishing and shipping, while considering environmental conservation. Engaging stakeholders early in the planning process to address local population concerns and foster community support for projects is also essential.

By adopting a proactive approach to environmental assessment and incorporating conservation measures into project designs, the Black Sea region can achieve a sustainable balance between renewable energy development and environmental preservation. Environmental impact assessments (EIAs) should be comprehensive, covering potential effects on marine biodiversity, water quality, and coastal habitats. Mitigation strategies, such as creating artificial reefs or using noise-reducing technologies during construction, can minimise the environmental footprint of offshore wind projects. Ongoing environmental monitoring and adaptive management practices will ensure that any adverse impacts are promptly addressed and mitigated.

Infrastructure readiness

The readiness of infrastructure is pivotal for the large-scale deployment of offshore wind energy in the Black Sea region. This encompasses the development of port infrastructure, grid expansion, and the integration of digital solutions to enhance efficiency and reliability. Assessments of the infrastructure around the Black Sea ports are needed to determine their readiness and identify potential bottlenecks, such as the narrow roads around the port of Burgas, for example, which could complicate the transport of turbines. Securing diverse financing sources for infrastructure projects and maximizing the potential of existing port facilities to support offshore wind projects are key steps. National governments should embrace digital solutions to improve grid management efficiency and ensure that infrastructure development keeps pace with the growth of offshore wind energy projects.

Strategic planning of maritime space utilisation ensures that offshore wind deployment areas are incorporated into broader maritime spatial plans. This involves the development of comprehensive spatial plans that consider the needs of various stakeholders, including shipping lanes, fishing grounds, and conservation areas. Investing in advanced grid technologies, such as high-voltage direct current (HVDC) systems, can facilitate the efficient transmission of electricity from offshore wind farms to onshore grids. Additionally, fostering innovation in storage solutions, such as battery systems and hydrogen production, enhances the overall reliability and flexibility of the energy system.

To support the logistical demands of offshore wind projects, port facilities must be upgraded and expanded. This includes constructing specialised terminals for handling large wind turbine components, enhancing quay capacities, and providing adequate storage areas. Collaboration with international partners and leveraging best practices from established offshore wind markets in Western and Northern Europe can accelerate the development of world-class port infrastructure in the Black Sea region.

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The development of offshore wind energy in the Black Sea region presents a significant opportunity for Bulgaria, Romania, and their neighbouring countries to enhance energy security, support economic growth, and contribute to the EU's climate targets. This handbook provides comprehensive guidelines and best practices to help policymakers navigate the complexities of offshore wind project development and accelerate the deployment of renewable energy in the Black Sea region, paving the way for a sustainable and resilient energy future.

The successful deployment of offshore wind energy in the Black Sea region can serve as a model for other emerging markets in Central and Eastern Europe, similar to the recent coordinated efforts by the Baltic States to become net exporters of offshore wind energy. It will demonstrate the feasibility and benefits of large-scale renewable energy projects, encouraging further investment and innovation in the sector. By fostering a collaborative approach and leveraging regional strengths, the Black Sea region can become a leader in offshore wind energy, contributing significantly to the global transition towards a low-carbon economy.

INTRODUCTION

The response of the European Union (EU) to the Russian invasion in Ukraine has been to accelerate renewable energy deployment via the REPowerEU initiative. At its forefront has been the increase of investment in offshore wind energy, which is seen as a key technology for replacing natural gas imports, and which could provide more reliability to the electricity system. The European Offshore Renewable Energy Strategy, adopted in November 2020, prompted EU member states to set ambitious targets on offshore wind energy deployment and improve regional cooperation on cross-border infrastructure projects. Since then most offshore wind investment activity has been taking place in Northwestern Europe. Yet, the achievement of the hugely ambitious 2030 offshore wind goals for the EU, requires the urgent overcoming of the governance deficits preventing the faster development of offshore wind parks in the Baltic, Adriatic and Black Seas.

The following analysis is a handbook, guiding policymakers in Central and Eastern Europe (CEE) how to unlock the offshore wind potential in the region with a particular focus on Bulgaria, Romania, Croatia and Poland. Embracing offshore wind has two key benefits for CEE countries: reducing the dependence on fossil fuel imports and fostering sustainable economic growth for coastal areas. Offshore wind can also spur large-scale industrial decarbonisation leading to the economic revitalisation of lagging regions.

This handbook features four main sections. ***Chapter 1*** analyses the gaps in the current renewable energy legislation and demonstrates how cross-border collaboration could be vital to fully realise the economic benefits of offshore wind in the region. It also outlines strategies to develop coherent regulatory frameworks that are essential for attracting investment and ensuring the long-term viability of offshore wind projects. ***Chapter 2*** addresses the challenge of striking the right balance between environmental conservation and project development. It examines best practices in spatial planning to optimise offshore wind deployment while safeguarding marine ecosystems. ***Chapter 3*** focuses on the need for the building out of critical infrastructure including by integrating faster offshore wind into existing power grids and expanding the network to meet growing electricity demand. ***Chapter 4*** addresses the challenges of environmental impact assessments, outlining strategies for offshore wind projects to coexist with local ecosystems while meeting EU environmental standards.

The mapped-out guidelines are based on policy insights from mature offshore wind markets in Europe. They can provide CEE countries, and particularly the Black Sea markets, with a roadmap on how to harness existing expertise, transfer best practices and avoid potential pitfalls. By implementing robust governance frameworks, conducting thorough impact assessments and engaging with stakeholders, the CEE region can attract investment from the biggest offshore wind developers in a highly competitive market.

MAIN PREREQUISITES FOR UNLOCKING THE OFFSHORE WIND ENERGY POTENTIAL OF THE BLACK SEA REGION

The Black Sea region is poised to become a major player in the offshore wind energy market, but several key enabling conditions are yet to be established. Romania and Bulgaria face common challenges in developing their offshore wind industries. These include establishing and harmonising regulatory frameworks, upgrading port and power grid infrastructure, assessing the environmental impact in a cross-border setting and battling social acceptance issues.

The first step to unlocking the countries' offshore wind energy potential is to design a regulatory framework based on **transparent, consistent and competition-friendly principles and procedures**. The introduction of special offshore wind energy laws should clearly allocate risks, costs and responsibilities among stakeholders to ensure a stable investment environment. By minimising political and regulatory risks, governments can reduce the overall cost of deployment which will attract private investment. The Black Sea has more limited wind energy potential and is much deeper than the North Sea, which means that the levelized cost of electricity of Black Sea-based offshore wind parks will be much higher, probably in the range of EUR 80-90/MWh (in comparison in the North Sea it is closer to the EUR 60-70/MWh range).

Drawing on lessons from mature offshore wind markets such as the UK, Germany and Denmark, Black Sea countries have begun developing robust policy and legal frameworks. After years of being stuck in Parliament between votes in the Lower and Upper Chambers, the Romanian MPs adopted the first offshore wind energy law in the country in April 2024. The framework sets concrete targets for the development of the industry with the first parks aiming to become operational by 2032. Bulgaria, facing growing energy and climate security risks linked to its continued dependence on fossil fuel use in the electricity sector, has been trying to pass a special regulatory framework for offshore wind as well. Although the tabled law passed at first reading gathering a 2/3 majority in Parliament, pro-Russian parliamentarians began a persistent campaign against the initiative, organised vocal protests, and managed to scare the unstable parliamentary majority into delaying the adoption of the Law. The ongoing political instability in Bulgaria, which is likely to bring about the 7th consecutive elections in three years in October 2024, makes preserving the initial broad political support for the sector difficult.

Apart from the introduction of a sound regulatory framework, cross-border projects are also essential to maximise the region's offshore wind energy potential. **Joint initiatives between neighbouring countries** can ensure the efficient use of limited resources, optimise the grid integration costs and improve maritime spatial planning. Among the main areas with high offshore wind energy potential is along the common border between Bulgaria and Romania, which means that joint investment efforts such as combined environmental impact assessment, seabed and wind resource site mapping, port use optimisation and a common procurement framework would accelerate the development of the sector. A joint approach to Black Sea offshore wind development could attract additional EU funding from the Connecting Europe Facility (CEF) which has up to EUR 1.3 billion available for the 2021-2027 Multiannual Financial Framework (MFF) for technical assistance, studies and infrastructure development. The **Adria Wind Project** between Italy and Croatia in the Adriatic Sea serves as a model that could be replicated by Bulgaria and Romania, with financial support and technical assistance from the CEF. The project has been selected for EU funding for a 20-month preparatory study to carry out technical, financial and commercial assessments for a potential 300 MW wind farm. If the results are positive, construction could commence in 2026, and the wind farm could be operational by 2029.

Transforming ports into decarbonisation hubs is critical to the development of the offshore wind industry. Upgrading and modernising the port infrastructure in the Black Sea, so that it can support the construction, operation and maintenance of offshore wind farms will create jobs and boost local economies. Ports can also become centres for manufacturing, assembly and supply chain activities, further stimulating growth and employment in the renewable energy sector. Public information activities are essential to raise public awareness and support for offshore wind. Meanwhile, engaging with local communities, addressing their concerns about the potential negative impacts of offshore wind development and highlighting the environmental and economic benefits can help improve the social acceptance of the new industry. The latter also depends on promoting transparency, providing accurate information and involving stakeholders in the decision-making processes.

The future of offshore wind in the Black Sea region holds great promise. Abundant wind energy resources, coupled with the countries' ambitious plans for achieving energy independence and accelerating the decarbonisation of the national economy, represent a huge opportunity for sustainable economic development. Romania and Bulgaria hold a 200 GW technical offshore wind energy potential, a quarter of which can be exploited using mature bottom-fixed technologies.[1] Both countries have already attracted investment interest from Western developers. Yet Bulgaria has fallen behind, as its regulatory framework remains unclear or non-existent, and its maritime spatial plans outdated, without even featuring offshore wind at all.

To address some of these governance problems, Bulgaria, Romania and Greece have signed an agreement to cooperate on cross-border renewable energy development[2]. This coordinated approach to planning and assessment provides an excellent opportunity to exploit the renewable energy potential of the shared sea basin. By implementing the outlined steps below, the Black Sea countries can cultivate a thriving offshore wind industry in the region supporting the EU's clean energy transition goals.

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1 Trifonova, M., Vladimirov, M., *Wind Power Generation in Bulgaria: Assessment of the Black Sea Offshore Potential*. Sofia: Center for the Study of Democracy, 2021.

2 Bulgarian Ministry of Energy, *Bulgaria, Greece and Romania signed a Declaration for the development of joint RES projects in South-Eastern Europe*, *2024*.

DESIGNING AN EFFECTIVE REGULATORY FRAMEWORK

Since the launch of the **European Green Deal** in 2019, the EU has emphasised the central role of renewable energy, including offshore wind, in its long-term vision to achieve carbon neutrality by 2050. In response to the Russian invasion in Ukraine, the EU launched the **REPowerEU**[3] plan as a flagship instrument to accelerate the transformation process and to strengthen energy security on the back of a significant expansion of the share of renewables in the energy system. The EU has increased its 2030 renewable energy target from 40 percent to 45 percent of final energy demand. For the successful implementation of the Plan, 440 GW of operational wind capacity will have to be online by 2030[4]. This means the addition of 30 GW per year of new capacity on average until 2030, an impossible target without the significant uptake of new offshore wind energy capacity.

The new **Renewable Energy Directive (RED III)**, adopted in March 2023, reaffirms the 45% target and aims to simplify administrative procedures, emphasise maritime spatial planning and promote grid modernisation to accommodate the increased offshore wind capacity. RED III strengthens cross-border cooperation and supports innovation in renewable energy technologies to speed up investment, permitting, construction, and grid integration for offshore wind projects, thereby making a significant contribution to the EU's renewable energy targets and climate neutrality by 2050.

Recognising the crucial role of offshore renewable energy sources, the **EU Strategy on Offshore Renewable Energy**[5], unveiled in November 2020, outlined a comprehensive plan to harness this potential. The Strategy aims to increase Europe's offshore wind capacity from its current 12 GW to at least 60 GW by 2030 and 300 GW by 2050. It emphasises the need for substantial investment in research, innovation and infrastructure, including grid modernisation and enhanced cross-border energy links. Even more importantly, the EU plan focuses on creating a favourable regulatory environment, streamlining authorisation procedures and integrating maritime spatial planning to optimise the use of the sea space while minimising environmental impacts.

The 2023 **European Wind Power Action Plan**[6] builds upon the Strategy by addressing the urgent need for accelerated deployment across all elements of the wind energy investment process with a focus on rapid capacity expansion, regulatory reforms to speed up project approvals, and the integration of wind power into the wider energy system to improve grid stability.

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[3] European Commission, *REPowerEU Plan*, 18 May 2022.

[4] Rystad Energy & WindEurope, *The State of the European Wind Energy Supply Chain*, April 2023.

[5] European Commission, *An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future*, November 2020

[6] European Commission, *European Wind Power Action Plan*, October 2023

While the EU has developed an ambitious framework for the acceleration of wind energy projects, the deployment of effective regulations at national level varies considerably between EU Member States. In comparison to the mature offshore wind markets of Western and Northern Europe, the governments in Central and Eastern Europe are yet to fully develop legal and regulatory regimes that can ensure the meeting of their long-term offshore wind energy targets.

In Poland, offshore wind deployment plans were included in national strategies as early as 2009, and the first comprehensive legislation, the Offshore Act, was passed with broad political support in 2021. Romania adopted its first offshore wind law in April 2024, with the aim of bringing the first turbines online in 2032. While Estonia, Latvia and Lithuania do not have specific offshore wind laws, they have adapted their laws on renewable energy or maritime infrastructure to incorporate guidelines for the development of offshore wind farms, and all three Baltic countries see offshore wind as playing a crucial role in the decarbonisation of their economies. Latvia and Estonia are currently working on a joint offshore wind project called ELWIND, which receives funding from the CEF and is expected to bring 1 GW of offshore wind capacity online by 2030[7]. Similarly, Greece is at the starting line for offshore wind development, as well. While there are currently no operational offshore wind farms yet, it boasts excellent wind potential and a supportive special offshore wind law which was passed in July 2022. The Greek government has ambitious targets, aiming for 2 GW of offshore wind capacity by 2030, and they are actively seeking investors to bring projects to life. In contrast, Croatia and Bulgaria have not yet introduced specific offshore wind legislation, although Bulgaria has been debating the passage of a special offshore wind energy law since 2022.

Stakeholder engagement in the regulatory design process

Stakeholder involvement in the regulatory design process is essential to ensure that national, regional and local specificities are adequately reflected in the regulatory frameworks and to ensure the smooth take-up of offshore wind energy by addressing and resolving potential stakeholder concerns before projects are initiated. Stakeholder engagement should start as early as possible to ensure that stakeholders are actively participating in the shaping of the legislation. A key starting point is the development of a **public awareness campaign** about the strategic European importance of offshore wind energy for the overall decarbonisation, which would also **counter disinformation narratives** about the potential risks related to these projects aiming to discredit the overall deployment of the nascent technology.

Engagement tools should include a variety of mechanisms to accommodate different stakeholder preferences and needs, such as **public hearings, workshops, online surveys and the submission of written statements** of the proposed legal changes. To enable stakeholders to easily understand and engage with proposed legislation, accessible information on the legislative process should be provided, including plain-language summaries, fact sheets and online resources. This will also open the discussion to a wide

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7 ELWIND, *ELWIND official website*, July 2024

range of stakeholders, rather than limiting it to a narrow circle of experts. Moreover, maintaining ongoing communication channels with stakeholders throughout the drafting process, rather than just during specific consultation periods, is key to allow for iterative feedback and adjustments based on stakeholder input. To demonstrate the functionality of the engagement process, mechanisms should be put into place that provide feedback to stakeholders on how their input has been incorporated into the legislative process and how their concerns have been addressed. This will add to the overall transparency of the process, which can be further improved by publishing clear documentation of meetings, decisions, and feedback received from stakeholders.

The passing of the Offshore Wind Energy Act at first reading in Bulgaria was met with great expectations from investors, but also with fierce politically driven protests. The tourism and fishing industries, as well as some environmental groups reacted negatively to the legislative initiative, expressing concerns that wind turbines would be built in fishing areas, that the sight of them on the horizon would deter tourists from coming to the Black Sea, and that they would harm local fish and bird populations. Although their concerns are largely unfounded, the popular backlash against the Law highlights the need for a more sophisticated awareness raising campaign to dispel common myths about offshore wind energy and help Bulgarian society understand what the socio-economic benefits are, as well as the available strategies for mitigating environmental and other risks related to offshore wind projects. The Bulgarian parliament has so far failed to effectively communicate the benefits of offshore wind, allowing misinformation to spread. The period between the two readings of the law, ideally used to address the concerns of different stakeholders, has not included a broad societal discussion of the proposed regulatory framework. In addition, Bulgaria's ongoing political instability has prevented further constructive dialogue and action, blocking the passage of the Law at second reading.

The Romanian Parliament passed the Offshore Wind Law (Law 121/2024) with overwhelming support in April 2024 and the President quickly signed it into law, underlining the country's political commitment to offshore wind development. The initial proposal drafted by the Ministry of Energy in July 2023 aimed to install 3 GW by 2035, but this target was removed before the proposal reached parliament. Subsequent drafts and the final bill included several amendments to accelerate the deployment of offshore wind projects. Despite strong political support, stakeholder engagement was fairly limited to a public consultation on the Ministry's draft in the summer of 2023, where stakeholders could submit comments and attend a meeting organised by the Ministry to discuss specific provisions. Given the importance of the law in laying the groundwork for offshore wind development, a broader consultation process on the Parliament's version would have been beneficial for several reasons, including gaining the expertise and insights of industry experts and environmental groups, mitigating potential risks early in the process, ensuring social acceptance, and maximising economic and social benefits.

In **Poland**, the process of stakeholder engagement on offshore wind energy development has been very active. Between 2016 and 2019, a total of 2,053 marine user applications were submitted during the creation of the maritime spatial plan. This period involved extensive consultations with representatives from various sectors, where one of the primary topics was the allocation of sites for offshore wind farms. In 2021, alongside the Offshore Wind Act and the maritime spatial plan, the Polish Offshore Wind Sector Deal came into force, establishing a continuous platform for collaboration among government authorities, offshore wind farm (OWF) investors, supply chain participants, scientific and research institutions, and other expert organisations, that will ensure an effective policy co-creation process of developing the offshore wind industry in Poland. As part of this agreement, a Coordination Council and six working groups were formed. One of these groups specifically focuses on stakeholder cooperation, involving fishermen, maritime transport and shipping sectors and the military, as to address the cumulative impacts of the new industry on other economic activities in the maritime sector. Currently, there are ongoing discussions aiming at enhancing the effectiveness of this agreement to ensure it meets its objectives. Additionally, there is a recognized need within the industry to update the maritime spatial plan and designate new areas for wind farms.

Croatia established a working group of nine ministries to discuss the implementation of the EU's Maritime Spatial Planning Directive. Accordingly, a decision was taken in June 2023 to prepare a spatial plan for the Exclusive Economic Zone (EEZ) of the Republic of Croatia in the Adriatic Sea. The working group emphasised the need to involve all stakeholders related to the exploitation of the marine area. However, only representatives of relevant ministries and government agencies have been involved, and no final MSP has been agreed upon so far. It is crucial to also engage other participants who would be key to the development of offshore wind energy, such as grid connection managers, regional authorities and civil society organisations monitoring the environmental impacts of renewable energy projects, and industrial developers assessing the options for establishing extended supply chains and the necessary port infrastructure.

Auctioning, permitting and licensing procedures

Governments should develop detailed mapping exercises to estimate the offshore wind potential in national waters as to align the realistic short, medium and long-term targets for new capacity additions, considering different constraints such as power transmission network limitations, conflicts with environmental zones, marine traffic routes and competing economic activities. Regulatory frameworks should be designed to enable auction schemes, streamline siting and permitting procedures as to ensure the realistic achievement of targets within the planned timeline.

The regulatory framework should include a specific process for site mapping for offshore wind priority zones through a **tendering process** or an **open-door procedure**, whereby prospective investors can pre-selected areas for development. In the case of the former, the government takes responsibility for assessing the wind potential of areas in the country's EEZ, as well as the potential environmental and socio-economic impacts, linked to the deployment process and then auctions off the selected areas. In the open-door approach, developers identify areas for offshore wind development and then propose these areas to the government in the hope of obtaining permission to develop them[8].

Both approaches have pros and cons, and advanced offshore markets in the EU use different methods. In Germany and the Netherlands, areas for offshore wind are identified by the state and then auctioned off, while the French and Greek (as well as the US) systems use a mixed approach, where both the state and private developers can initiate new offshore wind projects. The **open process** has the advantage that investors can use their expertise and experience to identify the most promising sites based on their own data assessments, selecting areas that optimise their specific project requirements, potentially leading to more efficient and cost-effective projects. In addition, developers would not depend on the initiation of bureaucratic procedures by potentially hesitant governments but can respond quickly to changing market conditions and technological advances. On the other hand, developers face higher risks linked to the different potential conflicts of project development, which can be significantly reduced in case of initial site mapping. **A government-led process** can also ensure a more coordinated and strategic approach facilitating integrated development with existing infrastructure and grid connections, promoting efficient use of the available marine resources.

Recognising **non-price criteria** in the evaluation of projects, such as environmental impact, local jobs and supply chain creation and grid integration, can be key to ensuring that offshore wind projects contribute to wider sustainable development objectives, which can help gain acceptance from affected communities[9]. Both Germany and the Netherlands already include such criteria in their auctioning process. Another example of such non-price criteria is **local content requirements (LCRs)**, which stipulate that a certain percentage of a project's goods, services, labour or capital is sourced locally. In offshore wind auctions, LCRs can stimulate economic development by creating local jobs, improving skills and stimulating industrial growth. They can also increase public support by ensuring that local communities benefit directly from projects[10]. However, LCRs also typically increase project costs if local goods and services are more expensive than international alternatives. Local industries may lack the capacity or technology to meet project requirements, leading to delays and inefficiencies. In addition, LCRs can distort markets and make compliance and enforcement difficult[11]. To ensure a balanced approach, governments can implement LCRs gradually, invest in capacity building for local industries, and combine LCRs with other non-price criteria in auctions, such as environmental impact or circular economy practices, all with careful consideration of the ability of the local economy to meet the requirements. In general, governments should ensure that clear, transparent auction procedures and criteria are put in place to build confidence and encourage participation from a wide range of developers.

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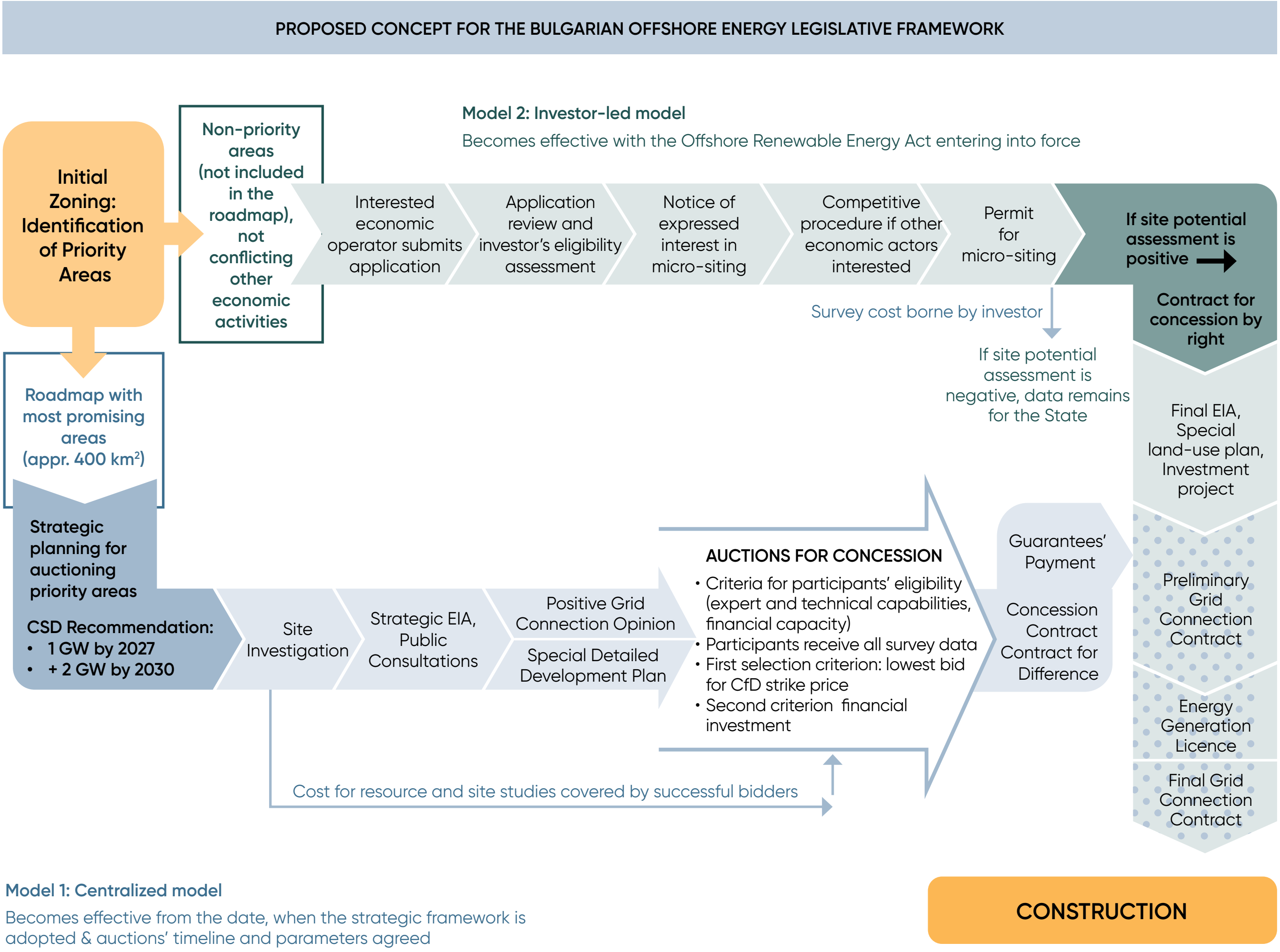
8 CSD, *The Energy Security and Innovation Nexus*, 2022

9 CSD, *Wind Power Generation in Bulgaria*, 2021

10 National Renewable Energy Laboratory, *A Supply Chain Road Map for Offshore Wind Energy in the United States*, 2023

11 CSIS, *Aligning Ambitions: State Strategies for Offshore Wind*, 2023

Figure 1. Site-development models in the proposed concept for offshore energy legislation in Bulgaria



Source: CSD

The permitting process is the cornerstone of responsible offshore wind development. Alignment with EU environmental policy, in particular the Habitats and Birds Directives, ensures strong safeguards for protected wildlife and ecosystems. Environmental impact assessments throughout the permitting process are essential, considering both the outcomes of individual projects and their cumulative impact on protected areas[12]. Exemptions from strict environmental regulations can be considered in exceptional cases, but should be granted cautiously and with robust mitigation plans. A two-stage permitting system can streamline this process. The first construction licence would focus on safety, environmental mitigation and detailed construction plans. The subsequent operating licence would assess the developer's financial and technical ability to operate the wind farm and establish a comprehensive decommissioning plan. In open procedures, where companies express interest in non-priority areas, additional competitive bids should be encouraged to ensure the selection of the project with the **highest potential and minimum negative impacts**. In addition, clearly identifying the responsible licensing

[12] CSD, *The Energy Security and Innovation Nexus*, 2022

authority and setting transparent timelines will ensure efficiency and predictability for developers. Finally, the inclusion of clear grid connection conditions in both construction and operation licencing promotes the smooth integration of offshore wind energy into the national grid.

Decommissioning plans need careful consideration to minimise the potential negative environmental impacts. Applicable legislation should require plant operators to remove generation assets with minimum effects on the seabed and the associated marine life. The development of clear standards outlining the specific components that must be removed and the potential options for leaving certain elements in place, considering environmental impacts and costs, is essential[13]. In addition, aligning decommissioning regulations with existing waste management legislation will encourage recycling and responsible waste management of offshore wind farm components, promoting a circular economy approach. By drawing inspiration from successful practices in Denmark and the Netherlands, Black Sea countries can establish a regulatory framework that promotes the responsible and sustainable development of offshore wind energy.

In Denmark, the construction permit specifies decommissioning liabilities of the operators and their obligation for restoring the soil to its original state at their own expense. Concession holders submit integrated plans for decommissioning to the Danish Energy Agency (DEA) at least two years before the final decommissioning. Similarly, wind farm permits in the Netherlands mandate the offshore wind energy operators to dispose of all materials during decommissioning. A framework that prioritises environmental integrity, ensures smooth grid integration and mandates responsible decommissioning practices will pave the way for a sustainable and successful offshore wind sector.

Polish offshore wind regulations require offshore wind farms to meet specific standards for design, construction, operation and decommissioning. Developers are required to submit an expert report, prepared by an experienced consultancy, demonstrating compliance with these standards. The Polish Ministry of Climate and Environment defines the detailed requirements for the equipment to be used, as well as the operation, maintenance and decommissioning processes. This ensures that all phases of offshore wind projects meet strict technical and environmental criteria and emphasises the importance of expertise and proven experience in the field[14].

The newly passed offshore wind law in Romania determines that the exploration permit for offshore wind projects will be issued by the Ministry of Energy following the conclusion of a concession agreement, with detailed methodologies to be approved by June 2025. By the end of 2024, the Romanian Energy Regulatory Agency (ANRE) will be tasked with issuing the necessary regulations for the authorisation of offshore wind farms. During the construction phase, the Competent Authority for the Regulation of Offshore Petroleum Operations in the Black Sea (ACROPO) will supervise the project in

13 ORE Catapult, *End-of-life planning in offshore wind*, 2021.

14 Parliament of Poland, *Act of 17 December 2020 on the promotion of electricity generation in offshore wind farms*, 2020

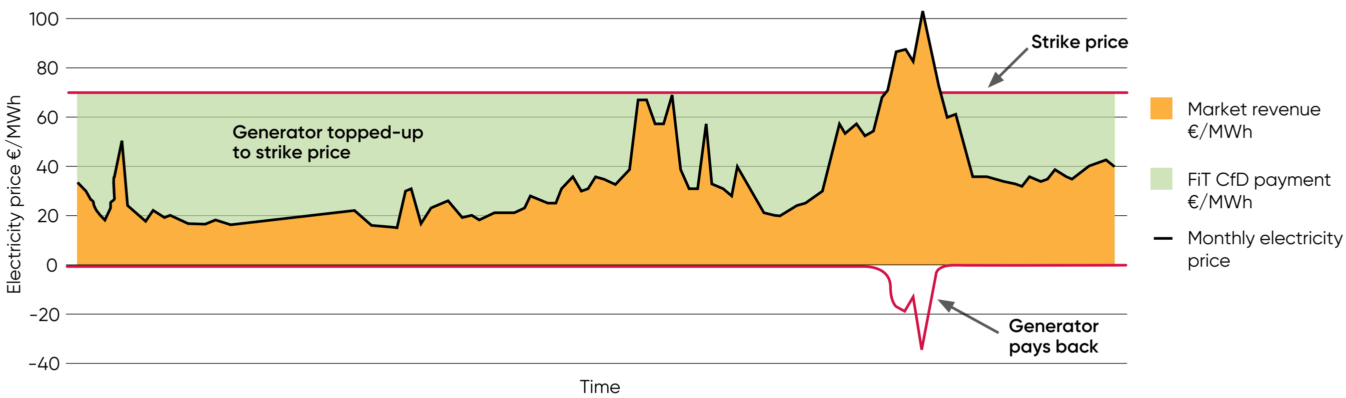
accordance with its technical and economic documentation. Decommissioning in Romania will involve the commitment to certain obligations detailed in the Decommissioning Permit and Concession Contract, with disposal processes required to meet updated environmental standards. The developer must restore the site to its original state in accordance with the conditions set by the environmental authority, and ACROPO monitors the decommissioning activities based on its regulations[15].

Financial support instruments

Creating an enabling environment for private investment and public-private partnerships is essential for the capital-intensive offshore wind industry. Designing an effective regulatory framework for offshore wind requires the careful consideration of different financial mechanisms that can be introduced to attract investment and ensure the commercial viability of projects. The existence of financial support instruments plays a crucial role in the development of the sector in nascent markets. EU countries with longer experience in offshore wind have successfully used various state support tools such as **feed-in tariffs, tax credits, Contracts for Difference (CfD) and grants** to incentivise private investors to develop prospective zones. Germany's early adoption of feed-in tariffs under the Renewable Energy Sources Act (EEG) was one of the most aggressive approaches to the sector development. Similarly, the UK offers tax breaks and grants to reduce upfront costs for developers.

Streamlined permitting and support for infrastructure development are key elements. For example, in Denmark, the government shares early-stage risks linked to the accurate mapping of the wind potential and the drawing of prospective zones making it easier for developers to take a final investment decision or to join a tender for concession rights on the seabed. In addition, the introduction of competitive auctions has helped drive down costs and encourage innovation. The UK's CfD scheme is a prime example. This competitive process has led to significant cost reductions and efficiency gains.

Figure 2. Contracts for difference



Source: UK Department of Energy & Climate Change, Planning Our Electric Future: a White Paper for Secure, Affordable and Low-Carbon Electricity DECC, July 2011, reproduced under the Open Government Licence.

[15] Parliament of Romania, *Law no. 121 of 30 April 2024 on offshore wind energy*, 2024

Box 1. Contracts for difference

CfDs are financial agreements designed to support the deployment of renewable energy projects by providing **price stability and reducing investment ris**k. In offshore wind markets, CfDs are used to guarantee a fixed revenue per unit of electricity generated over a period of time, typically 15 years. If the market price of electricity falls below the agreed strike price, the government pays the generator the difference, ensuring the project remains financially viable. Conversely, if the market price exceeds the strike price, the generator pays the excess back to the government. This mechanism not only secures a predictable income for investors, encouraging them to commit capital to offshore wind projects, but also limits the financial exposure of the government to high market prices.

CfDs have been instrumental in driving down costs and stimulating large-scale investment in offshore wind in countries such as the UK. The difference between one-sided and two-sided CfDs is that with a one-sided CfD, developers are paid the difference when market prices are below the agreed strike price, but are not required to repay the difference to the government when market prices are higher, whereas a two-sided CfD entails the mutual obligation for developers and governments to make payments and repayments whenever market prices deviate in either direction, balancing the risks and rewards more evenly.

The Netherlands and Germany have also pioneered **zero-subsidy tenders**, or negative bidding, where developers rely solely on market prices, showing that due to advances in technology, such as the significant increases in the size of turbines in recent years, and economies of scale (multiple large wind farms in close proximity), offshore wind is becoming increasingly cost competitive. However, this approach is less suitable for less mature markets where revenue stability is critical to making offshore wind projects financially viable considering the much greater risk associated with the lack of experience by local authorities about the project development process, the potentially lower wind speeds and the higher financial costs. Mechanisms such as CfDs ensure that developers receive a stable income, reducing financial risk and uncertainty. CfDs are often favoured to negative bidding for offshore wind energy, as they **mitigate unnecessary financial pressures on developers and reduce costs passed to consumers and the supply chain**. In CfD auctions, developers submit bids for the revenue they require. The lowest bidder wins, ensuring that there are no cost overruns, and that the developer will implement the project on time. Conversely, negative bidding requires developers to pay for the right to build, which can lead to higher development costs. These tend to be transferred to the supply chain and consumers through increased electricity prices. Negative bidding also results in higher financing costs due to the variable revenues that could be unpredictable, which in turn requires reliance on more expensive equity finance.

Poland and Lithuania have also introduced competitive tenders and CfDs in their frameworks for advancing offshore wind industries. In Poland, Phase I projects often involve partnerships between state-owned enterprises like PGE and Orlen and experienced international offshore wind developers. These projects have a CfD reference price capped at EUR 71.82/MWh, which is further indexed for inflation. Moving into Phase II, starting in 2025, projects in the Polish Baltic Sea will compete in dedicated auctions for CfDs. The Polish Ministry of Climate and Environment proposes a maximum price for auctions in the amount of EUR 110.14/MWh, also with an indexation. In Lithuania, developers can either pay a development fee (the first tender for 700 MW was won with a fee of EUR 20 million) or seek support through a two-way CfD, with prices ranging between EUR 64.31 and EUR 107.18 per MWh. The total state aid for Lithuania's offshore wind CfDs is estimated at approximately EUR 193 million over 15 years.

By introducing competitive auctions with CfDs, the Bulgarian offshore wind draft law targets experienced developers and achieves the lowest possible cost for the generated electricity. The auction price sets a strike price within the concession agreement, stabilising the expected revenues for power plant operators at a pre-agreed level throughout the contract. This revenue stability aids investors in securing more favourable bank loans. In exchange, concession holders must sell all generated electricity on an organised exchange, with the compensation calculated by the government being the difference between the average monthly market price on the Bulgarian power exchange, IBEX, and the strike price (EUR 85/MWh). CfDs could be managed by the Energy Security System Fund, which would compensate operators when market prices fall below the strike price and collect payments from the developers during periods of high market prices.

In April 2024, Romania adopted Government Decision No. 318/2024[16], introducing a CfD scheme to support new capacity from low-carbon emissions technologies[17]. The initial CfD, amounting to EUR 3 billion was launched for solar and onshore wind projects, with plans to include other technologies like offshore wind and nuclear in future phases. Throughout July and August 2024, the National Energy Regulatory Authority approved Order No. 51/2024[18], establishing the methodology for determining and collecting the contribution for CfD, while the Ministry of Energy approved Order No. 1120/2024 concerning the state aid scheme[19].The first auction, covering 1.5 GW of installed capacity (1 GW for onshore wind and 0.5 GW for solar), is expected to take place by the end of 2024 and will set maximum prices at EUR 78/MWh for solar and EUR 82/MWh for wind. The second auction, for 3.5 GW (1.5 GW for onshore wind and 2 GW for solar), is scheduled for the third quarter of 2025. Developers will bid for contracts and receive payments for the difference between the contract price and the market price if the market price falls below the contracted price. These contracts, lasting 15 years, will be supported by the Modernisation Fund until 2030, after which the cost of maintaining the scheme will be transferred to consumer bills. This guaranteed revenue stream enables developers to secure financing for intermittent renewable sources by ensuring predictable payback periods and minimum returns on investment, protecting investors from market fluctuations. In compliance with the Energy Market Directive update, all revenue generated from the CfD scheme will benefit end-consumers in a manner that encourages overall electricity reduction and/or peak-shifting activity.

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[16] Government Decision No. *318*/2024.

[17] *Official Gazette of Romania*, 10 April 2024.

[18] Order No. *51*/2024.

[19] *Official Gazette of Romania*, 5 August 2024.

International cooperation

Cross-border cooperation is essential to maximise the development of the CEE offshore wind resources, raise the general international investment appetite in the renewables sector and accelerate the expansion and modernisation of the power grid. Good practices include the **North Sea Wind Power Hub**, involving Denmark, Germany and the Netherlands, as well as the **Baltic Energy Market Interconnection Plan (BEMIP)**, which aims at integrating the Baltic Sea region into the wider European energy market. The latter has effectively ended the energy isolation of the Baltic States through several key achievements such as connecting them to the Nordic electricity market and launching a joint offshore wind tender planning tool. Ongoing efforts focus on synchronising the Baltic States' electricity grids with European grids, increasing transmission capacity in the Nordic region and developing a regional decarbonised gas market[20].

To promote effective cross-border cooperation, it is crucial to harmonise regulations and standards with neighbouring countries. This includes developing common regulatory frameworks and aligning permitting procedures, environmental assessments and grid connection standards. Establishing bilateral or multilateral agreements to define roles, responsibilities and financial arrangements for shared offshore wind infrastructure is another important step. In addition, regional coordination bodies such as the North Seas Energy Cooperation (NSEC), which aims to facilitate the development of a common offshore grid and unlock the large renewable energy potential of the North Sea, can oversee joint planning and policy alignment.

Emerging offshore wind markets can accelerate their development by **leveraging the expertise of international partners** rather than trying to build such expertise from scratch. International joint ventures and projects draw on the expertise, technology and financial resources of several countries. For example, the **Gemini offshore wind farm** in the Netherlands, developed by Dutch (HVC, Van Oord, Ensol) and international (Northland Power, Siemens, NKT Cables) partners, demonstrates the benefits of such collaboration. It has an installed capacity of 600 MW and a total area of 68 km². Operated by Northland Power, a Canadian energy company with a portfolio of 2,681 MW of low-carbon energy, the project was constructed by Van Oord of the Netherlands, with turbines supplied by Siemens of Germany and cables by NKT Cables of Denmark. The project demonstrates the benefits of engaging international partners with long-standing expertise in their respective fields while leveraging the local knowledge of national partners.

Encouraging international partnerships through incentives such as tax breaks, grants or streamlined approval processes can attract foreign investment and encourage collaboration. Facilitating knowledge sharing through forums, workshops and research initiatives can further enhance collective expertise. This is the aim of the *Black Sea Renewable Energy Coalition (BSREC)*, which brings together experts from more advanced offshore wind markets and stakeholders from the Black Sea region to ensure that already existing best practices will be included in national strategies and regulatory frameworks. Establishing joint financing programmes, such as **public-private partnerships (PPPs)** and **international green bonds**, can support collaborative offshore

[20] European Commission, *Baltic Energy Market Interconnection Plan*, 2024

wind projects. In PPPs, projects can benefit from governments providing initial funding, policy support and regulatory frameworks, while private companies bring technical expertise, operational experience and additional capital. Green bonds are debt securities issued by governments, companies or other organisations to finance projects that have a positive impact on the environment. The funds raised from green bonds are earmarked exclusively for low carbon projects. Green bonds can attract a diverse group of domestic and international investors who are interested in developing their environmental, social and governance (ESG) investment strategies.

There is **significant potential for cross-border collaboration between Bulgaria and Romania** in the pursuit of fully exploiting the offshore wind potential of the Black Sea. By aligning their regulations and standards with those of their Black Sea neighbours (e.g. Ukraine, Moldova, and Turkey) and participating in joint ventures and international projects, they can accelerate offshore wind development. Conducting joint Environmental Impact Assessments (EIAs) can streamline the permitting process and ensure comprehensive assessments, thus providing a robust framework for decision-making. It is essential that these analyses focus on critical issues such as bird migration patterns, marine ecosystems and fisheries.

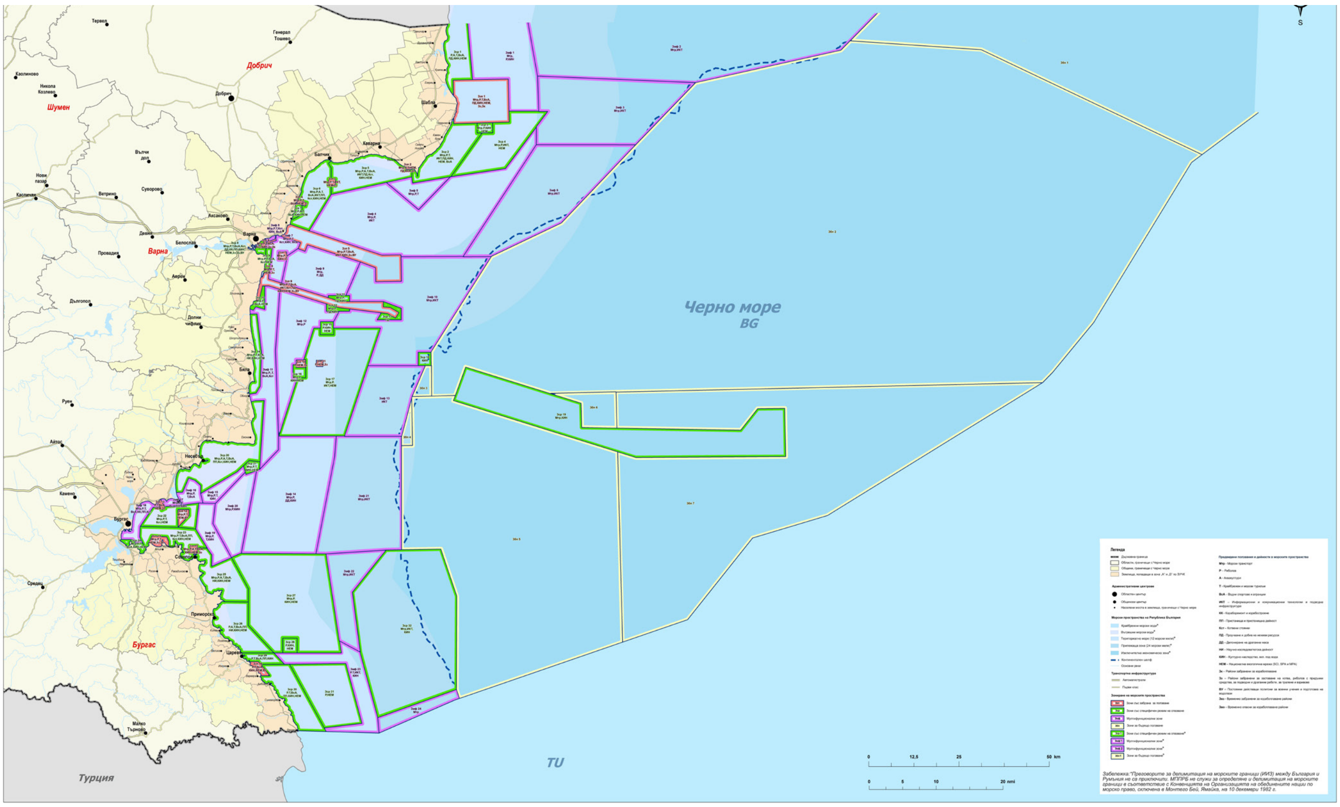
By working together, Bulgaria and Romania can develop more robust mitigation strategies to minimise the environmental impact of offshore wind projects, thus ensuring a more sustainable future for both countries. To facilitate the integration of offshore wind energy into their national grids, Bulgaria and Romania should consider developing joint grid development projects. This includes the design and construction of cross-border transmission lines and interconnections, which will increase the reliability and efficiency of electricity distribution. Joint grid projects can also help balance supply and demand across the region, making the energy system more resilient. The joint development of infrastructure such as ports, maintenance facilities and supply chains can significantly reduce costs and improve efficiency. Bulgaria and Romania can create joint hubs for the assembly, storage and maintenance of wind turbines and related equipment. To conclude, enhanced cross-border collaboration and regional coordination can facilitate the overcoming of technical and regulatory obstacles, attract investment and guarantee that offshore wind projects are economically viable and environmentally sustainable.

MARITIME SPATIAL PLANNING

Maritime Spatial Planning (MSP) is a process that regulates marine activities. It is conceived as an analytical approach to organising human activities in marine areas to minimise impacts on marine ecosystems while maintaining their functions in support of human needs. MSP is an extension of land-based spatial planning, which needs to consider the wider coastal environment and associated activities. The introduction of the MSP process aims to co-ordinate the spatial impacts of the activities of different users by making them protective of the marine environment.

The development of Marine Spatial Plans (MSPs) represents a significant step forward in the application of ecosystem management to the marine environment. MSPs help EU Member States to efficiently organise and optimise the sea area to meet national energy objectives. By designating specific areas for offshore wind energy development and studies, it minimises delays in the development of renewable energy infrastructure and supports the achievement of "Good Environmental Status". To fully exploit offshore wind energy as a clean domestic source, sufficient space must be allocated for wind turbines and the supporting electricity grid.

Figure 3. Bulgaria's Maritime Spatial Plan does not designate areas for offshore wind yet (purple = multipurpose areas)



Source: European MSP Platform

Maritime Spatial Planning is set to become a crucial part of offshore wind development by providing **a structured framework that incorporates environmental, economic and social factors**. Over time, advances in three main areas – environmental impact, management and networking with key stakeholders, and alignment with other related EU documents – have improved the precision and effectiveness of MSP. This planning approach helps to identify optimal sites for offshore wind, avoid overlap with other maritime activities, ensure minimal environmental impact and provide regulatory clarity, thereby enabling the sustainable and efficient growth of offshore wind energy.

A successful MSP process requires certain baseline data to provide information on the different factors affecting the offshore wind potential. Environmental and geological data includes the evaluation of marine species populations, the mapping of the seabed and critical habitats that could be most vulnerable to offshore wind developments. Socio-economic data includes detailed information about human activities that shape up the maritime economy and the lives of local communities. These datapoints need to be considered both separately and together to provide a complete understanding of the viability of a particular site and its challenges when it comes to building capacity for offshore wind.

Stakeholder engagement and collaboration in MSP

Box 2. Important EU legislation for maritime spatial planning

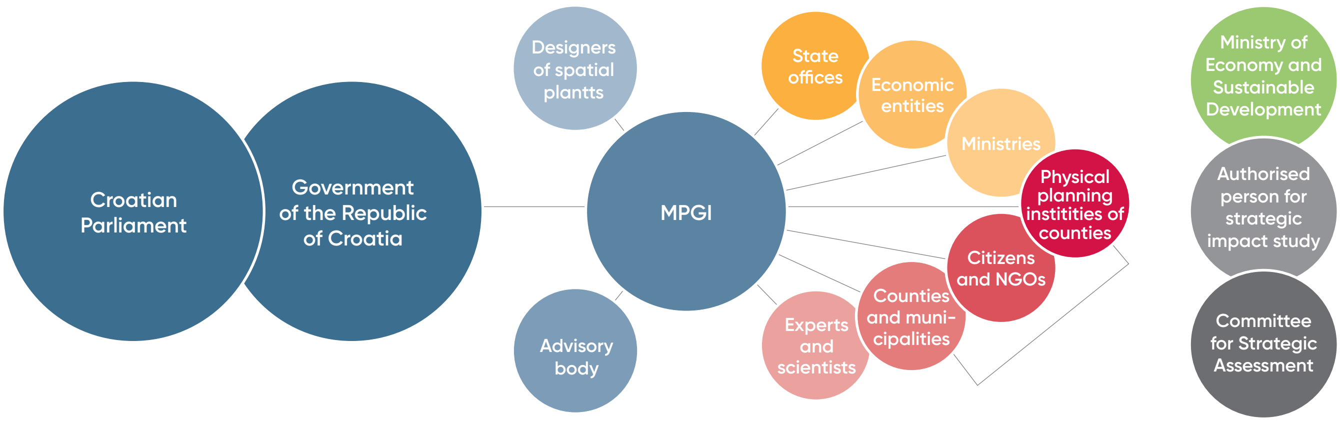
In many CEE countries, maritime spatial plans do not yet identify areas suitable for offshore wind development, and Croatia has not yet adopted a plan at all. Nevertheless, national policies on energy and the environment often cover aspects of MSP and offshore wind, as they contain provisions requiring executive authorities to map and assess the existing potential for different types of renewables in different territories.

When developing MSPs it is important to consider relevant EU strategic documents and regulations, including:

- The Sustainable Blue Economy strategy that emphasises the role of offshore wind in economic transformation, balancing conservation and development, improving cross-border cooperation, and accelerating decarbonisation.
- EU Strategy on Offshore Renewable Energy that points to the need for including an offshore wind deployment pathway in the MSPs.
- EU's Biodiversity Strategy for 2030 that mandates the improved management of marine protected areas in MSPs.

Involving key stakeholders in the development of Marine Spatial Planning (MSP) is crucial for ensuring both faster progress and higher quality outcomes. Engaging diverse stakeholders throughout the MSP process **allows for transparent justification of spatial allocation decisions and helps resolve conflicts through a series of consultations**. Evidence-based research, supported by tools for transparent and quantitative data analysis, is essential for creating effective spatial and temporal allocations. To foster meaningful participation, stakeholders must understand the purpose, functionality, and expected outcomes of the MSP, which requires dedicated time and resources for effective engagement. The successful implementation of MSP relies on stakeholders' ability to apply MSP principles, though the specific key stakeholders may differ across countries. For example, key stakeholders in the case of Croatia have been Counties, Local Offices of the State Geodetic Administration, Land Registry Offices, the Ministry of Economy and Sustainable Development, the Ministry of Physical Planning, Construction and State Property, the Croatian Energy Regulatory Agency (HERA), the Croatian Energy Market Operator (HROTE), the Croatian Transmission System Operator (HOPS), and HEP Distribution System Operator (HEP DSO).

Figure 4. Maritime spatial planning actors and processes in Croatia



Source: Faculty of Mechanical Engineering and Naval Architecture of the University of Zagreb

Due to the limited size of European seas, it is important for all Member States to include the concept of **multi-use practices** in offshore wind farms during stakeholder consultations. This approach will allow two or more activities to take place in the same area at the same time. The goal is to increase space efficiency and reduce the collective environmental footprint of human activities in these confined marine environments. In addition, this could be an excellent method for resolving conflicts between stakeholders, as it allows each user of the marine space to have equal participation in the exploitation of the sea resources.

Zoning and allocation of marine space

When selecting sites for offshore wind development, a comprehensive approach that considers economic, social, natural, cultural, and environmental factors is essential. Among these, the environmental considerations are the most complex due to the wide range of impacts involved. The environmental impact analysis for MSP must account for protected natural areas, such as NATURA 2000 sites, covering 18% of the EU's land area and more than 8% of its marine territory.[21] It should also address air traffic, special purpose areas, dumped munitions, aquaculture, fishing, energy infrastructure, military training, tourism, and submarine cables and pipelines.

[21] European Commission, *Natura 2000*.

A crucial step in minimising the negative environmental impact of offshore wind development is identifying ecologically significant or vulnerable areas through comprehensive data collection and analysis. This involves assessing biodiversity, habitat types, and ecological processes using tools such as remote sensing, field surveys, and ecological modelling. Key areas may include breeding or feeding grounds for marine species, critical habitats like coral reefs or seagrass beds, and regions with unique geological or oceanographic features. Once these areas are identified, they should be protected under national or international legislation, and regular monitoring should be conducted to assess the effectiveness of the protective measures.

The European Commission supports **wildlife sensitivity mapping** as "an effective tool for identifying areas where the development of renewable energy might impact sensitive communities of wild plant and animals, and thus should be avoided"[22]. However, this tool does not replace site-specific appropriate assessments required under Art. 6 of the Habitats Directive and Environmental Impact Assessments. Cross-border collaborations in monitoring programs, supported at the national level and spanning large areas and extended time periods, can enhance sensitivity mapping efforts, particularly in understanding the impact of offshore wind infrastructure on bird and bat migration.

Cross-border collaborations in monitoring programs that cover large areas and large periods of time can also improve the process of sensitivity mapping. This approach is particularly helpful in observing the potential future impact of offshore wind infrastructure on birds and bats migration. One good practice is to **create a coherent network of protected areas through cooperation and coordination with neighbouring countries**. A notable example of this is the Baltic Sea Region, where Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, and Sweden collaborate under the HELCOM-VASAB framework. By sharing data and engaging in joint planning processes, these countries have managed to harmonise environmental protections and spatial allocations across borders. Tools like the HELCOM Map and Data Service enable transparent, quantitative data analysis, demonstrating to stakeholders how spatial and temporal allocations have been formulated, thus facilitating effective cross-border maritime spatial planning.

Key considerations for the successful designation of areas for different marine uses

In order to successfully designate specific areas for different marine uses, the following practical examples are essential:

- It is important to ensure the social acceptance of onshore residents and conflicting economic activities to avoid negative socio-economic impacts from the deployment of wind farms. For development areas located between 500 metres and 2 kilometres from offshore development zones, national authorities should carry out detailed assessments to avoid negative aesthetic, noise and light impacts.

- For other economic, recreational and public uses, detailed studies should be carried out within 500 metres to mitigate noise, shadow flicker and

[22] European Commission, *The wildlife sensitivity mapping manual*, 2020

safety risks. In addition, a minimum distance of 500 metres is required from civil airports to avoid radar interference, and detailed studies are also required in offshore wind development areas up to 15 kilometres from aviation infrastructure.

- Wind farms should not be built within 500 metres of world heritage sites, protected cultural units, memorial heritage and ethnological areas up to a distance of 30 kilometres.

- Professional training and cross-sectoral cooperation of experts is essential, including the improvement of information systems to identify potential restrictions.

- Robust MSP not only supports national development goals, but is also consistent with broader EU strategies, providing a coherent approach to achieving both national and EU objectives. To advance MSP in the CEE region, it is essential to **adopt ecosystem-based strategies, use rigorous assessment methods, prioritise inclusive stakeholder participation and enforce legally binding plans**. In this way, countries can navigate the complexities of maritime governance, promote sustainable growth and contribute to a resilient marine ecosystem within the EU framework.

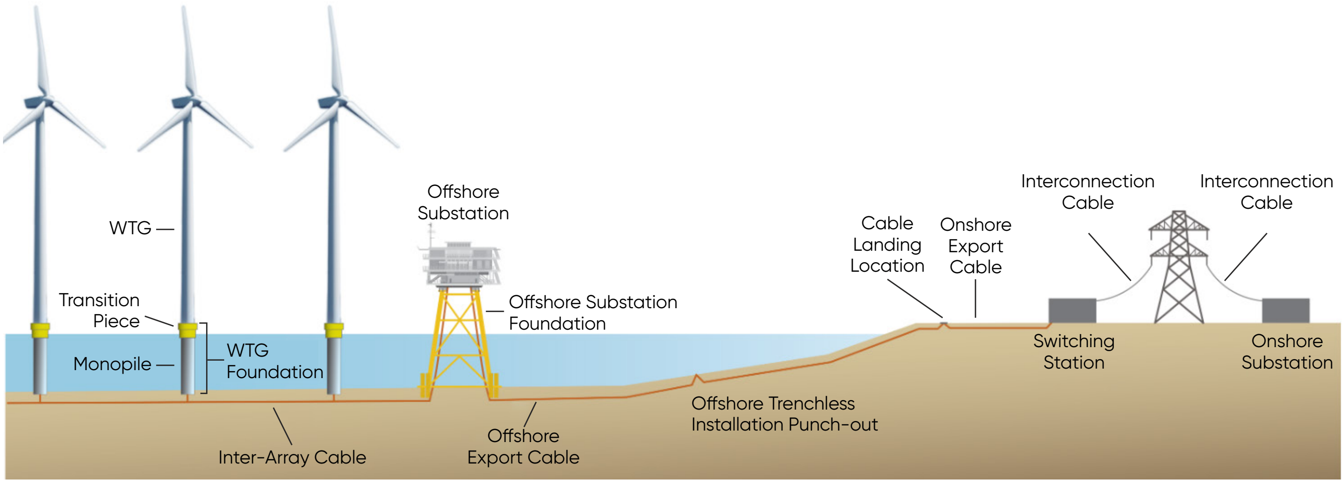
GRID AND INFRASTRUCTURE DEVELOPMENT

The deployment of offshore wind energy is among the most complex endeavours in the energy transition. It requires investments in large-scale and capital-intensive infrastructure necessary for the installation, maintenance and servicing of wind farms. This process necessitates the support of specialised vessels and the expansion of accompanying infrastructure, including ports, service bases, shipyards, and factories. Moreover, to effectively integrate large amounts of wind energy into the national power system, it is also essential to upgrade the electrical grid both onshore and offshore. It is necessary to create connection points that enable the transmission of energy inland, ensuring the stability and reliability of the electricity network to cope with varying weather conditions. Before the operation of offshore wind farms begins, it is vital to complete the grid investments and secure processing capacities of logistical and production facilities, allowing projects to be executed on time and ensuring reliable energy delivery to consumers. While those investments drive up complexity and costs, they are also a significant economic opportunity with the potential to create employment in the value chain.

Support infrastructure for the installation, operation and onshore grid connection of offshore wind farms

Installation terminals serve as the logistical hubs for the assembly, storage, and transportation of wind turbine components. These terminals are typically located near wind farm production sites to facilitate the efficient loading and unloading of large, heavy equipment and parts. They also support the pre-assembly of turbine components, which helps streamline the installation process offshore, reducing time and costs. Additionally, installation terminals accommodate essential infrastructure, such as cranes and heavy-lift vessels, ensuring that the components are safely and efficiently transported to their final offshore locations. The area of such terminals can vary depending on the capabilities and needs of a given region – existing and planned installation ports range from 20 hectares (e.g., T5 Baltic Hub, Gdańsk) to 450 hectares (e.g., Esbjerg Port). While using available coastal areas for the offshore wind infrastructure is considered to bring less direct income for the investor when compared to container ports for large-scale maritime transport, ambitious EU plans for offshore wind warrant the development of new installation terminals, especially on basins like the Baltic or Black Sea. Although using foreign offshore wind deployment hubs is possible, utilising domestic ports creates additional economic benefits, stimulates local supply chain growth and increases employment opportunities. This, in turn, can serve as an incentive for public sector investment and government support to mitigate financial risks and ensure the necessary infrastructure is in place to support the burgeoning offshore wind industry and enhance energy security.

Figure 5. Offshore wind infrastructure



Source: Dominion Energy

Operation and Maintenance (O&M) bases serve as the central hubs for coordinating and executing maintenance activities, ensuring the continuous and efficient operation of existing offshore wind farms. Located near the coast, O&M bases house facilities for the storage of spare parts and tools, workshops for equipment repair, and offices for administrative and technical staff. They also provide docking and refuelling services for maintenance vessels and helicopters, which are essential for transporting personnel and equipment to and from the offshore sites. By centralising these critical functions, O&M bases help minimise downtime, enhance safety, and reduce operational costs. Service bases are typically located in smaller ports closest to the planned wind farms. These are often tourist towns that are also hubs for fishing activities. While ports come with employment opportunities, there is still a risk of social tensions. To mitigate opposition, developers offer grant programmes, subsidies, and jobs for local communities. In some cases, adapting ports for offshore operational and maintenance activities requires modernisation (deepening, renovation of breakwaters, etc.).

Factories are essential to the offshore wind energy industry, serving as the primary sites for the manufacturing and assembly of key components such as wind turbine blades, nacelles, and towers. These factories are equipped with specialised machinery and technologies that enable the mass production of high-quality, precision-engineered parts necessary for the efficient operation of offshore wind farms. The proximity of production facilities to installation terminals significantly reduces transportation costs and logistical complexities, facilitating a smoother and more efficient deployment of offshore wind projects. Investments in manufacturing plants, which Europe increasingly needs to meet tightening supply chains, can be attracted by a clear strategy and vision for building offshore wind farms in the region. An investor needs to be assured that there will be a market for its manufactured components. Therefore, robust policy support, long-term planning, and guaranteed project pipelines are essential to create a stable and attractive investment environment.

Shipyards are used for constructing and assembling the vessels and platforms required for installing, maintaining, and operating offshore wind farms. Shipyards are equipped with the facilities and expertise to build specialised ships, such as installation vessels, service operation vessels (SOVs), and heavy-lift ships, which are crucial for transporting and installing large wind turbine components at sea. Additionally, shipyards with large construction sites can contribute to the production of transformer stations and foundations such as monopiles, jackets, and floating platforms. The latter is particularly attractive for shipyards because they are assembled at the quay and towed to the site by barges – this process does not require berthing space for installation vessels.

Power export is a critical element of the development of the offshore wind energy industry, involving the transmission of generated electricity from offshore wind farms to onshore grids. The power export system consists of offshore and onshore substations, inter-array cables between turbines and the platform, and export cables that transport electricity from sea to land. The installation and maintenance of this cabling is carried out using specialised vessels known as cable-layers, which carry massive cables from spools located in ports. The power export system is the most sensitive component of an offshore wind farm complex. Due to the high capital intensity of investments, supply chain constraints, and the need to adhere to schedules, developers sometimes might be tempted to adopt cheaper and more readily available products, often at the expense of quality and reliability. However, the electricity export infrastructure should be the last area where cost-cutting measures are applied, not only because it is crucial to ensure stable and safe operation but also because the financial impact of downtime and costly maintenance far outweigh initial savings.

A breakdown in the power export system can result in downtime ranging from 30 to 60 days, as the marine environment complicates service access. Financial losses due to the suspended power generation are compounded by the costs of organising repairs, including mobilising vessels, delivering spare parts, and deploying qualified personnel. As much as 83% of financial losses and insurance claims due to offshore wind farm failures are linked to cable problems[23]. This underscores the importance of ensuring high-quality and professional cable installation, as well as organising timely repair actions when necessary. The proximity of suppliers to wind farms facilitates immediate response, reduces the carbon footprint associated with the transport of spare parts, and minimises the risk of unforeseen supply chain disruptions, such as those experienced during the Suez Canal crisis or the closure of manufacturing plants in China during the COVID pandemic.

To prevent technical failures in substations, electrical equipment must be continuously monitored, and the technical sophistication of the predictive maintenance system should be comparable to the standards known from nuclear power plants, especially for large offshore wind projects with an installed capacity exceeding 1 GW. The scale of offshore wind farms and their critical points of vulnerability further justify the need to classify these facilities as critical infrastructure and ensure security in terms of national defence.

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23 DNV, *80% of insurance claims in offshore wind are related to subsea cable failures – How can the industry manage these risks?*, Accessed: 18.06.2024

Strategic infrastructure planning

To meet the challenges associated with implementing offshore wind energy, early, integrated, and broadly consulted planning of support infrastructure development is essential. The first step in this process should be a **comprehensive analysis of existing facilities, investment areas, and grid connection points**, particularly in coastal regions. Established businesses including shipyards, ports, oil & gas companies and steel construction factories can incorporate different aspects of offshore wind into their business strategies and adapt their operations to new opportunities. However, for this to happen, companies must be assured that offshore wind energy will develop in their country.

While offshore wind already has a firm place in EU energy and climate policies, each country must assess the potential and incorporate the role of this sector into their strategic documents on energy transition when bringing these plans down to the local level. **A clear development strategy for offshore wind resources** requires cross-party support and consensus. Particularly important from the perspective of planning transmission network development, each transmission system operator (TSO) in the EU is required to present ten-year network development plans. These documents must ensure that new energy sources, such as offshore wind farms, are included to facilitate their integration into the grid. TSOs must plan for the construction of new substations and the reinforcement of existing ones to manage the larger power flow. This also includes upgrading transmission lines to higher capacities and ensuring that they can handle the variability and intermittency of wind energy. At the continental level, an example for a holistic approach to the expansion of offshore cross-border connections in Europe are the proposals published by ENTSO-E in January 2024, contained in the ONDP (Offshore Network Development Plans). These plans are part of the trans-European TYNDP (Ten-Year Network Development Plan) framework. They were developed for each maritime region of Europe although the concepts of the so-called corridors are not binding in any way. Instead, they are proposals for building a common European market effectively by providing offshore transmission infrastructure, designed through modelling and cooperation with national TSOs and expert NGOs.

In the context of planning infrastructure such as ports, shipyards, and factories for offshore wind energy projects, having well-thought-out industrial policies can foster economic growth and technological innovation while ensuring energy security and regional development. By supporting these infrastructural projects, governments can stimulate local economies through significant employment opportunities, ranging from construction and engineering to maintenance and logistics. Industrial policy helps develop a robust supply chain, reducing dependency on imports and lowering costs by incentivising local production of critical components. It can also promote technological advancements by funding research and development, leading to more efficient and competitive manufacturing processes.

Emerging trends and technological advancements

The **increasing size of structures** in the offshore wind sector results from the need to enhance the efficiency and energy output of wind turbines. As technology advances, turbines are becoming larger, and their components, such as rotor blades, towers, and substructures, also need to be adapted to these sizes. Despite voices in the industry advocating for slowing down the continuous increase in component sizes in favour of enhancing the availability and reliability of proven equipment, suppliers continue to compete to offer the highest possible power generation capacity. This pressure is further intensified by Chinese manufacturers, who plan to introduce turbines with power exceeding 20 MW. This trend also brings logistical and operational challenges. The transportation and installation of these massive components require specialised vessels, equipment, and advanced coordination. Additionally, ports and shipyards must be adequately equipped and adapted to handle such large elements. To meet these challenges, instead of receiving components from installation terminals via large ships, the blades, nacelles, and towers can be transported using barges, which convey individual elements to the installation site.

One of the most dynamically developing technologies in the offshore wind sector are **floating foundations**. Unlike traditional fixed-bottom structures, floating foundations can be deployed in deeper waters (over 60 metres deep) using anchors. Currently, this method of installation is relatively costly; however, the rapid pace of cost reduction and accelerating commercialisation will unlock the wind potential of deeper marine areas in Europe, such as the northern waters of France or zones far from the shore in the Black Sea. The floating wind technology offers several advantages. It allows for the placement of wind turbines in locations with stronger and more consistent windspeeds, thereby increasing energy production. Additionally, the floating foundations minimise the environmental impact on the seabed, which is beneficial for marine ecosystems. As the technology matures and becomes more cost-effective, it is expected to play a crucial role in expanding offshore wind capacity and contributing significantly to Europe's renewable energy mix.

Box 3. High-voltage alternating current vs. high-voltage direct current

Currently, the most commonly used technology for power export is high-voltage alternating current (HVAC) due to its proven efficiency and cost-effectiveness for farms located relatively close to shore (up to 50-100 kilometres). However, exporting power via high-voltage direct current (HVDC) can potentially be more economically advantageous for investments located further from the shore. Compared to traditional alternating current, HVDC generates lower transmission losses. HVDC also stabilises voltage and frequency in the grid, avoids the need for reactive power compensation, and uses less equipment and space, resulting in less invasive environmental impact.

While the decision to use HVDC or HVAC requires careful analysis for each project, HVDC is often justified for distances exceeding 100 kilometres and wind farm capacities exceeding 1 GW. HVDC can also relieve pressure on the onshore grid. Poland, for example, where energy-intensive consumers are located in the south of the country, is planning to build a special north-south HVDC power bridge - a kind of highway that will allow offshore wind energy to replace conventional generation sources inland.

Energy islands, such as the Bornholm Energy Island[24], offer a highly innovative approach to optimising the export of power generated by offshore wind farms. These artificial islands will function as centralised hubs that collect electricity from various offshore wind farms and efficiently transmit it to the mainland. By consolidating power transmission, energy islands can reduce the need for multiple, individual export cables, thereby lowering costs and simplifying logistics. Additionally, they can integrate various energy storage solutions, such as batteries or hydrogen production facilities, to balance supply and demand and enhance grid stability. They can also enable the integration of other renewable energy sources and can support the development of hybrid offshore connections.

Hybrid offshore connections, such as the Danish-German Combined Grid Solution Kriegers Flak[25], integrate offshore wind farms with interconnectors linking different national grids. They offer multiple benefits, including optimised use of transmission capacity, reduced costs, and enhanced energy security by allowing surplus wind energy to be shared across borders. However, they also pose risks such as complex regulatory frameworks, unclear division of costs, transmission capacity reductions as a result of operational deratings, potential reliability issues due to shared usage, and coordination challenges between different national grid operators and wind farm developers.

In the future, as the number of offshore wind projects increases and the electrification needs of the European economy are progressively met, offshore wind farms could play a crucial role in the **production of hydrogen** and its derivatives, an approach being piloted, for example, by the Deep Purple project[26] in Norway. This production can be off-grid or integrated with the grid to stabilise output during periods of low wind. Hydrogen can also be stored and used in these periods to generate electricity via fuel cells. Electrolysers can be located onshore to make use of excess generation, at offshore substations or even at individual turbines. In addition, derived fuels such as e-methanol can be particularly beneficial to the maritime industry. Companies are already starting to use it to decarbonise their fleets, highlighting the potential of this fuel to support the transition of freight transport to cleaner energy.

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[24] Bornholm Energy Island, *The green future of offshore wind hubs and hybrid connections*, Accessed: 18.06.2024

[25] 50hertz, *Kriegers Flak – Combined Grid Solution*, Accessed: 18.06.2024

[26] TechnipFMC, *Deep Purple™ Pilot*, Accessed: 18.06.2024

ENVIRONMENTAL CO-EXISTENCE

According to the latest Action Plan for Grids, the EU aims to increase its wind and solar generation capacity to at least 1000 GW by 2030. The big chunk of this built-up will be offshore renewables, up to 317 GW[27] by 2050. The Black Sea has been identified as one of the five key basins for deploying these capacities[28]. Thus, the sustainable integration of the new offshore infrastructure in the Black Sea is not only desirable for achieving national and international decarbonisation targets, but crucial considering the vulnerable status of the Black Sea ecosystem. Among the most important, potentially negative impacts of the deployment of offshore wind include the heightened risk of collision causing increased mortality for birds and bats, their displacement and alteration of behaviour.[29]

Zooming in on the threats and vulnerabilities of the marine ecosystem of the Black Sea, the planned offshore wind projects "can pose serious threats to the marine bird and mammal species under protection in the Natura 2000 sites designated in the basin".[30] The EU experience shows that the successful penetration of offshore wind energy depends on a sound public policy design and legislation, with well-coordinated marine planning and permitting procedures ensuring reliable environmental protection. There is a need to improve the understanding of the challenges and possible solutions to accelerate offshore wind energy infrastructure deployment while also restoring the marine ecosystems of the Black and the other European Seas; as well as raise awareness and educate the public about opportunities for environmental co-existence.

International and national regulations

The protection of the Black Sea basin is subject to a multitude of national, regional and international regulations, strategies and action plans. With Romania and Bulgaria being Member States of the European Union and Georgia, Ukraine and Turkey as candidate countries, a special emphasis should be placed on EU regulations.

In a chronological order, the most important (and oldest) treaty is Council of Europe's **Berne Convention on the Conservation of European Wildlife and Natural Habitats**[31]. It was the first international treaty to protect both species and habitats and has led to the creation of the subsequent networks of protected areas **– Natura2000** under the EU Habitats Directive, and Emerald. Another relevant treaty is the Convention on the Protection of the Black Sea Against Pollution also referred to as the "Bucharest Convention". The document has set in 1992 the basic framework agreement for biodiversity

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27 European Commission, *EU Action Plan for Grids*, November 2023

28 EPG, *Offshore wind – the enabler of Romania's decarbonisation*, January 2023

29 Galparsoro, I., Menchaca, I., Garmendia, J.M. et al, *Reviewing the ecological impacts of offshore wind farms*, 2022

30 EPC Consultanță, *Pressure, threats and impacts on life in the Black Sea*, 2024

31 Council of Europe, *Bern Convention*, Accessed: 01.08.2024

protection, inter alia, between the six countries accessing the basin, and three specific Protocols. These include the control of land-based sources of pollution, dumping of waste, and joint action in the case of accidents (such as oil spills). Also relevant for the basin is the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) which is a legal conservation tool with the purpose to reduce threats to cetaceans notably by improving current knowledge on these animals[32].

After the adoption of the Habitats Directive in 1992, the cornerstone of the EU biodiversity policy along with the Birds Directive covering a thousand species and 230 characteristic habitat types, another fundamental piece of legislation was adopted in 2001 – the Strategic Environmental Assessment Directive (SEA). It aims "to provide high level of protection to the environment and contribute to integrating environmental considerations into the preparation, adoption and implementation of plans and programmes to promote sustainable development"[33].

The Marine Strategy Framework Directive (MSFD) has followed in 2008 to achieve a good environmental status of the EU's marine waters and sustainably protect the resource base upon which marine-related economic and social activities depend. Through the MSFD, the ecosystem-based approach became a legally binding and operational principle for managing the EU's entire marine environment[34].

The Environmental Impact Assessment Directive, which came into force in 2011, mandated that major building or development projects in the EU must first be assessed for their environmental impacts before the actual start of the project[35]. Although the European Commission clarified in 2022 that offshore wind farm developers are to **deploy their projects in compliance with the relevant requirements specified in this directive**[36], there is no automatic obligation for an environmental impact assessment as this requirement is set by the Member State if the project is likely to have significant effects on the environment.

More recent EU environmental policies include the EU Biodiversity Strategy that targets the protection of at least 30% of EU seas by 2030. In addition, the recently approved Nature Restoration Law introduces a first-of-its-kind regulation on nature restoration, which aims to put measures in place to restore at least 20% of the EU's land and sea areas by 2030, and all ecosystems in need of restoration by 2050[37].

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32 ACCOBAMS, *Introduction*, Accessed: 01.08.2024

33 European Commission, *Strategic environmental assessment*, Accessed: 01.08.2024

34 European Commission, *Marine environment,* Accessed 01.08.2024

35 European Commission, *Environmental Impact Assesment,* Accessed 01.08.2024

36 European Parliament, *Answer on behalf of the European Commission*, November 2022

37 European Council, *Nature Restoration Law*, June 2024

According to the **EU's Environmental Impact Assessment Directive**, the project developer must provide the approval authority with an EIA report containing information on potential significant effects, reasonable alternatives, features of the projects and/or measures to avoid, prevent, reduce or offset likely significant impacts on the environment. The assessment has to consider a variety of environmental factors, such as biodiversity, water, air, climate, even cultural heritage. The availability of this data for each project is key in order to make an accurate estimate of the cumulative impacts.

An important component of the Environmental Impact Assessment is the conduct of adequate public consultations. Apart from the information about the assessment being publicly available, more importantly is that concerned local communities and stakeholders should be directly engaged in the decision-making process. This should include members of the local communities such as fishermen, farmers, the tourism industry, environmental NGOs, etc. By considering the opinions expressed by the stakeholders, as well as directly allowing them to participate in consultations, the developers and authorities not only increase the social acceptability of the proposed projects, but also have the opportunity to anticipate and thus find solutions to different obstacles to the completion of the exploration and, then, construction of the offshore wind projects.

An example for the value of stakeholder engagement is the challenging process of the update of the Natura 2000 zones in Romania and Bulgaria, which need to allocate around 8% and 22%, respectively,[38] more marine water sites to the Natura 2000. Involving local stakeholders and specialised environmental organisations can help identify these potential areas of conservation before they are recognised officially by the authorities.

Box 4. Critical habitats

The term **"critical habitat"** is defined internationally as an area of high biodiversity conservation significance. Endangered species, endemic and/or range-restricted species, highly threatened and/or unique ecosystems and a concentration of migratory and/or congregatory species can be found there[39]. These areas need special protection and management, which make them of highest priority for conservation. When protecting critical habitats, offshore wind energy developers should follow the International Finance Corporation's Sustainability Framework, and specifically indicator number six, which defines the responsibilities towards protecting and conserving biodiversity, maintaining ecosystem services and sustainably managing living natural resources[40]. For offshore wind farms, relevant habitats include those with "high biodiversity and a relatively high abundance of threatened species, those habitats that sequester large amounts of blue carbon as well as those with cetacean migration corridors and seabird flyways"[41].

[38] Biodiversity Information System for Europe, *Countries*, Accessed: 01.08.2024

[39] RGI, *Essential Environmental Concepts Offshore Wind*, June 2022

[40] Ibid.

[41] Ibid.

Mitigating the impact of noise, vibration, light and the presence of man-made infrastructure

The process of deploying offshore wind energy parks in the Black Sea consists of certain elements (such as constructing, operating, maintaining and decommissioning the wind turbines) that have the potential to disturb or even hurt the habitats and certain species living in or around the designated areas. These include noise and vibration from installing the bottom-fixed foundations as well as from vessels transporting the workers and the needed materials, light from the installed turbines, underwater cables etc. The Offshore Coalition for Energy and Nature (OCEaN)[42] has developed a comprehensive collection of mitigation measures, available upon request that helps developers and authorities avoid or minimise the impacts the deployment of offshore wind farms can have on the environment:

Risk of collision mortality for birds and bats:

- Siting: avoid migration flyways or areas used frequently by bats and birds when siting
- Vision-based collision mitigation: consider applying achromatic patterns to the blades to enhance the detectability of turbines, painting blades in black, using UV colours
- Sensitivity mapping: careful siting avoiding valuable areas for sensitive seabird species (e.g. near seabird breeding colonies)
- Shutdown on demand/curtailment using camera or radar technology to determine when rotation of the blade should be halted (e.g. migratory periods/ specific time of the day).

Displacement due to disturbance and injury

- Use least-intrusive equipment during geophysical surveys and perform it outside the sensitive periods for threatened species
- Avoid spawning and nursery habitats and species-rich habitats
- For marine mammals and sea turtles, use light design options: if possible, within the national regulations, use adaptive light controls to manage light timing/intensity/colour, use the lowest light intensity possible, use ultraviolet wavelengths and avoid light slip by lightening only the object or area intended.
- For benthos, define exclusion zones for anchoring.

Barrier effects

- Adjustment of piling energy (soft start): gradual increase of the piling energy so that noise-sensitive animals are able to leave areas.

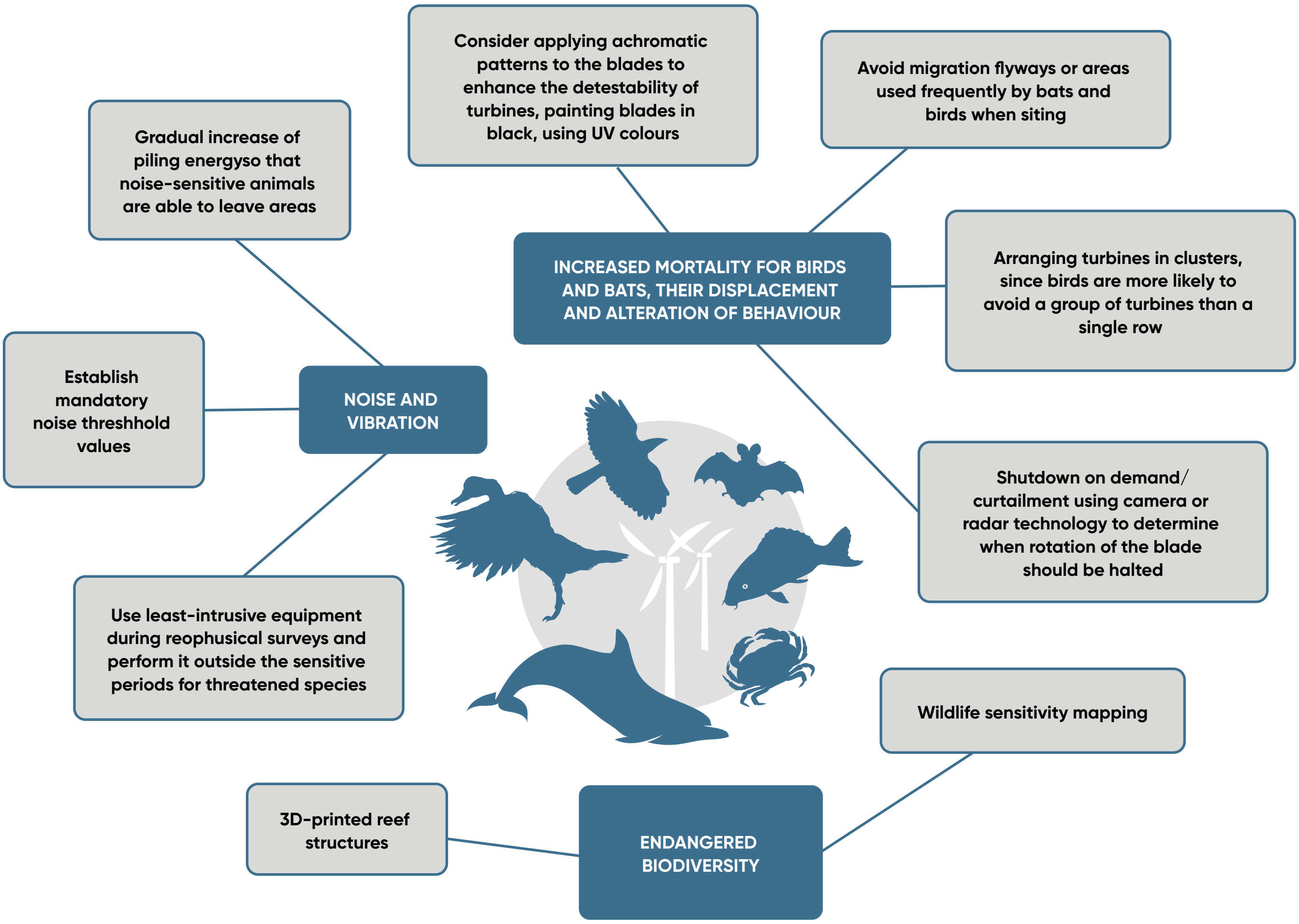
[42] OCEaN is an initiative uniting NGOs, wind industry actors and transmission system operators in an open forum that aims to accelerate the deployment of offshore wind energy and grid infrastructure while ensuring alignment with nature protection and healthy marine ecosystems.

- Establish mandatory noise threshold values, looking at cumulative values as well.

- Layout design: arranging turbines in clusters, since birds are more likely to avoid a group of turbines than a single row; flights paths of migrating birds should be taken into consideration. This measure has yet to be tested offshore.

Local initiatives have also been tested. WWF Denmark has deployed a dozen 3D-printed reef structures on the seabed between the wind turbines at Anholt Offshore Wind Farm. They hope to create a habitat where the cod, a fish with historically low populations in the region, can thrive and contribute to a healthier, more resilient marine ecosystem[43].

Figure 6. Environmental co-existence risks



Source: CSD

[43] Orsted, *Exploring how 3D-printed reefs can benefit biodiversity*, Accessed: 01.08.2024

Mitigating environmental risks

The Rapid climate change has been devastating the Black Sea ecosystems, which are among the most vulnerable globally. Both developers and national and local authorities have enough tools at their disposal to ensure that the risks from the deployment of offshore wind energy are minimised and the projects do not contribute to the environmental degradation of the coastal areas. Governments in the region should conduct a thorough **Strategic Environmental Impact Assessment** based on different sensitivity maps before each new capacity auction, along with maintaining the requirement that developers then also plan and implement a separate site-specific Environmental Impact Assessment for their proposed offshore wind project. Once put in practice, these actions will minimise the potential risks of barrier for migration/movement, collision for birds and bats, displacement and injury made by noise, vibrations, light and the built infrastructure in the sea.

In addition, a **comprehensive stakeholders' engagement process** will be key to both avoiding possible bottlenecks in making decisions and in boosting the social acceptance of the industry by the local communities and economic interests in the region that could be affected. Finally, Black Sea governments should invest in **cross-border, long-term research and monitoring programs** that would help in the continuous improvement of the current environmental practices related to offshore wind. As the offshore market in the Black Sea is just emerging, additional research will be key to understanding how infrastructure can best co-exist with nature and to identifying practices that hinder this objective.

WHAT'S NEXT?

The offshore wind sector plays a pivotal role in the European Union's strategy to achieve climate neutrality by 2050. As Central and Eastern European (CEE) countries – specifically Bulgaria, Romania, Croatia, and Poland – embark on their journey to join the offshore wind race, it is essential that regional policymakers pay close attention to several critical areas that would guarantee the successful and sustainable development of the sector.

- **Enabling regulatory frameworks**: Navigating the complexities of offshore wind development requires the design of a transparent and effective regulatory framework with clear long-term deployment targets, competitive auction procedures, market-based financial instruments and clear environmental impact and risk mitigation requirements. To ensure public acceptance and project efficiency, it is essential to maintain continuous stakeholder engagement and transparent feedback mechanisms from project inception to operation.
    - Bulgaria should therefore launch a public information campaign as soon as possible, combined with public stakeholder consultations on the Black Sea coast, to effectively debunk myths about offshore wind and address the concerns of local stakeholders. Subsequently, the draft law should be revised and, if necessary, amended, and then submitted to the Parliament for a second reading as a high priority to ensure its adoption before the end of 2024.
    - Similarly, the Romanian government should prioritise the timely implementation of its commitment to commission an expert study, approve offshore wind zones and subsequent implementing legislation by June 2025.
- **Maritime Spatial Planning**: Achieving a harmonious balance between economic growth and environmental protection requires the development of consistent and balanced maritime spatial plans that try to find workable compromises between different marine-based economic activities.
    - MSP strategies in the CEE region should place an emphasis on comprehensive data management, the integration of nature restoration and energy transition planning, and cross-border cooperation in order to establish coherent networks of Marine Protected Areas (MPAs).
    - The Croatian government needs to accelerate the adoption of its MSP, including the identification of areas for offshore wind development, in order to realise its renewable energy potential.

  - Bulgaria and Romania should prioritise the identification of suitable areas for offshore wind by sharing data and collaborating on the design of their MSPs, taking into account important cross-border elements, to capitalise on their maritime resources and contribute to the region's energy transition goals.

- **Grid and Infrastructure Development**: CEE governments should give priority to the modernisation of ports for offshore operations, ensuring alignment with technical standards and bearing in mind the increasing dimensions of structures. Furthermore, the development of domestic installation terminals can stimulate local economies and reinforce the supply chain. Early planning of support infrastructure, including substations and interconnection facilities, will help mitigate logistical challenges and optimise project efficiency.

  Therefore, CEE countries should take immediate steps to take stock of their current port infrastructure and its suitability to become a hub for the offshore wind industry. In addition, TSOs should include in their ten-year network development plans estimates of the grid expansion requirements and associated costs to connect offshore wind farms to the onshore grid. To facilitate this process, governments should designate high-priority areas and announce official targets for offshore wind capacity.

- **Environmental Conservation and Impact Mitigation:** It is essential to balance offshore wind development with environmental preservation, which requires rigorous EIAs and proactive engagement with local communities. Compliance with EU directives on biodiversity, water quality and cultural heritage is of paramount importance, which will require collaboration with specialist environmental organisations. The use of wildlife sensitivity mapping and advanced technologies such as shut-down-on-demand systems can effectively mitigate impacts on sensitive habitats and migratory species. The adoption of an offshore wind law should be followed by an expert study to identify the best areas for offshore wind development, where the environmental impact is minimal. The Romanian government is planning such a study now that the law has been passed, and Bulgaria should follow suit by setting an equally ambitious timeline for concrete measures to follow the adoption of its offshore wind law.

  Adherence to these recommendations is crucial for navigating the regulatory, spatial, infrastructure, and environmental challenges related to the development of the offshore wind energy industry. By fostering inclusive stakeholder engagement, leveraging international cooperation, and embracing technological innovation, CEE nations can accelerate their transition to renewable energy, align with EU climate objectives, and foster economic growth while safeguarding marine ecosystems. The success of offshore wind development in the CEE region hinges on proactive policy-making, strategic investment, and collaborative efforts towards a sustainable and resilient energy future.