Integrating Nature into Offshore Wind Development

Stocktake and Recommendations

GINGR
Global Initiative for Nature, Grids and Renewables

Ocean Conservancy®

ACKNOWLEDGEMENTS

The Offshore Working Group was convened under the auspices of the Global Initiative for Nature, Grids and Renewables (GINGR), a collaborative initiative of the International Union for Conservation of Nature (IUCN) and the Renewables Grid Initiative (RGI).

The Offshore Working Group is comprised of:
Shamini Selvaratnam (Chair), Ocean Conservancy, Susan Gourvenec, Engineering X - Royal Academy of Engineering, Tricia Jeadle, The Nature Conservancy, Hanh Nguyen, World Economic Forum, Rennie Myers, Ørsted, Amisha Patel, Global Offshore Wind Alliance, Cristina Simioli, Renewable Grids Initiative.

Amy Finalyson and Shamini Selvaratnam are the lead authors of the report, with significant contributions from the working group members and team from the GINGR secretariat. Additional editorial support was provided by Marion Davis.

GINGR
The Global Initiative for Nature, Grids and Renewables (GINGR) is a collaborative effort by the International Union for Conservation of Nature (IUCN) and the Renewables Grid Initiative (RGI) to ensure that the global energy transition is both just and sustainable. GINGR provides assessment tools and guidance to help governments, industry, and financiers quantify and report their contributions to Nature- and People-Positive outcomes in the deployment of wind, solar, and electricity grid infrastructure. Through its Technical Working Groups on offshore energy, linear infrastructure, metrics, monitoring, reporting, and People-Positive, GINGR is developing a globally aligned framework to track biodiversity gains and co-created community benefits. By harmonizing renewable energy expansion with ecosystem restoration and community well-being, GINGR supports a rapid, fair energy transition – one that protects biodiversity, empowers local communities, and helps achieve global climate and sustainability targets.

Table of Contents

Executive Summary

Large-scale expansion of offshore wind capacity has a vital role to play in the global energy transition needed to avert the threat of runaway climate change. At the same time, it can and must contribute to halting and reversing biodiversity loss. This report examines key pathways for enabling the offshore wind sector to contribute to the global societal goal of a nature-positive future. This means offshore wind expansion that not only avoids harm to sensitive species and ecosystems, but has a measurable positive impact on biodiversity.

Significant progress has already been made, through voluntary actions by developers, advances in research and innovation, and changes to the landscape of policy and regulatory frameworks that are critical to enabling progress at scale. However, gaps remain even in the most mature offshore wind markets, and there is a need for analysis focused on how to unlock the potential socio-economic benefits of nature-positive offshore wind in new and emerging markets.

This report highlights the need to mature best practice and develop standards for implementing biodiversity non-price criteria, in particular to overcome perceived tensions between cost and nature. It also calls for improved integration of biodiversity measures across the value chain of enabling infrastructure, especially offshore transmission and ports, underlining how regional or sea-basin approaches to planning could both reduce costs and enhance benefits to nature. Lastly, the report discusses the need to incorporate nature-positive considerations into plans for decommissioning wind farms at the end of their operational life.

With regard to **non-price criteria,** key recommendations for governments and regulators include:

- Require that new offshore infrastructure cause no net loss to biodiversity, and work towards requiring the delivery of net-positive impact.
- Advance implementation of biodiversity non-price criteria in all public infrastructure tenders, and align this with ecosystems-based marine spatial planning (MSP) and streamlined permitting.
- Establish state-administered strategic funds to support coordinated action on conservation priorities.
- Work with stakeholders to share knowledge and experience and develop comprehensive best practice guidance.

Industry, civil society, technical experts and financial institutions need to play a role, too. Actions recommended for stakeholder collaboration include co-developing and adopting detailed best practice guidance that addresses key tensions identified; defining threshold conditions for use of biodiversity criteria in new and emerging markets, and mapping pathways towards them.

With regard to integrating **nature-positive measures into offshore grids**, key recommendations for policy-makers and regulators include:

- Establish ecosystem-based strategic planning for offshore grid infrastructure to optimize for net-positive nature impacts as well as technical and economic efficiency.
- Collaborate regionally to identify offshore grid corridors and manage the impacts on the marine ecosystem.
- Mandate biodiversity criteria in auctions that target grid infrastructure impacts specifically, and consider tenders for offshore grid infrastructure shared across projects and/or borders.
- Work with stakeholders to improve understanding of best practice and locally relevant nature-inclusive design measures, and ensure that permitting frameworks allow their easy adoption.

Non-state stakeholders can support progress by strengthening cross-sector dialogue and cooperation to align technical, environmental and economic objectives, and by building additional evidence and capacity for nature-inclusive design in grid infrastructure, including guidance and training for both regulators and developers.

With regard to **integrating nature-positive measures into port development**, key recommendations for policy-makers and regulators include:

- Clearly align port expansion strategies with offshore wind plans and existing environmental laws. Where these are lacking, introduce minimum biodiversity protection standards to guide development.
- Establish an ecosystem-based MSP approach that includes all port infrastructure, as well as related changes in vessel transit routes.
- Incentivize the use of nature-based solutions through public financing and procurement rules.

As first-generation offshore wind farms approach the end of their operational lives, there is growing discussion of how to decommission them in ways that uphold environmental integrity and social responsibility – and how to plan proactively for **nature-positive decommissioning** of new wind farms. Key recommendations for policy-makers and regulators include:

- Incorporate decommissioning into MSP, to align with objectives for conservation, fisheries and the blue economy.
- Include non-price criteria for sustainable decommissioning in offshore wind tenders.
- Create enabling regulatory and financial mechanisms to support nature-positive outcomes, with flexibility to adapt to shifting environmental conditions, and require transparent reporting and monitoring on decommissioning practices.
- Develop or adopt international decommissioning standards to prevent the export of environmental risk, and invest in domestic recycling and processing capacity.

Overall, the literature review this report is based on makes clear that huge progress has been made in finding ways for offshore wind to contribute to the urgent nature-positive agenda. Many solutions are being developed and implemented, but key challenges remain. Through strong multi-stakeholder collaboration, offshore wind can become a model for all ocean sectors.

1 Introduction

The climate and biodiversity crises are closely interlinked. This means that, in addition to its crucial role in global climate change mitigation, an expansion in offshore wind must also contribute to halting and reversing biodiversity loss. A wide range of industry, government and environmental stakeholders have highlighted the benefits of activating synergies with the Kunming-Montreal Global Biodiversity Framework (KMGBF).[1] It is the responsible path forward and essential to maintaining the public trust and social license needed to achieve global offshore wind targets.

The offshore wind industry has faced economic and policy shifts, but a collective focus on partnership and smart priorities is enabling continued, resilient growth aligned with global energy and nature ambitions. It is critical to keep up the momentum. By leading the way in integrating nature-positive interventions, offshore wind can be a role model for other sectors whose operations impact ocean health.

The Global Initiative for Nature, Grids and Renewables (GINGR) has brought together multiple stakeholders to support governments, companies and the financial sector to deploy renewables and power grids in a nature-positive, timely and socially responsible manner. It is developing technical frameworks, providing practical guidance, facilitating dialogue around key challenges, and coordinating action.[2]

This report, prepared by the Ocean Conservancy, which chairs the GINGR offshore working group,[3] contributes to that mission. Drawing on nearly three years of observing market developments and the integration of biodiversity measures across public and private frameworks and informed by a large body of research and stakeholder input, it examines how to optimize the use of biodiversity criteria in offshore wind procurement; how to integrate nature-positive measures in offshore grid and port infrastructure; and how to align decommissioning frameworks with nature-positive objectives.

The rest of this section provides an overview of the status of nature-positive offshore wind. Section 2 then looks at the use of biodiversity non-price criteria, while Section 3 focuses on nature-positive enabling infrastructure – both offshore grids and ports. Section 4 focuses on decommissioning. Every section includes a gap analysis, policy recommendations for governments, and supporting actions that stakeholders can undertake. An annex provides an overview of the literature and initiatives reviewed.

Terminology in this space includes nature-positive, biodiversity-positive, net gain and net positive impact. For the purpose of this report, each of them are relevant in so far as they refer to the deployment of offshore wind that leaves an overall positive and measurable impact on biodiversity, in line with the definition of the Nature Positive Initiative (NPI).[4]

[1] See https://www.cbd.int/gbf.
[2] See https://www.gingr.org.
[3] See https://www.gingr.org/offshore.
[4] Nature Positive Initiative (2023). "The Definition of Nature Positive." https://4783129.fs1.hubspotusercontent-na1.net/hubfs/4783129/The%20Definition%20of%20Nature%20Positive_v12.pdf.

STATUS OF NATURE-POSITIVE OFFSHORE WIND

Significant progress has been made on making offshore wind nature-positive, and current best practices are well documented. Several developers have introduced voluntary biodiversity targets, and they are already taking measures to mitigate negative impacts and implement restoration at the project level, in line with the mitigation hierarchy framework.[5]

It is also clear what enabling actions are required of policy-makers and regulators to unlock the potential of nature-positive wind at scale. Ecosystem-based marine spatial planning (MSP) encompassing all ocean activities against a backdrop of continued climate change is a key first step. Governments must identify ecologically sensitive areas, as well as areas where offshore wind can be developed without harming sensitive species and habitat. They need to adopt robust regulatory requirements for environmental protection, if not already in place, and enforce them. They should also integrate biodiversity targets in offshore wind procurement.[6]

Progress is happening in each of these areas, but it varies significantly by geography, and gaps remain even in the most mature offshore wind markets. Barriers include perceived tensions between economic and environmental priorities, inadequate institutional capacities, and a need for area-specific evidence. Multi-stakeholder collaboration underpins any potential solution. Wider implementation challenges, such as the need for a standardized biodiversity metrics framework for offshore wind,[7] improving and sharing the evidence base, or developing increasingly granular pathways for action,[8] can only be addressed in partnership.

Multiple forums and initiatives are operating in this space, and a wealth of reports, position papers and recommendations have been published in recent years (see annex for an overview). Despite this strong foundation and the substantial body of work underway, several challenges remain in translating high-level frameworks and project-level best practices into systematic and global implementation, at the pace and with the rigour required.

[5] OCEaN (2024). "Avoidance and Minimisation of Environmental Impacts from Offshore Wind and Grid Infrastructure." Offshore Coalition for Energy and Nature. https://offshore-coalition.eu/launch-of-report-avoidance-and-minimisation-of-environmental-impacts/.
See also the OCEaN Energy & Nature Database: https://offshore-coalition.eu/database-projects/.
[6] UNGC (2024). "Net-Positive Biodiversity in Offshore Renewable Energy: Minimum Criteria and Recommendations for Action." New York: Ocean Stewardship Coalition, UN Global Compact. https://unglobalcompact.org/library/6197.
[7] Stephenson, P.J. (2024). "Monitoring Biodiversity at Sea: Discussion Paper on Advancing Standardised Biodiversity Monitoring for Nature-Positive Offshore Wind Development." GINGR Navigator No. 2. Berlin: Global Initiative for Nature, Grids and Renewables. https://www.gingr.org/_files/ugd/0928d6_ad2fa2c80b9b4cf1a35386bf347212bb.pdf.
[8] See UNGC (2024), "Net-Positive Biodiversity in Offshore Renewable Energy," as well as:
WEF (2025). "Nature Positive: Role of the Offshore Wind Sector." Insight report. World Economic Forum. https://reports.weforum.org/docs/WEF_Nature_Positive_Role_of_the_Offshore_Wind_Sector.pdf.
WWF (2025). "Towards Nature Positive for the Ocean: Pathways for Corporate Contributions." World Wide Fund for Nature. http://doi.org/10.5281/zenodo.15587372.

Unresolved tensions remain between nature protection and timely and cost-effective deployment of offshore wind, and they create challenges in the development of clear guidance and ambitious policy. It is important that strategies to strengthen biodiversity outcomes enhance the long-term cost competitiveness of offshore wind and not create disproportionate burdens that could disadvantage it relative to more environmentally harmful fossil fuel energy sources.

Up until now, the collective focus has been mainly on establishing nature-positive pathways for the construction and operation of wind farms, with less attention to the wider value chain or to impacts on nature at the point of decommissioning. Moreover, existing evidence and guidance on best practices is based mainly on mature markets in northern Europe, even though significant offshore wind expansion is also being promoted elsewhere.

2 Using biodiversity non-price criteria in procurement

As offshore wind scales up, auction frameworks will likely play a major role in determining the extent to which nature-positive impact is systematically integrated into deployment, complementing minimum criteria and ISO standards. Non-price criteria (NPC) have emerged as a key policy lever that governments can use to require or incentivize biodiversity protection and restoration outcomes beyond current minimum legal requirements.

This section examines how auction design and NPC can be used to drive biodiversity protection and restoration in offshore wind development. It reviews current practices, identifies implementation gaps, and proposes policy and industry actions to scale nature-positive outcomes.

CURRENT USE AND STAKEHOLDER PRIORITIES

Recognizing that competition based on price alone can limit the societal value of offshore wind development, several markets have introduced NPC into their auction and tender processes to integrate policy objectives such as resilience and security, supply chain development, system integration, circularity, community engagement and biodiversity.

Historically, environmental legislation and permitting rules have set minimum standards for limiting negative environmental impacts – and, in rare cases, for pursuing net-positive biodiversity impacts. When applied at the pre-qualification stage, biodiversity NPC can set a higher minimum standard for a given project that all developers must meet. When applied at the award stage, they can help more ambitious proposals to stand out, leading to stronger projects overall and raising standards further.

Current examples of biodiversity criteria indicate that this policy mechanism is still taking shape. While there are several strong case studies available, these are limited in geographic scope, and they vary substantially in their design and implementation.

European markets, including Belgium, France, Germany, the Netherlands and the UK, are among the most advanced in exploring use of biodiversity criteria. The EU's 2024 Net-Zero Industry Act requires Member States to apply sustainability-related NPC to at least 30% of renewable energy auction volumes, or to at least 6 GW per year.[9] The law's implementing regulation provides further guidance on criteria to be used,

[9] See overview at https://single-market-economy.ec.europa.eu/industry/sustainability/net-zero-industry-act_en#new-mandatory--rules-in-in-public-procurement-auctions-and-other-schemes.

including biodiversity criteria to reward projects that minimize negative impacts and/or pursue restoration measures.[10] It states that when biodiversity criteria are used at the award stage, they should incentivize net-positive biodiversity impact. However, critical details – such as criteria design specifications, whether to apply criteria at the pre-qualification or award stage, and the assessment methodology – are largely left to Member States' discretion. While some flexibility is important, lack of coordination risks producing a patchwork of inconsistent approaches, leading to unnecessary complexity and additional costs and risks for offshore wind projects.

In North America, state solicitations in Massachusetts, New York, New Jersey and Maryland have incorporated environmental criteria, though they generally focused more on minimizing harm than on achieving positive impacts, or assessing a per-megawatt fee for strategic monitoring and regional projects. Environmental criteria are often bundled with unrelated criteria and scored together – an approach that has been criticized for lack of transparency. However, some U.S. states are starting to expand environmental weighting and transparency requirements, laying the groundwork for introducing net positive criteria.[11]

Other regions with less mature offshore wind markets are less likely to use biodiversity criteria. Where NPC are used in emerging offshore wind markets – for example, in Japan, South Korea and Australia – NPC considerations typically centre on technical deliverability and economic benefits as these markets seek to attract investment and establish cost competitiveness and local supply chains.[12]

While there is broad support for NPC as an important and necessary new feature of offshore wind procurement, there is less agreement on how best to implement biodiversity criteria or how to weight them relative to other criteria. Industry tends to advocate for a narrower scope of use, lest they exacerbate the economic challenges that offshore wind expansion already faces. This could entail, for example, using biodiversity criteria only for pre-qualification, and selected auctions and markets, and focusing only on proven, not innovative measures. Some in industry have suggested that biodiversity criteria used at the award stage should focus on corporate environmental, social and governance (ESG) strategies rather than project-specific commitments.

Environmental NGOs, in contrast, consistently advocate for more ambitious implementation of biodiversity criteria,[13] and suggest applying them to all renewable energy auctions, with comprehensive coverage of the mitigation hierarchy in both pre-qualification and award criteria.[14] There is also a higher prevalence of support for criteria that require or incentivize net-positive outcomes.

[10] See Commission Implementing Regulation (EU) 2025/1176 at http://data.europa.eu/eli/reg_impl/2025/1176/oj.
[11] James, M. et al. (2023). "Using Non-Price Criteria in State Offshore Wind Solicitations to Advance Net Positive Biodiversity Goals." South Royalton, VT, US: Institute for Energy and the Environment at Vermont Law and Graduate School and The Nature Conservancy. https://www.vermontlaw.edu/wp-content/uploads/2024/07/iee-tnc_offshore-wind-report_20230606_1644.pdf.
[12] GWEC (2025). "Global Offshore Wind Report 2025." Lisbon: Global Wind Energy Council. https://www.gwec.net/reports/globaloffshorewindreport.
[13] WWF (2025). "Unlocking the Potential of Non-Price Criteria in Wind Energy Auctions." Position paper. World Wide Fund for Nature. https://www.wwf.eu/?18641841/NPC-in-wind-energy-auctions-position-paper.
TNC (2025). "Beyond Price: How Non-Price Criteria in Renewable Energy Auctions Can Help Deliver for Climate, Nature and People." The Nature Conservancy. https://www.nature.org/content/dam/tnc/nature/en/documents/n/o/non-price-criteria-TNC-europe.pdf.
[14] This summary of industry and NGO views is based on review of responses to the EU Commission consultation on the Implementing Regulation as well as position papers from the stakeholder groups mentioned, detailed in the Annex.

Other factors need to be considered as well. For example, as offshore wind build-out accelerates, space availability outside of sensitive areas may be increasingly limited. Cumulative impacts are also not yet well understood, and current frameworks do not consistently address them. While many stakeholders agree that criteria should incentivize project-level measures, some call for criteria to include contributions to dedicated national or regional funds, to enable the coordination of positive measures across multiple projects.[15]

GAP ANALYSIS

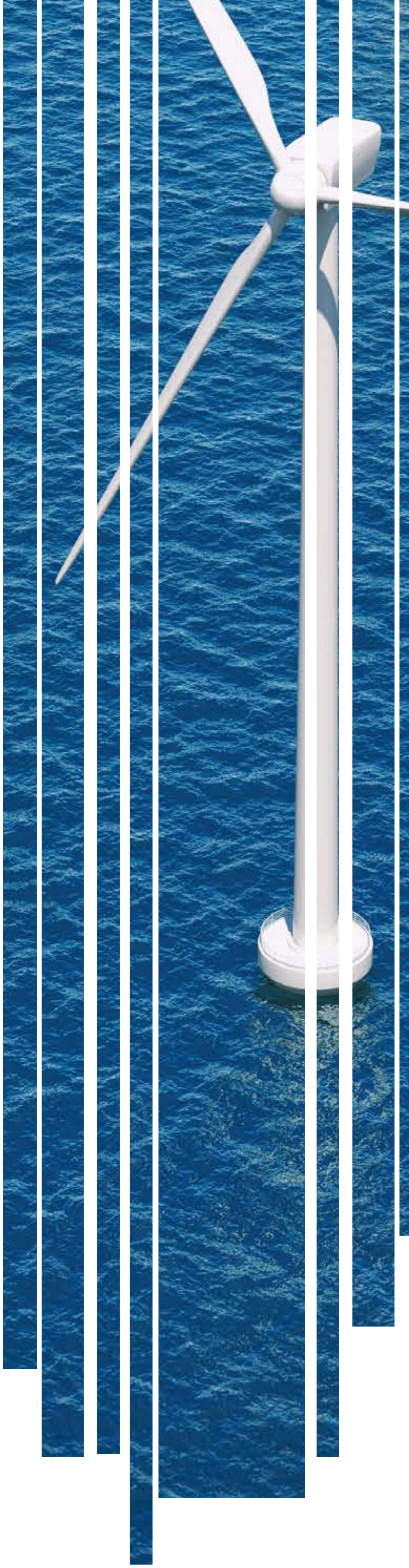
The evidence and literature review identified three key gaps that need to be addressed to unlock the potential of biodiversity non-price criteria.

1. Detailed best practice guidance that resolves key tensions

There is broad consensus on some aspects of best practice – for example, that biodiversity criteria should be developed and applied through robust, transparent processes, and that their intended use should be communicated clearly and early. Stakeholders also agree that the criteria should drive action that is additional and complementary to obligations under existing law, and that they should be designed to avoid imposing excessive additional costs or administrative burdens.

In some key areas, however, there is no agreement yet on best practice. As noted above, opinions differ, for instance, on when to apply biodiversity criteria – at the pre-qualification or the award stage; on the scope of auctions and markets in which to use biodiversity criteria; on whether to incentivize innovation, specific proven measures, or net-positive outcomes more broadly; and how much weight to give biodiversity relative to other criteria in competitive assessments.

The lack of consensus on best practices may limit the extent to which the use of biodiversity criteria can drive meaningful nature-positive outcomes. This, in turn, makes it harder for governments to secure additional societal value from offshore wind projects, and for the industry to plan and price projects. Stakeholders across the board agree that standardization and regional harmonization are critical enabling conditions for nature-positive offshore wind.



[15] The UK has introduced a Marine Recovery Fund, paid for by offshore wind developers, to enable biodiversity measures to be delivered more strategically from an ecological perspective, and across multiple projects.

2. Systematic assessment of options for mitigating implementation risks

Cost and project risk are frequently cited as reasons to limit the use of biodiversity criteria, as they could hinder the realization of offshore wind targets. However, there is not enough evidence yet to gauge how material the costs and risks are in practice, nor has there been a detailed analysis of how any risks could be mitigated. It is important to achieve a shared understanding of these issues. A key question worth investigating further, is how much the broad use of strictly defined biodiversity tender criteria would affect the strike price of offshore wind under different market structures.

Experience in Europe already highlights potential ways to lower the risk to developers through auction design. Examples put forward by key stakeholders include transparent guidelines and clear timelines, financial limits on restoration commitments, scoring focused on delivery methodology rather than absolute scale, and standardized assessment methodologies.

It may also be possible to remove other barriers to offshore wind deployment barriers while creating headroom for the use of biodiversity criteria. Certain approaches to spatial planning and site selection could reduce risks and costs to developers while improving outcomes for nature – such as integrating ecological sensitivity mapping early, and government-led pre-auction environmental assessments. There are also known issues with permitting. Stakeholders have recommended ways to achieve efficiencies without reducing due diligence on environmental protection, such as digitalization, boosting permitting resources, or a one-stop-shop approach.

It is important to recognize that any additional costs may contribute to making offshore wind less competitive with other energy technologies that do not face such requirements. For example, in some cases governments have recovered the costs of pre-auction environmental assessment from offshore wind developers after awarding the tender.[16] Costs such as these should be considered in the round with those required of other energy infrastructure projects.

3. Mapping threshold conditions for market suitability and enabling local benefits

The prevailing public discourse on market suitability lacks clear pathways for global deployment of nature-positive offshore wind, with no limited evidence-based recommendations on conditions to be met for a market to be suitable, how to meet those conditions, or the potential benefits of doing so.

Some stakeholders argue that mature offshore wind markets are suitable, but newer markets should wait until a competitive offshore wind industry is established. It is important to examine the assumptions being made. Newer markets have the opportunity to leapfrog the journey taken by mature markets by embedding nature-positive and community benefit frameworks into national offshore wind programs from the outset. By doing so, they can unlock social license to operate and deliver lasting socio-economic benefits, building on proven approaches from established European markets and tailoring them to local needs from the outset.[17]

[16] For instance, the consortium awarded the tender for Ijmuiden Ver, which used NPC to focus proposal towards positive nature contribution, was required to pay €20 million to the Dutch authorities. See SSE Renewables (2024). "SSE and APG Move Forward with Development of Offshore Wind Farm in the Netherlands." July 9. https://www.sserenewables.com/news-and-views/2024/07/sse-and-apg-move-forward-with-development-of-offshore-wind-farm-in-the-netherlands/..

[17] Arsenova, M., P. Skyt, and A. Qadeer (2024). "The Strategic Value of Community Benefits in Offshore Wind Development." Discussion paper. Washington, DC: Offshore Wind Development Program, World Bank Group. https://www.esmap.org/ESMAP-Offshore-Wind-Community-Benefits.

In contrast, if price is the main or only factor in selecting projects, there is potentially a greater risk that they may cause environmental harm, especially in markets where the legislative frameworks that should provide robust minimum protection standards are also less mature.

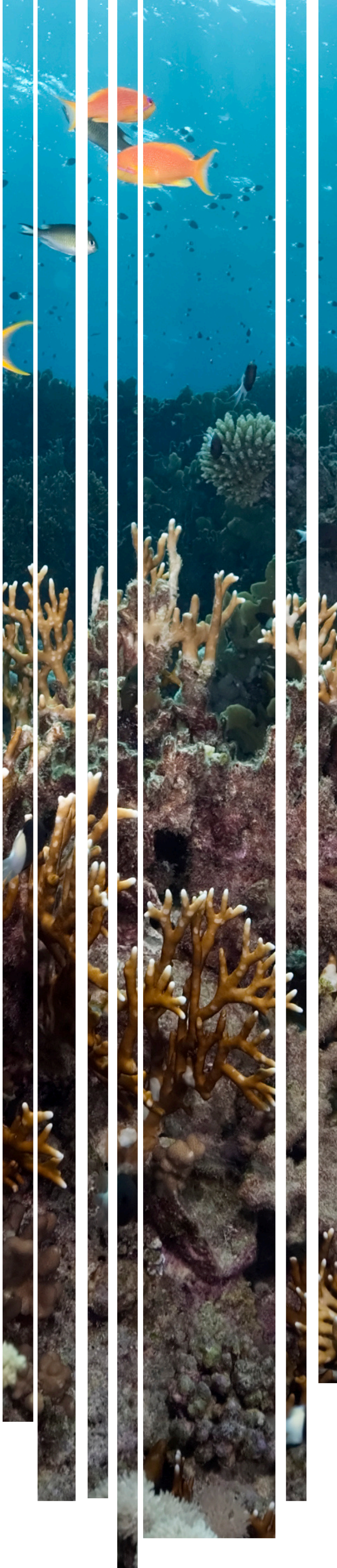
Across all markets, failure to demonstrate a clear alignment with nature protection is likely to hinder offshore wind deployment over time. In newer markets in particular, evidence suggests that environmental concerns, including due to misinformation, can be key drivers of opposition.[18]

NGOs have also vocally advocated for adding socio-economic criteria alongside biodiversity criteria, which they argue would help de-risk projects and enhance community support. However, this has occurred mainly in the context of mature European markets where NPC are already in use. Pilots or studies that include both socio-economic and biodiversity NPC, including in new and emerging markets, could improve the evidence base. It is also important to harmonize methodologies for measuring environmental and socio-economic impacts.[19]

POLICY RECOMMENDATIONS FOR GOVERNMENTS AND REGULATORS

- Establish a requirement (if not already in place) that new offshore infrastructure (including, but not limited to, wind farms) cause no net loss to biodiversity, and work towards requiring the delivery of net positive impact.
- Advance implementation of biodiversity non-price criteria in all public infrastructure tenders, and work with stakeholders to develop and adopt clear and comprehensive standards and best practices that mitigate project risk while optimizing nature-positive outcomes.
- Align the implementation of NPC with action on ecosystems-based spatial planning and on speeding up permitting processes for offshore wind.
- Establish state-administered strategic funds to enable a coherent set of interventions aligned with strategic conservation priorities, and work towards regional coordination where there are significant ecological benefits.
- Work with stakeholders to share knowledge and experience, and develop comprehensive best practice guidance. Initiatives such as the Global Clean Power Alliance and the Global Energy Transitions Forum, among others, could provide space for this.

[18] For example, the Global Wind Energy Council (GWEC, 2025, ““Global Offshore Wind Report 2025”) has highlighted the relationship between perceptions of nature impact and social license, citing a recent case in Brazil where local campaigners opposed offshore wind on grounds of perceived negative impact on marine and coastal ecosystems. While the scientific basis of the opposition has been questioned, the controversy may nonetheless result in permitting delays and financial losses for developers.
[19] See Stephenson (2024), “Monitoring Biodiversity at Sea.”



SUPPORTING ACTIONS FOR STAKEHOLDERS

To complement government and regulatory action, industry, civil society, technical experts and financial institutions must coordinate to accelerate nature-positive offshore wind development. Some actions that non-state actors could take include:

Develop and adopt comprehensive best practice guidance

- Co-develop practical guidance to operationalize biodiversity criteria in offshore wind auctions and projects, ensuring alignment with robust environmental legislation, mitigation hierarchy principles, and measurable biodiversity outcomes.
- Standardize design approaches by mapping use cases (e.g., pre-qualification vs. award criteria, "no net loss" vs. "net positive impact", innovation vs. proven measures), developing weighting and scoring methodologies, and creating a shared "menu" of best practices adaptable to different markets.
- Build and align accountability frameworks, including transparent monitoring, reporting and enforcement mechanisms to ensure credible biodiversity outcomes across jurisdictions.
- Promote pooled or strategic financing mechanisms (e.g., biodiversity funds to support coordinated, cumulative biodiversity benefits.)

Assess and mitigate implementation risks systematically

- Quantify and clarify cost and risk factors associated with integrating biodiversity criteria in different market contexts, leveraging real project data and comparative analyses.
- Identify practical financial risk mitigation strategies in auction and permitting design (e.g., setting financial limits on restoration commitments, scoring methodology focused on delivery quality, standardized assessments).
- Integrate risk mitigation strategies into delivery frameworks, including planning, permitting and financing processes, to create more efficient and lower-risk pathways for biodiversity integration.
- Translate findings into actionable guidance for both policy-makers and project developers to reduce uncertainty and enable more ambitious biodiversity criteria.

Define threshold conditions for market suitability and acceleration pathways

- Identify enabling conditions for successfully integrating biodiversity criteria into emerging and developing offshore wind markets (e.g., ecological data availability, legislative maturity, institutional capacity, supply chain readiness, financing mechanisms).
- Map pathways to accelerate these conditions, including capacity-building, early ecological mapping, targeted finance and policy support.
- Develop tiered guidance and market typologies to help countries adopt biodiversity criteria progressively, starting with essential measures and scaling ambition over time.
- Link biodiversity and socio-economic co-benefits (e.g., community support, just transition outcomes) to strengthen local buy-in and political feasibility.

3. Nature-Postive Enabling Infrastructure

Large investments in key enabling infrastructure are needed in order for offshore wind capacity targets to be met. This section examines how decisions around two critical enablers of offshore wind expansion – offshore grids and ports – can affect biodiversity outcomes. It reviews existing efforts to integrate ecological considerations and proposes pathways for more strategic, ecosystem-based planning to achieve measurable net-positive biodiversity outcomes.

OFFSHORE GRID

Meeting global offshore wind targets will require a huge expansion of power grids to deliver the power generated to onshore users. Europe alone faces offshore transmission investment needs of €400 billion through 2050, requiring up to 54,000 km of subsea routes to connect generation to onshore networks.[20] Building out this infrastructure can harm nature through physical disturbances of species and habitat, habitat fragmentation, and noise during installation. Once the offshore grid is operational, further harm may be caused by electromagnetic fields and by heat emitted from cables. While these risks are significant, measures to avoid or mitigate impacts through good planning and design are well understood.[21]

Responsibility for cable route selection and environmental management varies by jurisdiction. The developer-led model, common outside of Europe, involves developers proposing cable routes as part of the project consent or permit application, subject to the same environmental impact assessment (EIA) processes as the offshore wind infrastructure itself. It is typical to specify which cables will be used, for example, and how the installation will be done to minimize environmental harm.

In much of the EU, the process is led by the transmission system operator (TSO), which identifies the grid route, proposes alternative routes to connect the generation assets, conducts a cost-benefit analysis, and seeks approval from the regulator competent authority. A number of European TSOs, such as Energinet[22] and TenneT,[23] are moving to integrate biodiversity and nature-inclusive design considerations into the technical design and procurement of offshore grid infrastructure.

[20] According to ENTSO-E's latest network development plan.
[21] OCEaN (2024), "Avoidance and Minimisation of Environmental Impacts from Offshore Wind and Grid Infrastructure."
[22] Energinet (2024). "Sustainability Report 2023." Fredericia, Denmark. https://en.energinet.dk/about-our-reports/reports/sustainability-report-2023/.
Energinet (2025). "Integreret Årsrapport 2024." Dok. 24/11172-1. Fredericia, Denmark. https://energinet.dk/om-publikationer/publikationer/integreret-aarsrapport-2024/.
[23] Hermans, A. (2023). "Nature-Inclusive Design: Offshore Grid." Presented at the TenneT, January 26. https://renewables-grid.eu/app/uploads/2023/01/Annemiek_Hermans_presentation_260123_NID_Offshore_Grid.pdf.

Recent publications on nature-positive offshore wind have highlighted cable-laying impacts and mitigation measures as a key focus area.[24] Given that offshore wind farms are inextricably linked with the cables that service them, recommendations for industry and policy-makers overlap a great deal, founded in the mitigation hierarchy, ecosystem-based planning and robust environmental assessments.

Marine spatial planning (MSP) informed by ecological sensitivity mapping can play an important role in deciding where to place both cable routes and wind farms. Grid corridors can be chosen to avoid the most ecologically sensitive areas. However, as noted, ecosystem-based MSP, while increasingly pursued, is not yet the norm worldwide, so overlaps between cable routes and sensitive or protected areas remain common.

In emerging offshore wind markets, the World Bank's Energy Sector Management Assistance Programme (ESMAP) is providing guidance on how to develop early-stage spatial and environmental screening frameworks, including how to identify optimal grid connection zones and transmission corridors that minimize conflicts with sensitive marine habitats.[25]

If cable routes are planned project by project, they can easily become inefficient and complex, especially in areas targeted for high volumes of deployment. Instead, as is being done in the North Sea, strategic and regional planning can optimize shared infrastructure across countries, significantly reducing the volume of new infrastructure required.[26] When embedded in strategic sea basin planning that integrates energy systems with ecological concerns, this approach can lower costs and maximize benefits for both biodiversity and energy systems.

There are some promising signs, such as the latest work programme of the North Seas Energy Cooperation (NSEC), which has committed to incorporating ecosystem-based MSP and environmental sensitivity mapping into regional grid design.[27] Key publications from the European Network of Transmission System Operators (ENTSO-E) have also focused on these issues.[28] However, to keep making progress, data is needed that is not available in all markets. Moreover, historically, such coordination has been driven not by environmental concerns, but by cost and efficiency.

[24] WWF (2025). "Towards Nature Positive for the Ocean."
[25] See, e.g.: ESMAP (2024). "Integrated Environmental & Social Sensitivity Mapping:Guidance for Early Offshore Wind Spatial Planning." Washington, DC: World Bank Group. https://www.esmap.org/Integrated_Environmental_Social_Sensitivity_Mapping.
[26] Elia Group and Ørsted (2024). "Making Hybrids Happen: Enabling Offshore Hybrid Projects to Enhance Europe's Energy Transition." White paper. https://cdn.orsted.com/-/media/www/docs/corp/com/about-us/whitepaper/elia-group-x-orsted-making-hybrids-happen.pdf.

The use of NPC in offshore wind auctions is also relevant here. Measures to improve the environmental impact of cables are already being driven through the use of biodiversity criteria. For example, at Hollandse Kust West Site VI, where ecology was the primary award criterion, the winning project includes "tree reefs"[29] to create habitat at cable crossings.

Reflecting market maturity, Europe has a dedicated and formalized multi-stakeholder collaboration initiative, OCEaN (Offshore Coalition for Energy and Nature), that brings together offshore wind developers, transmission system operators and NGOs. They are sharing best practices, working to fill research gaps, and jointly advocating for change to accelerate the deployment of sustainable offshore wind and grid infrastructure.

GAP ANALYSIS

The evidence and literature review identified two key gaps that need to be addressed to move towards nature-positive offshore grids:

1. Enabling nature-positive design of cable installation

Using NPC in offshore wind auctions is the main policy mechanism to drive nature-positive action – not just minimize harm – in offshore wind projects, including from associated grid infrastructure. However, there is currently no guidance on how to explicitly address grid-related impacts with this mechanism. The procurement processes for TSOs also lack consistent requirements to drive nature-positive outcomes.

Research in mature offshore wind markets is expanding the evidence base. The UK's Crown Estate has funded work to improve understanding of the interactions between subsea power cables and the marine environment,[30] as well as to examine the potential benefit for nature of different design solutions for cables.[31] Such research can lead to better-informed grid planning.

While some fundamentals are likely applicable to other regions, it would be beneficial to develop similar evidence specific to new and emerging markets. Global standards on electromagnetic fields and heat emissions from cables are also needed. In general, cable specifications are tightly regulated for safety; if nature-inclusive design (NID) measures are to be permitted, robust evidence will be needed to demonstrate the benefits.

[27] The Crown Estate (2023). "2023, Cefas, Offshore Wind Evidence and Change Programme (OWEC), Electromagnetic Fields (EMF) Modelling Workshop." Marine Data Exchange, July. https://www.marinedataexchange.co.uk/details/TCE-3718.
[28] The Crown Estate (2024). "2023, The Crown Estate, Offshore Wind Evidence and Change Programme (OWEC), Nature Inclusive Cable Enhancement Programme (NICE)." Marine Data Exchange, January. https://www.marinedataexchange.co.uk/details/TCE-3902.
[29] NSEC (2024). "Work Programme 2025–2027." North Seas Energy Cooperation. https://circabc.europa.eu/ui/group/9198696f-e42c-4a88-b4f1-7a1788eb9b7c/library/956a342b-0135-45ae-bc9a-20427de22333/details.
[30] ENTSO-E (2024). "Offshore Network Development Plans: European Offshore Network Transmission Infrastructure Needs." Pan-European summary. Brussels. https://eepublicdownloads.blob.core.windows.net/public-cdn-container/tyndp-documents/ONDP2024/web_entso-e_ONDP_PanEU_240226.pdf.
[31] The Crown Estate (2024). "2023, The Crown Estate, Offshore Wind Evidence and Change Programme (OWEC), Nature Inclusive Cable Enhancement Programme (NICE)." Marine Data Exchange, January. https://www.marinedataexchange.co.uk/details/TCE-3902.

2. Ecologically informed strategic planning and cooperation

While some TSOs are pioneering nature-inclusive approaches, the systematic integration of nature-positive measures in grid planning is still relatively new and more common in some markets than in others. Strategic coordination of offshore electricity grid development is institutionalized in Europe, advancing in North America and nascent elsewhere. Across the board, the primary driver of coordination is technical and economic efficiency. Knowledge gaps also remain regarding long-term, population-level effects and cumulative impacts from subsea electricity cables, especially in emerging market contexts.

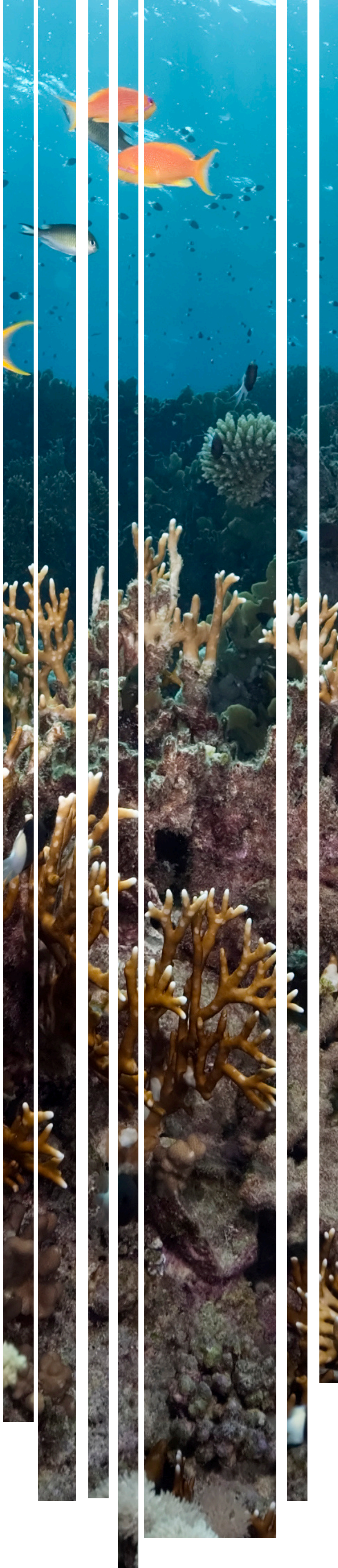
POLICY RECOMMENDATIONS FOR GOVERNMENTS AND REGULATORS

- Establish ecosystem-based strategic planning for offshore grid infrastructure to optimize for net-positive nature impacts as well technical and economic efficiency.
- Work to identify regional offshore grid corridors and ecosystem based management of marine impacts.
- Mandate biodiversity criteria that target grid infrastructure impacts specifically and set out clear, evidence-based standards for measures to address.
- Work with stakeholders to improve understanding of cable-laying techniques and of locally relevant nature-inclusive design measures, and allow for easy adoption of appropriate NID measures within permitting frameworks.
- Based on these outputs, consider tenders for offshore transmission infrastructure that is shared across projects and/or borders, to minimize the number of interventions needed on the seafloor.

SUPPORTING ACTIONS FOR STAKEHOLDERS

Strengthen cross-sector cooperation to support policy and regulatory development.

- Establish structured cooperation platforms to connect offshore wind and grid stakeholders in emerging markets.
- Facilitate joint evidence generation on the ecological impacts of grid infrastructure, with emphasis on region-specific contexts, ecological sensitivities and mitigation options.
- Coordinate advocacy and technical engagement to ensure that ecosystem-based planning and biodiversity criteria are embedded in national and regional grid development strategies.
- Align technical, environmental and economic objectives through shared dialogue between grid operators, developers, environmental NGOs and regulators to accelerate deployment while safeguarding biodiversity at the local level.



Build evidence and capacity for nature-inclusive design in grid infrastructure

- Advance research and data collection on ecological impacts and mitigation measures for subsea cables, transmission corridors, and associated infrastructure.
- Promote and pilot NID solutions that are scientifically sound and locally relevant, enabling early adoption in permitting frameworks.
- Share technical knowledge and practical experience across markets to support standardization and accelerate uptake of proven biodiversity-positive grid practices.
- Create open-access guidance and training for regulators and developers on best practices in cable routing, NID techniques and ecosystem-based planning approaches.
- Consider innovation subsidies for new technologies and mitigation measures, to help them scale up and build a path to market.

PORTS

Ports hold strategic importance for global trade, national energy security and local employment. Their competitiveness matters to national decision-makers, and their ability to adapt to meet the needs of the offshore wind industry will influence the cost-competitiveness of offshore wind relative to other energy sources.

Ports are vital to achieving national and international offshore wind targets, serving as key hubs for the specialized infrastructure and services that developers and the supply chain rely on throughout construction, operation, maintenance and decommissioning. Achieving ambitious growth in installed capacity, and accommodating larger turbines and emerging floating technologies, will require substantial investment in both new and upgraded port facilities.

In Europe alone, an estimated €2.4 billion in port investments is needed, on top of €4.3 billion invested in the past three years, to enable offshore wind targets in the region.[32] Globally, an estimated US$18 billion in port investments will be needed to bring the pipeline of announced offshore wind projects online.[33] Managing the impacts of these port investments on nature will be critical to ensuring truly nature-positive offshore wind.

Current status and stakeholder priorities

Like most industrial infrastructure, historically, ports have had a negative impact on the ecosystems in which they operate. Coastal areas are the most biodiverse oceanic zones and provide a range of valuable ecosystem services. Coastal ecosystems such as salt marshes, seagrass, wetlands, kelp forests and mangroves not only provide habitat for numerous species, but also store carbon and protect the land from storm surges. Port upgrades to support offshore wind deployment can harm sensitive ecosystems through actions such as dredging and land reclamation.

[32] WindEurope (2025). "Europe Needs Stronger Ports and More Vessels to Meet Its Offshore Wind Goals." August 4. https://windeurope.org/news/europe-needs-stronger-ports-and-more-vessels-to-meet-its-offshore-wind-goals/.
[33] GWEC and BCG (2023). "Mission Critical: Building the Global Wind Energy Supply Chain for a 1.5°C World." Brussels: Global Wind Energy Council and Boston Consulting Group. https://www.gwec.net/reports/supplychain.

Downstream impacts from the fossil fuel and shipping industries that ports facilitate are also significant. As they sit at the intersection of different ocean industries, ports are well placed to help drive a sustainable and equitable transition across the blue economy and support a level playing field between offshore wind and other ocean users.

Interest in nature-positive ports has grown in recent years as part of a broader shift towards more sustainable port operations and improved climate resilience.[34] This is evident in actions taken by several ports around the world.[35] New workstreams have also emerged, and reports have been published by stakeholders including the UN Global Compact, the World Bank Group and the World Economic Forum. The Maritime Resilience Breakthroughs were launched at COP27, with ports chosen as the initial focus, recognizing the close links between nature, climate and the future resilience of ports as critical infrastructure.[36] The Resilience4Ports (R4P) initiative that came from this work does not explicitly address nature-positive ports, but protecting and enhancing natural ecosystems is part of its 10-point action framework.[37]

The current body of work sets out the case for nature-positive ports, presents case studies of practical action already happening, identifies key challenges, and proposes enabling measures, technical guidance and pathways for action.[38] There are common themes in the enablers for nature-positive ports and offshore wind, including the need for more knowledge, data and monitoring; the importance of engaging with shared stakeholders – from coastal communities to policy-makers and vessel owners – and the need to unlock investment. Collaborating on shared challenges could thus accelerate sustainable offshore wind deployment. Strategic coordination on where ports are developed and how they are utilized could also have co-benefits for biodiversity.

[34] Lloyd's Register Foundation (2025). "Foresight Review of Nature-Positive Engineering." Report No. 2025.1. https://www.lrfoundation.org.uk/publications/foresight-review-of-nature-positive-engineering.
[35] Two good sources of case studies are: UNGC (2023). "Sustainable Ocean Principles: Practical Guidance – Ports." New York: Ocean Stewardship Coalition, UN Global Compact. https://communications-assets.unglobalcompact.org/docs/publications/UNGC-Practical%20Guidance-Ports.pdf.
World Bank (2025). "Nature-Based Solutions for Ports: An Overview of NBS Implementation in Practice – Opportunities and Challenges." Washington, DC: World Bank. https://hdl.handle.net/10986/43420.
[36] Resilience Rising (2022). "The Maritime Resilience Breakthroughs." https://www.climatechampions.net/media/dirpvrah/maritimeresiliencebreakthroughs.pdf.
[37] ICSI (2025). "Resilience4Ports: Strategic Plan 2025-27." International Coalition for Sustainable Infrastructure. https://sustainability-coalition.org/publication/resilience4ports-strategic-plan-2025-27/.
See also the Resilience4Ports website: https://sustainability-coalition.org/work/projects/resilience4ports/.
[38] For example, see World Bank (2025), "Nature-Based Solutions for Ports," and: WEF (2025). "Nature Positive: Role of the Port Sector." Insight report. World Economic Forum. https://www.weforum.org/publications/nature-positive-transitions-sectors/port-sector/.

GAP ANALYSIS

The evidence review identified two main gaps that need to be addressed to accelerate progress towards nature-positive ports:

1. Integrated approach to nature-positive ports and offshore wind

While the offshore wind and ports sectors work together on many aspects of infrastructure development, they have yet to collaborate strategically on the nature-positive agenda. This means they may miss potential synergies that would enable them to achieve greater benefits for nature across the value chain.

Typically, there are separate initiatives looking at nature-positive ports, nature-positive offshore wind, and port investment as an enabler of offshore wind. For example, wind industry analysis of European offshore wind port requirements makes limited reference to environmental considerations.[39] The same is true of a recent report looking at the role of port development in scaling offshore wind in emerging markets.[40] Key reports on nature-positive ports, in turn, make limited or no reference to offshore wind. The literature on nature-positive ports emphasizes the need to engage the full ports value chain in this work, but while the maritime transport industry is involved, offshore wind is absent from key ports initiatives related to nature, such as R4P or the World Economic Forum stakeholder group working to operationalize guidance for nature-positive ports.

An integrated approach to policy-making is also needed. For example, the draft EU Ports Strategy makes no reference to legal frameworks for nature protection and restoration, such as the Habitats Directive. Moreover, ports are not always included in marine spatial planning, a key process for balancing ocean use and nature protection.

The wind industry has called for strategic planning to ensure that ports are equipped to enable offshore wind targets. However, this work is not typically joined up with advocacy for efforts to optimize outcomes for nature, and there are no frameworks to enable a sea-basin approach to nature restoration. Although the literature on offshore wind discusses such approaches, it does not typically include port infrastructure in the frame.

2. Focus on measurable biodiversity goals and a level playing field

To the extent that nature protection and restoration measures are discussed in the context of ports, it is typically as a way to improve port climate resilience and operational efficiency, with less emphasis on achieving concrete, measurable biodiversity targets.

[39] WindEurope (2021). “A 2030 Vision for European Offshore Wind Ports: Trends and Opportunities.” Brussels. https://windeurope.org/data/products/a-2030-vision-for-european-offshore-wind-ports-trends-and-opportunities/.
[40] Systemiq (2025). “Capturing the Offshore Wind Opportunity: The Critical Role of Port Development and Regional Coordination in Scaling Offshore Wind in Emerging Markets and Developing Economies.” https://www.systemiq.earth/wp-content/uploads/2025/06/Capturing-the-offshore-wind-opportunity.pdf.

While some individual ports with nature strategies may apply rigorous biodiversity frameworks, global initiatives and pathways for operationalizing nature-positive ports lack consistent guidance on biodiversity measurement and alignment with the mitigation hierarchy. They do not tend to use terms such as no net loss or net gain, and work on biodiversity impact metrics is not consistently emphasized. Biodiversity impact is only one of several factors seen as contributing to nature-positive ports, along with emissions, pollution and circularity. Emphasis is typically placed on coastal ecosystems with significant “blue carbon” value, more than on other vulnerable habitats or species.

Without a more consistent approach, there is a risk that ocean industries will be subject to inconsistent standards. This can also be seen when comparing offshore wind with the shipping sector, which ports can influence through the usage rules they set. The latter is making huge progress on greenhouse gas emission reduction, but to date has focused far less than the offshore wind sector on managing other environmental impacts.[41]

POLICY RECOMMENDATIONS FOR GOVERNMENTS AND REGULATORS

- Clearly align public strategies and policies related to the expansion of port infrastructure with relevant environmental protection legislation and strategic plans for future offshore wind development.
- Establish an ecosystem-based MSP approach that includes all port infrastructure and related changes in vessel transit routes.
- Incentivize use of nature-based solutions that support nature-positive outcomes, through public financing and procurement rules.

SUPPORTING ACTIONS FOR STAKEHOLDERS

To complement government and regulatory actions on aligning port development with environmental protection and MSP, stakeholders across industry, civil society and technical communities should coordinate efforts to integrate biodiversity-positive approaches into ports development as a key enabler of offshore wind. Actions that could be taken by non-state actors include:

Strengthening collaboration between ports and offshore wind

- Establish joint platforms and workstreams connecting ports and offshore wind stakeholders, building on existing global initiatives (e.g., Resilience4Ports, WEF pathways, offshore wind biodiversity workstreams).
- Integrate offshore wind industry representatives into port-focused forums (e.g., R4P) to promote alignment on shared challenges and opportunities.
- Identify and scale joint enabling measures, such as shared ecological baselines, strategic mitigation plans, or joint nature enhancement projects in and around ports.
- Promote shared advocacy and local engagement, ensuring that strategic planning processes (e.g., MSP, port masterplans) embed measurable biodiversity goals and support nature-positive energy transitions.

[41] WWF (2025), “Towards Nature Positive for the Ocean.”

Advance evidence, standards and nature-based solutions for ports

- Develop and disseminate evidence on the ecological impacts and biodiversity co-benefits of nature-based solutions for port infrastructure.
- Create and harmonize standards and metrics for measuring biodiversity outcomes in ports, ensuring alignment with offshore wind biodiversity frameworks to avoid inconsistent benchmarks across ocean industries.
- Pilot and scale projects such as coastal and marine habitat restoration, living shorelines and enhanced blue carbon ecosystems as part of port upgrades and expansions.
- Foster knowledge-sharing and capacity-building to help ports in emerging and developing markets apply nature-based solutions cost-effectively and at scale.

4 Decommissioning

As first-generation offshore wind farms approach the end of their operational lives, there is growing discussion of how to extend their lifetime, repower or decommission them in ways that uphold environmental integrity and social responsibility. This transition point presents a critical opportunity to align end-of-life strategies with the objectives of nature-positive offshore wind deployment.

Historically, end-of-life planning has received less attention than project development and operations. However, the scale of future decommissioning is significant: by 2035, more than 3.5 GW of offshore wind assets worldwide are expected to reach the end of their operational life.[42] Without deliberate planning, end-of-life processes risk replicating environmental and social harms observed in other sectors. For example, unsafe and poorly regulated oil and gas decommissioning and shipbreaking have led to pollution, biodiversity loss and human health impacts.[43]

Focus is beginning to shift. The trade association RenewableUK published a report this year laying out the key trade-offs and challenges involved in different end-of-life scenarios for offshore wind farms.[44] In addition to looking at commercial and technical challenges, the report highlights the environmental challenges and opportunities involved.

Decommissioning offshore wind farms will have both direct and indirect impacts on local seabeds and coastal ecosystems. Key concerns include physical disturbance from removal activities (e.g., monopile extraction, cable retrieval), sediment resuspension and potential contaminant release, underwater noise impacts on sensitive species, and downstream impacts from the potential export of decommissioned materials to countries with weaker environmental safeguards.

Moreover, offshore wind foundations and associated scour protection can function as artificial reefs, supporting diverse assemblages of invertebrates, fish and marine mammals. Decisions about whether, when and how to remove or retain infrastructure can thus significantly affect biodiversity outcomes. Full removal can disturb benthic habitats, colonizing communities, and other species these communities support. Strategically retaining or repurposing some structures may support ecological enhancement and continuity, but create other considerations for navigation, fisheries or baseline restoration goals.

Conversely, if materials are not removed and reused, more virgin materials will need to be extracted, leading to the well-documented and significant adverse environmental impacts from mining operations. Some analysts have argued that in order to meet global offshore wind expansion targets sustainably, it is imperative to find ways to refurbish components and recycle materials.[45] In any case, there are significant opportunities

[42] Spyroudi, A. (2021). “End-of-Life Planning in Offshore Wind.” ORE Catapult. https://ore.catapult.org.uk/resource-hub/analysis-reports/end-of-life-planning-offshore-wind.
[43] Engineering X (2024). “Safer End of Life for Offshore Wind Infrastructure: Workshop Report, November 2024.” London: Royal Academy of Engineering. https://engineeringx.raeng.org.uk/media/hcdl42tu/engineeringx-offshore-wind-workshop-report.pdf.
[44] RenewableUK (2025). “Developing Effective End- of-Life Policy Frameworks for UK Offshore Wind.” London. https://www.renewableuk.com/media/bfcjsiwa/developing-effective-end-of-life-policy-frameworks-for-uk-offshore-wind.pdf.

for both the supply chain and improved nature-positive outcomes in end-of-life policy frameworks that enable circular economy solutions.

Stakeholders increasingly recognize the need to embed decommissioning considerations from project inception, including through regulatory and financial frameworks. It is also important to rely on ecological evidence to guide decisions on whether to fully or partially remove infrastructure for the best biodiversity outcomes. Strengthening cross-border coordination can help avoid regulatory gaps and resulting biodiversity losses.

GAP ANALYSIS

1. Lack of coherent regulatory frameworks

Regulations governing decommissioning are fragmented and often lack explicit biodiversity provisions. There is little clarity on expectations for infrastructure removal, timelines or adaptive management pathways. This is a particular barrier to the adoption of nature-inclusive design at the inception of offshore wind projects, as there is uncertainty around the future of such schemes.

2. Insufficient ecological evidence

Although data on ecological colonization is growing, there are still no standardized approaches for assessing the relative benefits and harm to biodiversity from removing, modifying or fully retaining wind farm structures. Similarly, there are few widely accepted and government-endorsed approaches for measuring and comparing site-specific, downstream and upstream biodiversity trade-offs.

3. Weak accountability and risk export

End-of-life components may be shipped to jurisdictions with weak environmental safeguards, and efforts to recycle them thereby could lead to unintended harm to human health and ecosystems.

4. Limited integration with strategic ocean planning

Decommissioning is often absent from marine spatial planning, biodiversity strategies and permitting frameworks.

POLICY RECOMMENDATIONS FOR GOVERNMENTS AND REGULATORS

- Incorporate decommissioning into marine spatial planning to align with objectives for conservation, fisheries and the blue economy.
- Include non-price criteria for sustainable decommissioning in offshore wind tenders.
- Develop or adopt international decommissioning standards to prevent the export of environmental risk and ensure biodiversity safeguards along the value chain.
- Create enabling regulatory and financial mechanisms (e.g., decommissioning bonds, biodiversity offset funds, circular economy incentives) to support nature-positive outcomes.
- Require transparent reporting and monitoring on decommissioning practices, including biodiversity indicators, restoration actions and material flows.

[45] Bennet, L., A. Spyroudi, and L. Stevenson (2022). “End of Life Materials Mapping for Offshore Wind in Scotland: Report from Phase 1 of the Elmwind Project.” ORE Catapult. https://ore.catapult.org.uk/resource-hub/analysis-reports/end-of-life-materials-mapping-for-offshore-wind-in-scotland.

- Enable regulators to adapt decommissioning requirements and strategies to shifting environmental baselines with regard to biodiversity, particularly as conditions naturally change due to climate change, natural variability and host of other factors.
- Invest in domestic recycling and processing capacity to minimize environmental burdens on other regions and strengthen local green industries.

SUPPORTING ACTIONS FOR STAKEHOLDERS

To complement government and regulatory measures, stakeholders across industry, civil society and research communities must play an active role in embedding biodiversity and circularity principles into decommissioning frameworks. This is essential to ensure offshore wind delivers positive ecological outcomes throughout its full lifecycle. Actions they can take include:

Develop nature-positive decommissioning frameworks

- Co-develop technical guidance and standards to evaluate ecological outcomes of different decommissioning options (full removal, partial retention, adaptive reuse), ensuring alignment with biodiversity, restoration, and circularity objectives.
- Integrate biodiversity considerations early by embedding decommissioning planning into leasing and permitting frameworks, with clear ecological criteria and adaptive management pathways providing clarity on conditions under which ecological enhancements may appropriately remain in place post-decommissioning.
- Promote harmonization across markets through common reference standards and principles to enable predictable and nature-positive decommissioning processes globally.

Strengthen accountability and international coherence

- Advance international standards and governance frameworks to prevent regulatory arbitrage, particularly related to transboundary waste flows and downstream biodiversity impacts.
- Embed decommissioning safeguards in multilateral ocean and climate policies to ensure coherent treatment of end-of-life infrastructure across jurisdictions.
- Foster transparency and accountability through common reporting frameworks on biodiversity impacts, restoration actions and material flows.

Advance circularity and biodiversity co-benefits

- Integrate circular economy principles into decommissioning strategies, prioritizing reuse, recycling and responsible disposal to reduce extraction pressures elsewhere.
- Pilot biodiversity-positive retention or repurposing of offshore structures where ecological benefits can be demonstrated (e.g., artificial reefs, habitat continuity).
- Promote innovative financing mechanisms that support both circularity and nature-positive outcomes, including decommissioning bonds or biodiversity offset funds.

5 Conclusion

Offshore wind is already recognized as a vital sector in the global energy transition needed to avert dangerous climate change. Nature-positive offshore wind goes further, addressing the connected threat of biodiversity loss and offering enhanced socio-economic value to the communities where it is developed. There is clear opportunity for offshore wind to lead the way and model urgently needed regenerative development for other ocean-based industries.

Huge progress has been made in recent years to look at what more offshore wind can do for nature. Many solutions are being developed and implemented, whether technical solutions or enabling frameworks. However, gaps remain, and there is more work to do.

This report has examined four key entry points for improved integration of biodiversity in the global expansion of offshore wind: through use of non-price criteria in renewable energy auction, and in the planning of offshore transmission infrastructure, ports and decommissioning.

Policies and institutions have a central role to play. Explicitly incorporating biodiversity criteria in auctions for offshore wind – in pre-qualification stage and/or at the award stage – can make nature-positive design the new norm and gradually raise standards. Such criteria could also include the offshore grid, as well as plans for sustainable decommissioning at the end of a wind farm's life. Other valuable policy tools include marine spatial planning and robust environmental protection policies, backed by consistent enforcement.

Multi-stakeholder collaboration is critical to progress. The industry, civil society, technical experts and financial institutions can contribute in multiple ways, but particularly by helping to advance shared knowledge and learning on best practice, which is still developing. Much of the existing literature is based on experience in mature markets in Europe, so as this work progresses, it is important to prioritize analysis and guidance that speak to new and emerging markets.

Annex: References

As noted in the introduction, this report is based on a review of a wide range of reports and other publications and documents. This annex presents them in two groupings: items cited in the text, and supplemental reading – that is, materials that informed this report, but are not cited directly.

Works cited

Arsenova, M., P. Skyt, and A. Qadeer (2024). "The Strategic Value of Community Benefits in Offshore Wind Development." Discussion paper. Washington, DC: Offshore Wind Development Program, World Bank Group. https://www.esmap.org/ESMAP-Offshore-Wind-Community-Benefits

Bennet, L., A. Spyroudi, and L. Stevenson (2022). "End of Life Materials Mapping for Offshore Wind in Scotland: Report from Phase 1 of the Elmwind Project." ORE Catapult. https://ore.catapult.org.uk/resource-hub/analysis-reports/end-of-life-materials-mapping-for-offshore-wind-in-scotland

Elia Group and Ørsted (2024). "Making Hybrids Happen: Enabling Offshore Hybrid Projects to Enhance Europe's Energy Transition." White paper. https://cdn.orsted.com/-/media/www/docs/corp/com/about-us/whitepaper/elia-group-x-orsted-making-hybrids-happen.pdf

Energinet (2024). "Sustainability Report 2023." Fredericia, Denmark. https://en.energinet.dk/about-our-reports/reports/sustainability-report-2023/

Energinet (2025). "Integreret Årsrapport 2024." Dok. 24/11172-1. Fredericia, Denmark. https://energinet.dk/om-publikationer/publikationer/integreret-aarsrapport-2024/

Engineering X (2024). "Safer End of Life for Offshore Wind Infrastructure: Workshop Report, November 2024." London: Royal Academy of Engineering. https://engineeringx.raeng.org.uk/media/hcdl42tu/engineeringx-offshore-wind-workshop-report.pdf

ENTSO-E (2024). "Offshore Network Development Plans: European Offshore Network Transmission Infrastructure Needs." Pan-European summary. Brussels. https://eepublicdownloads.blob.core.windows.net/public-cdn-container/tyndp-documents/ONDP2024/web_entso-e_ONDP_PanEU_240226.pdf

ESMAP (2024). "Integrated Environmental & Social Sensitivity Mapping: Guidance for Early Offshore Wind Spatial Planning." Washington, DC: World Bank Group. https://www.esmap.org/Integrated_Environmental_Social_SSensitivity_Mapping

GWEC (2025). "Global Offshore Wind Report 2025." Lisbon: Global Wind Energy Council. https://www.gwec.net/reports/globaloffshorewindreport

GWEC and BCG (2023). "Mission Critical: Building the Global Wind Energy Supply Chain for a 1.5°C World." Brussels: Global Wind Energy Council and Boston Consulting Group. https://www.gwec.net/reports/supplychain

Hermans, A. (2023). “Nature-Inclusive Design: Offshore Grid.” Presented at TenneT, January 26. https://renewables-grid.eu/app/uploads/2023/01/Annemiek_Hermans_presentation_260123_NID_Offshore_Grid.pdf

ICSI (2025). “Resilience4Ports: Strategic Plan 2025–27.” International Coalition for Sustainable Infrastructure. https://sustainability-coalition.org/publication/resilience4ports-strategic-plan-2025-27/

James, M., K. Jannusch, K. Koenig, J. McGowan, J. Small, and E.I. Yahr (2023). “Using Non-Price Criteria in State Offshore Wind Solicitations to Advance Net Positive Biodiversity Goals.” Institute for Energy and the Environment at Vermont Law and Graduate School and The Nature Conservancy. https://www.vermontlaw.edu/wp-content/uploads/2024/07/iee-tnc_offshore-wind-report_20230606_1644.pdf

Lloyd’s Register Foundation (2025). “Foresight Review of Nature-Positive Engineering.” Report No. 2025.1. https://www.lrfoundation.org.uk/publications/foresight-review-of-nature-positive-engineering

Nature Positive Initiative (2023). “The Definition of Nature Positive.” https://4783129.fs1.hubspotusercontent-na1.net/hubfs/4783129/The%20Definition%20of%20Nature%20Positive_v12.pdf

NSEC (2024). “Work Programme 2025–2027.” North Seas Energy Cooperation. https://circabc.europa.eu/ui/group/9198696f-e42c-4a88-b4f1-7a1788eb9b7c/library/956a342b-0135-45ae-bc9a-20427de22333/details

OCEaN (2024). “Avoidance and Minimisation of Environmental Impacts from Offshore Wind and Grid Infrastructure.” Offshore Coalition for Energy and Nature. https://offshore-coalition.eu/launch-of-report-avoidance-and-minimisation-of-environmental-impacts/

RenewableUK (2025). “Developing Effective End-of-Life Policy Frameworks for UK Offshore Wind.” London. https://www.renewableuk.com/media/bfcjsiwa/developing-effective-end-of-life-policy-frameworks-for-uk-offshore-wind.pdf

Resilience Rising (2022). “The Maritime Resilience Breakthroughs.” https://www.climatechampions.net/media/dirpvrah/maritimeresiliencebreakthroughs.pdf

Spyroudi, A. (2021). “End-of-Life Planning in Offshore Wind.” ORE Catapult. https://ore.catapult.org.uk/resource-hub/analysis-reports/end-of-life-planning-offshore-wind

SSE Renewables (2024). “SSE and APG Move Forward with Development of Offshore Wind Farm in the Netherlands.” July 9. https://www.sserenewables.com/news-and-views/2024/07/sse-and-apg-move-forward-with-development-of-offshore-wind-farm-in-the-netherlands/

Stephenson, P.J. (2024). “Monitoring Biodiversity at Sea: Discussion Paper on Advancing Standardised Biodiversity Monitoring for Nature-Positive Offshore Wind Development.” GINGR Navigator No. 2. https://www.gingr.org/_files/ugd/0928d6_ad2fa2c80b9b4cf1a35386bf347212bb.pdf

Systemiq (2025). “Capturing the Offshore Wind Opportunity: The Critical Role of Port Development and Regional Coordination in Scaling Offshore Wind in Emerging Markets and Developing Economies.” https://www.systemiq.earth/wp-content/uploads/2025/06/Capturing-the-offshore-wind-opportunity.pdf

The Crown Estate (2023). “2023, Cefas, Offshore Wind Evidence and Change Programme (OWEC), Electromagnetic Fields (EMF) Modelling Workshop.” Marine Data Exchange, July. https://www.marinedataexchange.co.uk/details/TCE-3718

The Crown Estate (2024). “2023, The Crown Estate, Offshore Wind Evidence and Change Programme (OWEC), Nature Inclusive Cable Enhancement Programme (NICE).” Marine Data Exchange, January. https://www.marinedataexchange.co.uk/details/TCE-3902

TNC (2025). “Beyond Price: How Non-Price Criteria in Renewable Energy Auctions Can Help Deliver for Climate, Nature and People.” The Nature Conservancy. https://www.nature.org/content/dam/tnc/nature/en/documents/n/o/non-price-criteria-TNC-europe.pdf

UNGC (2023). “Sustainable Ocean Principles: Practical Guidance – Ports.” New York: Ocean Stewardship Coalition, UN Global Compact. https://communications-assets.unglobalcompact.org/docs/publications/UNGC-Practical%20Guidance-Ports.pdf

UNGC (2024). “Net-Positive Biodiversity in Offshore Renewable Energy: Minimum Criteria and Recommendations for Action.” New York: Ocean Stewardship Coalition, UN Global Compact. https://unglobalcompact.org/library/6197

WEF (2025). “Nature Positive: Role of the Offshore Wind Sector.” Insight report. https://reports.weforum.org/docs/WEF_Nature_Positive_Role_of_the_Offshore_Wind_Sector.pdf

WEF (2025). “Nature Positive: Role of the Port Sector.” Insight report. https://www.weforum.org/publications/nature-positive-transitions-sectors/port-sector/

WindEurope (2021). “A 2030 Vision for European Offshore Wind Ports: Trends and Opportunities.” Brussels. https://windeurope.org/data/products/a-2030-vision-for-european-offshore-wind-ports-trends-and-opportunities/

WindEurope (2025). “Europe Needs Stronger Ports and More Vessels to Meet Its Offshore Wind Goals.” August 4. https://windeurope.org/news/europe-needs-stronger-ports-and-more-vessels-to-meet-its-offshore-wind-goals/

World Bank (2025). “Nature-Based Solutions for Ports: An Overview of NBS Implementation in Practice – Opportunities and Challenges.” https://hdl.handle.net/10986/43420

WWF (2025). “Towards Nature Positive for the Ocean: Pathways for Corporate Contributions.” http://doi.org/10.5281/zenodo.15587372

WWF (2025). “Unlocking the Potential of Non-Price Criteria in Wind Energy Auctions.” Position paper. https://www.wwf.eu/?18641841/NNPC-in-wind-energy-auctions-position-paper

Supplimental Reading

ARUP and Resilience Rising (2022). "Port Resilience: Framework for Action." https://sustainability-coalition.org/wp-content/uploads/2022/11/2022-Ports-Report_V2.pdf

BirdLife International (2025). "Making Nature Count in Offshore Wind Auctions." https://www.birdlife.org/wp-content/uploads/2025/05/BirdLife_NPC-report_Online-Version.pdf

BirdLife International (2023). "Winds of Change: Powering Healthy Seas through a Nature Positive Energy Transition." https://www.birdlife.org/wp-content/uploads/2023/05/Winds-of-Change_BirdLife-Europe-Central-Asia.pdf

ESMAP (2025). "Making Offshore Wind Work: Key Factors for Successful Development of Offshore Wind in Emerging Markets." https://www.esmap.org/Offshore-Wind-Key-Factors

Eurelectric (2024). "Power Plan 2.0 – A Guidebook to Electrify in Harmony with Nature." https://powerplant.eurelectric.org/wp-content/uploads/2024/06/Eurelectric-Biodiversity-Integration-Guidebook-12-06-24_FINAL.pdf

European Commission (2025). "Responses to European Commission Public Consultation: Renewable energy auctions – Implementing Act on Non-Price Criteria." https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14410-Renewable-energy-auctions-Implementing-Act-on-non-price-criteria/feedback_en?p_id=19011

ICSI and R4P (2024). "Moving the Needle on Port Resilience." https://sustainability-coalition.org/wp-content/uploads/2024/11/R4P-Report_2024.pdf

ICSI (2024). "Resilience4Ports: Call to Action." https://sustainability-coalition.org/publication/resilience4ports-call-to-action/

IOC UNESCO (2021). "Principles of Sustainable Ocean Planning." https://www.ioc.unesco.org/en/sustainable-ocean-planning

Nordic Energy Research (2023). "Coexistence and Nature-Inclusive Design in Nordic Offshore Wind Farms." https://www.norden.org/en/publication/coexistence-and-nature-inclusive-design-nordic-offshore-wind-farms

Nordic Innovation (2024). "New Offshore Wind Ports in the Nordics: Opportunities for Collaboration and Strategic Innovation." https://norden.diva-portal.org/smash/get/diva2:1893478/FULLTEXT01.pdf

NSEC (2024). "Delivering the Offshore Renewable Energy Ambitions in Europe." North Seas Energy Cooperation. https://www.benelux.int/wp-content/uploads/2024/11/NSEC-Recommendations-SIGNED.pdf

NYSERDA (2020). “Cumulative Impact Studies.” https://briwildlife.org/energy-offshore-wind-in-nys/

Ocean Panel (2025). “Handbook on Sustainable Ocean Plans.”
https://oceanpanel.org/wp-content/uploads/2025/10/25_HLP_Handbook_v10.pdf

SSE Renewables (2023). “Non-Price Criteria in Renewables Auctions.”
https://www.sserenewables.com/media/s4ujcww4/sser-position-paper-non-price-criteria-in-renewables-auctions-june-2023.pdf

TNC (2023). “Offshore Wind for Nature.” The Nature Conservancy.
https://www.nature.org/content/dam/tnc/nature/en/documents/Biodiversity-Opportunities-in-Offshore-Wind-Development-A-Symposium-Report.pdf

UN High Level Climate Champions and the Marrakech Partnership (2023). “Ocean Breakthroughs.”
https://ocean-breakthroughs.org/

WEF (2025). “Principles for Responsible Deployment of Renewable Energy Infrastructure.” World Economic Forum.
https://reports.weforum.org/docs/WEF_Principles_for_Responsible_Renewables_Deployment_2025.pdf

WEF (2024). “Clean Energy as a Catalyst for Nature-Positive Transition.” World Economic Forum.
https://www3.weforum.org/docs/WEF_Clean_Energy_2024.pdf

WWF (2025). “Towards Nature Positive for the Ocean: Offshore Wind Brief.”
https://files.worldwildlife.org/wwfcmsprod/files/Publication/file/4os77cmb19_NPOP_Offshore_Wind_Sector_Summary.pdf

WWF (2024). “New Horizons: The Space Needed for Offshore Wind Energy in the EU.”
https://www.wwfcaucasus.org/?15163891/report-space-for-offshore-wind

WWF (2023). “Building a Nature-Positive Energy Transformation.”
https://files.worldwildlife.org/wwfcmsprod/files/Publication/file/56sr3qndka_Nature_Friendly_Energy_Report.pdf

Ørsted (2023). “Uniting Action on Climate and Biodiversity.”
https://orsted.com/en/what-we-do/insights/white-papers/uniting-action-on-climate-and-biodiversity