# Regulatory and Policy Frameworks for Offshore Wind Projects: Spatial and Temporal Considerations in Light of Fisheries Sustainability amid Climate Change

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**Abstract**

*This article explores the interplay between offshore wind projects (OWPs) and fisheries within a climate change context. There is scant literature reviewing the interaction and regulatory framework that applies or ought to apply to these two uses of the sea. We attempt to fill the gap by critically examining the relationship between OWPs, fisheries and climate change to then identify the key challenges arising from their interaction and co-existence. These issues not only slow down the deployment of offshore wind projects but also put in perspective the consequences of such projects. Advancing the state of the art, we put forward broad regulatory suggestions based on science-policy interfaces and marine planning concerning the spatial and temporal factors of OWPs to achieve the peaceful and sustainable co-existence of two essential resources – offshore wind and fisheries.*

## 1. Introduction and scope

Offshore wind projects (OWPs) are on the rise. By 2019, OWPs had been constructed in 18 coastal states, and at least 17 other countries are planning to build OWPs in the near future.[1] In Europe alone, there are 25 gigawatts (GWs) of installed capacity and 5,402 turbines have been built in 12 countries.[2] Consequently, the space they occupy at sea is also increasing. In the North Sea, the

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All websites were last accessed on 10 September 2022.

[1] Energy Monitor, 'Weekly data: The number of countries generating offshore wind power is set to double' (18 April 2022), available at: https://www.energymonitor.ai/sectors/power/weekly-data-the-number-of-countries-generating-offshore-wind-power-is-set-to-double; Ting Zhang, et al. 'Global offshore wind turbine dataset.' [2021] Scientific Data 8.1: 1-12.

[2] Wind Europe, *Offshore Wind in Europe: Key trends and statistics 2020* (2021), at p. 6.

European Commission estimates that by 2030 an area of between 5,000 $km^2$ and 10,000 $km^2$ (about the size of Lebanon) will be needed for new projects to meet a target of 70 GWs of installed capacity.[3] OWPs produce clean energy, which helps countries achieve their emission reduction targets and accomplish the sustainable development goals (SDGs), particularly Goals 7 and 13.[4]

Likewise, fish are valued natural resources that provide millions of people with food and a livelihood.[5] Wild catches take place both near the coast and offshore, and fish farming is currently mostly done near the coast. OWPs take over traditional fishing areas and also affect life underwater. Marine fish species are vital for the conservation of marine ecosystems and the attainment of SDGs, especially Goal 14. In addition, climate change poses severe threats to marine biodiversity, including fish species.[6]

Although OWPs help slow down climate change by producing clean energy, they also have an impact, both positive and negative, on fish and the overall marine environment as a result of the construction[7] and operation[8] of wind turbines, and the way these turbines are decommissioned.[9] Thus, the development of OWPs challenges the sustainability of marine fisheries and the integrity of marine ecosystems, particularly with the changing conditions that result from climate change. Sea governance conflicts and tradeoffs between fisheries and energy policies and objectives are prompted by divergent uses of the sea in overlapping spaces. They affect the climate, fisheries and energy development and range from: claims related to compensation to fishers not able to fish in a particular zone, health and safety considerations, fish depletion and displacement and the environmental impact of OWPs on the seabed and water around it.

With the rapid uptake of OWPs, both technical and political voices are calling for policy measures to coordinate and ensure a sustainable balance between these two industries. As highlighted by the European Commission, there is an increasing need to “understand and anticipate future interaction

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[3] European Commission and Clément Dupont, Frédérick Herpers, Christophe Le Visage, *Recommendations for positive interactions between offshore wind farms and fisheries: short background study* (2020), Publications Office. https://data.europa.eu/doi/10.2826/017304, at p. 8-9.
[4] Zhang, Ting, et al. (n 1).
[5] Tarique Faiyaz, and Abdullah Al Arif, ‘Towards a Blue Revolution in the Bay of Bengal: Tackling Illegal, Unreported and Unregulated Fishing Through Effective Regional Cooperation’, [2022] The Journal of World Investment & Trade 23, no. 1, at p. 10.
[6] Nathaniel L. Bindoff, et al., *Changing ocean, marine ecosystems, and dependent communities*, IPCC special report on the ocean and cryosphere in a changing climate (2019): 477-587, at p. 450.
[7] Andrew B. Gill, et al. ‘Setting the Context for Offshore Wind Development Effects on Fish and Fisheries’ [2020] Oceanography 33(4), at pp. 120-122; European Commission and Dupont et al. (n 3), at p. 13.
[8] Lena Bergström, et al. ‘Effects of offshore wind farms on marine wildlife—a generalized impact assessment’ [2014] Environmental Research Letters 9.3, at pp. 6-9.
[9] Ignacio Herrera Anchustegui; Gunnar Eskeland; Frode Andre Skjeret; Mariia Melnychenko; Jonas Lødøen; Henrik Holmen Brown; and Lasse Erik Christian Lund, *Understanding decommissioning of offshore infrastructures: A legal and economic appetizer*, Energiomstilling Vest (2021).

and possible conflict between fisheries and windfarms and associated mitigating approaches".[10] The European Parliament went further in 2021 and put it more succinctly when it stressed the need to avoid the possible negative and long-term impact of offshore wind turbines on certain ecosystems, fish stocks and biodiversity, and consequently on entire fisheries.[11]

Striking a balance between these key resources – offshore wind energy and fisheries – and stakeholders – society, energy developers, fishers and the environment – is essential when conflicts arise between them. Effective resolution of these conflicts requires governance frameworks based on a solid science-policy interface[12] encompassing both resources and stakeholders.[13] Such an approach needs to take into account the spatial and temporal factors associated with OWPs at every stage of their lifespan, together with an integrated ecosystem assessment framework and ocean governance tools.[14] Instruments such as marine spatial planning (MSP), environmental impact assessments, licensing conditions and compensation mechanisms play a key role in ensuring the sustainability of fisheries and the conservation of the marine environment in and around OWPs.[15]

In this paper, we identify areas of interplay and conflict between fisheries and OWPs and suggest policy alternatives and tools based on spatial and temporal considerations to promote the sustainable multi-use of sea spaces for OWPs and fisheries, with due regard to environmental and socio-economic impacts.[16] Our paper's aim is to serve as a global and multi-jurisdictional roadmap of the interaction and regulatory options that exist for the coordination of these two activities at sea. Understanding key spatial and temporal considerations will help alleviate conflicts between these two industries and facilitate co-existence through the development of regulatory tools. This approach implies that, to some extent, we do not seek to explore legal clashes that might arise between these interactions in a given jurisdiction, or to discuss the adequacy of particular norms. Instead, our discussion of *what, when and how* to regulate offshore wind projects seeks to support regulators in developing coherent policies for offshore wind energy and fisheries.

The article is structured as follows. Section 2 conducts an analysis of the interplay between OWPs, fisheries and climate change, and we highlight the main problems they pose for one another. Then,

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[10] European Commission and Dupont et al. (n 3), at p. 6.
[11] EU Parliament Resolution, "The impact on the fishing sector of offshore windfarms and other renewable energy systems" 7 July 2021 (2019/2158(INI)), available at https://www.europarl.europa.eu/doceo/document/TA-9-2021-0338_EN.html.
[12] See generally, Joachim Claudet, et al., 'A roadmap for using the UN decade of ocean science for sustainable development in support of science, policy, and action' [2020] One Earth 2, no. 1: 34-42; Sybille Van den Hove 'A rationale for science–policy interfaces' [2007], Futures 39, no. 7: 807-826.
[13] Gill et al. (n 7), at p. 124.
[14] Simon Levin and Jane Lubchenco, *Offshore Wind Development in the Northeast US Shelf Large Marine Ecosystem* (2008), at p. 17.
[15] Levin and Lubchenco (n 14), at p. 17.
[16] Maximilian Felix Schupp et al., 'Fishing within offshore wind farms in the North Sea: Stakeholder perspectives for multi-use from Scotland and Germany' [2021] 279 Journal of Environmental Management, 111762, at p. 8.

in Section 3, we identify three key factors that are likely to lead to conflict between stakeholders: competition for space, the location and optimization of activities and stakeholder participation. These are *spatial* factors that need to be taken into account for the peaceful co-existence of offshore windfarms and marine fisheries. Having analysed spatial interactions and conflicts, we discuss the *temporal* aspects to be considered when dealing with these conflicts, in Section 4. This analysis is based on licensing – as OWPs are governed by licences – in a before, during and after or outside the licence perspective. We conclude the article with reflections on the role of science-policy-based governance frameworks in maximizing co-existence and minimizing conflicts between these two important industries.

# 2. Interplay between OWPs, fisheries and climate change

## 2.1 Effects and links

The interplay between OWPs, fisheries and climate change is non-linear, complex and dynamic. While offshore wind energy and fisheries are important natural resources, climate change poses a threat to the entire planet. The use of offshore wind energy can reduce carbon emissions and help slow down the pace of climate change, which benefits most living beings, including fish species. However, the location and construction of offshore wind turbines and access rights within OWPs can create conflict, which are known as resource conflict. In addition, there are concerns about the interaction between OWPs and fisheries, both in the short and long term.

Below we discuss the way the trio interact with each other (OWPs and fisheries; fisheries and climate change; OWPs and climate change). These interactions are then synthesized to understand the tripartite confluence of OWPs, fisheries and climate change.

Climate change has a very negative impact on the ocean and will continue to do so in the foreseeable future unless we drastically change our actions.[17] Fish stocks and other marine organisms bear the brunt of climate change as they experience a warmer ocean, increased acidification, deoxygenation, upwelling and frequent extreme events, among other things.[18] The marine fisheries sector is extremely susceptible to climate change, which substantially alters the availability of fish and fish products, resulting in significant economic consequences for the nations that are most dependent on the sector.[19] Recent research shows that fish catches in some

[17] See generally, Bindoff et al. (n 6), pp. 477-587.
[18] Bindoff et al. (n 6), at p. 450.
[19] See generally, Manuel Barange et al. *Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options*, (FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, 2018).

tropical exclusive economic zones are likely to decline by up to 40% by the 2050s, which will limit the ability of some coastal states to achieve their SDGs.[20]

The direct effects of climate change include shifts in the abundance and distribution of commonly exploited marine species.[21] For example, it has been observed that warm-water species, such as anchovies, mackerel and bluefin tuna, are generally being displaced towards the poles.[22] Furthermore, fish and invertebrates tend to move towards higher latitudes and deeper water.[23] The climate-induced redistribution and poleward movement of fish stocks will cause conflict between nations.[24] Moreover, climate change has become a source of concern for fishers and fishing activities.

OWPs affect the marine environment, including fish species, both positively and negatively.[25] This has been up for debate in the last decade. Some studies seem to focus on the negative impacts of OWPs, such as one that revealed that underwater noise during the construction of OWPs has severe effects on marine and aquatic lives,[26] several other studies claimed that there is still a dearth of knowledge on the impact of electromagnetic fields created by the subsea cables used in OWPs on fish and other marine species.[27]

In contrast, other studies found a positive correlation between OWPs and fish stocks as increased growth and production of several species were observed.[28] Evidence shows that the structures of the OWPs have reef effects, which benefit both fisheries and the fishers who work in and around

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[20] Vicky WY Lam, et al. 'Climate change, tropical fisheries and prospects for sustainable development' [2020] Nature Reviews Earth & Environment 1.9: 440-454 at p. 441.

[21] Edward H Allison, et al. 'Vulnerability of National Economies to the Impacts of Climate Change on Fisheries', [2009] 10(2) Fish and Fisheries, 173-196 at p. 176.

[22] Kevern Cochrane et al. 'Climate Change Implications for Fisheries and Aquaculture' [2009] 530 FAO Fisheries and Aquaculture Technical Paper 212 at p. 2.

[23] William WL Cheung et al. 'Large-scale Redistribution of Maximum Fisheries Catch Potential in the Global Ocean under Climate Change' [2010] 16(1) Global Change Biology 24-35, at p. 25.

[24] Jess Melbourne-Thomas et al. 'Poleward bound: adapting to climate-driven species redistribution' [2022] Reviews in Fish Biology and Fisheries 32:231–251 at p. 232.

[25] Natalie, Haynes Sanders et al. 'Marine Protected Areas and Offshore Wind Farms' in Paul D. Goriup, *Management of Marine Protected Areas: A Network Perspective* (Wiley Blackwell, 2017): 263-280, at p. 266.

[26] Laura Florentina Gușatu et al. 'Spatial and temporal analysis of cumulative environmental effects of offshore wind farms in the North Sea basin' [2021] Scientific reports 11.1 (2021): 1-18 at pp. 5-7.

[27] See generally, Marcus C. Öhman, Peter Sigray, and Håkan Westerberg, 'Offshore windmills and the effects of electromagnetic fields on fish' [2007] AMBIO: A journal of the Human Environment 36, no. 8: 630-633; Zoë L. Hutchison, David H. Secor, and Andrew B. Gill, 'The interaction between resource species and electromagnetic fields associated with electricity production by offshore wind farms' [2020] Oceanography 33, no. 4: 96-107, at p. 105.

[28] R. Van Hal, A. B. Griffioen, and O. A. Van Keeken. 'Changes in fish communities on a small spatial scale, an effect of increased habitat complexity by an offshore wind farm' [2017] Marine Environmental Research 126: 26-36 at p. 32; Tara Hooper, and Melanie Austen, 'The co-location of offshore windfarms and decapod fisheries in the UK: Constraints and opportunities' [2013] Marine Policy. 43:295-300, at p. 296.

them.[29] However, this increase in fish productivity in and around OWPs needs to be balanced against the loss of fishing grounds as a result of the placement of windfarms.[30] Also, the value of ecosystem services lost by OWPs needs to be weighed against the value of the energy produced by them.

Somewhere in the middle, studies and legislative reactions are also found. For instance, A study from 2015 revealed that an OWP in the North Sea did not have long-term negative impact on fish species,[31] however, authorities continue to be wary of them. For instance, a recently adopted European Parliament Resolution stressed the need to avoid the potential long-term negative impact caused by OWPs on fisheries and marine ecosystems.[32] Thus, the long-term, cumulative effects of OWPs on fisheries are yet to be confirmed and require further research.

Further, offshore wind farms produce clean energy and provide social benefits by decarbonizing energy supplies and mitigating climate change and pollution.[33] Several studies confirm that OWPs contribute to tackling climate change by reducing global greenhouse gas emissions.[34] Moreover, offshore wind energy has high climate value for states as it reduces the cost of meeting their climate targets.[35] OWPs also enjoy public support as people are willing to pay for them and the designation of new marine protected areas (MPAs).[36] Thus, it is incontrovertible that OWPs help address climate change, which is arguably the greatest threat facing humanity today.

## 2.2 Tripartite confluence of OWPs, fisheries and climate change

OWPs are here to stay as their effects on marine ecosystems and fisheries are far less severe than those of climate change.[37] However, it is a matter of balancing trade-offs as OWPs give rise to

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[29] Ruth L. Perry, and William D Heyman, 'Considerations for Offshore Wind Energy Development Effects on Fish and Fisheries in The United States' [2020] Oceanography 33.4: 28-37 at p. 31.
[30] Steven Degraer et al., 'Offshore Wind Farm Artificial Reefs Affect Ecosystem Structure and Functioning' [2020] Oceanography 33.4: 48-57 at p. 55.
[31] Claus Stenberg et al. 'Long-term effects of an offshore wind farm in the North Sea on fish communities' [2015] Marine Ecology Progress Series 528: 257-265 at p. 257.
[32] European Parliament (n 11).
[33] Claire Haggett, et al. 'Offshore Wind Projects and Fisheries' [2020] Oceanography 33, no. 4: 38-47 at p. 39.
[34] Cong Dong, Guohe Gordon Huang, and Guanhui Cheng, 'Offshore wind can power Canada' [2021] Energy 236: 121422 at p. 1; Ozan Akdağ and Celaleddin Yeroglu. 'An evaluation of an offshore energy installation for the Black Sea region of Turkey and the effects on a regional decrease in greenhouse gas emissions' [2020] Greenhouse Gases: Science and Technology 10.3: 531-544 at p. 532.
[35] Alexana Cranmer and Erin Baker, 'The global climate value of offshore wind energy' [2020] Environmental Research Letters 15.5: 054003 at p. 1.
[36] Aljona Karlõševa et al. 'Marine trade-offs: Comparing the benefits of off-shore wind farms and marine protected areas' [2016] Energy Economics 55: 127-134 at p. 127.
[37] See generally, Haggett et al. (n 33); American Clean Power Association, *Offshore Wind and Fisheries: The Science Behind Coexistence* (June 2021).

challenges in relation to the use of the ocean. OWPs have an impact on humans living in their vicinity, even if they are out at sea, and lead to conflict with other sea users as well as nature.[38]

The sea-related impact of offshore wind is greater than perhaps thought. It is well documented that fishing communities, the fishing industry and conservationists tend to be wary of or opposed to OWPs. There are grounds for this discontent. OWPs require large ocean spaces, which could otherwise be used for fishing activities or establishing MPAs. They also have knock-on effects as the loss of fishing grounds due to OWPs may lead to overfishing in other areas, which poses environmental and conservation threats. In addition, they may also give rise to socio-cultural conflicts due to the loss of traditional fishing grounds.[39]

These are mainly legal and policy questions that involve science-policy interfaces which need to be addressed to minimize conflicts when developing OWPs in areas with extensive fishing activity. MSP, together with the application of a precautionary and ecosystem-based approach, offers solutions to most of these problems, as is discussed below. MSP helps manage multiple uses of the ocean space and their impact on humans by harmoniously organizing various sectors, including fishing, shipping, tourism and offshore energy production, while preserving the marine environment.[40] In addition, judicious scheduling of the construction, installation, repair and removal of offshore wind infrastructures can help mitigate potential conflicts between OWPs and fisheries. However, the way in which these are integrated into national offshore wind policies and the extent of such integration are up for debate. The next sections describe how the incorporation of spatial and temporal considerations can resolve conflicts between fisheries, OWPs and climate change. The reconciliation of these conflicts requires a purpose-designed regulatory framework based on the latest scientific information, which will help policy leaders make informed choices for a more sustainable future on earth.

# 3. Spatial and stakeholder considerations for OWPs to promote the sustainability of fisheries

From the previous discussion of the interplay between OWPs, fisheries and climate considerations three central *legal* issues can be identified that need to be addressed by the policymaker and enforcer: the expansion of offshore wind activities at sea in terms of their size and pressure for

[38] Ignacio Herrera Anchustegui, 'Distributive Justice, Community Benefits and Renewable Energy: Offshore Wind Projects' in Ruven Fleming KH, and Leonie Reins (eds), *Sustainable Energy Democracy and the Law* vol 26 (Brill | Nijhoff 2021).
[39] Herrera Anchustegui (n 38).
[40] See generally, Catarina Frazão Santos et al, 'Marine spatial planning' in Charles Sheppard (ed), *World Seas: An environmental evaluation* (Academic Press, 2019), pp. 571-592.

space, the possibilities or barriers for co-location and co-utilization of those sea spaces and conflict resolution and stakeholder participation.

These three issues are discussed in this section, focusing on the potential legal conflicts associated with them. When to solve these conflicts, i.e., the temporal considerations, is the main theme of the following section (Section 4).

## 3.1 Press for space

The number of OWPs is increasing globally. The US Department of Energy reported in 2021 that 5.5 GWs were installed in 2020 alone, with China in the lead, followed by the Netherlands, the UK, Belgium and Germany.[41] By the end of 2020, the total installed capacity had reached 32 GWs from 200 operating projects. There are plans to push these numbers much further. In Europe alone, the European Commission aims to reach at least 70 GWs by 2030 in the North Sea.[42] Global estimates almost double that number, reaching 123 GWs of new capacity before 2026,[43] with 2030 estimates reaching up to 215 GWs.[44]

The spatial footprint that OWPs will generate is dependent on the production capacity, rather than the number of turbines.[45] However, the size of them is massive and ever-increasing. The current capacity densities for European wind farms range from 5 to 5.4 MW/km$^2$ but with broad capacity density diversions from 3 MW/km$^2$ to even 18MW/km$^2$, depending on the location.[46] In more easily graspable terms, the European plans involve finding a further 5,000 km$^2$ to 10,000 km$^2$ for new projects in the North Sea by 2030.[47] For example, Hornsea Two, located in the UK, is estimated to cover an area of more than 460 km$^2$ [48] – almost one and a half times the size of Malta (320 km$^2$), a country with more than 500,000 inhabitants. The vast amount of space occupied at sea is substantially more than that of offshore hydrocarbon exploitation. Oil and gas projects tend to use much less space, impinging on other activities to much smaller extent. Consequently, OWPs are likely to trigger more conflict with other sea users. As previously mentioned, OWPs not only

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[41] United States Department of Energy, *Offshore Wind Market Report: 2021 Edition* (2021), available at https://www.energy.gov/sites/default/files/2021-08/Offshore%20Wind%20Market%20Report%202021%20Edition_Final.pdf, at p. x
[42] European Commission and Dupont et al. (n 3), at p. 8-9.
[43] United States Department of Energy (n 41), at p. 40.
[44] United States Department of Energy (n 41), at p. 42.
[45] European Commission and Dupont et al. (n 3), at p. 8-9.
[46] European Commission and Deutsche WindGuard GmbH, *Capacity Densities of European Offshore Wind Farms* (2018), at p. 27-28.
[47] European Commission and Dupont et al. (n 3), at p. 8-9.
[48] Ørsted, *Hornsea Projects, Hornsea 2*, https://hornseaprojects.co.uk/hornsea-project-two/about-the-project#honsea-project-two-timeline-2022.

compete with fisheries for those sea spaces,[49] but also with other sea users. Maritime transport and recreational sailing will be affected as OWPs may block sea lanes and navigation paths. Navy and defence operations could also be affected, and OWPs may reduce areas that could have been designated as protected areas for environmental purposes.

Regulatory schemes are confronted with the need to organize ocean space – both in terms of areas licensed for a specific project (as discussed in Section 4.2) and the planning of activities and area prioritization more generally (Section 4.1). This is the case for areas located within the scope of national jurisdiction and control (the territorial sea and the exclusive economic zone) as we discuss below, where all OWPs are currently developed, and maybe in the future for the High Seas.[50] Existing literature stresses the technical possibilities for deploying wind turbines in areas beyond national jurisdiction, but also highlights the legal complexities around them.[51] Regulatory schemes and solutions for constructing OWPs on the High Seas are, however, outside of the s scope of this paper.

## 3.2 Allocation and optimization of space via multi-use and co-location

Defining the location of OWPs is a key aspect in the planning of offshore energy developments as it directly addresses the pressure on space. Authorities and/or developers identify areas with favourable wind conditions and low risk of conflict with other users and administer these spaces to maximize societal benefit. Area allocation, therefore, deals with *spatial* considerations as 'sea lots' are designated or claimed for the activity. However, as we discuss in Section 4, the awarding of sea space may take place at different times in the life of a project. This can be *before* licences are granted – typically through a combination of maritime spatial planning and/or governmental earmarking processes – or *during* the licensing procedure, typically in areas where the project developers themselves select the areas in which they wish to build an OWP.[52]

The designation or determination of areas for OWPs is based on preliminary studies to identify areas in which wind currents are strong and seabed conditions make fixed or floating technologies

[49] For more on global fishing areas, see the classification of 19 marine fishing areas by the Food and Agriculture Organization of the United Nations: https://www.fao.org/cwp-on-fishery-statistics/handbook/general-concepts/main-water-areas/en/.
[50] See Part VII of the United Nations Convention on the Law of the Sea (1982).
[51] CW Zheng et al, 'An overview of global ocean wind energy resource evaluations' [2016] 53 Renewable and Sustainable Energy Reviews, 1240; Paul Elsner and Suzette Suarez, 'Renewable energy from the high seas: Geo-spatial modelling of resource potential and legal implications for developing offshore wind projects beyond the national jurisdiction of coastal States' [2019] 128 Energy Policy, 919; Todd Emerson Hutchins, 'Crafting an International Legal Framework for Renewable Energy on the High Seas' [2021] 51 Environmental Law, 485.
[52] World Bank Group & Renewables Consulting Group, *Offshore Wind Roadmap for Colombia* (2022), at pp. 177-178.

possible. These studies reveal general conditions over large areas, including wind speeds, water depths and basic geological information. Once these preliminary studies have been conducted by the state, licensing procedures on more specific spaces within a given area are conducted, which may include permits for the seabed use and offtake separately or jointly in a single procedure.[53] Individual studies for the particular areas may be conducted by the state, project developers or a combination of the two, as experiences in the North Sea have demonstrated.[54]

Fishing activities are designated through similar mechanisms based on MSP tools and/or the award of licences and fishing permits in particular areas. Key to the co-existence and co-location of OWPs and fisheries is the balance of technical and social considerations when designating an area for one particular use or excluding an activity from it. It is the role of the regulators to find ways to maximize synergies and facilitate co-utilization of overlapping resources in the same space. The literature points out that it is possible for fisheries to be co-located and co-exist nearby or within OWPs. Co-location and co-existence are not the same concepts, however. Co-location implies sharing the same space, while co-existence means acting in adjacent spaces.[55]

Regulators need to turn their attention to finding options that allow for co-existence and co-location. By optimizing space and permitting co-existence of activities, resource-use efficiency can be achieved. However, neither solution is problem-free. Where there is co-location and co-existence, accidents are more likely to take place, moreover there is "lack of insurance coverage for damages to gear or vessels inside OWPs, and lack of cooperation and knowledge exchange between sectors."[56] Co-location may lead to many accidents or lost fishing equipment, for example, while co-existence might result in the sites being overused.

Regulatory measures, however, have traditionally been somewhat sceptical of co-existence. This 'resistance' to co-location can be traced back to the Law of the Sea. The United Nations Convention on the Law of the Sea ('UNCLOS') grants states the right to create safety zones with regard to installations and structures for the exploitation of energy at sea in the Exclusive Economic Zone.[57] The objective of such safety zones is to ensure the safety of both the installations and those in vessels on the sea. Safety zones can be up to 500 metres "measured from each point of their outer edge, except as authorized by generally accepted international standards or as

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[53] World Bank Group & Renewables Consulting Group (n 52), at pp. 177-178.
[54] European Commission and Dupont et al. (n 3), at pp. 18-19.
[55] The Crown State (United Kingdom), *Changes to fishing practices around the UK as a result of the development of offshore windfarms – Phase 1 (revised)*, available at: https://www.thecrownestate.co.uk/media/2600/final-published-ow-fishing-revised-aug-2016-clean.pdf, at p. vi.
[56] Laura Florentina Gușatu et al, 'A Spatial Analysis of the Potentials for Offshore Wind Farm Locations in the North Sea Region: Challenges and Opportunities' [2020] 9 ISPRS International Journal of Geo-Information; Gill et al. (n 7), at p. 120.
[57] Articles 56 and 60 United Nations Convention on the Law of the Sea (1982).

recommended by the competent international organization."[58] All ships must respect safety zones by staying outside those designated areas, unless otherwise stated.[59]

In Europe, most vessels are banned from entering OWP sites to avoid accidental damage and collisions,[60] due to the implementation of safety zones. However, legislative changes are taking place, integrating the latest scientific developments into the regulatory instruments. As a result of this, fishing is treated differently from simple movement (transit) within a windfarm, however, there is an increasing number of examples of allowing vessels to enter and navigate OWP sites if under 24 metres.[61] In the case of Belgium, Germany and the Netherlands, legal regimes prohibit fishing activities up to 500 metres from each turbine.[62] In Denmark, the distance is reduced to up to 200 metres.[63] In the UK, fishing with passive gear is allowed within OWPs after the construction period has elapsed.[64]

Alternatively, regulators may opt to set exclusive and exclusion zones. These two alternatives are the opposite of space-sharing: they limit activities or prevent them altogether. Exclusive areas allow one activity-type only, while exclusion zones prohibit them altogether. The latter, the default alternative, grants a sanctuary for marine life that is thus protected from fishing and OWP activities.[65] This protection, however, is limited and cannot be said to equate to that of MPAs.[66] However, the long-term effects of OWPs on marine species are under-researched. Furthermore, exclusion of fishing activities in OWP designated areas might have two negative consequences. First, exclusion of fishing activities may even result in fewer fishing activities as there are no new fishing locations that are sustainable or possible.[67] Second, they are likely to cause great financial losses for fishers and a re-distribution of fishing locations, which would affect local communities and fishing patterns but would also probably have a cross-border and regional impact. Furthermore, setting exclusion zones for fishing activities from an OWP designated area is likely to trigger claims for compensation against either the OWP's developer or the state.

[58] Article 60.5 United Nations Convention on the Law of the Sea (1982).
[59] Article 60.6 United Nations Convention on the Law of the Sea (1982).
[60] European Commission and Dupont, et al. (n 3) at p. 10.
[61] Denmark, Germany and the Netherlands are examples of this as highlighted by the European Commission and Dupont et al. (n 3), at p. 10-11.
[62] Gill et al. (n 7), at p. 120; European Commission and Dupont et al. (n 3), at p. 11.
[63] European Commission and Dupont et al. (n 3), at p. 11.
[64] Gill et al (n 7), at p. 120; European Commission and Dupont et al. (n 3), at p. 11.
[65] Gill et al (n 7), at p. 120.
[66] Gill et al (n 7), at p. 120.
[67] Gill et al (n 7), at p. 121.

## 3.3 Conflicts derived from stakeholder interaction

Pressure for space, allocation of areas, co-existence and divergent interests at sea creates points of contact and stress for different stakeholders. Interaction between different parties with diverse interests might lead to conflicts. Disputes often result from direct interaction (such as compensation claims or accidents in areas that allow for co-location or co-existence), as well as more indirect contact, for example, environmental groups concerned about the impact of projects. Conflicts can also arise for a variety of reasons, before, during and after an OWP has been completed. Inappropriate measures might bring projects to a standstill or result in the authorization of other project that should not have received approval. Appropriate regulatory frameworks are essential for balancing interests, allocating rights and duties and preventing and mitigating disputes between parties. These things can be done by taking preventative measures that deal with space allocation and/or co-location or exclusion, or through compensatory means (e.g., direct or indirect financial compensation). Thus, conflict resolution mechanisms related to stakeholder interaction may be implemented at different temporal stages, as we discuss in Section 4.

Furthermore, ocean governance regimes are compelled to achieve procedural and distributive justice, to recognize that the parties affected by others, stakeholder participation and a balanced allocation of burdens and benefits. Despite the importance of public participation, the literature shows that consultation with fishing communities is often neglected in the planning of OWPs.[68] Regulatory schemes must first identify the relevant stakeholders with legitimate interest in the process around OWPs and fisheries. These go well beyond energy regulators, fishers and OWP developers and include varied groups such as citizens living in the vicinity of the wind farms or onshore installations, nature conservation groups, tourist associations, maritime transport providers, the navy, etc. Citizen and stakeholder involvement are crucial to foster a sense having one's interest taken into account and to reduce conflict.[69] Finally, participation legitimizes projects and adds a sense of participatory democracy in the decision-making process. How far and how binding stakeholder involvement should be, who can participate and in which parts of the process these things can be done are questions that must be addressed when constructing legal frameworks.

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[68] Aoife O'Keeffe and Claire Haggett, 'An investigation into the potential barriers facing the development of offshore wind energy in Scotland: Case study – Firth of Forth offshore wind farm' [2012] 16 Renewable and Sustainable Energy Review, 3711; Gill et al. (n 7), at p. 122.
[69] Herrera Anchustegui (n 38); Haggett et al. (n 33), at p. 44.

# 4. Temporal considerations for OWPs to ensure fisheries sustainability

The regulatory framework challenge when deploying OWPs in areas with fishing activities is to find an equitable balance between these different interests and stakeholders, ensuring coherence between ocean and energy policies. If this were achieved, it would prevent many conflicts and help minimize negative environmental impacts. It could be done by adopting regulatory instruments with different foci, levels of detail and, perhaps more importantly, timespans. Unlike most of the literature on the topic, our approach is to have a legal discussion about the interfaces to highlight *when* and under which *set of instruments* regulators may find mechanisms to deal with these complex relations.[70] We identify three key points at which governance schemes should be applied: before any OWP activity, during the licensing of an OWP and after the construction of the OWP (or outside the licensing and planning process).

Our objective with this legal mapping is to showcase the timescales, tools and strategies available to regulators in adopting different measures to manage the interactions between OWPs, fisheries and climate considerations. It is important to note that these are not one-size-fits-all solutions; legislative choices ought to be accompanied by technical expertise, societal considerations and legal coherence. Lastly, the discussions about these regulatory avenues and their timespans are especially useful for jurisdictions with limited offshore energy experience, such as Colombia, South Africa, Turkey, Brazil and India, to name but a few, in expanding their offshore wind activities.[71]

## 4.1 Before licensing

The most critical stage in balancing competing interests between OWPs, fisheries and climate considerations is the one that governs ocean spaces before any OWP has begun or has even been planned. Tools such as MSP, site selection of offshore energy exploitation and designation of areas for fishing activities or naturally protected environments have existed for decades and are recognized by the literature and legislature as key coordinating tools to solve conflicts and properly plan ocean activities. By their very nature, they are preventive/organizational tools, mainly directed at assessing best possible uses of the sea and dealing with the issues of space allocation and optimization, as discussed in Section 3.1 and 3.2. Early-stage and collaborative planning are "crucial to prevent conflict with other activities, and especially with fisheries".[72] In this section,

[70] See also highlighting a temporal approach to governance of conflicts and interactions between fisheries and OWPs: European Commission and Dupont et al. (n 3).
[71] Alastair Simon Piers Dutton, et al, *Going Global: Expanding Offshore Wind to Emerging Markets*, (World Bank Group, 2019).
[72] European Commission and Dupont et al. (n 3), at p. 15.

we discuss three of these tools: marine or maritime spatial planning measures, area allocation procedures and allocation of activities.

### 4.1.1 The role of MSP as a coordinating tool to solve resource conflicts

Marine or maritime spatial planning ('MSP') is the cornerstone of regulatory frameworks dealing with spatial and temporal management measures of ocean spaces.[73] Discussions about fisheries, offshore energy and climate measures often take place in the context of MSP instruments.[74] Examples of this keep arising in mature and new markets for OWPs. For example, in Europe with the adoption of national marine plans or regional instruments, such as the EU Maritime Spatial Planning Directive,[75] or in the US with the environmental assessments conducted under the National Environmental Policy Act as part of MSP planning.

The objective of MSP regulatory regimes is to support the sustainable development of ocean activities in light of the large and rapid increase in demand for maritime spaces. These instruments acknowledge the clash between offshore renewable energy exploitation and fishing activities, and some of them, like the EU Maritime Spatial Planning Directive, go further and integrate science-policy interface tools such as the ecosystem-based approach to handle these interactions. The Directive requires European Union member states to set up national maritime plans that take "into consideration relevant interactions of activities and uses", including aquaculture, fisheries and energy exploitation.[76]

More specifically, through MSP, states can identify overlapping areas, develop fisheries and renewable energy policies jointly, help identify the potential impact of these policies and co-existence opportunities, guide mitigation and seek regulatory techniques to improve interactions between OWP developers, fishers and other sea users.[77] Importantly, MSP activities ought to include stakeholder participation, preferably at an early stage and throughout the process. This provides important input and gives the plans legitimacy as discussed in Section 3.3.[78] This is because MSP "mechanisms are a way to better anticipate, mitigate or compensate incidences of windfarms on activities such as fishing".[79] Consequently, MSP techniques become a roadmap for

[73] Schupp MF et al. (n 16), at p. 8; European Commission, 2020, p. 18-19.
[74] Haggett et al. (n 33), at p. 43.
[75] Directive 2014/89/EU establishing a framework for maritime spatial planning (OJ [2014] 257/135).
[76] Article 8 and Recitals 1 and 3 of the Directive 2014/89/EU establishing a framework for maritime spatial planning (OJ [2014] 257/135).
[77] Haggett et al. (n 33), at p. 43.
[78] See the requirement on stakeholder participation of Article 9 of Directive 2014/89/EU establishing a framework for maritime spatial planning (OJ [2014] 257/135).
[79] European Commission and Dupont et al. (n 3), at p. 19.

further specific instruments such as licensing procedures, and a highly recommended starting point on the road to achieving coherence and balancing of activities and concerns.

An aspect needing further development in MSP in general, and OWPs and fisheries in particular, is strengthening regional cooperation, i.e., between different countries in a region.[80] Fisheries and OWPs are activities that have spillover effects in neighbouring lands and in interconnected marine environments (in the case of wind, there can be cases of 'wind steal' between wind farms in different countries; boats from a jurisdiction may fish in the waters of a different state). Some limited efforts are already being made regarding cross-border MSP that will positively affect the relationship between OWPs and fisheries. An example of this is the 'North Seas Countries' Offshore Grid Initiative' in which policymakers and governmental institutions have expressed their desire to harmonize MSP with a view to increasing deployment of OWPs and trade of the electricity produced from them.[81] These efforts ought to also include OWPs and fisheries interactions.[82]

### 4.1.2 Area allocation and space sharing: fishing in OWPs or OWPs in MPAs?

Area allocation for OWPs is a major decision that requires sound scientific advice and rational policy considerations, as discussed in Section 3.1. Legal regimes may allocate areas for OWPs as part of their MSP or prior to licensing procedures but as part of offshore renewable energy-specific activities. An example of this is Norway where the state conducts studies in order to then 'open up areas' to be licensed for offshore energy activities (wind and hydrocarbon) pursuant to the 1996 Petroleum Act and the 2010 Offshore Energy Act.[83] Furthermore, before licensing area allocation may be utilized by systems that have seabed licenses separated from offtake licenses. Area allocation procedures carried out prior to the licence being granted may map all sea spaces of the coastal state or just parts of it. Comparative experiences in the North Sea show both trends. Within

[80] Haggett et al. (n 33), at p. 42.
[81] See the Political Declaration on Energy Cooperation between the North Seas Countries 2016 which establishes a mandate to support and develop regional cooperation towards an offshore grid development in the North Sea. It should however be noted that as a result of Brexit, the UK is currently, at the time of writing, not formal members of the regional cooperative body. Another notable regional forum which facilitates regional cooperation to reduce environmental impacts in the North Sea, adopt an ecosystem-based approach to management and to further promote the deployment of offshore renewables, through both binding and non-binding instruments (policies) is facilitated through the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention). See *inter alia* the General Report to North Sea Ministers on Follow-Up to the 2002 Bergen Declaration available at https://www.ospar.org/site/assets/files/1238/north_sea_general_report.pdf accessed 01/06/2022
[82] Glen Wright et al, 'Establishing a legal research agenda for ocean energy' [2016] Marine Policy 63:126–134.
[83] Lov om petroleumsvirksomhet [petroleumsloven], LOV-1996-11-29-72 and Lov om fornybar energiproduksjon til havs (havenergilova), LOV-2010-06-04-21. See also for projects combining oil, gas and wind in Norway: Ignacio Herrera Anchustegui, 'Is Hywind Tampen's State Aid Approval a Kickstart for the Norwegian Offshore Wind Industry?' [2020] European State Aid Law Quarterly. Vol 19/2.

area allocation procedures “some countries (e.g., Belgium, the Netherlands) have pre-allocated exclusive use in identified areas, where others have kept to the identification of larger potential zones to be further investigated (e.g., Denmark)”.[84]

Conducting area allocation studies and designations grants the state control over the activities to be conducted and, if planning is used, would ideally lead to a minimization of conflict with fishers and other sea users. Designation of areas – and exclusion of areas for OWPs – allows for timely planning, stakeholder considerations to be duly taken care of and more informed decision-making. Unsurprisingly, before licensing area allocation is the default mechanism in most legal systems, with examples ranging from Taiwan and the US to most of the North Sea coastal states.[85]

Area allocation is generally followed by a decision on allocating activities and space sharing before a license is issued. As mentioned in Section 3, pressure for space is the key driver behind conflicts between OWPs and fisheries. Although space sharing has traditionally been seen as impossible, modern science has turned the tide.[86] Scientists now claim that some fisheries thrive in and around offshore wind installations and fishing can take place therein, allowing multi-use of ocean space,[87] provided that the safety of the fishers and security of the installations are ensured. However, the literature distinguishes between the different options for co-location of OWPs with fishing areas, indicating a preference for passive gear fisheries, aquaculture and recreational fisheries.[88] For the same reason, offshore wind installations can be situated within an MPA. With such a move, co-existence reduces conflict because the areas in which fishing can take place are less restricted by the presence of OWPs, avoiding or mitigating the loss of fishing grounds.[89]

Multi-use solutions to avoid resource conflicts entail allowing commercial fishing operations within OWPs. However, this has attracted mixed reactions from key stakeholders, including reports of equipment losses by fishers.[90] Furthermore, some of the literature has also pointed out the benefits of creating exclusion zones for fishing activities within OWPs. By doing so, the no-

[84] European Commission and Dupont et al. (n 3), at pp. 18-19.
[85] World Bank Group & Renewables Consulting Group (n 52), at p. 179.
[86] Jan Reubens, Steven Degraer, and Magda Vincx, ‘The ecology of benthopelagic fishes at offshore wind farms: a synthesis of 4 years of research’ [2014] Hydrobiologia 727.1 (2014): 121-136, at p. 132.
[87] See inter alia: Schupp MF et al., (n 16); Feargal Brennan and Athanasios Kolios, *Structural integrity considerations for the H2Ocean multi modal wind-wave platform,* European Wind Energy Association Conference and Exhibition 2014, EWEA 2014 (European Wind Energy Association, 2014); Bela H. Buck, and Richard Langan, *Aquaculture perspective of multi-use sites in the open ocean: The untapped potential for marine resources in the anthropocene* (Springer Nature, 2017); Eduardo Quevedo et al, ‘Multi-use offshore platform configurations in the scope of the FP7 TROPOS Project’ [2013] MTS/IEEE OCEANS-Bergen, pp. 1-7.
[88] Haggett et al. (n 33), at p. 41.
[89] Matthew Ashley et al, ‘Co-locating offshore wind farms and marine protected areas: A United Kingdom perspective’ in Katherine L. Yates, Corey J. A. Bradshaw, *Offshore Energy and Marine Spatial Planning* (Routledge, 2018).
[90] Schupp MF et al. (n 16); Hooper, Tara, Matthew Ashley, and Melanie Austen, ‘Perceptions of fishers and developers on the co-location of offshore wind farms and decapod fisheries in the UK’ [2015] Marine Policy 61: 16-22.

fishing zone acts as an MPA, bringing positive benefits to the fish stocks, as well as allowing recreational fishers to conduct their activities closer to the structures. [91]

Alternatively, co-locating OWPs with MPAs is a potential way of avoiding or mitigating the loss of fishing grounds accruing from exclusive zones or safety areas. Sanders and colleagues highlight the fact that minor conservation concerns were raised regarding OWP sites situated, albeit partially, within an MPA in the short-term.[92] Caution is required before and during the construction phase of OWPs within or near MPAs to prevent adverse impacts on marine fauna and their habitat.[93] However, once an OWP is functional, the site could help restore fish stocks.[94]

Further research to understand the benefits of having fisheries in and around OWPs combining knowledge about the ecological effects of OWPs on fisheries with their socio-economic impact on fishers is crucial.[95] Multi-use solutions require a science-policy interface to prepare a robust legal framework, good practice guidance and capacity building of the stakeholders.

## 4.2 During the licensing process and within the licence terms

Once a license is issued to develop an OWP, the developer begins its construction. This phase has four stages – pre-construction site selection, construction, operation, production and management, and decommissioning.[96] Each stage can impact the marine environment, including fisheries, in and around the OWP site.[97] Careful consideration is required at every stage of the licensing process and development of an OWP to ensure marine conservation and the sustainability of fisheries. The following subsections discuss the potential impact of OWPs during the license period on the development of policy recommendations.

Before we discuss these phases in more detail, it is worth noting that any physical interventions relating to the construction, repair, operation, maintenance and dismantlement of OWP structures may have both short and long-term effects. Naturally, the short-term effects are mitigated rapidly once the intervention is over, but the long-term effects continue to exist for an extended period, even beyond the life of the OWP. As discussed in Section 2, the effects of OWPs are often localized and contingent on the characteristics of the site where the structures are located. Moreover, the

[91] Hooper and Austen (n 30), at p. 295.
[92] Sanders, Haynes and Goriup et al. (n 25).
[93] Sanders, Haynes and Goriup et al. (n 25), at p. 263.
[94] Sanders, Haynes and Goriup et al. (n 25).
[95] Vanessa Stelzenmüller et al, 'Sustainable co-location solutions for offshore wind farms and fisheries need to account for socio-ecological trade-offs' [2021] Science of The Total Environment 776: 145918.
[96] Perry and Heyman (n 31), at p. 30.
[97] Elizabeth T. Methratta et al, 'Offshore Wind Development in the Northeast US Shelf Large Marine Ecosystem' [2020]" 33(4), Oceanography, pp. 16-27 at p. 18; Sanders, Haynes and Goriup et al. (n 25), at p. 265.

potential effects of OWPs will depend on many factors, including the extent of the site, the material used in constructing the structure, the technology employed and the duration of the construction and repair work. Therefore, licensing procedures and licensing conditions ought to consider the specific features of each site and project rather than considering the effects of OWPs generally.

The following subsections deal with the effects of the four major stages of the license phase on fisheries and how these can be addressed or mitigated.

### 4.2.1 Pre-construction site selection

Regulatory schemes may allow project developers to take the initiative and identify and request a particular site for a project to be built, subject to conditions. This has been dubbed an *ad hoc* procedure with minimal state control as it is unsolicited.[98] In this *ad hoc* or 'open-door procedure', as it is known, for example, in Denmark,[99] developers approach the state with pre-identified areas and submit a request for a specific sea location for them to develop an OWP. These procedures and area allocation modality work on a first-come, first-served basis,[100] but an application does not mean that a project will necessarily be granted, or consultation will take place. The documentation to be authorized to operate an OWP and the documentation for the area requested to be used are submitted jointly. However, developers are typically granted a period to conduct wind and seabed surveys and are then expected to confirm their interest to construct the wind farm.

Open-door procedures for area allocation have been used in developing markets where there is little government planning or even involvement,[101] or for relatively small projects, as is the case in Denmark where six small offshore wind farms have been built since 1999; the 10.8 MW Avedøre Holme commissioned in 2010 is the latest example of this modality.[102] Opting for site allocation driven by private initiatives at the time authorization requests are made gives little or no opportunity for coordination between other interests, including those related to fisheries, and OWPs, making such modalities more prone to misalignment of priorities and activities.

The pre-construction stage does not usually have notable adverse effects on fish and other marine fauna at the specific site or in the surrounding area. However, site selection may have a significant negative impact on marine lives if the process involves seismic surveys, which generate acute

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[98] World Bank Group & Renewables Consulting Group (n 52), at p. 177-178.
[99] Danish Energy Agency, *Procedures and Permits for Offshore Wind Parks*, available at: https://ens.dk/en/our-responsibilities/wind-power/offshore-procedures-permits.
[100] See, for example §23 of the Danish Renewable Energy Act, no 1791 of 2 September 2021 as changed by Act no 804 of 7 June 2022.
[101] World Bank Group & Renewables Consulting Group (n 52), at p. 180.
[102] Danish Energy Agency, *Analyse af åben dør-ordningen* (2021), at p. 6, available at https://ens.dk/sites/ens.dk/files/Vindenergi/analyse_af_aaben_doer-ordningen.pdf.

underwater noise.[103] This can be avoided by using the latest technology in site selection and coordinated and prudent decision-making.[104]

### 4.2.2 Construction

The construction of OWPs, which involves intense sounds and vibration from pile driving, may have a temporary but significant impact on marine mammals, seabirds, fish and fisheries,[105] as well as the seabed. In particular, the noise produced during the OWP construction phase has raised serious concerns regarding the potential adverse impact on the surrounding marine ecosystems, including living organisms.[106] Data collected under the United Kingdom Food and Environment Protection Act (FEPA) reveal that OWPs do not usually seem to affect the morphological features of the seabed permanently, but the natural processes and structures of the marine environment are normally disturbed during their construction phase.[107] Furthermore, research shows that fish species tend to circumvent the OWP sites that are under construction because of the habitat disturbance, noise and turbidity created during the construction process.[108] Consequently, fish and shellfish resources might be temporarily displaced and reduced.[109] In addition, the construction phase of OWP may have an adverse impact on fish roe owing to turbidity and sedimentation.[110]

Fishing activities are apparently disrupted when the installation of an OWP is underway. While OWPs typically preclude fishing activities during their construction and in some instance, operation, the fisheries sector is pressing to allow fishing activities within offshore wind farms,[111] as we discussed in Section 4.1. A potential solution to avoid the impact of an OWP on fish and fisheries during the construction phase is to schedule the construction taking spawning and fishing seasons into consideration.[112] The construction calendar should also avoid the migratory periods of marine fish and mammals and the breeding seasons of noise-sensitive species to minimize the

[103] Douglas P. Nowacek, et al, ‘Marine seismic surveys and ocean noise: time for coordinated and prudent planning’ [2015] Frontiers in Ecology and the Environment 13, no. 7: 378-386 at p. 382; Hans Slabbekoorn et al, ‘Population-level consequences of seismic surveys on fishes: An interdisciplinary challenge’ [2019] Fish and Fisheries 20, no. 4: 653-685.
[104] Nowacek, et al. (n 103) at p. 378.
[105] Gill et al. (n 7), at p. 121; European Commission and Dupont et al. (n 3), at p. 13; Karlõševa et al. (n 36), at p. 128.
[106] T. Aran Mooney, Mathias H. Andersson, and Jenni Stanley, ‘Acoustic impacts of offshore wind energy on fishery resources’ [2020] Oceanography 33, no. 4: 82-95 at p. 87; European MSP Platform, *Conflict Fiche 5: Offshore Wind and Commercial Fisheries, Offshore Wind and Fisheries* (2021), at p. 5.
[107] Stephen C. Mangi, ‘The Impact of Offshore Wind Farms on Marine Ecosystems: A Review Taking an Ecosystem Services Perspective’ [2013] Proceedings of the IEEE, 101(4), pp.999-1009 at p. 1002.
[108] European Commission and Dupont et al. (n 3), at p. 14.
[109] European Commission and Dupont et al. (n 3), at p. 14; European MSP Platform (n 106), at p 5.
[110] European MSP Platform (n 106), at p. 5.
[111] Schupp MF et al. (n 16), at p. 2.
[112] European Commission and Dupont et al (n 3), at p. 14.

impact of OWP construction on these species.[113] In places where seabed drilling may pose a significant risk to the marine environment, or create considerable visual pollution, floating wind farms could be considered, especially in deeper water areas further away from the shore.[114] However, it is not always possible to schedule the construction in line with spawning and fishing seasons for several reasons, including weather conditions and the limited availability of installation vessels.[115]

More generally, it is essential to apply the best available scientific information and procedures to limit the environmental impact of an OWP during its construction and operation phase.[116] This could be done, for example, by including certain construction standards in the licensing criteria or demanding the adoption of an installation calendar that factors in spawning and fishing seasons. However, there is a dearth of scientific information about the impact of OWP construction on most species, making it challenging to make an accurate estimate of what it would be, which highlights the need for further research to comprehensively address the impact of an OWP on ecologically and commercially important species.[117]

### 4.2.3 Operation, production and management

Knowledge about the long-term effects of OWPs on the marine environment has not been fully developed yet as the technology is so new.[118] Nevertheless, post-construction monitoring data reveals vital information on the recovery of marine lives that have been affected by OWPs.[119]

Although the effects of OWPs during their construction phase are predominantly negative, their operation phase may have both positive and negative impacts.[120] Some commentators argue that once the construction is over, the interaction between OWPs and fisheries is restricted to occupying ocean spaces that were previously accessible by fishers for fishing activities.[121] However, routine maintenance and occasional repair work may cause some temporary stress on the marine environment and living organisms.[122] Recent studies based on environmental monitoring data could not establish any negative effects of OWPs during their operation phase.[123] Rather, research

[113] UICN France, *Development of renewable marine energies and the preservation of biodiversity. Synthesis for decision-makers*. (2014), at p. 38.
[114] European Parliament (n 11), at p. 6.
[115] European Commission and Dupont et al. (n 3), at p. 14.
[116] Karlõševa et al., (n 36), at p. 128.
[117] Mooney, T. et al. (n 106), at p. 92.
[118] Sanders, Haynes and Goriup et al. (n 25), at p. 265.
[119] Sanders, Haynes and Goriup et al. (n 25), at p. 265, 268.
[120] Bergström, et al. (n 8), at p. 6.
[121] European Commission and Dupont et al. (n 3), at p. 14.
[122] European Commission and Dupont et al. (n 3), at p. 14.
[123] European Commission and Dupont et al. (n 3), at p. 14.; Perry and Heyman (n 31), at p. 31.

shows that the number and total biomass of fish and non-fish species such as crabs have increased within OWPs during this phase.[124] This positive impact of OWPs on marine living resources within and around OWPs is due to the "artificial reef effect", which supports fish feeding and breeding by reducing fishing pressure.[125] Artificial reef structures created by OWPs attract fish species that prefer rocky habitats, without impacting species that prefer the original sandy bottom.[126] However, the increase of fish around OWPs, which is known as the 'spill-over effect', has not yet been conclusively established.[127]

Conversely, recent research shows movement and behavioural differences in species that migrate using magnetic signals and forage using electric/magnetic signals as the subsea cables create electromagnetic fields during the operation phase of OWPs.[128] Shifts in water currents and wind wakes due to the presence of OWP may change the movements of nutrients, which could have important implications for biological production of marine organisms. Larval dispersion and distribution may also be altered due to changing currents.[129]

One key regulatory aspect is that during the operation of OWPs, some sets of rules do not allow fishers to conduct any activity within the safety area of the OWPs, for between 20 and 25 years. Given the alleged positive effects on the marine environment produced by the artificial reef effect, permitting fishing activities within OWP sites subject to the observance of certain safety protocols could help mitigate resource conflicts and some countries are considering transit rules for fishing vessels within OWPs.[130]

Furthermore, policy decisions allowing fishing vessels to pass through offshore wind farms or turbines might also help in instances where fishing activities are not permitted.[131] Even though an OWP site allows fishing activities, fishers may avoid OWP sites due to the risk of accidental damage to the structures on the seabed or the undersea cables, ship strikes and damage to fishing gear.[132] This can make it problematic to establish a compensation regime for the loss of fishing grounds.

With regard to fishing authorization and right of transit within an OWP, regular consultation and engagement between the OWP and the fisheries sectors can facilitate collaborative arrangements

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[124] European Commission and Dupont et al. (n 3), at p. 14.; Perry and Heyman (n 31), at p. 31.
[125] Degraer (n 32), at p. 55; European Commission and Dupont et al. (n 3), at p. 14.
[126] See generally, Stenberg et al. (n 26).
[127] European Commission and Dupont et al. (n 3), at p. 14.
[128] Gill et al. (n 7), at p. 121.
[129] Gill et al. (n 7), at p. 121.
[130] European MSP Platform (n 106), at p. 14-17.
[131] European MSP Platform (n 106), at p. 17.
[132] European MSP Platform (n 106), at p. 5.

to the benefit of both sectors. For example, if fishing boats are allowed within the OWP, they can help monitor the site and collect relevant data on the impact of OWP on fisheries.[133] This will help licensees and/or the state to continuously monitor the OWP site and the surrounding environment during its operation.[134] Data collected from existing OWP sites can be utilized in developing future OWPs, incorporating a science-policy interface in the planning of new areas to be licensed.[135] In order to advance the current knowledge on the impact of OWPs on fisheries, it is also important to employ targeted data collection across jurisdictional boundaries while monitoring individual sites.[136] An understanding between the fisheries sector and the OWP developer has been reached in France, which will benefit the fishing community.[137]

### 4.2.4 Decommissioning

The average lifespan of an OWP is between 20 and 25 years, and after that period of operation, the OWP needs to be decommissioned,[138] something typically required in the licensing conditions and the regulatory framework.[139] Decommissioning may entail the dismantling, removal, recycling or abandonment of the OWP infrastructure.[140] There is a general lack of information on the impact of the decommissioning of OWPs on fish and fisheries as only a handful of OWPs have been dismantled so far.[141]

Based on the limited information available, it is understood that decommissioning can have a significant impact on the marine environment depending on a number of factors such as the OWP site, the size of the turbines and their foundations and so on.[142] The removal of OWP infrastructure may disturb the marine habitat, and other options for decommissioning can also have an impact on fish and fisheries.[143] In addition, the removal of the infrastructure damages the reef effect which benefits fish and other marine lives.[144] Therefore, it is essential to consider the implications of future decommissioning of OWPs on marine lives. Some countries require an environmental impact assessment (EIA) before allowing an OWP to be decommissioned to establish the potential

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[133] European MSP Platform (n 106), at p. 17.
[134] Gill et al. (n 7), at pp. 124-125.
[135] European MSP Platform (n 106).
[136] Gill et al. (n 7), at p. 125.
[137] European MSP Platform (n 106), at p. 17.
[138] Tomer Fishman and T.E. Graedel, 'Impact of the establishment of US offshore wind power on neodymium flows' [2019] Nature Sustainability, 2(4), pp. 332-338 at p. 335.
[139] Herrera Anchustegui et al (n 9).
[140] Gill et al. (n 7), at p. 121.
[141] European Commission and Dupont et al. (n 3), at p. 14; Gill et al. (n 7), at p. 121.
[142] See generally, Eva Topham and David McMillan, 'Sustainable decommissioning of an offshore wind farm' [2017] Renewable energy 102 (2017): 470-480; see also, Sanders, Haynes and Goriup et al. (n 25), at p. 267.
[143] Gill et al. (n 7), at p. 121.
[144] Degraer (n 32), at p. 52

effects of decommissioning on the surrounding environment.[145] Most countries bordering on the North Sea also demand a decommissioning plan. This should take into consideration the marine environment and fisheries activities.[146]

Another concern surrounding the decommissioning of OWPs is the management of waste generated during the dismantling or removal of the OWP structures. The applicability of general waste treatment norms to the decommissioning of OWPs is not conclusively established.[147] As yet, there are few regulatory incentives to recycle decommissioned components.[148] It is also important to notify other stakeholders, e.g., fishers who undertake fishing activities within or near the OWP site, about the dismantling schedule early on so that they can prepare accordingly. Spawning and fishing seasons should be avoided in scheduling the dismantling and removal of -OWP structures.

The above discussion highlights the fact that each stage of the lifespan of an OWP has an impact – be it positive or negative – on the marine environment, including fisheries. Licensing conditions governing each of these phases (site selection, construction, operation and decommissioning) are key regulatory instruments to address these different consequences. Based on the existing technical and environmental knowledge, it is important to adopt a life-cycle approach when approving licenses to develop OWPs. This implies a dynamic and encompassing vision regarding OWPs over time, into which circular and sustainability considerations are integrated. Furthermore, interactive and ongoing consultation between the OWP developers and other stakeholders should be given paramount importance during, or prior to, the licensing process. Lastly, consultations should be effusively participatory and take place early in the process, which will enable the stakeholders to influence the project to their advantage.[149]

## 4.3 Outside the license or post-licensing: compensatory measures and voluntary contributions

Conflicts between fisheries and OWPs may be addressed preventatively as part of MSP and stakeholder participation, or possibly as part of the licensing procedure. However, these alternatives may be insufficient, particularly once some damage has been caused or it is foreseen

[145] B.A. Hamzah, 'International rules on decommissioning of offshore installations: some observations' [2003] Marine Policy, Volume 27, Issue 4, pp. 339-348, at p. 340.
[146] Herrera Anchustegui et al (n 9).
[147] Ruven Fleming, Heyd Fernandes Más, and Ceciel T. Nieuwenhout, 'Wind Farm Waste – Emerging Issues with Decommissioning and Waste Regulation in the EU, Denmark and the United Kingdom' [2018] OGEL, 2018(2) at p. 2.
[148] See Eva Topham et al, 'Recycling offshore wind farms at decommissioning stage' [2019] Energy policy, 129, pp. 698-709; Herrera Anchustegui et al (n 9).
[149] Tim Gray, Claire Haggett, and Derek Bell, 'Offshore wind farms and commercial fisheries in the UK: A study in stakeholder consultation' [2005] Ethics place and environment 8, no. 2, pp. 127-140 at pp. 129, 134.

by fishers. In these cases, compensation would be the appropriate tool to address the situation. Regulatory regimes, therefore, ought to develop alternatives that both have a conflict-preventing nature and/or compensation mechanisms that complement and cover regulatory gaps left by the before and during-licensing frameworks. We propose two alternative avenues. First, compensatory mechanisms typically incorporated by hard-law instruments and as special rules outside of tort law or extracontractual liability regimes. Second, we discuss voluntary contributions, before or during the lifetime of the OWP to increase its social acceptance among fishers.

### 4.3.1 Compensatory mechanisms

A few countries have mechanisms for compensation granted to fishers for the loss of income as a result of placing an OWP in what were fishing waters. This happens, as we discussed in Section 3, when authorities impose no-fishing areas inside and near OWPs, when fish migrate to other parts of the sea due to the impact of the turbines or when fishers need to navigate longer distances or alter their routes, which increase their costs.[150] Compensatory regimes are typically adopted in addition to other mitigation measures and are considered a last-resort mechanism or even a not-preferred tool by the non-legal literature.[151]

Compensatory measures have a clear restitutory function. They aim to restore and address any financial losses, preventing conflict and an inadequate allocation of economic benefits and burdens between the parties, and address energy justice issues more generally.[152] The North Sea is a good example of a hybrid approach to compensation regimes. Although there are some salient examples of such mechanisms, some countries have opted not to include them: Belgium, Germany and the Netherlands do not have any,[153] whereas Denmark and Norway do.

In Denmark, the Danish Fisheries Act establishes a regime in which compensation must be paid by an OWP developer to all affected fishers based on documented losses.[154] This compensation needs to be negotiated even *before* the license to operate the OWP has been granted and the absence of an agreement on it would prevent the licence from being awarded. Compensation is given for losses during the construction as well as the operation of OWPs. These negotiations are conducted between the developer and the Danish Fishers Organisation (Danmarks Fiskeforening) or individual fishers. The compensation covers the loss in the project area but is also related to the grid system and its installation/location in the seabed and is based on data that has been collected

[150] Gill et al. (n 7), at p. 125.
[151] European Commission and Dupont et al. (n 3), at p. 18.
[152] Herrera Anchustegui (n 38).
[153] European Commission and Dupont et al. (n 3), at p. 18.
[154] §76 to 80 of the LBK nr 261 af 21/03/2019, Bekendtgørelse af lov om fiskeri og fiskeopdræt (fiskeriloven).

over a range of two to ten years, usually.[155] If no agreement between the developers and the fishers is reached, a special complaint board may be set up to decide on the amount of compensation.

In Norway, the Norwegian Offshore Energy Act compensates fishers for losses connected to OWPs. These rules were implemented as a result of consultations and voices raised by different stakeholders. The compensation comes from either the state or the licensee, depending on the type of damage. In the case of the state, the payment is made when the granting of areas for OWPs makes it “impossible or significantly more difficult” to fish.[156] Only exceptionally, according to §9-4 of the Norwegian Offshore Energy Act, are project developers and operators financially liable for losses related to the development of infrastructure. “Fishers in Norway”, meaning people that are registered in the fishers’ registry as well as owners of vessels that are in the Norwegian fishing vessels registry, are entitled to this compensation.[157]

### 4.3.2 Voluntary contributions

Some jurisdictions encourage project developers to give voluntary (non-statutory) contributions or payments to fishers. Like compensation payments, they seek to generate project support or minimize opposition. Unlike compensation payments, they are typically not connected to actual losses. Voluntary contributions can take the form of one-off or yearly payments.[158] The UK is the leading example of this sort of conciliatory mechanism. Project developers such as Ørsted have “donated £300,000 to the West of Morecambe Fisheries Fund to benefit the local fishing industry through the provision of common equipment and training as part of the Walney Extension offshore wind farm project.”[159] Also in the UK, the fishers’ association, Holderness Fishing Industry Group, has received funding from different developers to conduct research projects as well as help local fisheries.[160] In the US, the Vineyard Wind project has set up a fund that is a voluntary compensation mechanism, supporting fishers and addressing financial losses by contributing to the purchase of equipment and payment of insurance.[161]

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[155] Danish Energy Agency, *Offshore Wind and Fisheries in Denmark* (2018), available at: https://ens.dk/sites/ens.dk/files/Globalcooperation/offshore_wind_and_fisheries_in_dk.pdf.
[156] §9-2 Lov om fornybar energiproduksjon til havs.
[157] §9-1 Lov om fornybar energiproduksjon til havs.
[158] Herrera Anchustegui (n 38).
[159] Herrera Anchustegui (n 38), p. 237.
[160] Haggett et al. (n 33), at p. 42.
[161] Bureau of Ocean Energy Management, *Vineyard Wind 1 Offshore Wind Energy Project: Supplement to the Draft Environmental Impact Statement* (2020), available at: https://www.boem.gov/sites/default/files/documents/renewable-energy/Vineyard-Wind-1-Supplement-to-EIS.pdf.

# 5. Conclusion

OWPs are expected to proliferate as the world transitions towards decarbonization and cleaner energy sources with a view to addressing climate change and its impact on life on Earth. Only a few countries have enacted laws to regulate OWPs to date, and others will no doubt follow suit sooner or later. Interventions and instruments that govern OWPs must consider the effects of offshore windfarms on fisheries and the marine environment. This is an aspect that sometimes might be overlooked, particularly in light of the current political pressure and speed at which offshore renewable energy projects are being proposed as climate change mitigation measures. Failing to create a robust legal regime that accommodate these two industries within the marine environmental context is likely to lead to clashes between different interest and slow or halt activities that would have been beneficial to society and the planet.

This article provides a checklist of spatial and temporal considerations that policymakers will find helpful in designing a regulatory framework for OWPs, which, in turn, will help address or minimize the negative effects of OWPs on fish and fisheries. These considerations also could help avoid or mitigate current and potential conflicts between OWPs and other sectors, mainly fisheries, that operate in the same ocean space. For example, although the Norwegian Offshore Wind Energy Law provides a compensation regime for fishers who would lose fishing grounds due to the construction of OWPs, the Norwegian Fishermen's Association is aware that more OWPs would mean losing more fishing grounds and damaging fishers' livelihood.[162] While the compensation regime could solve the problem in the short term, MSP, including options for multi-use or co-locating OWPs with MPAs, would help in the long term.[163] In addition to these spatial considerations, there are several temporal aspects of OWP regulation, which means interventions should follow an appropriate timeframe. In this article, we discussed pre, during and post-license interventions that can help avoid conflicts and ensure smooth regulation of OWPs.

[162] Frazer Norwell, 'Why Norwegian fishermen are against more offshore wind farms,' The Local, 26 March 2021, available at: https://www.thelocal.no/20210326/why-norwegian-fishermen-are-against-more-offshore-wind-farms/.
[163] Katherine L Yates et al, 'Introduction: Marine spatial planning in the age of offshore energy' in Katherine L. Yates, Corey J. A. Bradshaw, Offshore Energy and Marine Spatial Planning (Routledge, 2018) pp. 1-5.

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