NATURE PROTECTION AND OFFSHORE RENEWABLE ENERGY IN THE EUROPEAN UNION

Position Paper

WWF European Policy Office

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CONTENT

EXECUTIVE SUMMARY

Climate change and biodiversity collapse are the two greatest threats facing both humans and nature today. These crises are intertwined, and must be addressed jointly. In parallel, **solutions put forward to address one of these crises should not contribute to worsening the other one.**

To limit global temperature increase to 1.5°C as set in the Paris Agreement, the EU must achieve climate neutrality by 2040, thereby eliminating fossil fuels and achieving a 100% renewables-based energy supply as soon as possible. Alongside energy sobriety, offshore renewable energy constitutes an essential part of the energy transition towards a resilient and fully decarbonized economy, and is indispensable in achieving a climate neutral Europe. Tremendous efforts at EU level are now needed to provide the enabling conditions for substantially increasing renewable energy capacity by 2030. The development of the EU's offshore renewable energy sector will generate employment opportunities, contributing to the EU's sustainable blue economy and supporting economic recovery following the Covid-19 pandemic.[1]

At the same time, development of offshore renewables adds to the already numerous other economic at-sea activities, which add their own pressures to marine ecosystems. Thus, offshore renewable energy projects must be considered within the broader context of our ocean's degrading health due to overexploitation of resources, pollution, acidification and habitat destruction, to name a few causes. Beyond implications for biodiversity, this trend is problematic from a climate perspective, as the ocean plays a vital role in regulating our planet's climate.

Offshore renewable infrastructure is still infrastructure. It needs to be subject to best-practice planning and design, and requires rigorous evaluation using both environmental impacts assessments (EIA) and strategic environmental assessments (SEA). When developing offshore renewable projects, it is therefore crucial to adopt an ecosystem-based approach, use marine space carefully and support ocean resilience by staying within ecosystem boundaries.

Offshore renewable energy development will only achieve its objective of supporting the EU's transition towards truly sustainable societies if it offers solutions for the climate crisis that are fully compatible with marine biodiversity recovery, ocean resilience and a just energy transition. This paper primarily refers to offshore renewable wind energy in examples as it is the most mature offshore renewable energy to date, however the principles outlined also apply to tidal, floating solar, wave and indeed, any future renewable energy in the maritime space.

[1] High Level Panel for a Sustainable Ocean Economy, Transformations for a Sustainable Ocean Economy, https://oceanpanel.org/ocean-action/files/transformations-sustainable-ocean-economy-eng.pdf

Key policy recommendations

- The increased deployment of offshore renewable energy needed to meet the EU's climate and energy targets must **not be done at the expense of environmental protection in European seas and should not compromise existing biodiversity targets in the EU.**

- Regional cooperation, between Member States and neighbouring states, should be fostered through joint planning and acting on regulatory barriers, and also by **creating regional marine spatial usage maps** that are accessible to all stakeholders and regularly revised via a robust common monitoring framework.

- Investments in offshore energy projects should align with the Paris Agreement, actively support the UN Sustainable Development Goals and should be consistent with both the 'energy efficiency first' principle and Do No Significant Harm criteria set out under the EU Taxonomy.

- Transparent and inclusive participatory processes and stakeholder involvement will be crucial in preventing and solving conflicts with other sea space users and uses. Offshore renewable energy projects should be developed in **full respect of the Partnership Principle**, as enshrined by the European Code of Conduct on Partnership, and should be included under development plans created at the local and regional level which aim to develop **secure supply chains and decent jobs**.

- The development of offshore renewable energy should be integrated with other relevant EU policies. It should be aligned with a coherent and accelerated action plan for marine **conservation and restoration**. Offshore renewable energy projects' site location should be based on ecosystem-based and forward-looking **Maritime Spatial Planning** and effective **Strategic Environmental Assessments**. Offshore renewable development also needs to be aligned with the requirements set up by the **MSFD** for Sustainable Blue Economy planning and implementation.

- As a first principle, **renewable energy developments should not be placed within Marine Protected Areas (MPAs) and other ecologically valuable areas for sensitive species and habitats**. In particular, they must not be allowed in EU strictly protected areas designated as such under the EU Biodiversity Strategy.

- Member States should always subject offshore renewable energy projects to inclusive, transparent and effective **Environmental Impact Assessments (EIAs)**, including outside of protected areas.

THE ROLE OF OFFSHORE RENEWABLES IN MEETING CLIMATE & ENERGY TARGETS

We are in a race against time. We have less than a decade to limit global temperature increase to 1.5°C and avoid the most catastrophic impacts of climate change. Under current policy scenarios, the world is still heading for a temperature rise just under 2.9°C this century[2].

According to the UN Emissions Gap Report 2019, **the EU must cut greenhouse gas (GHG) emissions by at least 65% compared to 1990 levels by 2030** if it is to do its share to stay below the 1.5°C, and that is without taking into account equity-related issues such as the EU's wealth and responsibility for historical emissions. This would translate into a yearly GHG emissions reduction rate of 7.6% per year.[3]

In the longer term, the IPCC projects that the world would need to become carbon neutral by 2050 for a 50% chance of staying below the 1.5°C temperature goal.[4] At EU level, **it is both feasible and necessary that the EU achieves climate neutrality by 2040**. According to various studies[5], this can be done through a **complete phase out of fossil fuels - including gas - and a switch to a 100%-renewables based energy system by 2040**. At the same time, individual and collective solutions must be applied across all sectors, through a more efficient use of our energy, behavioural change and generalised public participation, and dedication to environmental and biodiversity protection.

Huge efforts are needed if we are to create the enabling conditions at EU level for substantially increasing renewable energy capacity during this decade. The EU's target of at least 32% of renewable energy by 2030 has been an important driver of climate action, but it is insufficient to achieve a fully decarbonised economy by 2040, and it should be increased to **at least 50% by 2030**.

Whereas most of the renewable energy capacity is expected to be covered by onshore wind and solar energy, deployment rates of offshore wind energy are also predicted to grow substantially . As the European Commission stated, "*Europe's seas will be at the forefront of the EU's efforts to go carbon-free: offshore wind will be the fastest growing technology*"[6]. Commitments have been made at EU-level to massively deploy offshore wind energy during this decade, from 12 GW today[7] to 3 to 5 times this amount in 2030.

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[2] See: https://climateactiontracker.org/global/temperatures/
[3] UNEP, "Emissions Gap Report 2019", 26 November 2019.
[4] IPCC, "Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty", December 2018, p. 96.
[5] See for example: Climate Action Network (CAN) Europe and European Environment Bureau, "Building a Paris Agreement Compatible (PAC) energy scenario", June 2020; DIW Berlin, "Make the European Green Deal Real – Combining Climate Neutrality and Economic Recovery", June 2020; Climact, "Increasing the EU's 2030 emissions reduction target", June 2020; LUT University, "100% renewable Europe. Leadership scenario", May 2020.
[6] European Commission, "Impact Assessment: Stepping up Europe's 2030 climate ambition", September 2020, p. 59.
[7] WindEurope, "Offshore Wind in Europe: Key trends and statistics 2019", February 2020.

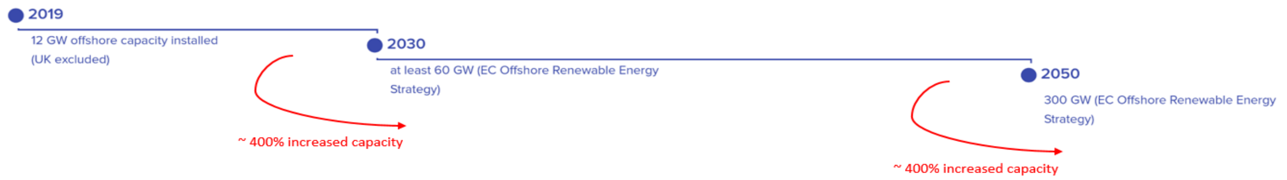

Figure 1: Timeline of offshore renewable energy deployment, according to milestones outlined the European Commission's Offshore Renewable Energy Strategy

In our race to decarbonise our energy systems, we must not forget the underlying objective of this climate transition, which is to stop the degradation of the planet's natural environment, for the benefit of nature and people. Since 1980, the ocean has absorbed up to 30% of human-induced CO2 emissions[8], and this is just one of the many invaluable services it provides to our societies - however, to fulfill this task, marine environments have to be healthy and resilient. Yet today, our ocean ecosystems are under increasing pressure and it is crucial to adopt an integrated approach and respect ecosystem boundaries when rolling out offshore energy. Ignoring the carrying capacity of marine ecosystems means contributing to altering the ocean's natural capacity to regulate climate, ultimately defeating the purpose of the clean transition.

Good governance is essential to ensure that deployment of offshore renewable energy occurs in a nature-friendly manner and supports a just energy transition that leaves no one behind. It is important to recognize that realizing offshore renewable energy's full potential in Europe should not compromise the achievement of both Good Environmental Status and Favourable Conservation Status in EU Waters, as well as the marine protection targets embedded in the EU Biodiversity Strategy. While technological innovation may permit ramping up of offshore renewable energy production in the future, through e.g. cost reduction or more efficient use of space, such increase in production must not be done at the expense of environmental protection in EU seas. Wise spatial planning outside of sensitive areas, using marine space in a careful and considered manner while preserving ocean resilience, and working in a nature-based way while adhering to precautionary principles are all considerations that need to be taken into account when meeting energy targets. In other words, reaching energy production targets is an equation within which environmental requirements are a constant, and technological innovation is a variable that will evolve positively over time.

Regulations and investment

The various forms of offshore energy production, such as offshore floating wind and solar power, wave and tidal energy require different regulatory approaches adapted to both their different environmental impacts and their financial support needs in terms of innovation and deployment.

Public procurement rules and investment incentives should ensure that companies across the supply chain commit to upholding the principles of decent jobs[9], while crucially driving sustainable investment and renewable supply chain development. This means that investments should be incentivised in a consistent manner with the 'energy efficiency first' principle and should not harm biodiversity and environment goals as set out by the EU Taxonomy. For instance, the United Nations Environment Programme's Finance Initiative (UNEP-FI) recently published guidelines for investors in offshore renewables, based on an analysis of the various policy, regulatory and reputational risks associated with the impacts of those projects.[10] Public procurement rules should therefore

[8] IPCC, Special Report on the Ocean and Cryosphere in a Changing Climate, 2019.
[9] See ETUC's definition of quality jobs as having good wages, access to social protection, lifelong learning opportunities, safe and healthy working conditions, reasonable working hours and trade union representation: https://www.etuc.org/en/document/etuc-resolution-defining-quality-work-etuc-action-plan-more-and-better-jobs#:~:text=the%20following%20features%3A-,Good%20wages,with%20good%20work%2Dlife%20balance
[10] United Nations Environment Programme Finance Initiative (2021) Turning the Tide: How to finance a sustainable ocean recovery—A practical guide for financial institutions, https://www.unepfi.org/publications/turning-the-tide/

also align with the Paris Agreement and ensure that investments are consistent with and actively support the UN Sustainable Development Goals.

Many of the issues arising with regards to the deployment of renewable energy sources - in particular in Eastern Europe - relate to investor risk and policy uncertainty. It would be relevant to dedicate EU funding for regulatory and capacity support for local municipalities wishing to develop projects. One such project is France Nature Environnement's 'Éoloscope offshore'[11], a planning tool for territorial dialogue that allows organisations to better understand their own and others' positioning on offshore wind projects, allowing for informed positions on the feasibility and acceptability of an offshore wind project and identification of contentious issues early on.

Across borders: regional cooperation and transdisciplinary frameworks

It is important to recognise the added value of cross-border offshore renewables development as a tool for increasing domestic renewable energy sources and reducing costs through economies of scale and space. Furthermore, ecosystems do not follow man-made borders, and can be connected beyond frontiers. Regional cooperation and planning at a sea-basin scale is therefore vital.

The EU constitutes an appropriate level to design an enabling framework and provide adequate funding to foster regional cooperation between Member States and better integrate offshore renewable energy in their energy systems. However, regional cooperation cannot be restricted to EU Member States. EU Member States should also cooperate with bordering third parties, for instance in complex sea basins such as the Mediterranean, or with neighbouring countries such as the UK and Norway in the North Sea or Russia in the Baltic Sea.

Regional cooperation should be the guiding principle for planning and developing offshore renewable energy sources. The EC shall foster regional cooperation between Member States and neighbouring States through an enabling framework and funding. High Level Groups based on the North Sea Energy Cooperation (NSEC) example for the North Sea or the Pomeranian Offshore Wind Conference for the Baltic Sea should be established for the Black Sea and the Mediterranean Sea. In addition to carrying out joint planning and acting on regulatory barriers, it offers the opportunity for creating regional marine spatial usage maps, which enable centrally storing data and maps for all stakeholders to access.[12]

Nevertheless, storing data and maps and sharing them through common platforms only constitute a first step, which must be complemented by a review mechanism of the general transdisciplinary framework that integrates socio-economic, governance and environmental dynamics in space and time, including across borders. Offshore renewable projects must be taken into account holistically, both as part of a national MSP process and through a regional coherent process. In order to adapt to changing conditions, it will be critical to deepen the analysis on adaptive governance and understand the key socio-ecological relationships on which governance depends at national, regional and EU levels. To do so, a regular revision mechanism for both MSP plans and processes should be coupled with a robust monitoring framework to help countries ensure their plans are effective, feasible and relevant, as well as to allow them to put into practice the precautionary principle when in doubt. To ensure cross-border consistency and effectiveness, countries should work on common monitoring frameworks.

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[11] For more information see France Nature Environnement, *Éoloscope offshore*, 2020, final version expected second semester 2021, current working version available at: https://ged.fne.asso.fr/silverpeas/LinkFile/Key/fa8009ab-0cfa-4dd8-b954-2c9a05948d12/%C3%89oloscope_offshore_v0_web.pdf

[12] For instance see Helcom, Map and Data Service, https://helcom.fi/baltic-sea-trends/data-maps/

Offshore renewable energy and a just transition

The clean energy transition is expected to be positive for overall job creation[13]. Yet, offshore renewable energy development can have different local impacts, as well as offer opportunities, and should therefore be developed in a transparent, open and inclusive way to ensure positive effects are optimised, negative impacts mitigated, policy resilience and community buy-in. Offshore renewable energy projects should be developed in full respect of the Partnership Principle as enshrined by the European Code of Conduct on Partnership and in line with best community led local development practices[14].

Renewable value chains will need to grow to meet offshore renewable energy goals. The jobs created in manufacturing, maintenance and decommissioning activities of offshore renewable infrastructure, as well as indirect activities linked to the value chain, must first and foremost benefit regions which have been negatively impacted by the transition. The EU must look to develop value chains in Europe to maximise the social and environmental value of the transition.

Efforts to foster a just transition should be particularly implemented in regions negatively affected by the transition to ensure that jobs lost in fossil sectors are replaced by sustainable ones. These jobs should contribute to an economy that is sustainable, circular and consistent with the Paris Agreement commitment to limit global average temperature rise to 1.5℃. Furthermore, to be sustainable in the long-term and to be consistent with a just transition, the jobs created in the offshore renewable value chain must also be decent, ensured through commitment to social dialogue and collective bargaining.

Clear, comprehensive and inclusive development plans are needed, at the territorial level to develop and maintain secure supply chains and service provision, including through targeted reskilling and upskilling of existing and future offshore workers. They should be backed up by national and EU commitments and strategies over the long-term, including through long-term financial frameworks. In addition, minimum time-bound targets for reskilling existing workers in the oil and gas industries within the local area, with a clear plan to achieve this, would also be helpful and contribute to delivering a just transition for workers.

Local-level capacity building and administrative support for municipalities are vital to ensure good local plan development. This will enable these important stakeholders to engage in the development of renewable projects and also to ensure they truly benefit communities and lead to a redistributive and just transition. Local-level engagement should also ensure that strategies are developed in a holistic way, aiming to unlock sustainable synergies with fishing communities and sustainable tourism, while natural resources and biodiversity are protected and ecosystem functions vital for people's wellbeing are preserved.

Finally, offshore renewables projects should always benefit local communities and contribute to a redistributive transformation of the energy system. As an example, support to the development of offshore renewables may require regulatory measures to improve the access for community energy schemes, which can in turn reduce energy poverty and redistribute the costs and benefits of the transition fairly.

[13] Offshore wind is estimated to generate approximately 4.9 direct jobs and 4.2 indirect jobs for every 1 million euros invested, while oil and gas generate 0.8 direct and 1.8 indirect jobs (figures taken from “UK export finance and domestic jobs” (2020) by Vivid Economics based on “Garett-Peltier "Green versus brown: Comparing the employment impacts of energy efficiency, renewable energy, and fossil fuels using an input-output model" (2017)”)

[14] An example of pioneering practices is illustrated in the “People’s Transition:Community-led Development for Climate Justice”report (2020) by TASC and FEPS. Available here: https://www.feps-europe.eu/attachments/publications/feps-tasc_the_peoples_transition_-_2020.pdf (accessed 05/03/2021). Other examples and guidelines of good practices exist, for examples, the Europe Beyond Coal “Seven Golden Rules for Open and Inclusive Just Transition Planning”, available here: https://beyond-coal.eu/2019/07/15/seven-golden-rules-for-open-and-inclusive-just-transition-planning-at-the-regional-level/

Technical considerations for energy efficiency of offshore wind turbines

Energy production optimisation is a key consideration when constructing an offshore wind farm. From an energy perspective, the wind density equation in the figure below is central to decisions concerning location of turbines, spacing between turbines, blade size and tower height. As can be seen from the formula below, wind speed is the most influential factor in achieving maximum energy production. At higher tower heights, the wind is stronger and more stable and larger blades can capture more wind. A larger swept area and higher wind speeds mean more mechanical power and thus, more electrical power from the generator. This optimisation of energy output is why engineers and developers increasingly favour higher turbines with larger blades.

Another consideration for maximizing the energy capacity of wind turbines is spacing between turbines. Interference, when turbines reduce the wind available to any turbines downwind of them, increases the closer wind turbines are to one another and results in decreased energy production. Wind speeds being reduced around and downstream of wind turbines as they convert kinetic energy to electricity, is often referred to as the 'wake effect'.[15] This can also lead to increased drag and turbulence, as turbines too close together allow turbulent air leaving the blades of one to pass on to turbines downstream. This stresses internal components, shortening the lifespan of the turbine, and can also worsen noise issues in the surrounding environment.

At sea, wind turbines have more space and the farther they are placed from buildings and topography, which increase turbulence, the stronger and more stable the wind is. Spacing is a delicate calculation as the farther apart turbines are the more costly the wind farm becomes. Furthermore, the Betz theory states that no horizontal axis wind turbine can extract more than 59.3% of kinetic energy from wind, this is known as the 'Betz limit'. Optimal functioning of wind turbines is impacted by a number of environmental factors meaning that one cannot rely on them to function at constant peak capacity, resulting in developers needing to compensate with a higher number of wind turbines in order to meet energy targets. From a policy and developer perspective, detailed analyses are undertaken to find the correct balance between efficiency in terms of spacing, energy targets, size and number of wind turbines, and the corresponding costs of space and materials.

$$= \frac{1}{2} pAv^3$$

Wind density
(power available)

A = swept area **v** = wind speed **p** = impact of air density (power)

Figure 2: Wind density equation, used to calculate the theoretical maximum power available to a wind turbine.

[15] See Agora-Energiewende's study 'Making the Most of Offshore Wind': https://static.agora-energiewende.de/fileadmin/Projekte/2019/Offshore_Potentials/176_A-EW_A-VW_Offshore-Potentials_Publication_WEB.pdf

Spotlight on hydrogen: an energy carrier receiving a lot of attention

Achieving decarbonisation of the economy will require integrating significant amounts of renewable energy sources into all sectors (e.g. industry, buildings, transport) and having recourse to high levels of direct electrification in the heating and cooling, and transport sector. A circular economy and a steep reduction in energy demand will also be essential to meeting our climate and energy goals. In some sectors however (e.g. aviation, shipping and heavy freight, production of steel, and basic chemicals), direct electrification will not be sufficient to meet energy demand and thus renewable hydrogen will play an important role. This has led to strong interest in hydrogen at the EU level, particularly regarding its production via offshore wind, and it is important to highlight here the disadvantages of hydrogen in the energy transition and also where it could, in specific circumstances, be used.

Contrary to the hype surrounding it, hydrogen is not a magic wand for instant decarbonisation. It is not an energy source but an energy carrier (like electricity), and it is only considered a clean energy source insofar as the energy that was used to produce it emanates from 100% renewable energy sources. Renewable hydrogen refers to the reliance on renewable energy sources (solar and wind) to provide an electric current for electrolysis. Yet today, over 95% of all hydrogen production is fossil-fuel based[16] and is mostly used for industrial chemical purposes.

Producing hydrogen entails significant energy losses, and also has a major impact on the environment through considerable water usage coupled with land and sea use. Current uses of hydrogen are mostly unsustainable and directed towards industrial applications which are expected to decrease in the coming decades (e.g. oil refining providing car fuels, ammonia for fertilizers, methanol), and so are not compatible with climate targets. A major shift in the production and use of hydrogen in Europe is needed before it can hold any promise to help decarbonise our economy, starting with producing only renewable hydrogen.

In addition to the aforementioned environmental and sustainability issues of current hydrogen production, the problem of energy inefficiency is also associated with hydrogen as it is an energy carrier. The European sea space is limited, in addition to the environmental conservation imperative, by a vast number of uses (military, fisheries, maritime routes, etc) and so space for new activities must be allocated through careful and coordinated planning. The potential proliferation of hydrogen energy clashes with its poor energy-efficiency record: around 60% of the original electrical energy is lost during the conversion of electricity into hydrogen through electrolysis and then of hydrogen back into electricity. Hydrogen production in this instance would lead to multiplication of windfarms in an already-crowded and pressured seaspace, with inefficient energy returns.

Taking all of these issues into account, we recommend that both onshore and offshore renewable hydrogen should only be produced from a surplus of renewables capacity. Within this scope, hydrogen will constitute a valuable asset to the clean transition, balancing the electricity grid by decreasing pressure on the electricity grid during peaks in demand and providing seasonal storage.[17]

[16] IRENA, Hydrogen from renewable power: Technology outlook for the energy transition, (2018), p. 13, https://www.irena.org/publications/2018/Sep/Hydrogen-from-renewable-power.

[17] You can read more about our hydrogen position ' WWF European Policy Office 'Climate neutrality by 2040: can hydrogen help?', available at: https://wwfeu.awsassets.panda.org/downloads/hydrogen_wwf_eu_position_summary_april_2021_final.pdf

Box 1: Recommendations on the use of offshore renewables in meeting climate and energy targets

- The increased deployment of offshore renewable energy needed to meet the EU's climate and energy targets must **not be done at the expense of environmental protection in EU seas**.

- Regional cooperation, between Member States and neighbouring states, should be fostered through joint planning and acting on regulatory barriers, and also by **creating regional marine spatial usage maps** that are accessible to all stakeholders and regularly revised via a robust common monitoring framework.

- Hydrogen acquired using offshore renewable energy should only be produced from **surplus renewables capacity**.

Box 2: Recommendations to ensure a fair deployment of offshore renewables

- Investments in offshore energy projects should align with the Paris Agreement, actively support the UN Sustainable Development Goals and should be consistent with both the 'energy efficiency first' principle and Do No Significant Harm criteria set out under the EU Taxonomy.

- Offshore renewable energy projects should be developed in **full respect of the Partnership Principle**, as enshrined by the European Code of Conduct on Partnership, and should be included under development plans created at the local and regional level which aim to develop **secure supply chains and decent jobs**.

OFFSHORE RENEWABLES IN THE MARINE ENVIRONMENT

Offshore renewable energies are vital to the energy transition. However, the United Nations Environment Programme Finance Initiative acknowledged in 2021 that "*as marine renewables grow in prominence, there is also a clear need for greater clarity on their impacts on society and the environment as well as how they interact with other users of the marine environment*".[18] WWF promotes a transformational change to a sustainable, "blue" economy that provides social and economic benefits for current and future generations; restores, protects and maintains the diversity, productivity and resilience of marine ecosystems; and is based on clean technologies, renewable energy, and circular material flows.[19]

It is imperative to acknowledge that offshore renewable energy projects are industrial infrastructure projects. Throughout their development cycle, their environmental impacts must be understood so as to best be avoided and to be addressed to avoid further degradation of our marine ecosystems. The example of offshore wind energy is illustrated below.

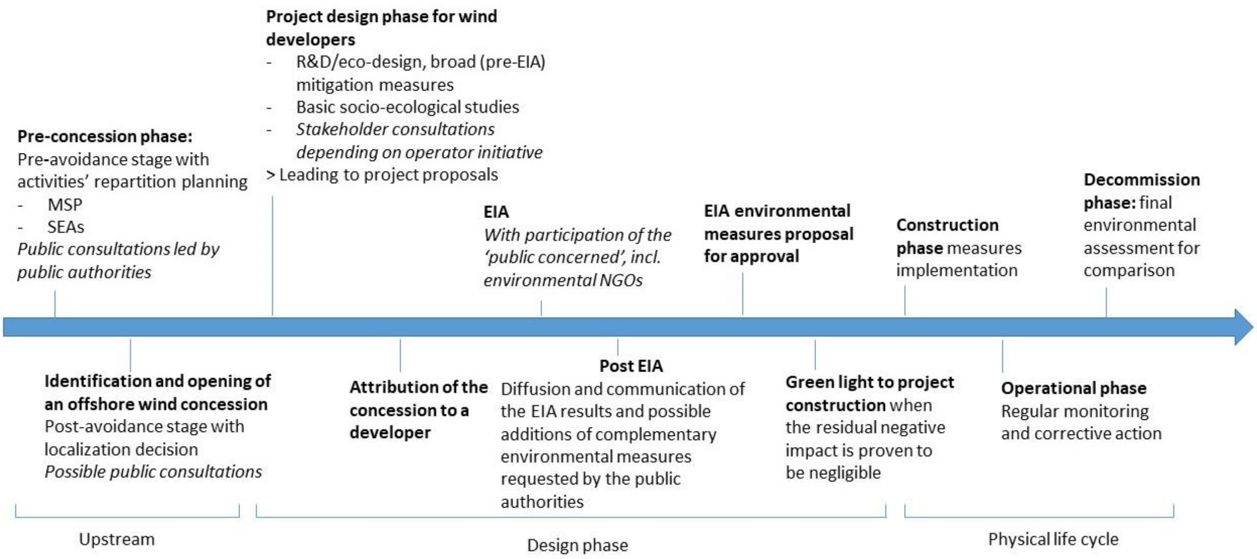

Figure 3. Overview of an offshore wind energy project broad development cycle. WWF, 2021.

[18] de Vos, K., Smith, J., Bruneau, N., Fritsch, D., Wilson, C., Garfunkel, A., Rising Tide: Mapping Ocean Finance for a New Decade, The United Nations Environment Programme Finance Initiative, 2021, https://www.unepfi.org/wordpress/wp-content/uploads/2021/02/The_Rising_Tide-Mapping_Ocean_Finance_for_a_New_Decade.pdf

[19] WWF, Deep seabed mining is an avoidable environmental disaster, 2021, https://wwf.panda.org/wwf_news/press_releases/?1416441/Deep-seabed-mining-is-an-avoidable-environmental-disaster

Understanding the risks posed to the marine environment

Offshore renewable energy projects are vital to implement the energy transition. However, their potentially significant negative impacts on marine and coastal environments must also be acknowledged, so that they are best avoided and managed.

Currently, the most prominent form of offshore renewables is offshore wind farms. Hence, they are the renewable energy infrastructures with the most data available regarding their environmental impacts. Pressure resulting from offshore wind farms typically consists of construction and operational noise, for instance from ship traffic for service and maintenance, shifts in hydrodynamics and sedimentation dynamics, habitat change, degradation or loss, potential reef or fish aggregating device (FAD) effect, electromagnetic fields and increased water temperature due to cables, various forms of pollution and waste such as chemical releases due to sacrificial anodes and anti-corrosion coatings, artificial lights, risks of collision, migration barriers .[20][21][22][23][24]

Due to these impacts, offshore wind farms affect all surrounding ecosystems below and above water, including benthic species and communities, phytoplankton, fish, marine mammals, turtles, as well as birds and bats.

Furthermore, the effects of offshore wind farms on the marine environment also have a temporal dimension. As such, their importance may vary according to migration seasons for birds or cetaceans, spawning seasons for fish, or based on other seasonal pressures of human origins such as fishing seasons.

Lastly, it is worth noting that the impacts and risks vary depending on the technology used, as well as the scale and location of projects. Assessments of risks and impacts should always be case specific.

[20] Defingou M, Bils F, Horchler B, Liesenjohann T & Nehls G (2019): PHAROS4MPAs- A Review of Solutions to Avoid and Mitigate Environmental Impacts of Offshore Windfarms, BioConsult SH on behalf of WWF France, https://tethys.pnnl.gov/sites/default/files/publications/PHAROS4MPAs_OffshoreWindFarm__CapitalizationReport.pdf

[21] WWF-France (2019), Safeguarding marine protected areas in the growing Mediterranean blue economy. Recommendations for the offshore wind energy sector. PHAROS4MPAs project, https://pharos4mpas.interreg-med.eu/

[22] Piante, C., et al, 2019, Safeguarding Marine Protected Areas in the Meditteranean Blue Economy: Recommendations for Offshore Wind Energy Sector, Pharos4MPAs, Online https://pharos4mpas.interreg-med.eu/fileadmin/user_upload/Sites/Biodiversity_Protection/Projects/PHAROS4MPAs/OWF_POLICYBRIEF_17june_single_page.pdf

[23] Draget, E., Environmental Impacts of Offshore Wind Power Production in the North Sea: A Literature Overview, WWF Norway, 2014, https://www.wwf.no/assets/attachments/84-wwf_a4_report___havvindrapport.pdf

[24] Pellow, M. R. (ed.). Wildlife and Wind Farms, Conflicts and Solutions, Volume 3 (Offshore: Potential Effects), 290 pages, 2019, ISBN: 9781784271275; Volume 4 (Offshore: Monitoring and Mitigation), 330 pages, 2019, ISBN: 9781784271312.

PRESSURES, INTENSITY AND OCCURRENCE OF IMPACTS ON MARINE HABITATS AND ANIMAL GROUP

PRESSURE	IMPACT	TAXONOMIC GROUP / HABITATS	IMPACT INTENSITY DURING: Siting phase	Construction	Operation	Decommissioning
Cable laying	Habitat loss	**Habitats/ benthic communities**	—	MEDIUM/HIGH	LOW	LOW/UNKNOWN
Cable laying	Physical damage, disturbance		—	MEDIUM/HIGH	LOW	UNKNOWN
Foundations occupation	Habitat loss/ Physical damage, disturbance		—	MEDIUM/HIGH	LOW	—
Submerged structures	Reef effect		—	—	UNKNOWN	UNKNOWN
Underwater operating cables	Electromagnetic fields/Temperature increase		—	—	UNKNOWN	—
Piling noise	Physical damage, disturbance	**Fish**	—	HIGH	—	—
Underwater operating cables	Electromagnetic fields		—	-	UNKNOWN	UNKNOWN
Submerged structures	Reef effect		—	-	UNKNOWN	UNKNOWN
Foundations occupation	Habitat loss		—	MEDIUM/HIGH	LOW	—
Piling noise	Physical damage, disturbance	**Marine mammals**	—	HIGH	—	—
Ship traffic / Ship presence	Collision / displacement		UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Ship traffic - noise	Displacement		LOW/MEDIUM	MEDIUM/HIGH	MEDIUM/HIGH	MEDIUM/HIGH
Ship traffic	Displacement	**Birds**	LOW/MEDIUM		LOW/MEDIUM/HIGH depending on species	
Light	Collision		LOW		LOW/MEDIUM/HIGH depending on species	
Operating wind turbines	Collision		—	—	LOW/MEDIUM/HIGH depending on species	—
Operating wind turbines	Barrier effect		—	—	LOW/UNKNOWN	—
Operating wind turbines	Collision	**Bats**	—	—	UNKNOWN	—
Ship traffic	Collision	**Sea turtles**	LOW/MEDIUM	MEDIUM/HIGH	LOW/MEDIUM	LOW/MEDIUM
Piling noise	Physical damage, disturbance		—	HIGH	—	—
Light	Disorientation		UNKNOWN	UNKNOWN	UNKNOWN	UNKNOWN
Underwater operating cables	Disorientation due to EMF		—	—	UNKNOWN	—
Waste and pollution	Habitat degradation, disturbance, physical damage	**All taxonomic groups and habitats**	LOW	LOW	LOW	LOW
Sacrificial anodes	Habitat degradation, disturbance, physical damage		—	UNKNOWN	UNKNOWN	UNKNOWN

Figure 4. Pressures, intensity and occurrence of offshore wind energy impacts on marine habitats and animal groups, Pharos4MPAs, 2019.[25]

Offshore renewable energy projects and their associated infrastructures, such as transmission cables[26], can constitute new sources of cumulative impacts on marine and coastal environments, while our European seas are already in a dire situation. It is of note that the objective to reach Good Environmental Status in all EU waters by 2020, as required by the Marine Strategy Framework Directive (2008/56/EC), has failed.[27] The development of offshore renewable energy should be aligned with a coherent and accelerated action plan for marine conservation and restoration, delivering on existing European and international conservation objectives and creating further carrying capacity for marine ecosystems.

Focus 1 - Noise, an invisible pollution

Offshore renewable energy projects have been associated with noise impact issues. Monopile bottom-fixed wind turbines particularly result in piling noise during the construction phase, which disturbs and injures fish, marine mammals, turtles … For instance, pile driving can lead to the displacement of dolphins by up to 50 km.[28] Likewise, a study observed that 40% of the cods in a 400 meter perimeter around a pile driving operation were injured by the resulting noise.[29] It has also been demonstrated that the diameter of the pile is interrelated with the noise produced: the bigger the pile, the louder the noise.[30] With offshore wind turbines constantly increasing in size, this must be fully acknowledged.

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[25] Piante, C., et al, *Safeguarding Marine Protected Areas in the Meditteranean Blue Economy: Recommendations for Offshore Wind Energy Sector*, Pharos4MPAs, 2019, Online https://pharos4mpas.interreg-med.eu/fileadmin/user_upload/Sites/Biodiversity_Protection/Projects/PHAROS4MPAs/OWF_POLICYBRIEF_17june_single_page.pdf

[26] For instance, see European Commission, Guidance on Energy Transmission Infrastructure and EU nature legislation, 91, 2018, https://ec.europa.eu/environment/nature/natura2000/management/pdf/guidance_on_energy_transmission_infrastructure_and_eu_nature_legislation_en.pdf

[27] European Environmental Agency, Marine Message II, EEA Report No 17/2019, https://www.eea.europa.eu/highlights/europes-seas-face-uncertain-future

[28] Piante, C.,, et al, 2019, Safeguarding Marine Protected Areas in the Meditteranean Blue Economy: Recommendations for Offshore Wind Energy Sector, Pharos4MPAs, Online https://pharos4mpas.interreg-med.eu/fileadmin/user_upload/Sites/Biodiversity_Protection/Projects/PHAROS4MPAs/OWF_POLICYBRIEF_17june_single_page.pdf

[29] Defingou M; Bils F, Horchler B, Liesenjohann T & Nehls G (2019): PHAROS4MPAs- A Review of Solutions to Avoid and Mitigate Environmental Impacts of Offshore Windfarms, BioConsult SH on behalf of WWF France, https://tethys.pnnl.gov/sites/default/files/publications/PHAROS4MPAs_OffshoreWindFarm__CapitalizationReport.pdf

[30] Koschinski S., Lüdemann K., Noise mitigation for the construction of increasingly large offshore wind turbines: Technical options for complying with noise limits, Report commissioned by the Federal Agency for Nature Conservation, Isle of Vilm,

Operating the wind turbines also creates noise impacts. For instance, continuous noise emissions resulting from the shipping traffic due to maintenance work can pose a risk for certain species. Likewise, the turbine's gearbox and generator vibrate while being used. The vibrations are then conducted and diffused underwater by the turbine's tower, which is likely to affect the behaviour of species in its vicinity.[31] As an example, noise from operation activities are equivalent to a symphonic orchestra[32] and could be heard as far as 18 kilometers away by certain whale species.[33] Lastly, the issue of cumulated noise pollution must also be taken into account. For instance, a study for an offshore wind farm in the North Sea showed that while the predicted noise from cable laying was not considered significant, "*when considered together with other activities on site and another nearby offshore renewables scheme, simultaneous construction noise was assessed as potentially having a cumulative effect*" on multiple marine species.[34]

Solutions exist that are capable of effectively reducing those negative noise impacts.They can be divided into primary and secondary noise mitigation methods.[35] Primary mitigation methods are related to the production of noise. For instance, it is possible to choose foundation types that limit or prevent the use of pile driving, such as gravity based or jacket foundations. Secondary noise mitigation reduces the diffusion of noise. As an example, when pile driving is necessary, technologies such as bubble curtains also help decrease the noise produced. In the North Sea, a study showed how mitigation measures could help decrease the risk of population decline of harbour porpoises due to the cumulative impacts of wind farm construction.[36]

Broadly speaking, some EU countries such as Germany, Belgium, the Netherlands, and Denmark have legally restricted underwater noise to protect marine ecosystems. In Germany for instance, a maximum sound exposure level of 160 dB (SEL) and 190 dB (peak-to-peak) at a distance of 750 m during pile driving was established in 2008.[37][38] Despite all those measures, it is important to acknowledge that many uncertainties remain with regards to underwater noise pollution, namely those relating to the operational phase.[39]

Germany, Online: https://www.bfn.de/fileadmin/BfN/meeresundkuestenschutz/Dokumente/Noise-mitigation-for-the-construction-of-increasingly-large-offshore-wind-turbines.pdf

[31] Betke K., Schultz von Glahn M., Matuschek R., Underwater noise emissions from offshore wind turbines, 2004, Online, https://tethys.pnnl.gov/sites/default/files/publications/Betke-2004.pdf

[32] S. Chauvaud, L. Chauvaud, A. Jolivet, coord. (2018) Impacts des sons anthropiques sur la faune Marine, Quae Edition

[33] Piante, C.,, et al, 2019, Safeguarding Marine Protected Areas in the Meditteranean Blue Economy: Recommendations for Offshore Wind Energy Sector, Pharos4MPAs, Online https://pharos4mpas.interreg-med.eu/fileadmin/user_upload/Sites/Biodiversity_Protection/Projects/PHAROS4MPAs/OWF_POLICYBRIEF_17june_single_page.pdf

[34] For instance, see European Commission, Guidance on Energy Transmission Infrastructure and EU nature legislation, 91, 2018, https://ec.europa.eu/environment/nature/natura2000/management/pdf/guidance_on_energy_transmission_infrastructure_and_eu_nature_legislation_en.pdf

[35] Koschinski S., Lüdemann K., Noise mitigation for the construction of increasingly large offshore wind turbines: Technical options for complying with noise limits, Report commissioned by the Federal Agency for Nature Conservation, Isle of Vilm, Germany, Online: https://www.bfn.de/fileadmin/BfN/meeresundkuestenschutz/Dokumente/Noise-mitigation-for-the-construction-of-increasingly-large-offshore-wind-turbines.pdf

[36] Verfuss, U.K., Plunkett , R., Booth, C.G. & Harwood, J.: Assessing the benefit of Noise Reduction Measures During Offshore Wind Farm Construction on Harbour Porpoises, Report Number SMRUC-WWF-2016-008 provided to WWF UK, June, 2016, https://www.wwf.org.uk/sites/default/files/2016-10/15_11_24_wwf___finalreport%5B1%5D.pdf

[37] Koschinski S., Lüdemann K., Noise mitigation for the construction of increasingly large offshore wind turbines: Technical options for complying with noise limits, Report commissioned by the Federal Agency for Nature Conservation, Isle of Vilm, Germany, Online: https://www.bfn.de/fileadmin/BfN/meeresundkuestenschutz/Dokumente/Noise-mitigation-for-the-construction-of-increasingly-large-offshore-wind-turbines.pdf

[38] German Federal Agency for Nature Conservation, Impulse sound, https://www.bfn.de/en/activities/marine-nature-conservation/pressures-on-the-marine-environment/underwater-noise/impulse-sound.html

[39] Lena Bergström et al., 2014, Environmental Research, Letters. 9 034012, https://iopscience.iop.org/article/10.1088/1748-9326/9/3/034012/pdf

Upstream concession site designation, avoiding rather than mitigating impacts

Getting the location right begins with MSP and SEAs

Limiting the environmental impacts of offshore renewable energy infrastructure starts with getting their location right. This allows avoiding sensitive or protected areas, and fosters discussions with other sectors, also facilitating socio-economic acceptability of the projects. This phase takes place before an offshore wind concession, i.e. its location, is designated. While MSP and SEAs are led by public authorities, it is important that all sectors, including offshore energy, are associated in the discussion and designation of sea uses. Ultimately, MSP and SEAs must lead to designating concession areas for offshore renewable energy sites that are optimum both for nature and developers.

From an environmental perspective, it is not enough to assess the environmental impacts of projects on an individual basis. It is possible that a project is positively assessed by the EIA, but that it may still not be sustainable due to its cumulative impacts on the environment when it is added to other projects, including at a cross-border level.

That is why systematic, strategic and smart site selection needs to be mandatory for all activities at sea, including renewable energy, getting beyond individual projects' analysis to allocate space for offshore renewable energy development only in areas which are considered suitable from an ecological point of view. The site-selection process must align with international standards, clear environmental criteria, and current knowledge of cumulative impacts and life-cycle assessments.[40][41]

Sound site-selection must be facilitated through ecosystem-based maritime spatial planning (EB MSP).[42][43] To guide the sustainable development of new activities such as offshore renewables, these plans should be based on sensitivity mappings, most of which are still lacking in Europe, and provide final localizations based on a set of ecological constraints that excludes key areas such as major ecological corridors, important nurseries and feeding grounds. Whenever identified, data gaps must also be addressed and the precautionary principle applied to ensure offshore renewable energy projects are not developed in unidentified sensitive areas. Research should dedicate significant efforts to the identification of areas suitable for offshore renewable energy development where the impacts to nature will be minimal, as well as to the assessment of cumulative impacts from multiplying large scale projects.

Furthermore, offshore renewable energy projects are being developed in increasingly used marine spaces. They are, as a result, also increasingly likely to come into conflict with other sea activities and uses. Those conflicts, in turn, could significantly hamper the development of offshore energy projects, resulting in stranded assets, financial uncertainty for investors, reputational risks, etc.[44]

In a joint report with the European Commission and the European Investment Bank, the United Nations Environment Programme Finance Initiative actually recommends to blue finance investors "*not to finance projects [...] until a stakeholder engagement process is in place*" and to "*encourage developers to be proactive*

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[40] WWF, Offshore wind farms and marine protection in the North Sea, 2020, https://d2ouvy59p0dg6k.cloudfront.net/downloads/2020jan28_offshore_mpa_wwf_position_paper.pdf

[41] For instance, see Convention on Migratory Species, Renewable Energy Technologies and Migratory Species: Guidelines for Sustainable Deployment, 2014, https://www.cms.int/sites/default/files/document/Doc_10_2_2_Guidelines_Renewable_Energy_E.pdf

[42] WWF, Achieving ecosystem-based marine spatial plans, 2020, https://wwfeu.awsassets.panda.org/downloads/wwf_position_paper_ecosystem_based_approach_in_msp___feb2020.pdf

[43] WWF, Guidance Paper, *Ecosystem-based Maritime Spatial Planning in Europe and how to assess it*, 2021, https://wwfeu.awsassets.panda.org/downloads/wwf_eb_maritime_spatial_planning_guidance_paper_march_2021.pdf

[44] United Nations Environment Programme Finance Initiative (2021) Turning the Tide: How to finance a sustainable ocean recovery—A practical guide for financial institutions, https://www.unepfi.org/publications/turning-the-tide/

in engagement with stakeholder groups from the outset, both to manage reputational impacts and to ensure healthy working relationships that minimise potential for operational impacts down the line".[45]

Maritime spatial planning multi-stakeholder dialogues that are forward-looking and inclusive will be key in avoiding such situations, as they allow for better understanding of the interconnections between those projects and other maritime sectors and sea uses. In doing so, it will help ensure that offshore renewable energy projects are developed in areas where they won't negatively affect other sectors or sea uses as well as the environment. Whenever possible, such multi-stakeholder dialogues should also facilitate multi-uses of the sea space. The relevant data should also be collected and transparently shared with all relevant stakeholders.

In turn, the MSP process must be open to stakeholders' inputs, for instance through meaningful public consultations and engagement workshops with local community representatives.[46] Especially, Indigenous peoples[47] have the right to be heard and participate in decision-making, planning and implementation of projects that may affect their rights to self-determination, to participation, their human rights, and / or legal, customary or traditional use of land and natural resources and/or their culture. Free, Prior and Informed Consent (FPIC) by the rights holders (or the organization they might nominate to represent them), is an UN-principle that should be followed in all cases where indigenous peoples are affected. According to WWF, an important requirement of FPIC is consent/approval from rights holders should be required in order for a license to be granted. Inputs from stakeholders must be used through a meaningful governance structure, which should be able to reflect their views, facilitate negotiations, and modify planning accordingly where appropriate.

Site-selection must also be based on Strategic Environmental Assessments (SEA), as required both by the Maritime Spatial Planning Directive (2014/89/EU) and the SEA Directive (2001/42/EC), which says that all plans and programmes likely to have significant environmental effects should be subject to an SEA, including those related to energy.[48]

Focus 2: Grid connection

Just as power generation infrastructure, grid connections are likely to have negative impacts on marine and coastal environments.[49] As a first principle, grid networks should also avoid MPAs. When grid connections are bound to lie within MPAs, they should reduce their environmental impacts as much as possible and favour the least impactful routes.

Another example for how difficult and relevant proper decisions are is linked to the many cables which are already crossing the protected area of the Wadden Sea, and more are to come. The Wadden Sea is also a World Heritage Site. Crossing the sensitive area by cables from offshore wind farms can hardly be avoided, but to minimize the impact as much as possible both a bundling of cables in just a few routes would be required and – in order to save valuable space – to use only cables with a very high high-voltage direct current (HVDC) capacity, thus usually combining several offshore wind farms in one cable.

[45] United Nations Environment Programme Finance Initiative (2021) Turning the Tide: How to finance a sustainable ocean recovery—A practical guide for financial institutions, https://www.unepfi.org/publications/turning-the-tide/

[46] To learn more, for instance see Foundation For European Progressive Studies, The People's Transition: Community-led development for Climate Justice, https://www.feps-europe.eu/resources/publications/762-com_publications.publications.html The Europe Beyond Coal "Seven Golden Rules for Open and Inclusive Just Transition Planning" provide further guidance on the specific timelines and practices for meaningful consultation and engagement of stakeholders, available here: https://beyond-coal.eu/2019/07/15/seven-golden-rules-for-open-and-inclusive-just-transition-planning-at-the-regional-level/

[47] In Europe, for Sweden and Finland in the EU, as well as Norway, this for instance applies to the Sami people. The Sami council, or one of the three Sami Parliaments, might be stakeholders in this context.

[48] Article 3, Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment

[49] For instance, see European Commission, Guidance on Energy Transmission Infrastructure and EU nature legislation, 2018, https://ec.europa.eu/environment/nature/natura2000/management/pdf/guidance_on_energy_transmission_infrastructure_and_eu_nature_legislation_en.pdf

One good practice example of a grid operator is Eirgrid, a state-owned electric power transmission operator in Ireland. Meeting a target of 70% of electricity from renewables by 2030 requires significant changes to the grid, and Eirgrid opened up a three month public consultation to hear from a broad range of stakeholders on how to design the grid for a greatly increased renewables supply. They provided information prior to the consultation in an accessible manner, through plain language and videos, and made a concerted effort to make the consultation inclusive and representative of the Irish population by hosting individual consultations with youth groups, rural communities and civil society. The proposal will be developed at the end of 2021 based upon the responses received during the consultation and, if submissions are adequately taken into account, will be an excellent example of public participation of citizens in designing their national grid.[50]

Both ecosystem-based MSP and SEAs should adopt a long-term perspective, anticipating the possible shifts in ecosystems, for instance in the face of climate change. They should be used to ensure that offshore renewables are not deployed in future climate refugia areas. They should also take into account the cumulative impacts of offshore renewable energy projects across the regional sea basins. As part of the maritime spatial planning exercise, planning for offshore renewable energy projects should also consider socio-economic factors.[51] Based on the MSP and SEA directives, offshore energy SEAs should be based on a participatory approach and public consultations.[52][53]

Avoiding sensitive marine ecosystems and areas as a first principle

A key strategy to limit the footprint of offshore renewable energy projects consists in avoiding those areas within which their environmental impacts would be negatively multiplied, e.g. sensitive and protected areas. It is all the more important that those areas also are vital to mitigating and alleviating the impacts of climate change.[54][55]

The EU Biodiversity Strategy says that by 2030, a minimum of 30% of EU seas should be protected, including at least 10% of the seas as strictly protected areas. All protected areas should be effectively managed, monitored appropriately, and associated with clear conservation objectives and measures. They should also be integrated in ecological corridors, as part of a true Trans-European Nature Network.[56]

As a first principle, renewable energy developments should not be placed within Marine Protected Areas (MPAs) and other ecologically valuable areas for sensitive species and habitats. In particular, they must not be allowed in EU strictly protected areas designated as such under the EU Biodiversity Strategy. Offshore renewable projects should only be considered on an exceptional case by case basis in MPAs, under strict conditions, provided that they have been subject to the relevant mandatory assessments and proven that there are no other alternative sites outside of the considered MPA. In such instances, the pre-installation reference

[50] See: https://consult.eirgrid.ie/consultation/public-consultation-shaping-our-electricity-future
[51] Article 6(c), Directive 2014/89/EU
[52] Article 6, Directive 2001/42/EC
[53] Article 9, Directive 2014/89/EU
[54] Roberts, C., et al., Marine reserves can mitigate and promote adaptation to climate change, *PNAS* 114 (24), 2017, https://www.pnas.org/content/pnas/114/24/6167.full.pdf
[55] WWF, *Marine Protected Areas: Delivering ocean resilience to alleviate the effects of climate change*, 2020, https://wwfeu.awsassets.panda.org/downloads/mpa_fact_sheet___the_role_of_mpas.pdf
[56] European Commission, EU Biodiversity Strategy for 2030 Bringing nature back into our lives COM/2020/380, 2020, https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590574123338&uri=CELEX%3A52020DC0380

situation should first be properly defined. Furthermore, sensitive areas within MPAs should be mapped in order to define possible exclusion areas due to impacts on biodiversity.

In addition, projects developed in protected areas should be robustly assessed according to the relevant nature conservation legislation and with a focus on the precautionary principle, to ensure that site conservation objectives are fully met. Scientific evidence must demonstrate that the offshore renewable facilities, throughout their life cycle, are not detrimental to the conservation objectives of the MPA. Where needed, measures must be implemented to reduce the environmental impacts of the projects based on the site objectives of the impacted MPAs. Lastly, projects should be monitored by scientific experts tasked with impact assessments review and should bring enough evidence of a low negative impact at the ecosystem scale before any further decision on the projects' extensions.

Offshore renewable projects should also not be considered within MPAs lacking in management plans, keeping in mind that, in 2019, only 1.8% of the EU's marine area were covered by MPAs with management plans, despite 12.4% of the EU marine area being designated for protection.[57]

In countries where renewable energy projects already lie within MPAs or are at the stage of having an environmental impact and appropriate assessment carried out, the environmental impacts of these projects should be robustly assessed for the full life cycle of the project, on a case-by-case basis according to the relevant nature conservation legislation, science-based and subject to the precautionary principle. It is very important that countries which have the preferable policy of not allowing any renewable energy projects within MPAs are continuing this policy.

IUCN guidelines also state that renewable energy generation activities may not be appropriate for IUCN Categories I to III because they are habitat altering with potentially detrimental impacts. WWF is of the opinion that they should also be avoided in any OECMs that would contribute to the EU's 30% target of protecting the sea. IUCN guidelines already state that environmentally-damaging industrial activities and infrastructure development should not occur in OECMs.[58]

Focus 3 - The Natura 2000 network: a pan-European marine life haven that must be safeguarded

The Habitats and Birds directives provide for the creation of an ecological network of protected areas within the EU, this is known as the Natura 2000 (N2K) network. Member States are required to designate specific areas within their jurisdiction as part of the N2K network based on ecological criteria for the protection of listed habitats and species, and establish the appropriate conservation objectives and necessary measures for their protection. N2K, in addition to OECMs and other marine protected area designations, will play an important role in the EU's 30% target of European seas being effectively protected with one-third of the target (10%) being strictly protected. **In all instances, those N2K areas considered as strictly protected areas in the sense of the 2030 Biodiversity Strategy should not be deemed suitable to any derogation**.[59] In the vast majority of instances the N2K network constitutes the most effective way to safeguard marine and coastal ecosystems in the EU.[60] It is the cornerstone for

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[57] Borg, J., Burgess, S., Milo-Dale, L., Protecting our Ocean: Europe's challenges to meet the 2020 deadlines, WWF, 2019, https://wwfeu.awsassets.panda.org/downloads/protecting_our_ocean.pdf

[58] IUCN, 2019, Recognising and reporting other effective area-based conservation measures https://portals.iucn.org/library/sites/library/files/documents/PATRS-003-En.pdf, p.5

[59] While Natura 2000 sites, having been designated for the protection of nature and biodiversity and having a legal requirement for conservation objectives and measures, count towards the 30% target for protected areas, other nationally protected areas and OECMs should be counted towards the 30% target only if they comply with a minimum set of criteria.

[60] O'Leary and al., 2016, Effective Coverage Targets for Ocean Protection, Conservation letters, https://conbio.onlinelibrary.wiley.com/doi/epdf/10.1111/conl.12247

the protection of European biodiversity, recognised by the Commission as a "*haven to Europe's most valuable and threatened species and habitats*".[61]

In order to safeguard nature conservation in N2K areas, the Habitats Directive stipulates that an appropriate assessment (AA) of plans or projects likely to have a significant effect on the N2K sites and the protected habitats and species must be carried out, which brings us to the next point.[62] [63]

As a first principle, offshore renewable energy projects, including wind farms, should not be placed within marine protected areas, and other ecologically valuable areas for sensitive species and habitats, such as marine Natura 2000 sites. This also concerns projects of relevance outside Natura 2000 sites that may significantly affect the integrity of the N2K areas as according to Article 6 (3) of the Habitats Directive. Such an approach would also help ensure consistency across the coordinated N2K network in Europe, limiting the scope for arbitral discrepancies in effective protection from one Member State to the other, thereby improving the coherence and the effectiveness of this network.

Article 6 of the Habitats Directive obligates Member States to assess and ensure environmental protection as follows:[64]

> Article 6(1): Member States must establish the necessary conservation measures for "*special areas of conservation"* (SACs) which should be in line with the conservation objectives and should correspond to the ecological requirements of the protected habitats and species. These may include appropriate management plans.[65]
>
> Article 6(2): Member States must establish the appropriate measures to ensure that there will be no deterioration of protected habitats and no disturbance of protected species.
>
> Article 6(3): AA should be conducted for any project likely to have "*significant effects*" on a Natura 2000 site, either individually or in combination with other plans or projects, taking into account its conservation objectives. The competent authorities can only authorise a project or plan if they can ascertain, following the AA, that the plan or project will not adversely affect the integrity of the site.
>
> Article 6(4): In spite of a negative assessment following the application of Article 6(3), a project can still be carried out for '*imperative reasons of overriding public interest*', provided that there are no alternative solutions and that the State takes compensatory measures to ensure that the coherence of N2K is protected. However, where the site concerned hosts a priority natural habitat type and/or a priority species, the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest.

Alongside the publication of the offshore renewable energy Strategy in 2020, the European Commission released a non legally binding and revised "*Guidance document on wind energy developments and EU*

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[61] European Commission, Natura 2000, https://ec.europa.eu/environment/nature/natura2000/index_en.htm
[62] Defingou M; Bils F, Horchler B, Liesenjohann T & Nehls G (2019): PHAROS4MPAs- A Review of Solutions to Avoid and Mitigate Environmental Impacts of Offshore Windfarms, BioConsult SH on behalf of WWF France, https://tethys.pnnl.gov/sites/default/files/publications/PHAROS4MPAs_OffshoreWindFarm__CapitalizationReport.pdf
[63] The directive also states that competent authorities may authorise plans and projects only when they have ascertained that they will not adversely affect the integrity of the site.
[64] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, https://eur-lex.europa.eu/eli/dir/1992/43/oj/eng
[65] Article 4(1)(2) of the Birds Directive also states that measures must also be taken for 'special protection areas' (SPAs) which are areas designated under the Birds Directives for the conservation of listed wild birds.

nature legislation".[66] Based on the provisions of Article 6 of the Habitats Directive, the Commission's guidance document states that "*the Habitats Directive does not, a priori, exclude wind farm developments in or adjacent to Natura 2000 sites*" and that "*these need to be assessed on a case-by-case basis*". Member States can adopt a stricter national legal framework that is compatible with the Treaty on the Functioning of the European Union (FEU) and notified to the Commission.[67]

However, the following points must be noted:

- Relevant N2K areas must firstly be in a good state of conservation before any prospect of projects in the areas concerned is considered, even if compensatory actions, as referred to in Article 6, is an option.
    - Favourable conservation status (FCS) and/or Good Environmental Status (GES) should be both ideally used as baselines for assessing the good state of conservation in the relevant marine sites concerned. If these baselines are not met then any claim that *"all appropriate steps have been taken to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated"* is invalid[68].

- The target of at least 30% of effective protection of our seas by 2030 enshrined in the Biodiversity Strategy will likely not be achieved if the N2K network is not enhanced or completed, which is an obligation by virtue of the Habitats directive.

- Conservation must always be the first objective of all protected areas, not economic objectives. The application of the exceptional authorisation of a project based on article 6 (4) of the Directive should be a last resort, and it should be ensured that the conditions for the application of this provision (ie no alternative solutions, imperative reasons of overriding public interest, adoption of compensatory measures) are strictly applied. It should be stressed that article 6 (4) can only be applied following an appropriate assessment of the project in line with article 6 (3).

- The precautionary principle should be respected, and applied in alignment with conservation goals of the Habitats Directive and the Marine Strategy Framework Directive, with a view to achieve GES in all EU waters, especially since the 2020 deadline has been missed.[69]

- Offshore wind farms can help prevent some harmful maritime activities due to the necessary spatial measures to ensure their functioning, but this cannot be a substitute for the specific EU legislation put in place under Union environmental legislations to restore and/or protect sensitive habitats and species from those activities, as this is not the purpose of offshore wind farms. In this regard, it is also not acceptable to install offshore wind farm facilities in protected areas or sensitive marine ecosystems just because such a project may be designated as an OECM.
    - For instance, offshore wind farms are entities that have no official role in sustainable management measures under the Common Fisheries Policy (CFP) and thus do not fall within the scope of it. In this context, offshore wind farms should not be considered to contribute to the legal requirements set up by Article 11 of the CFP, which aims to safeguard protected ecosystems that fall under N2K, from harmful fishing activities by means of dedicated fisheries management conservation measures.
        - In this case, N2K areas should be protected from harmful fishing activities through the implementation of CFP Article 11, not through offshore wind projects, whose environmental impacts on biodiversity remain subject to debate.

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[66] European Commission, Guidance document on wind energy developments and EU nature legislation, C(2020) 7730 final, 2020, https://ec.europa.eu/environment/nature/natura2000/management/docs/wind_farms_en.pdf

[67] European Commission, Guidance document on wind energy developments and EU nature legislation, C(2020) 7730 final, 2020, https://ec.europa.eu/environment/nature/natura2000/management/docs/wind_farms_en.pdf

[68]GES falls under the Marine Strategy Framework Directive (MSFD) and provides marine descriptors for GES. It may be considered as another appropriate marker to FCS, which has a mores specific focus on certain species and habitats

[69] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0056

In all instances, it is important to assert again that those N2K areas considered as strictly protected areas in the sense of the 2030 Biodiversity Strategy should not be deemed suitable to any derogation. Furthermore, the IUCN guidelines state that renewable energy generation activities may not be appropriate for IUCN Categories I to III. In other words, protected areas that would fall under the scheme of the 10% strict protection target of the Biodiversity Strategy..

Status matters: why offshore renewable areas can't be considered as de facto MPAs or OECMs

Offshore wind farms may contribute to reducing the overall pressure of certain marine ecosystems as they allow for certain species to recover or reproduce in areas of less physical disturbance. However, offshore projects inherently have a negative impact which can be minimized but hardly reversed in a positive way. The introduction of the offshore renewable energy infrastructures in the marine ecosystem results in adding artificial hard substrates, including where there were none previously. Scientific research is still ongoing to assess how far this effect applies and if it can be considered positive i.e. by creating biodiversity hotspots due to a potential reef effect. A recent study concluded that "earlier reports on offshore wind turbines as biodiversity hotspots should be read with caution", as such claims often refers "to the typical species-rich second stage of succession reached after a few years of colonisation but disappearing in a later stage".[70] Likewise, the European Parliamentary Research Service acknowledged that, when wind turbines do attract marine life due to a reef effect, it is also necessary to make sure "this does not lead to species distortion or act as a stepping stone for invasive species".[71] In fact, "a positive reef effect is dependent on the nature and the location of the reef and the characteristics of the native populations".[72] In addition, restriction of fisheries in wind farm areas alone cannot be necessarily regarded as passive restoration, especially since the development of wind farms may lead to changes in the ecosystems.

Therefore, offshore renewable areas cannot and must not be considered *de facto* MPAs. It must be reminded that the primary objective behind the creation of an MPA is conservation of biodiversity and restoration of ecosystems, not economic growth of maritime industries. A sustainable blue economy and economic opportunities instead are welcome added benefits of MPAs if they do not compromise conservation goals of the sites. MPAs are designated based on science to achieve specific conservation objectives and if managed effectively contribute to reaching Good Environmental Status in EU waters. Their identification and designation follow principles of ecological coherence, they are meant to function as an effective network and are associated with management plans.[73] For an area to be saved from some forms of human pressures due to the presence of offshore renewable energy infrastructures does not match those criteria. Contrary to MPAs, the first objective of an area devoted to offshore renewable energy is economics, and nature protection benefits are only considered an added-value.

Offshore renewable energy areas should also not be classified as other effective area-based conservation measures (OECMs) as there is no reliable scientific evidence to lend credence to claims that they contribute to positive and sustained long-term outcomes for the in situ conservation of biodiversity and the associated ecosystem functions and services.

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[70] Degraer, S., Brabant, R., Rumes, B. & Vigin, L. (eds). 2019. Environmental Impacts of Offshore Wind Farms in the Belgian Part of the North Sea: Marking a Decade of Monitoring, Research and Innovation. Brussels: Royal Belgian Institute of Natural Sciences, OD Natural Environment, Marine Ecology and Management, 134 p

[71] Wilson A, B., Offshore wind energy in Europe, Briefing, European Parliamentary Research Service, November 2020, Online: https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/659313/EPRS_BRI(2020)659313_EN.pdf

[72] Langhamer O. (2012). Artificial reef effect in relation to offshore renewable energy conversion: state of the art. TheScientificWorldJournal, 386713. Online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3541568/pdf/TSWJ2012-386713.pdf

[73] Borg, J., Burgess, S., Milo-Dale, L., Protecting our Ocean: Europe's challenges to meet the 2020 deadlines, WWF, 2019, https://wwfeu.awsassets.panda.org/downloads/protecting_our_ocean.pdf

Conceiving sustainable infrastructure: Building in, with or for nature

After the location of a concession has been established, the conception phase of the offshore renewable energy projects starts. It offers new possibilities to limit the environmental impacts of projects to a negligible residual impact, and sometimes can integrate ecological components for the sake of nature. It is important to clearly understand the ins and outs of the various conception options opened, and their limitations.

For the sake of clarity, it is important to note that the notion of “mitigation measures” can be understood in two specific ways. First, mitigation measures can be understood broadly, thereby including measures spanning from planning and sitting e.g. with avoidance measures or design options, to construction with for instance bubble curtains to reduce noise pollution, operation e.g. with temporary shut down for reducing bird collisions and decommissioning for instance with repowering.[74]

But it can also be understood more specifically, in the context of the EIA, as the measures conceived based on the results of the EIA to address the environmental impacts of the technical options chosen for the infrastructure which is to be built.To avoid any confusion, it is therefore important to always specify which type of mitigation measures is being referred to.

Nature-inclusive design is an engineering approach seeking to integrate human constructions as much as possible into the natural environment through the use of appropriate materials and shapes. Where possible, offshore renewable energy infrastructures should be designed in a nature-inclusive way, reducing the impact on the environment as much as possible from the design phase onwards.

More than a life cycle analysis, eco-design is nature inclusive from an ecosystem-specific perspective, and specifically applies to the preliminary research and development or conception phase of the project. Infrastructure engineers tasked with developing the plans of the infrastructure cooperate with marine biologists to improve the integration of the infrastructure in the marine environment. Eco-design might guide engineering decisions so as to best integrate the infrastructure in the environment, potentially using biomimetism. For instance, proper scour protection can favor a better set of species around the fixed turbine compared to classic rocky use[75]. It might also involve research, for instance to choose construction materials that won’t be a source of pollution for the environment.[76]

Due to the complexity of marine ecosystems, eco-design measures can have both positive and negative environmental impacts and thus require pilot tests. For example, the platform's nature-inclusive design can seek to produce a reef effect. It is then however important to ensure that the reef effect is consistent with the surrounding ecosystems and with a compatible marine life settlement. Such a consistency in the reef effect produced can be achieved using an appropriate biosurface to promote proper complex species assemblages and a suitable substrate for improving water pollution control. As technical choices that are made by the developer, eco-design measures are part of the feasibility study requiring physical oceanographic analysis with sediment transport and wave energy models as well as trophic models to test the robustness of the technical solution before a life cycle assessment and economic evaluation. That is why they come at the conception phase

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[74] See Figure 1, Gartman et al., Mitigation Measures for Wildlife in Wind Energy Development, Consolidating the State of Knowledge — Part 1: Planning and Siting, Construction, Journal of Environmental Assessment Policy and Management Vol. 18, No. 3, 2016, https://tethys.pnnl.gov/sites/default/files/publications/Gartman-et-al-Part%201-Mitigation-Measures.pdf

[75] Lengkeek, W., Didderen, Karin, Teunis, Malenthe, Driessen, Floor, Coolen, Joop, Bos, Oscar, Vergouwen, Sophie, Raaijmakers, Tim, de Vries, Mindert, van Koningsveld, Mark, Eco-friendly design of scour protection: potential enhancement of ecological functioning in offshore wind farms. Towards an implementation guide and experimental set-up. Technical report, n° 17 - 001, 2017, https://www.researchgate.net/publication/315589657_Eco-friendly_design_of_scour_protection_potential_enhancement_of_ecological_functioning_in_offshore_wind_farms_Towards_an_implementation_guide_and_experimental_set-up

[76] For an example of eco-design see Lacroix and Pioch, The multi-use in wind farm projects: More conflicts or a win-win opportunity?, Aquatic Living Resources 24(2), 2011, https://www.researchgate.net/publication/277060788_The_multi-use_in_wind_farm_projects_More_conflicts_or_a_win-win_opportunity

and need to be included and assessed in the EIA of the project. Moderate or high risk of failure of nature based solutions for eco-conception implies potential negative and positive impacts that need to be explored in the subsequent EIA. That's also why it does not make sense to conceive eco-design as a mitigation measure when speaking of the specific EIA context.

Focus 4 - Floating technologies, a technological option to explore but no silver bullet for the environment

In the face of the environmental impacts of bottom-fixed offshore wind technologies, as well as to access new potential development areas further off the coast, floating offshore wind technologies are currently being developed. However, it is necessary to carefully assess whether those new technologies can constitute a silver bullet to solving issues associated with bottom-fixed turbines as floating offshore wind turbines are also associated with environmental impacts. For example, mooring chains and anchors used to secure floating turbines can scrape and damage the seafloor, which can also indirectly put sediments from the sea bottom back in suspension.[77] Besides, it was reported that a risk exists for ghost nets to attach to mooring lines, impacting fish, cetaceans and also diving seabirds.[78][79] Furthermore, the movement of floaters in the water also creates noise pollution during the operation phase.[80] In addition, floating wind farms are associated with issues shared with bottom-fixed turbines, such as being a potential obstacle to migratory routes of birds or bats, or constituting a FAD. Just as bottom-fixed wind turbines, they also require electric cables, which emit electromagnetic fields. It is worth noting that floating wind turbines are also often planned further off the coasts, in locations characterized by bigger depths with little already existing environmental data and knowledge available. When facing knowledge gaps, studies should be conducted to collect the appropriate data and feed into environmental impact assessments.

It is important that **research** further investigate the impacts of new offshore renewable technologies and technical options, e.g. floating turbines, floating solar, wave, or tidal. Broadly speaking, research focusing on offshore renewable energy should adopt a multidisciplinary perspective. Expected results include improved knowledge and evidence regarding the impacted marine environment, based on longer-term monitoring case studies, improved modelling approaches, cumulative impact assessments, the development and testing of mitigation methods as well as adaptive management.

[77] See page 62, Defingou M, Bils F, Horchler B, Liesenjohann T & Nehls G (2019): PHAROS4MPAs- A Review of Solutions to Avoid and Mitigate Environmental Impacts of Offshore Windfarms, BioConsult SH on behalf of WWF France, https://tethys.pnnl.gov/sites/default/files/publications/PHAROS4MPAs_OffshoreWindFarm__CapitalizationReport.pdf

[78] Catapult Offshore Renewable Energy, Environmental and Consenting Barriers to Developing Floating Wind Farms Including Innovative Solutions, 2016, https://ore.catapult.org.uk/app/uploads/2018/02/Floating-Wind-Farms-Workshop-Dec-2016.pdf

[79] Benjamins, S., Harnois, V., Smith, H.C.M., Johanning, L., Greenhill, L., Carter, C. and Wilson, B, 2014, Understanding the potential for marine megafauna entanglement risk from renewable marine energy developments. Scottish Natural Heritage Commissioned Report No. 791., https://tethys.pnnl.gov/sites/default/files/publications/SNH-2014-Report791.pdf

[80] See page 109, efingou M, Bils F, Horchler B, Liesenjohann T & Nehls G (2019): PHAROS4MPAs- A Review of Solutions to Avoid and Mitigate Environmental Impacts of Offshore Windfarms, BioConsult SH on behalf of WWF France, https://tethys.pnnl.gov/sites/default/files/publications/PHAROS4MPAs_OffshoreWindFarm__CapitalizationReport.p

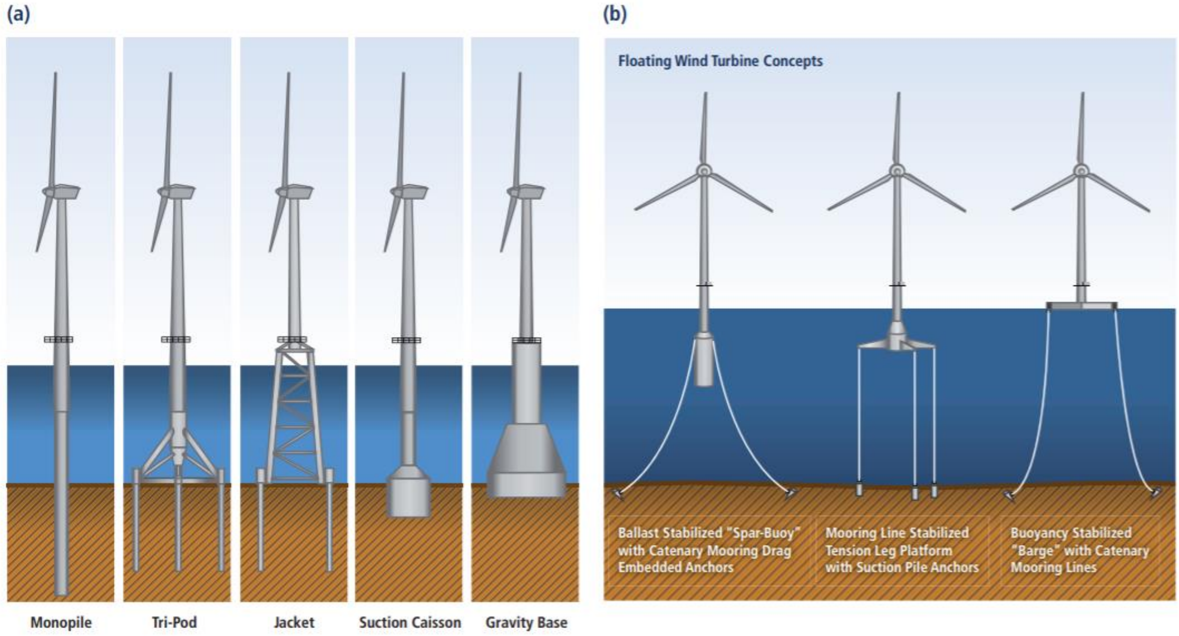

Figure 5. Various types of offshore wind turbine foundation options, IPCC, 2012[81]

Furthermore, research on projects at sea is always location specific. As a consequence, it is necessary that results from different projects across EU seas are compared and aggregated to provide solid analysis. This would require furthering coordination of research at a European level.

After the EIA of the project has been conducted, and before permit is granted, additional nature-inclusive design elements can be suggested to address the impacts that have been identified. As such nature-inclusive design elements can be part of mitigation measures as required by law. For instance, eco-friendly riprap can be used to reduce the electromagnetic effects of cables, seeking the best integration of cables within the marine environment in such a way that they form the most natural shelters and habitats for wildlife that occur in the specific areas selected. Those measures however are not likely to lead to fundamental reviews of the projects, which have already been approved, especially in terms of costs, profitability for the developers, geographic scope, etc.

Whether the impact of nature-inclusive design is positive is to be assessed over time. Nature-inclusive design must be accompanied by regular monitoring to ensure that the marine ecosystem reacts normally around an offshore renewable project, while maintaining its trophic characteristics, its ecological functions and its dynamics in terms of connectivity. In this regard, the issues of invasive species and ecological traps are of prime importance and therefore require regular ecological assessment. This makes it possible to develop adaptive and responsible nature-inclusive designs compatible with the protection of biodiversity in human-affected areas.

At the conception stage or during the EIA phase of the projects, nature inclusive design can lead to specific engineering decisions regarding the conception of the turbines and their spatial configuration. However, it is not to be mixed with **ecological engineering.** While nature inclusive design seeks to better integrate infrastructures in ecosystems, ecological engineering aims at modelling ecosystems themselves. For instance, while nature inclusive design would explore how a turbine can act as an artificial reef to avoid a FAD effect, ecological engineering applied to offshore renewables would consist in projects that would also purposively add massive and highly productive artificial reefs systems in the surrounding of the turbines with the creation of a whole new habitat. In practice, some private consultants have already started to introduce such eco-engineering projects, whose potential constitutes a change of the seabed habitat and thus is not inclusive in nature itself even if using

[81] IPCC, *Summary for Policymakers*. In: IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation[O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2011, https://archive.ipcc.ch/pdf/special-reports/srren/SRREN_FD_SPM_final.pdf

a nature based solution with biomimetic reefs. This can seek to achieve various objectives, including human-centred ones, such as increasing the productivity of the area for fisheries purposes.

Focus 5: Energy islands or hubs

Some EU countries are considering building so-called "energy islands or hubs" to support the development of offshore renewable energy infrastructures and to better connect energy generated from offshore wind and the energy systems. For instance, in Denmark, a 120,000 square metres artificial island is planned 80 kilometers off the coast of the Jutland Peninsula, to support 3 GW of offshore wind production.[82] Over time the capacity is set to expand from 3 to 10 GW. When the island is enlarged, it is expected to be as large as 64 football fields.

Similar projects are also being considered in Belgium and the Netherlands. Such projects must be subject to the same environmental rules and guidelines outlined in respective legislation and highlighted in this paper for other offshore renewable energy infrastructures. As a first principle, they should be kept out of MPAs and other ecologically valuable areas for sensitive species and habitats, and associated with robust EIAs and cumulative impact assessments factoring in the effects of the wind parks they are associated with. Meaningful stakeholder involvement and close cooperation between developers of energy islands and wind farms, as well as planning and environmental agencies, is needed to ensure comprehensive and coherent planning. It is important that planners explore every available option/scenario in terms of location and design before deciding on the actual building of islands or hubs. Since the needed materials to build such structures dramatically increases the footprint and impacts of these projects, using platforms instead may result in lower impact. In that regard, repurposing of oil/gas infrastructure bound for decommissioning could be a circular and viable alternative with a smaller impact.

Lastly, nature-inclusive design overall is also not to be mixed with **restoration**. Restoration can be defined as "*return of an ecosystem to a close approximation of its condition prior to a disturbance or period of specific management*"[83], as well as a process "*illustrating changes that occur as a degraded ecosystem recovers toward its original state*".[84] It must be distinguished from rehabilitation, which only leads to partial recovery.[85] Restoration requires knowledge of the environment before the degradation happened and must lead, with supporting evidence, to the recovery of lost ecological functions and biodiversity. In that perspective, compensating the impacts of an offshore infrastructure or integrating it in the surrounding environment in the best way possible through nature inclusive design does not equate to improving the degraded status of the area it was built in towards its initial state, i.e. restoration.

Claims were made that offshore renewable projects could be considered as delivering restoration, by preventing access to certain areas to harmful activities. However, the mere presence of an offshore renewable energy infrastructure cannot be considered restoration per se. At best, it opens a rehabilitation potential. Contributing to decreasing other pressures can hardly be generally described as 'net positive' since the effects of offshore

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[82] Danish Ministry for Climate, Energy & Utilities, Denmark is getting a new island: The world's first energy island is established 80 km out in the North Sea, 2021, https://kefm.dk/aktuelt/nyheder/2021/feb/danmark-bliver-en-oe-rigere-verdens-foerste-energioe-etableres-80-km-ude-i-nordsoeen

[83] Eggermont et al., Nature-based Solutions: New Influence for Environmental Management and Research in Europe, GAIA - Ecological Perspectives on Science and Society, 2015, https://www.researchgate.net/publication/285176201_Nature-based_Solutions_New_Influence_for_Environmental_Management_and_Research_in_Europe

[84] Halpern, B., Kendrick, G., Orth, R.J., Upgrading Marine Ecosystem Restoration Using Ecological–Social Concepts, *BioScience* 66 (2), 2015, https://www.researchgate.net/publication/287377533_Upgrading_Marine_Ecosystem_Restoration_Using_Ecological-Social_Concepts

[85] Ibid.

renewable energy projects can still be very important, not to mention that they're often not fully understood and that it's not given in the long run that other activities will be excluded from these areas.

Then, the possibility to implement restoration operations based on offshore renewable energy infrastructures depends on the nature of the ecosystems that have been altered. The majority of ecological functions cannot be substituted, and only a limited number of ecosystems are likely to be suitable for such compensatory actions. Especially, distinction can be made between soft and hard bottom beds:

- Soft bottom beds typically consist of clay, silt, mud (clay and silt together), and sand. The restoration of soft bottom beds requires passive restoration. There are no true restoration measures for soft substrates, other than excluding harmful activities. Because the ecological functions of naturally soft bottom beds cannot be substituted, the introduction of artificial constructions such as wind turbines in such areas cannot be considered as restoration. Instead, measures developed for instance to support benthic communities in such areas can at best be regarded as nature-based solutions and nature-inclusive design, and must then be considered in the EIA.
- Hard bottom beds can be defined as habitats consisting of coral, oyster or mussel reefs, or rocks for instance. Some hard bottom beds can be restored, like oyster reefs, but they remain exceptions. Restoration of these habitats should not lead to modifying the existing ecosystem. They must also compensate for the lost ecological functionality. Lastly, it must respect the principle of proportionality, making sure that the artificial elements added are proportionate to the loss generated. If not, the project is thereby conducted for other purposes than restoring the ecosystems to its prime status, to serve human-related objectives, and can then be regarded as ecological engineering to artificially boost ecological productivity for higher harvest of sea resources and/or to create new ecological structure and new ecological functions within the offshore wind farm area.

Before construction, making sure the “Green light” really is green: the need for effective EIAs

Once the concession has been attributed to a developer based on the project it conceived, the latter still it is vital that the latter undergo an Environmental Impact Assessments (EIA) before the construction can start.

EIA is key to addressing the environmental impacts of offshore energy projects. According to the Environmental Impact Assessment Directive (2014/52/EU), Member States must ensure that “*projects likely to have significant effects on the environment [...] are made subject to [...] an assessment with regard to their effects on the environment*”.[86]

Offshore wind farms are explicitly listed under Annex II of the EIA Directive, leaving it to Member States to decide whether these projects shall be subjected to an assessment. Annex 3 of the directive sets up criteria to determine whether the projects listed in Annex II should be subject to an environmental impact assessment, based on their characteristics, location and the type and characteristics of their potential impact. It mentions that the “*environmental sensitivity of geographical areas likely to be affected by projects must be considered, with particular regard to [...] coastal zones and the marine environment (ii), areas classified or protected under national legislation; Natura 2000 areas (v), areas in which there has already been a failure to meet the environmental quality standards, laid down in Union legislation and relevant to the project, or in which it is considered that there is such a failure (vi)”*. It is here reminded that the MSFD’s objective of achieving good environmental status in EU seas by 2020 has been missed. Science has also clearly established the potentially significant environmental impacts of offshore wind projects. Member States should always subject offshore renewable energy projects to EIAs, including outside of protected areas.

[86] Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment, https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02011L0092-20140515&from=EN

Under the EIA, offshore renewable energy projects must follow the mitigation hierarchy approach: avoid, minimize/reduce (restore and compensate in last resort only).[87] When avoidance is impossible or very limited, reduction measures need to be adopted during all phases, from site-selection, to exploitation and decommissioning. This includes for instance mandatory mitigation measures against underwater noise in EIA to reduce disturbance of underwater fauna, seabird and bats survey plans in all stages of development. Restoration and compensation measures are more uncertain and complex, and should be considered as a last resort to rebuild or offset what was lost. In some cases, compensation is impossible and requires sufficient avoidance and reduction to assure a limited effect on marine species both under and above water. It is difficult to predict whether the application of the mitigation hierarchy will be successful for all impacted ecosystems. It is possible that a group of species may still face an impact that cannot be reduced to a negligible level after the application of a mitigation hierarchy sequence. When there is a risk of such a substantial residual impact, the offshore project should not be granted development consent.

The natural carbon sequestration function of the seabed must also be considered in the EIA, and licenses for offshore wind turbines and the surrounding infrastructure. Organic carbon that sinks to the seabed is permanently removed from the carbon cycle. As much as 50-70% of this permanent carbon storage occurs in the coastal vegetated habitats, even though these habitats only occupy 0.3% of the oceanic area.[88] Therefore, all interventions on the seabed must be minimized to avoid the release of carbon. Offshore wind farms, on the other hand, can potentially help to bind more carbon, and boost biodiversity, if kelp production, or similar, is integrated in the farm construction.[89] Further, the EIA should assess the possibility for, and facilitate, co-location with other marine, renewable industries - for example offshore kelp production.

Clear licensing conditions must be set for how the developer, upon decommissioning, shall restore wind power areas back to their original quality. Clean-up costs must be included in the assessment of the finances of the project applied for, and it must be ensured that the developer guarantees sufficient funds for this.

Based on article 7 of the EIA directive, cross-border cooperation on offshore renewable energy projects should be part of the EIA phase where relevant.[90] Furthermore, the directive also provides for the participation of the 'public concerned', and specifically states that "*non-governmental organisations promoting environmental protection and meeting any requirements under national law shall be deemed to have an interest*".[91]

Once the EIA and the accompanying measures have been approved, the physical life cycle of the project can start. During the construction, operation and decommissioning phases, mitigation measures that have been agreed upon during the EIA must be implemented. It is also important that regular monitoring assess the effects of offshore renewable energy infrastructures over the marine environment throughout their life cycle.

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[87] WWF, First Things First: Avoid, Reduce … and only after that–Compensate, 2020, https://wwf.panda.org/discover/our_focus/forests_practice/climate_change_and_forest/?362819/First-Things-First-Avoid-Reduce--and-only-after-thatCompensate

[88]Carbon storage in Norwegian ecosystems, Bartlett, J., Rusch, G.M., Kyrkjeeide, M.O., Sandvik, H. & Nordén, J. 2020. (Page 35). Link: https://brage.nina.no/nina-xmlui/bitstream/handle/11250/2655580/1774b.pdf?sequence=3&isAllowed=y

[89]The impact of offshore wind farms on the marine environment, Steen H. et al. (2008) page 9: https://www.hi.no/resources/publikasjoner/fisken-og-havet/74725/fh_2008-9_til_web.pdf

[90] See for instance, European Commission, Guidance on the Application of the Environmental Impact Assessment Procedure for Large-scale Transboundary Projects, 2013, https://ec.europa.eu/environment/eia/pdf/Transboundry%20EIA%20Guide.pdf

[91] Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment, https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02011L0092-20140515&from=EN

Circular Design

Throughout the full project cycle, it is crucial to design, develop and deploy renewable offshore energy in a circular and renewable way. The infrastructure needs to be designed to disassemble and to refurbish/recycle, while all parts should be repairable, replaceable and completely reusable in one way or another. Repowering should also be used as a way to reduce the environmental impact of new offshore renewable energy deployment. A full life cycle of projects should be conducted before they are considered eligible for any public funding support.

Best available technologies should be used to reduce the impacts at all stages of development to avoid and reduce the impacts of offshore renewable energy projects. Initiatives and research focusing on sustainable circular infrastructure(s) should be supported. For instance, initiatives today emerge that focus on the recycling of wind turbine components.[92]

The substantial amount of metals and minerals needed to support the growth of renewable technologies[93] need to be responsibly and circularly sourced, instead of overexploiting land, (deep-)sea or even space metals and minerals. Failing to address circular design issues could prejudice the reputation of cleantech companies, or even the overall energy transition, which would not only be counterproductive to the energy sector but detrimental to the fight against climate change. Investments in (research) projects and start-ups are needed to support this transition.

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[92] For instance see https://www.lavenir.net/cnt/dmf20210118_01546303/terre-et-pierre-base-a-tournai-semble-avancer-dans-le-recyclage-des-pales, https://emis.vito.be/nl/artikel/what-happens-when-wind-turbines-get-old-new-industry-guidance-document-dismantling-and, http://www.seabiocomp.eu/news/collection/more/?id=25&coll=4&enews=1 , http://www.seabiocomp.eu/

[93] Weigl, C., An investigation into deep seabed mining and minerals, edited by Jeffries, B., for the WWF, 2020, https://wwfint.awsassets.panda.org/downloads/an_investigation_into_deep_seabed_mining_and_minerals_for_wwf_full_report_2020.pdf

Box 3: Recommendations on the use of offshore renewables in equilibrium with safeguarding the health of the marine environment

- The increased deployment of offshore renewable energy should not compromise the biodiversity targets set up in the EU.

- The development of offshore renewable energy should be **integrated with other relevant EU policies. It should be aligned with a coherent and accelerated action plan for marine conservation and restoration**, the latter aiming at delivering on existing European and international conservation objectives and creating further carrying capacity for marine ecosystems. Offshore renewable energy projects' site location should be based on ecosystem-based and forward looking **Maritime Spatial Planning** and effective **Strategic Environmental Assessments**. Offshore renewable development also needs to be aligned with the requirements set up by the MSFD for Sustainable Blue Economy planning and implementation, such as monitoring, measures to avoid/limit impacts, ecosystem services valuation and the use of the **precautionary principle**.

- **Transparent and inclusive participatory processes and stakeholders involvement** will be keys to preventing and solving conflicts with other sea space users and uses.

- Offshore renewable energy projects must follow the **mitigation hierarchy** approach: avoid, minimize/reduce, restore and compensate in last resort only.

- As a first principle, **renewable energy developments should not be placed within Marine Protected Areas (MPAs) and other ecologically valuable areas for sensitive species and habitats.** In particular, they must not be allowed in EU strictly protected areas designated as such under the EU Biodiversity Strategy.

- Offshore renewable areas should not be considered as de facto MPAs or other effective area-based conservation measures (OECMs).

- Where possible, offshore renewable energy infrastructures should be designed and developed in a **nature-inclusive way**, reducing the impact as much as possible from the design phase onwards. Nature-inclusive design must be accompanied by regular monitoring.

- **Restoration** of marine ecosystems should not be mixed with nature-inclusive design or rehabilitation. The possibility to implement restoration operations based on offshore renewable energy infrastructures depends on the nature of the ecosystems that have been altered and should therefore be assessed on a case by case basis .

- Member States should always subject offshore renewable energy projects to inclusive, transparent and effective **Environmental Impact Assessments** (EIAs), including outside of protected areas.

- Offshore renewable energy projects must be based on **circular design,** especially regarding the sourcing of building materials and the recycling of the infrastructures.

- **More research** is needed to better understand the environmental impacts of offshore renewable energy developments and their various technologies and technical options, especially cumulative impacts when infrastructures are deployed at an industrial scale.

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