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Expert Study on Ocean Multi-use in the German Exclusive Economic Zone (EEZ) of the North and Baltic Sea

Work package 3: Investigation of realistic combinations of maritime uses in the German EEZ

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Abbreviations

AIS - Automatic Identification System

AUV – Autonomous Underwater Vehicle

EEZ – Exclusive Economic Zone

BfN – Federal Agency for Nature Conservation

BNatSchG – Federal Nature Conservation Act (Bundesnaturschutzgesetz)

BSH – Federal Maritime and Hydrographic Agency

BMWSB – Federal Ministry of Housing, Urban Development, and Construction

CCS – Carbon Capture and Storage

CLV – Cable Laying Vessel

CO2 – Carbon dioxide

CTV – Crew Transfer Vessel

EEG – Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz)

EU – European Union

SDP – Land Development Plan

FFH – Fauna-Flora-Habitat Directive

GDWS – Federal Waterways and Shipping Agency

GES – Good Environmental Status

GKT – Large Component Replacement

HD – Habitats Directive

HLV – Heavy Lift Vessel

HSEG – High Seas Dumping Act

ICES – International Council for the Exploration of the Sea

IMTA – Integrated Multi-Trophic Aquaculture

JUV – Jack-up Vessel (special lifting vessel)

KVR – Collision Prevention Rules

MSFD – Marine Strategy Framework Directive

O&M – Operation and Maintenance

OSV – Offshore Support Vessel

OWE – Offshore Wind Energy

OWF – Offshore Wind Farm

ROG – Federal Spatial Planning Act (Raumordnungsgesetz)

MSP – Maritime Spatial Plan

ROV – Remote Operated Vehicle

SeeAnlG – Offshore Installations Act (Seeanlagengesetz)

SOV – Service Operation Vessel

TRL – Technology Readiness Level

UCH – Underwater Cultural Heritage

VRL – Bird Protection Directive (Vogelschutzrichtlinie)

WEA – Wind Energy Plant

WindSeeG – Offshore Wind Energy Act (Windenergie-auf-See-Gesetz)

WSV – Federal Waterways and Shipping Administration

WP – Work package

Glossary

MULTI-USE: Multi-use of the oceans encompasses the targeted, actively managed shared use of marine resources in close geographical proximity by two or more maritime activities. The degree of connection between maritime uses can vary in terms of spatial, temporal, provisioning, and functional dimensions. This variation ranges from activities that merely share the same maritime space (co-location) to the joint use of operations, logistics, and offshore infrastructure (Schupp et al. 2019).

SPACE: In maritime spatial planning, the term "space" is understood in three dimensions, as the sea encompasses the water surface, the water body, and the seabed. These layers can be assigned to different uses.

REQUIREMENTS OF SPATIAL PLANNING: In the ROG, these are composed of the objectives of spatial planning, principles of spatial planning, and other requirements of spatial planning (Section 3 (1) No. 1 ROG). For subsequent definitions, see Section 3 (1) Nos. 2 to 4 ROG.

PRIORITY AREA (MSP): A priority area is a maritime area that is designated for certain spatially significant functions or uses and excludes other spatially significant functions or uses in this area, insofar as these are not compatible with the priority functions or uses (Section 7 (3) sentence 1 ROG).

RESERVED AREA (MSP): A reserved area is a maritime area that is to be reserved for certain spatially significant functions or uses to which particular weight is to be given when weighed against competing spatially significant functions or uses (Section 7 (3) sentence 2 MSP).

AREA (MSP): In the MSP of the EEZ (cf. AWZROVAnl), an "area" refers to a larger maritime space that is to fulfill a specific function in spatial planning. This does not only concern wind energy, but also other uses of the sea, such as shipping routes, nature conservation areas, or fishing zones. In the MSP, an "area" therefore describes a maritime space that can encompass several potential uses and is primarily or provisionally intended for specific purposes.

SITE DEVELOPMENT PLAN (SDP): The SDP in accordance with the Offshore Wind Energy Act (WindSeeG) is a central planning instrument of federal sectoral planning for offshore wind energy. It forms the basis for preliminary area investigations (Sections 9 ff. WindSeeG) as well as for plan approval and planning permission (Sections 66 ff. WindSeeG). The SDP specifies areas, sites, timetables, and technical specifications to ensure the orderly construction of offshore wind turbines and connection lines and to achieve the national expansion targets for offshore wind energy.

SITE (SDP): A site in the SDP refers to a specific, defined area within an area that is intended for use by offshore wind turbines. These sites are explicitly designated in the SDP in order to plan and promote the expansion of wind energy. The SDP defines where and when these sites are to be developed and made available. In the WindSeeG, sites are defined as "sites within areas where offshore wind turbines connected to the grid are to be erected in a spatially coherent manner and for which a joint tender is therefore issued" (Section 3 No. 4 WindSeeG).

AREA (WINDSEEG): Areas are described in the WindSeeG and therefore also in the SDP as "areas in the exclusive economic zone or in coastal waters for the construction and operation of offshore wind turbines connected to the grid" (Section 3 No. 3 WindSeeG).

SAFETY ZONE: A legally prescribed zone established around offshore wind farms. This zone generally extends up to 500 meters from the outer edge of the wind turbines or the associated infrastructure. Safety zones are defined in the WindSeeG (Section 74 (2)) and SeeAnlG (Section 10

(2)) as follows: "Safety zones are areas of water extending up to 500 meters from any point on the outer edge of the facilities. The width of a safety zone may exceed 500 meters if generally accepted international standards permit this or if the competent international organization recommends it." [translation] Safety zones are established by the BSH and, insofar as the safety zones are necessary to ensure the safety of shipping, are coordinated with the GDWS (cf. Section 74 (1) WindSeeG, Section 10 (1) SeeAnlG). With the agreement of the BSH, the GDWS may, by general ruling, grant exemptions from the general prohibition on navigation within a safety zone as laid down in the KVRV (cf. Section 7 KVRV). Within the scope of this study, safety zones are regarded as possible sites for multi-use, insofar as corresponding exemptions have been granted (e.g. for passive fishing) or could in principle still be granted by the GDWS.

TECHNICAL EXCLUSION ZONE: A technical safety distance that encompasses areas around each individual wind turbine. This distance is not explicitly prescribed by legal regulations, but is based on technical and operational requirements and is determined by the wind farm operator, often depending on the maneuverability of the vehicles used. The distances are not fixed in principle, but can be adjusted based on risk assessments and compliance with requirements. Industry standards (DNV-ST-N001- Marine Operations and Marine Warranty) are used as a guideline, i.e., a distance of approximately 500 m for the worst class of maneuverability. Within the scope of this study, the exclusion zone defined by the operator is not considered for multi-use, as this space must be kept clear for emergencies, safety reasons, and maintenance purposes.

1. Introduction

The guiding principle of German spatial planning (cf. Section 1 (2) ROG) is the sustainable development of space. The steadily increasing pressure on the North Sea and Baltic Sea will necessitate the updating of the current maritime spatial plan for the German EEZ. The premise will be that the limited resource of (marine) space is used as **efficiently** as possible, **while taking into account the impact on the marine environment and the need to protect it**. Individual uses must not only be space-saving, but also as **safe and sustainable** as possible. They should interfere with each other as little as possible and avoid deteriorating the state of the marine environment. In this sense, uses of marine space include not only economic, scientific, and military uses, but also measures to protect the marine environment.

1.1. Subject of the commissioned report

In September 2023, the Federal Maritime and Hydrographic Agency (BSH) commissioned the Federal Ministry of Housing, Urban Development, and Construction (BMWSB) to prepare a report exploring the possibilities for multi-use of sites in the German exclusive economic zone (EEZ) in the North Sea and Baltic Sea. Conversely, the report does not cover the planning areas of the German coastal states.

In accordance with the commission, the report will be prepared in five steps:

1. Evaluation of findings from research and third-party funded projects
2. Evaluation of multi-use concepts and concepts in countries bordering the North Sea and Baltic Sea
3. Investigation of combinations of maritime uses that are realistically feasible in the German EEZ
4. Development of a concept for multi-use in the German EEZ based on specific case scenarios
5. Conclusion and recommendations for implementing the multi-use concept.

The report will analyze **which multi-uses** are **realistically feasible in the German EEZ** and are **recommended** from a legal, planning, technical, ecological, and economic perspective. However, the decision on the actual promotion and implementation of such combinations remains a political and legal matter.

1.2. Definition of 'multi-use in marine areas'

Based on the definition of the EU project MUSES (Schupp et al., 2019), this report defines **multi-use** as the **targeted and actively controlled shared use of marine resources** by two or more maritime activities in **close spatial and/or functional proximity**; this may also be limited to different time periods.

Multi-use is therefore not merely about the **coexistence** of several uses in the same space, but about the **active linking of activities**, for example through shared infrastructure, coordinated processes, or complementary ecological objectives.

Multi-use is not an end in itself, but a strategic tool for implementing overarching goals: **optimizing limited spatial resources**, **reducing negative environmental impacts**, **sharing and thus reducing costs**, and **promoting new, innovative uses and measures**.

Legal framework for the integration of multi-use into maritime spatial planning in the German EEZ

Spatial planning in the AWZ is governed by the ROG. The ROG works with area designations in accordance with Section 7 (3) sentence 1 ROG in spatial plans, in particular reserved and priority areas. According to Section 7 (3) sentence 2 no. 1 ROG, priority areas are areas "which are intended for certain spatially significant functions or uses and exclude other spatially significant functions or uses in this area, insofar as these are not compatible with the priority functions or uses."[1] In contrast, reserved areas pursuant to Section 7 (3) sentence 2 no. 2 ROG are areas "that are to be reserved for certain spatially significant functions or uses to which particular weight is to be given when weighed against competing spatially significant functions or uses."[2]

The maritime spatial plan for the EEZ is drawn up as a statutory instrument by the federal ministry responsible for maritime spatial planning in the EEZ, currently the Federal Ministry of Housing, Urban Development, and Construction (BMWSB), in accordance with Section 17 (1) sentence 1 ROG, in agreement with the relevant federal ministries. The preparatory procedural steps for drawing up the spatial plan are carried out by the BSH with the approval of the BMWSB.[3] According to Section 17 (1) sentence 4 ROG, the BMWSB also cooperates with neighboring states and countries "to ensure the coordination and coherence of the spatial plan with the spatial plans of neighboring states and countries." [translation] The current spatial plan for the German EEZ in the North Sea and Baltic Sea dates from 2021.[4] The provisions of the spatial plan for the EEZ are binding pursuant to Section 4 (1) and (2) ROG,[5] whereby spatial planning objectives[6] (which include, in particular, priority areas) must *be observed* and spatial planning principles[7] must be *taken into account*.[8] According to the current legal situation, spatial planning can already "promote multi-uses due to its coordinating function and standardized instruments."[9] Provided they

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1 See Spannowsky/Runkel/Goppel/Goppel, 2nd edition, 2018, ROG § 7 para. 67 ff.

2 See Spannowsky/Runkel/Goppel/Goppel, 2nd edition, 2018, ROG § 7 para. 76 ff.

3 Section 17 (1) sentence 3 ROG

4 Maritime Spatial Plan 2021 (Raumordnungsplan für die deutsche ausschließliche Wirtschaftszone in der Nordsee und in der Ostsee (Anlage zur Verordnung über die Raumordnung in der deutschen ausschließlichen Wirtschaftszone in der Nordsee und in der Ostsee) vom 19. August 2021, BGBl. I p. 3886).

5 Spannowsky/Runkel/Goppel/Runkel, 2nd ed. 2018, ROG § 17 para. 30.

6 According to Section 3 (1) No. 1 ROG, these are "binding specifications in the form of spatially and factually determined or determinable textual or graphic specifications in spatial plans for the development, organization, and protection of the region, which have been conclusively weighed by the regional planning authority."[translated]

7 According to Section 3 (1) No. 2 ROG, these are "statements on the development, organization, and protection of the area as guidelines for subsequent weighing or discretionary decisions; principles of spatial planning can be established by law or as specifications in a spatial plan." [translated]

8 See Spannowsky/Runkel/Goppel/Goppel, 2nd ed. 2018, ROG § 4 margin no. 22 ff.

9 Schlacke/Plate, Multifunktionale Flächennutzung: Potentiale und Grenzen des Raumordnungsrechts, ZUR 2024, 323 (328).

do not contradict each other, overlapping area designations are generally permissible, for example.[10] However, multi-uses are not yet explicitly mentioned at the legal level in the ROG.[11] According to the current legal situation, a (even greater) rethinking of planning practice is therefore necessary if multi-use developments are to be defined on a larger scale in the spatial planning scheme.[12] Not least from the perspective of the authorities involved in spatial planning, however, it is desirable that the ROG be clarified to explicitly refer to the possibility of defining multi-use developments.[13] The literature therefore suggests (not only for the AWZ) that the ROG be supplemented by "a model of multifunctional land use" [translation] (in Art. 1 (2) ROG) and "a new type of area, 'multifunctional areas'" [translation] (in § 7 (3) sentence 2 ROG).[14]

The draft law implementing the RED III Directive in the areas of onshore wind energy and solar energy, as well as for energy storage facilities at the same location, now includes an addition to Section 7 (1) sentence 2 ROG.[15] According to this clarifying[16] addition, which also creates a legal definition of multi-use, spatial plans may stipulate that "certain sites of the planning area, including area designations pursuant to [Section 7 (3) ROG], are intended for several compatible uses and functions (multi-use)". The purpose of the amendment is "against the backdrop of increasing competition for land use, to provide impetus for greater consideration of multifunctional use of space than has been the case to date in spatial planning schemes."[17]

The explanatory memorandum also emphasizes that multi-use "is not only aimed at the widest possible realization of individual uses and functions," but can also have positive effects on envi-

10 Schlacke/Plate, Multifunktionale Flächennutzung: Potentiale und Grenzen des Raumordnungsrechts, ZUR 2024, 323 (329).

11 Schlacke/Plate, Multifunktionale Flächennutzung: Potentiale und Grenzen des Raumordnungsrechts, ZUR 2024, 323 (329).

12 See Schlacke/Plate, Multifunktionale Flächennutzung: Potentiale und Grenzen des Raumordnungsrechts, ZUR 2024, 323 (329).

13 See also Schlacke/Plate, Multifunktionale Flächennutzung: Potentiale und Grenzen des Raumordnungsrechts, ZUR 2024, 323 (329).

14 Schlacke/Plate, Multifunktionale Flächennutzung: Potentiale und Grenzen des Raumordnungsrechts, ZUR 2024, 323 (329 ff.).

15 Entwurf eines Gesetzes zur Umsetzung der Richtlinie (EU) 2023/2413 in den Bereichen Windenergie an Land und Solarenergie sowie für Energiespeicheranlagen am selben Standort, 05.04.2024, https://www.bmwk.de/Redaktion/DE/Artikel/Service/Gesetzesvorhaben/240403-gesetz-umsetzung-red-3-wind-an-land-und-solarenergie.html, p. 25.

16 Entwurf eines Gesetzes zur Umsetzung der Richtlinie (EU) 2023/2413 in den Bereichen Windenergie an Land und Solarenergie sowie für Energiespeicheranlagen am selben Standort, 05.04.2024, https://www.bmwk.de/Redaktion/DE/Artikel/Service/Gesetzesvorhaben/240403-gesetz-umsetzung-red-3-wind-an-land-und-solarenergie.html, p. 87.

17 Entwurf eines Gesetzes zur Umsetzung der Richtlinie (EU) 2023/2413 in den Bereichen Windenergie an Land und Solarenergie sowie für Energiespeicheranlagen am selben Standort, 05.04.2024, https://www.bmwk.de/Redaktion/DE/Artikel/Service/Gesetzesvorhaben/240403-gesetz-umsetzung-red-3-wind-an-land-und-solarenergie.html, p. 87.

ronmental protection by reducing land consumption and the impairment of protected resources.[18] The explanatory memorandum also emphasizes that if the intended uses and functions are not fully compatible, "special attention should be paid to the [...] possibilities of the temporal dimension, e.g., interim and subsequent uses."[19] In addition, priorities could be set between intended uses and functions, with preference given to those uses that are in the overriding public interest.[20]

1.3. Subject of this report, study approach

This WP3 report builds on the results of the first two work packages, which summarized the current state of knowledge in the context of European and national 'research and third-party funded projects on the topic of multi-use' (WP1) and then existing and planned 'concepts, practices, and (pilot) projects in the field of multi-use in countries bordering the North Sea and Baltic Sea' (WP2) were presented.

This report now examines which combinations of maritime uses in the German EEZ are generally considered realistic based on current knowledge, without prejudging a final assessment. The comments on the individual uses do not yet refer to a specific geographical area, but to fundamental, yet realistic, possible combinations in the German EEZ in general.

Forms of use considered

The German EEZ in the North Sea and Baltic Sea is already being used in many ways. The pressure on these areas is constantly increasing. When considering possible multi-use scenarios, it is not only important to categorize the uses broadly, for example, as "fishing." Rather, it is necessary to distinguish precisely between their various forms, which in turn entail different spatial, technical, natural, socio-economic, and legal conditions and have different impacts on the environment.

The report does not only cover current forms of use and their design. Rather, it takes into account both the expected changes in current uses and possible new uses that are already known but have not yet been introduced. A distinction must also be made between changes that are already known and planned, and those that are possible in the future but have not yet been firmly planned.

The following figure (Figure 1) lists all of these forms of use that are realistically possible in the German EEZ and compares them with each other. The assessments achieved in this report for the

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18 Entwurf eines Gesetzes zur Umsetzung der Richtlinie (EU) 2023/2413 in den Bereichen Windenergie an Land und Solarenergie sowie für Energiespeicheranlagen am selben Standort, 05.04.2024, https://www.bmwk.de/Redaktion/DE/Artikel/Service/Gesetzesvorhaben/240403-gesetz-umsetzung-red-3-wind-an-land-und-solarenergie.html, p. 87.

19 Entwurf eines Gesetzes zur Umsetzung der Richtlinie (EU) 2023/2413 in den Bereichen Windenergie an Land und Solarenergie sowie für Energiespeicheranlagen am selben Standort, 05.04.2024, https://www.bmwk.de/Redaktion/DE/Artikel/Service/Gesetzesvorhaben/240403-gesetz-umsetzung-red-3-wind-an-land-und-solarenergie.html, p. 87.

20 Entwurf eines Gesetzes zur Umsetzung der Richtlinie (EU) 2023/2413 in den Bereichen Windenergie an Land und Solarenergie sowie für Energiespeicheranlagen am selben Standort, 05.04.2024, https://www.bmwk.de/Redaktion/DE/Artikel/Service/Gesetzesvorhaben/240403-gesetz-umsetzung-red-3-wind-an-land-und-solarenergie.html, p. 87 f.

respective combinations of uses are shown in color. As described in the definition of multi-use, the individual combinations refer to a geographically limited area. For the OWF example, the individual quadrants refer to a respective OWF including a safety zone. In terms of spatial planning, the quadrants refer to the three or four spatial dimensions of the respective marine area (seabed, water column, surface, air).

Figure 1 - Compatibility matrix – marine uses in the German EEZ.

The matrix already refers to the German EEZ and its conditions. Therefore, in addition to the category **'red** – fundamentally incompatible', a category 'blue' has also been introduced. This refers to combinations of uses that do not fundamentally overlap spatially in the German EEZ, although this may be the case in other countries. Quadrants marked 'green' refer to combinations of uses that may spatially overlap and are fundamentally compatible with each other.

In all cases, the combinations of uses marked 'yellow' or 'pink' are of particular interest for this report and, above all, for the following considerations in this report. In all these cases, we assume that, at least in principle, it should be examined under what conditions a combination would be possible. The color 'pink' means that the possible uses for 'CCS' and 'hydrogen production' are relevant, but the current state of knowledge is insufficient to make in-depth statements about the possible combinations.

The color 'white' was used to mark uses that require in-depth discussion of possible multi-use scenarios, but which are not considered in this report. This is due, on the one hand, to the complexity of the topic and, on the other hand, to the fact that other reports on this subject have already been commissioned.

Further details on the compatibility matrix

Nature conservation is not considered a separate land use in this report, as the legal framework is complex and the protected resources vary depending on the area. A comprehensive analysis of the compatibility of individual uses with the specific requirements of nature conservation areas would go beyond the scope of this study. The Federal Agency for Nature Conservation (BfN) is responsible for the technical planning of marine nature conservation areas in the German EEZ, while the formal designation of these areas is carried out by the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety, and Consumer Protection (BMUV).[21] At the same time, a conceptual distinction is made between **nature conservation** and **nature restoration**. While nature conservation primarily aims to preserve existing ecosystems, nature restoration encompasses targeted measures for active habitat enhancement. In the context of this report, this refers to interventions that promote biodiversity, such as biogenic, geogenic, or artificial reefs.

Incidentally, the legal basis for the compatibility of offshore wind farms with nature conservation areas is clearly regulated. In principle, neither use is permitted if wind turbines impair the conservation objectives of an area. Section 5 of the Offshore Wind Energy Act (WindSeeG) excludes the designation of such sites. However, an exception introduced in 2023 allows for the planning of offshore wind farms in nature conservation areas, provided that no significant adverse effects are to be expected in accordance with Section 34 of the Federal Nature Conservation Act (BNatSchG) or that specific conditions are met. This opens up the possibility of a case-by-case assessment. Currently, however, there are no overlaps between protected areas and wind power sites in the German EEZ.

Since the sand and gravel extraction areas currently used in the EEZ are located in the Sylt Outer Reef – Eastern German Bight nature conservation area, it is unlikely that this use will be combined with OWFs in the foreseeable future. In addition, it is the responsibility of the BfN's specialist planning department to decide on the approval of individual sub-areas within the approved concession areas. This use is therefore not directly subject to spatial planning and will not be considered in depth in this context.

The exploration of raw materials (hydrocarbons, sand and gravel extraction) must be considered separately from the resource extraction color-coded in the matrix. Exploration (seismic measurements, exploratory drilling) involves similar aspects and safety concerns to those associated with mobile research (chapter 2.7 and chapter 3.4) and exploration for CCS (chapter 2.4).[22] In the case of hydrocarbon extraction, further co-uses are possible in the corresponding mining concession areas; here, the incompatibility of use refers to the immediate vicinity of the extraction site (500-m safety zone).

Structure of the report

The following report is divided into two main chapters:

Chapter 2: Multi-use in connection with offshore wind energy
Chapter 3: Other combinations of multi-uses

21 See Section 57(2) BNatSchG.

22 Current mining areas are located in the Westerland 3 and OAM 3 concession areas, both of which are located in the Sylt Outer Reef NCA – Eastern German Bight. Legal proceedings are currently underway due to inaction regarding the BSK concession area, which extends beyond the Sylt Outer Reef NCA. No mining is currently taking place here.

Chapter 2: Multi-use in connection with offshore wind energy

In Chapter 2.1, we first examine the current legal framework in the German EEZ with regard to multi-use of OWFs and possibilities for further development. Building on WP2 (evaluation of concepts for multi-use in other European countries), we also revisit the examples of the Netherlands and Denmark, as these do not refer to individual combinations.

In Chapter 2.2, we describe the current spatial and technical basis of the OWFs currently planned in the German EEZ. In doing so, we also refer to maintenance requirements, insofar as they are relevant to the issue addressed in WP3. In this chapter and in this report, we focus mainly on the operational phase of an OWP. Aspects that may be relevant in the construction phase or post-use phase with regard to multi-use are not discussed further in this report. Where appropriate, these will be addressed in further work packages dealing with individual case constellations.

In Chapter 2, we then discuss each additional form of use that, as listed above, could potentially be combined with OWFs in the German EEZ.

In all cases, we provide a brief introduction to the respective form of use, especially those that currently do not exist at all or only exist in pilot form. However, even for known forms of use (especially fishing), we describe possible changes and developments that could potentially affect the possibility of future multi-use.

To the extent permitted by the current state of knowledge on these individual forms of use and to the extent relevant to the respective form of use, we examine the following aspects in each case:

Aspect/criterion:	**Question**
Legal framework	Does the current legal framework allow for the concrete implementation of multi-use with OWF, and to what extent, or is it capable of regulating such use?
Spatial requirements of use	Which sites are particularly suitable for the respective use and to what extent do these overlap with the sites planned for offshore wind energy in the SDP (as of draft 07.06.2024)? What requirements must these sites meet?
Functional compatibility and technical feasibility	What prerequisites arise from the technical conditions of the respective use? What synergies could possibly result from a multi-use? At what stage of OWF planning would such synergies need to be taken into account?
Seasonality of use	To what extent is the use seasonal and to what extent is this compatible in a semi-seasonal environment of an OWP, which is operated all year round but is more frequently visited in summer?
Safety aspects	What risks and hazards, and thus safety requirements, exist for the individual uses—also in relation to the conditions in the German EEZ (wind, currents, limited visibility, wave height)?
Negative/positive environmental and climate impacts	What negative/positive impacts arise from the respective further use (environment/climate)?
Economic efficiency and socio-economic benefits	What economic or business benefits result from the respective use?

Even though we are aware that the report is intended to serve marine spatial planning in the German EEZ in particular, these criteria make it clear that the individual forms of use are not only examined on the basis of their spatial requirements, but that other aspects are also taken into account when discussing possible multi-use options. The weighing up of these factors remains a political and legal decision. Individual issues can then also be included in the textual part of a spatial development plan. Overall, however, other control mechanisms will have to be used for any further use.

In all cases, we refer to the state of knowledge determined in WP1 and WP2 from projects/cases in countries other than Germany for the individual combination options. In addition, we expand on this with the findings from our expert surveys, which we have conducted from April 2024 to the present (see chapter Methodological Approach).

In addition, where relevant, the respective discussions refer to possible differentiations

- either arising from the different conditions in the German EEZ in the North Sea and Baltic Sea or
- result overall from the different conditions for OWFs, which are described in chapters 2.1 and 2.2.

However, more detailed scenarios will only be included in the next work package 4, which will address individual case constellations. Even in these cases, however, it should be noted at this stage that this report will only deal with representative wind farms and possible layouts. Under no circumstances can individual cases be examined.

Chapter 3: Other multi-uses

After discussing multi-use combinations with OWFs, in Chapter 3 we present further multi-use combinations that relate to a limited geographical area.

We will again proceed in the alphabetical order listed in Figure 1 and limit ourselves to combinations marked in yellow.

In general, the individual subchapters and thus the entire Chapter 3 are much shorter, as in many cases the exact design of the individual uses has already been described in Chapter 2.

Furthermore, chapter 3 does not serve as a basis for the further development of the multicriteria decision analysis to prepare for work package 4, as only the case constellation 'OWF and ...' will be considered in the further course of the study. In this respect, it is not possible to conduct a further legal review of any combinations of uses within the scope of this report.

Nevertheless, we consider Chapter 3 to be an important contribution to the discourse on possibilities for further multi-use combinations in the German EEZ and beyond. While WP1 and WP2 have shown that other countries and research and innovation projects have also largely focused on the multi-use of marine space in relation to OWFs, our work and expert surveys in recent weeks/months have shown that there is still a wider spectrum to be explored here.

Methodological approach

In addition to the findings from work packages 1 and 2, extensive literature research was carried out, AIS data on ship movements over a calendar year was analyzed, maps were created, and existing maps on individual uses and environmental conditions in the German EEZ were consulted.

Where available, additional documents were included in the research and, where possible, an **individual interview** was conducted with at least one expert for each type of use. Subsequently, three of the five planned 2- to 3-hour online group discussions (**workshops**) have been held to date, bringing together representatives of different types of use to identify the key points that are crucial for each type of use in order to enable multi-use with other types of use.

Interviews and workshops with experts and stakeholders provide valuable practical insights from different interest groups. Eighteen different interest groups were included in the course of the report due to their specific connection to multi-use, for example as experts, affected parties, or beneficiaries.

The following figure shows the interest groups for which a comprehensive contact list with over 250 personal contacts was created.

Identified interest groups:

- *Government agencies and regulatory bodies*
- *Energy sector*
- *Maritime transport sector*
- *Certification bodies*
- *Technical experts and consultants*
- *Federal associations*
- *Local communities*
- *Environmental protection groups*
- *Regional authorities*
- *Fishing industry*
- *Science and research institutions*
- *Investors and financial institutions*
- *Insurance companies*
- *Media representatives*
- *Supply chains and service providers*
- *Public health experts*
- *Trade unions and employee representatives*

Written survey of experts

Of the **approximately 250 contacts invited, 71 people participated.** With a **response rate of 28%**, expectations (20%) were exceeded, demonstrating the high level of commitment to the topic and the successful involvement of stakeholders.

All information was provided on a voluntary basis, including full names, company affiliation, and willingness to be contacted for further questions. The information provided was incorporated as reliable expert study for the content confirmation and expansion of the fact sheets as well as the evaluation objectives of WP3.

According to the participants' own information, an **average seniority of approximately 10 years** with relevant professional experience can be determined. Furthermore, Table 1 shows **broad participation from various types of organizations**: 34% of participants come from government institutions, 27% from business, 17% from non-governmental organizations (NGOs), 14% from academia, and 3% from associations.

Table 1 - Breakdown of participants by organization

Organization	Whole values	Percentage of responses (in %)
Total	71	1.0
Authority	24	0.3
Research/university	10	0.14

NGO	12	0.17
Companies	19	0.27
Other	3	0.04
Association	3	0.04

Table 2 shows that participants were mainly from the fields of nature conservation (24%) and energy (19%), followed by fisheries (16%), aquaculture (14%) and research (12%). Overall, the active participants represented a diverse range of backgrounds, which allowed different perspectives on opportunities and challenges to be captured.

Table 2 - Breakdown of participants by sector

Sector	Whole values	Percentage of responses (in %)
Total	85	1.0
Aquaculture	12	0.14
Energy	16	0.19
Fisheries	14	0.16
Research	10	0.12
Nature conservation	20	0.24
Nature restoration	2	0.02
Raw material extraction, or dumping	4	0.05
Shipping	6	0.07
Defense	1	0.01

Interview

In addition, based on the written questionnaire, **20 interviews** were conducted in one-on-one conversations with experts on the individual topics/uses. An overview of the interviews conducted can be found in Table 3 below.

Table 3 - Overview of interviews conducted

Interview topic	Organization of the interviewee
Aquaculture Algae	Blue Star Foods
Aquaculture Algae	Ocean Rainforest
Aquaculture Mussels	Kieler Meeresfarm
Carbon capture and storage (CCS)	GEOMAR
Energy	Offshore Wind Energy Foundation
Energy	Iberdrola Renovables
Energy	RWE
Energy/Nature restoration	ORSTED
Fisheries	Producer association
Nature conservation	BfN
Nature conservation	University of Rostock
Nature conservation Birds	DDA
Nature restoration Oysters	AWI
Raw material extraction (sand and gravel, oil and gas, pipelines)	LBEG
Stationary research	R&D FINO 3 team
Stationary research	DNV, FINO 2 Team
Stationary research	R&D, Operator FINO3
Stationary research	DNV, operator FINO2

Mobile research	Thünen Institute
Defense	BMVg

Workshops

Five workshops with five participants from different sectors are planned during the course of the assessment. The workshops are moderated and all participants are actively involved. The workshops aim to identify specific problems and develop concrete solutions that enable shared use. In particular, in-depth findings will be used to evaluate combinations of uses in WP4.

The standard workshop procedure is outlined below.

Duration: 2 hours (online)

10 minutes: Welcome and introductions

15 minutes: Introduction to the project and the workshop

- Introduction to the project and the topic of the workshop by the moderator.
- Presentation of findings to date and explanation of the reasons for the specific composition of the workshops (e.g., why the respective uses are considered in combination).

50 minutes: Presentations and discussion

- Each participant has 5 minutes to present their use and stimulate discussion on the question "How can a multi-use be realized with the other uses present?"
- Each presentation is followed by a short discussion round in which the other participants present their perspectives and any agreements or differences regarding the problems and solutions presented.

10 minutes: Break

- During this time, the moderators summarize the main findings from the discussions so far and present an initial conclusion.

5 minutes: Vote on the topic to be discussed in detail

- The participants vote on which main topic should be discussed in detail.

25 minutes: Intensive discussion

- Intensive discussion of the selected main topic or topics.
- The aim is to develop concrete solutions and determine the next steps.

5 minutes: Conclusion and farewell

Table 4 - Overview of workshop compositions

Workshop 1	Workshop 2	Workshop 3	Workshop 4*	Workshop 5
Aquaculture Mussels	Aquaculture	CCS	Aquaculture	Mining Pipelines
Aquaculture Algae	Aquaculture	Wind energy	Wind energy	Wind energy
Nature conservation	Active fishing	Wind energy	Active fishing	Hydrogen
Nature restoration	Passive fishing	Defense	Passive fishing	Mobile research
Shipping	Research Stationary	Defense	Nature restoration	Shipping

* Workshops not yet held at the time of the WP3 report. Findings will primarily be incorporated into WP4 for the evaluation of multi-use scenarios.

2. Multi-use in connection with offshore wind energy

This chapter systematically analyzes the complex issue of multi-use of sites in the German exclusive economic zone (EEZ) under the premise of offshore wind energy use as the basic form of use. The gradual development of the EEZ for offshore wind energy generation forms the basis for considering the legal, technical, economic, and ecological aspects of potentially complementary forms of use.

As shown in Figure 1, there are a number of other uses that could potentially be combined with OWFs in the German EEZ. The order of the additional uses discussed in Chapter 2.3 onwards is deliberately alphabetical, as it does not imply any evaluation or prioritization of the respective multi-use.

In addition, the respective characteristics of the individual uses have been sorted into separate chapters according to their superordinate category in order to avoid unnecessary duplication. Where relevant, the respective chapters point out the differences between the individual technologies/designs of the use, insofar as these are relevant for a possible combination with OWF.

As already outlined in Chapter 1, uses that are considered "unrealistic" from the outset in the coming decades or that are not even considered in the German EEZ are not discussed further here.

Table 5 shows the respective individual uses, as well as the level of experience with regard to individual use or multi-use with OWF in Germany and other countries.

The key figures on the level of knowledge and experience do not refer to the general 'TRL' (Technology Readiness Level); instead, they are to be understood as follows:

1 = No pilot plant (not even for single use) available in Europe
2 = Pilot plants for single use exist in Europe, but not in Germany
3 = Commercial plants for single use exist in Europe, but not in Germany
4 = Pilot plants available in Germany, but not in the EEZ
5 = Plants for individual use available in Germany, but not in the EEZ
6 = Individual use available in the German EEZ
7 = Pilot plants for multi-use with OWF available in Europe, but not in Germany
8 = Pilot plants for multi-use in Germany in the EEZ available

Table 5 - Possible future uses in combination with OWF in the German EEZ and current state of knowledge and experience regarding these respective uses

Category	Technology / Type of use	Level of experience
Aquaculture	Algae (sugar kelp, bladderwrack, others)	3, 5, 7, 8
Aquaculture	Fish aquaculture	3, 5
Aquaculture	European oysters	7, 8
Aquaculture	Mussels	2, 3, 4, 5, 6, 7, 8
CCS	Carbon capture and storage (CCS)	2, 3
Energy	Offshore solar power plants	7
Energy	Hydrogen production	1
Energy	Wave energy plant	2.4

Fishing	Passive fishing (traps, fish traps)	5, 7, 8
Fishing	Commercial shipping / Transit	6, 7
Research	Mobile research: at the same locations, but without fixed infrastructure	6, 7, 8
Research	Stationary measuring stations with permanently installed measuring equipment	6
Cables	Data cables	6
Cables	Power cables (interconnectors)	6
Nature restoration	European oysters	7, 8
Nature restoration	Geogenic reefs	7
Nature restoration	Artificial reefs	7
Shipping	Recreational boating (sailing, etc.)	6, 7
Existing conditions	Protection of underwater cultural heritage	6, 7
Existing situation	Sunken munitions	6

2.1. Legal framework

Introduction

The site of the German EEZ is approximately 32,991 km², of which 28,539 km² is in the North Sea and 4,452 km² is in the Baltic Sea.[23] This is a relatively small site in terms of Germany's population and resource and energy requirements. This is all the more true when one considers the diverse current and potential future uses of the EEZ (shipping, fishing, aquaculture, offshore wind energy, submarine cables and pipelines, nature conservation, raw material extraction, scientific marine research, military uses, CO_2storage, etc.), each of which places demands on the available sites. Against this backdrop, conflicts of use in the EEZ are inevitable.[24] In the German EEZ, the ambitious expansion targets for offshore wind energy pursuant to Section 1 (2) WindSeeG (installed capacity of at least 30 gigawatts (GW) by 2030, at least 40 GW by 2035, at least 70 GW by 2045) are leading to increased space requirements, displacing various other uses such as active fishing, which is prohibited in the safety zones of OWF (see below).[25]

The need for efficient land use in the EEZ has given rise to the idea of managing sites within the framework of so-called multi-use. As discussed in the previous chapter, scientific literature defines multi-use of the sea as 'the shared use of resources in close geographical proximity by one

23 Federal Agency for Nature Conservation, 2024, https://www.bfn.de/zustaendigkeiten-und-zulassungsverfahren#:~:text=The%20German%20EEZ%20covers%20a%20total%20area%20of%204,452%20km%C2%B2%20in%20the%20Baltic%20Sea).

24 See, for the perspective under international law, for example, Proelss, The Law on the Exclusive Economic Zone in Perspective: Legal Status and Resolution of User Conflicts Revisited, in Ocean Yearbook Online, 2012.

25 See, for example, Stelzenmüller et al., From plate to plug: The impact of offshore renewables on European fisheries and the role of marine spatial planning, Renewable and Sustainable Energy Reviews 2022, https://doi.org/10.1016/j.rser.2022.112108.

or more users'.[26] According to this understanding, multi-use is an umbrella term that covers a variety of combinations of uses in the marine environment. For offshore wind energy in particular, it represents a shift away from the concept of almost exclusive use towards the comprehensive shared use of resources and space by one or more users.[27]

This chapter deals with the legal framework for the multi-use of sites in the German EEZ, highlighting general legal hurdles and potential using the example of the integration of marine aquaculture[28] and fisheries[29] into OWFs.[30] The study focuses on the options available to the competent authorities in terms of spatial and technical planning, preliminary site investigations including subsequent suitability assessments, the respective approval procedures, and the subsequent design of the usage regime for the respective sites with regard to a multi-use.

The chapter also addresses the question of what legislative changes could be considered in order to place the multi-use of OWF in the German EEZ on a legally secure and practicable footing. However, whether and which multi-uses will be pursued remains a matter for political consideration and is not addressed in this study.

In order to elaborate on the relevant regulatory options in more detail, the chapter makes comparative legal reference to the current legal situation regarding multi-use in other countries located on the North Sea and Baltic Sea, as already presented in WP2, with a closer look at the Netherlands and Denmark.

Promotion of multi-use of OWFs in Directive (EU) 2018/2001

Article 15b(3) sentence 1 of Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources[31] requires Member States to "promote" the multi-use of areas necessary for national contributions to the Union's overall target for energy from renewable sources for 2030 (so-called renewable energy areas[32]). However, the directive does not contain a definition of the term "multi-use." In addition, Article 15b(3) sentence 2 of the directive stipulates that renewable energy projects must be "compatible with existing uses of these areas." The provisions introduced

26 Schupp et al., Toward a Common Understanding of Ocean Multi-Use, Front. Mar. Sci. 2019, https://doi.org/10.3389/fmars.2019.00165.

27 Schupp et al., Toward a Common Understanding of Ocean Multi-Use, Front. Mar. Sci. 2019, https://doi.org/10.3389/fmars.2019.00165.

28 See Maar et al., Multi-use of offshore wind farms with low-trophic aquaculture can help achieve global sustainability goals, Communications Earth & Environment 447 2023, https://doi.org/10.1038/s43247-023-01116-6.

29 See Bonsu et al., Co-location of fisheries and offshore wind farms: Current practices and enabling conditions in the North Sea, Marine Policy 2024, https://doi.org/10.1016/j.marpol.2023.105941.

30 Initial thoughts on this topic can already be found in Mochtak, Windenergieanlagen und Marikultur: Rechtliche Fragen der multifunktionalen Nutzung der ausschließlichen Wirtschaftszone der Nordsee, Dissertation, Rostock, 2018.

31 Directive (EU) 2018/2001 of the European Parliament and of the Council of December 11, 2018 on the promotion of the use of energy from renewable sources, ELI: http://data.europa.eu/eli/dir/2018/2001/2024-07-16.

32 See Wulff, Die Umsetzung der Erneuerbare Energien-Richtlinie (RED III) in nationales Recht, NVwZ 2024, 368 (369 ff.).

by Directive (EU) 2023/2413 (known as the RED III Directive)[33] aim to reduce restrictions on other forms of lake use (including food production, nature conservation, and nature restoration) through multi-use of sites, which are now also to be used for the production of renewable energy.[34]

In this context, Recital 27 of Directive (EU) 2023/2413 clarifies that spatial planning is an essential tool in this regard "to identify and manage synergies for land, inland water, and lake use at an early stage." [translation] Within the framework of spatial planning, the multi-use of sites (including through changes in use) should therefore also be examined, enabled, investigated, and promoted "provided that the different types of use and activities are compatible with each other and can coexist."[35] Union law therefore also provides an important impetus for the integration of multi-use into maritime spatial planning with regard to OWF. The German government has taken up this impetus in its current draft law implementing the RED III Directive, which also contains provisions on multi-use (in particular, an amendment to Section 7 (1) sentence 2 ROG).[36]

Multi-use and maritime spatial planning in the EEZ

As already outlined in chapter 1.1, spatial planning in the EEZ – and thus also the inclusion of multi-use of OWFs in the EEZ – is governed by the ROG. With regard to OWFs, particular mention should be made of the designation of priority and reserved areas for wind energy at sea.[37] Under current legislation, spatial planning can already "promote multi-use due to its coordinating function and standardized instruments."[38] Provided they do not contradict each other, overlapping area designations are generally permissible.[39] The current spatial plan for the EEZ already contains initial provisions regarding the multi-use of reserved areas for offshore wind energy. One example is an overlap with reserved areas for research, whereby the principle of "multi-use" stipulates that "fisheries research should remain possible in the same form and scope as it has been practiced to date."[40] The use of reserved areas for offshore wind energy for passive fishing (with traps and baskets outside the area bounded by the outer installations and outside the immediate

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33 Directive (EU) 2023/2413 of the European Parliament and of the Council of October 18, 2023, amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC with regard to the promotion of energy from renewable sources and repealing Council Directive (EU) 2015/652, ELI: http://data.europa.eu/eli/dir/2023/2413/oj.

34 Recital 27 Directive (EU) 2023/2413.

35 Recital 27 Directive (EU) 2023/2413. Quote translated.

36 Entwurf eines Gesetzes zur Umsetzung der Richtlinie (EU) 2023/2413 in den Bereichen Windenergie an Land und Solarenergie sowie für Energiespeicheranlagen am selben Standort, April 5, 2024, https://www.bmwk.de/Redaktion/DE/Artikel/Service/Gesetzesvorhaben/240403-gesetz-umsetzung-red-3-wind-an-land-und-solarenergie.html, p. 25.

37 See Maritime Spatial Plan 2021 (Raumordnungsplan für die deutsche ausschließliche Wirtschaftszone in der Nordsee und in der Ostsee), p. 11.

38 Schlacke/Plate, Multifunktionale Flächennutzung: Potentiale und Grenzen des Raumordnungsrechts, ZUR 2024, 323 (328). Quote translated.

39 Schlacke/Plate, Multifunktionale Flächennutzung: Potentiale und Grenzen des Raumordnungsrechts, ZUR 2024, 323 (329).

40 Maritime Spatial Plan 2021 (Raumordnungsplan für die deutsche ausschließliche Wirtschaftszone in der Nordsee und in der Ostsee), pp. 11 and 13. Quote translated.

vicinity of the outer installations) and by the German Armed Forces (e.g., installation and operation of fixed facilities such as transmitting and receiving equipment on energy generation facilities) should be possible according to the provisions (as a principle) in the current spatial plan.[41] However, as multi-uses have not yet been explicitly mentioned at the legislative level,[42] there is a need – as already outlined in Chapter 1.1 – to rethink planning practice if multi-uses are to be specified on a larger scale in the spatial planning scheme.[43] Legal clarification is also desirable and can be found, as already mentioned in Chapter 1.1, in the draft law implementing the RED III Directive.[44] The explanatory memorandum to the draft law also contains a statement specifically on the multi-use of OWF. According to this, "uses that are in the overriding public interest are to be given priority among the various uses."[45] According to Section 1 (3) WindSeeG, these priority uses "in the overriding public interest" include the construction of wind turbines at sea and offshore connection lines. The explanatory memorandum to the law further states that the requirement for "compatible uses and functions" in the text of the law means that "specifications for incompatible multi-uses [...] are not considered from the outset."[46] According to this, with regard to the requirement of compatibility between the various uses, "multi-use of offshore wind energy areas by active fishing [...] shall not be excluded" "provided that it is clearly demonstrated that environmentally compatible and safe wind power expansion and operation is not jeopardized despite multi-use by active fishing."[47] Furthermore, "intensification of land use [...] should not run counter to the [...] goal of reducing the impact on environmental assets."[48]

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41 Maritime Spatial Plan 2021 (Raumordnungsplan für die deutsche ausschließliche Wirtschaftszone in der Nordsee und in der Ostsee), pp. 11 and 13.

42 Schlacke/Plate, Multifunktionale Flächennutzung: Potentiale und Grenzen des Raumordnungsrechts, ZUR 2024, 323 (329).

43 Vgl. Schlacke/Plate, Multifunktionale Flächennutzung: Potentiale und Grenzen des Raumordnungsrechts, ZUR 2024, 323 (329).

44 Entwurf eines Gesetzes zur Umsetzung der Richtlinie (EU) 2023/2413 in den Bereichen Windenergie an Land und Solarenergie sowie für Energiespeicheranlagen am selben Standort, April 5, 2024, https://www.bmwk.de/Redaktion/DE/Artikel/Service/Gesetzesvorhaben/240403-gesetz-umsetzung-red-3-wind-an-land-und-solarenergie.html, p. 25.

45 Entwurf eines Gesetzes zur Umsetzung der Richtlinie (EU) 2023/2413 in den Bereichen Windenergie an Land und Solarenergie sowie für Energiespeicheranlagen am selben Standort, April 5, 2024, https://www.bmwk.de/Redaktion/DE/Artikel/Service/Gesetzesvorhaben/240403-gesetz-umsetzung-red-3-wind-an-land-und-solarenergie.html, p. 88. Quote translated.

46 Entwurf eines Gesetzes zur Umsetzung der Richtlinie (EU) 2023/2413 in den Bereichen Windenergie an Land und Solarenergie sowie für Energiespeicheranlagen am selben Standort, April 5, 2024, https://www.bmwk.de/Redaktion/DE/Artikel/Service/Gesetzesvorhaben/240403-gesetz-umsetzung-red-3-wind-an-land-und-solarenergie.html, p. 88. Quotes translated.

47 Entwurf eines Gesetzes zur Umsetzung der Richtlinie (EU) 2023/2413 in den Bereichen Windenergie an Land und Solarenergie sowie für Energiespeicheranlagen am selben Standort, April 5, 2024, https://www.bmwk.de/Redaktion/DE/Artikel/Service/Gesetzesvorhaben/240403-gesetz-umsetzung-red-3-wind-an-land-und-solarenergie.html, p. 88. Quote translated.

48 Entwurf eines Gesetzes zur Umsetzung der Richtlinie (EU) 2023/2413 in den Bereichen Windenergie an Land und Solarenergie sowie für Energiespeicheranlagen am selben Standort, April 5, 2024, https://www.bmwk.de/Redaktion/DE/Artikel/Service/Gesetzesvorhaben/240403-gesetz-umsetzung-red-3-wind-an-land-und-solarenergie.html, p. 88. Quote translated.

Multi-use in the technical planning of the WindSeeG

With the SDP, the WindSeeG provides for a separate planning instrument in which the BSH[49] can primarily make technical planning specifications for the EEZ.[50] The matters for which the SDP can make technical planning specifications in accordance with Section 4 (1) sentence 2 and Section 5 WindSeeG include, among other things, areas (i.e., "areas for the construction and operation of offshore wind turbines connected to the grid"[51]), sites (i.e., "sites within areas in which offshore wind turbines connected to the grid are to be erected in spatial proximity and for which a joint tender is therefore issued"[52]), the chronological order of tenders for the sites, the calendar years of commissioning and the expected installed capacity, as well as standardized technical principles and planning principles.

Standardized technical and planning principles pursuant to Section 5 (1) sentence 1 no. 11 WindSeeG are particularly important for multi-use, as they can influence the design of OWFs and thus create the conditions for additional uses of the sites to be taken into account at an early stage. For the AWZ, the SDP contains the aforementioned specifications pursuant to Section 5 (1) sentence 1 WindSeeG for the period of in tribution from 2026 onwards. Pursuant to Section 6 (9) sentence 2 WindSeeG, the SDP is binding internally for the planning approval and licensing procedures pursuant to Part 4 of the WindSeeG, the SeeAnlG and the SeeAnlV (insofar as these continue to apply).[53]

In the case of determinations pursuant to Section 5 (1) Nos. 1, 2, and 6-11 WindSeeG, which also include areas and sites, Section 5 (3) sentence 1 WindSeeG stipulates that these must not conflict with overriding public or private interests.[54] Section 5 (3) sentence 2 WindSeeG lists the most important grounds for exclusion in the form of examples ("in particular")[55] (e.g., endangering the marine environment). Interests not listed in this catalog but which must be taken into account as unwritten interests pursuant to Section 5 (3) sentence 1 WindSeeG include those relating to fisheries, marine aquaculture, and nature and species conservation.[56] For each determination in the SDP, the relevant interests must be identified and weighed up in each specific case.[57] In this context, unwritten interests only preclude a determination if they are affected to a comparable extent as the interests listed in Section 5 (3) sentence 1 WindSeeG.[58]

Consideration of the overriding public interest pursuant to Section 1 (3) WindSeeG

When weighing up the respective interests against the interest in a determination, however, § 5 (3) sentence 3 WindSeeG requires that the "overriding public interest in the construction of wind turbines at sea and offshore connection lines and their significance for public safety" pursuant to

49 See Section 6 WindSeeG.

50 See Section 4 (1) sentence 1 WindSeeG.

51 Section 3 No. 3 WindSeeG. Quote translated.

52 Section 3 No. 4 WindSeeG. Quote translated.

53 See BerlKommEnergieR/Kerth, 5th ed. 2022, WindSeeG § 6 margin no. 22 ff.

54 See BerlKommEnergieR/Kerth, 5th ed. 2022, WindSeeG § 5 margin no. 43 ff.

55 BerlKommEnergieR/Kerth, 5th ed. 2022, WindSeeG § 5 margin no. 44.

56 See BT-Drs. 18/8860, 273; BerlKommEnergieR/Kerth, 5th ed. 2022, WindSeeG § 5 margin no. 43.

57 Spieth/Lutz-Bachmann/Spieth, Offshore-Windenergierecht, 1st edition 2018, WindSeeG § 5, para.29.

58 Spieth/Lutz-Bachmann/Spieth, Offshore-Windenergierecht, 1st edition 2018, WindSeeG § 5, para. 30.

§ 1 (3) WindSeeG be taken into account. This weighing directive gives offshore wind energy priority in the weighing of interests.[59] However, the priority given to the expansion of wind energy does not make it completely unnecessary to weigh it against other interests in individual cases.[60] According to recent case law (in the context of Section 2 EEG), however, the overriding public interest "can only be overcome in atypical exceptional cases, which would have to be justified on technical grounds based on the specific circumstances of the respective situation."[61] In practice and case law (again in the context of Section 2 EEG), this weighting has already led to a considerable strengthening of the interests of wind energy in the balancing of interests.[62] However, there is currently no case law on the significance of the overriding public interest specifically for determinations in the SDP.

Under EU law, the construction of OWF is also considered to be in the "overriding public interest" and serves "public health and safety" when weighing up legal interests in individual cases – including in the context of the Habitats Directive[63] and the Birds Directive[64] – in accordance with Article 3(1) of Regulation (EU) 2022/2577.[65] According to case law, this prioritization under EU law means that the weighting given by the German legislature in Section 1(3) WindSeeG "must also be taken into account in the assessment, taking into consideration the primacy of the Habitats Directive under EU law."[66] This can (only) be agreed to the extent that the prioritization under EU law (*overriding* public interest) coincides with that in Section 1 (3) WindSeeG (*overriding* public interest).

Consideration of spatial planning requirements in the context of sectoral planning

In the present context, it is particularly important that specifications pursuant to Section 5 (3) sentence 2 no. 1 WindSeeG are **inadmissible** in particular **if they do not comply with the requirements of spatial planning pursuant to Section 17 (1) ROG**. According to Section 3 (1) No. 1 ROG, these are spatial planning objectives, spatial planning principles, and other spatial planning requirements. According to Section 3 No. 2 ROG, spatial planning objectives are "binding specifications in the form of spatially and factually determined or determinable textual or graphic specifications in spatial plans for the development, organization, and protection of space, which have been conclusively weighed up by the spatial planning authority." In contrast, principles of spatial planning pursuant to Section 3 (1) No. 3 ROG are "statements on the development, organization,

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59 Theobald/Kühling/Toros, 126th ed., July 2024, WindSeeG § 1 para. 21 f.; BT-Drs. 20/1634, 70. Quote translated.

60 See BT-Drs. 20/1634, p. 70 and p. 73.

61 OVG Greifswald (5th Senate), judgment of February 23, 2023 – 5 K 171/22 OVG (with comment by Hovorková), para. 135. Quote translated.

62 See Kindler/Husemann, KlimR 2025, 2 (4), with further references (however, mainly on onshore wind energy).

63 Council Directive 92/43/EEC of May 21, 1992, on the conservation of natural habitats and of wild fauna and flora, ELI: http://data.europa.eu/eli/dir/1992/43/2013-07-01.

64 Directive 2009/147/EC of the European Parliament and of the Council of November 30, 2009, on the conservation of wild birds, ELI: http://data.europa.eu/eli/dir/2009/147/2019-06-26.

65 Council Regulation (EU) 2022/2577 of December 22, 2022, establishing a framework for the accelerated deployment of renewable energy, ELI: http://data.europa.eu/eli/reg/2022/2577/2024-07-01.

66 VG Köln (14th Chamber), decision of January 19, 2023 – 14 L 387/22, BeckRS 2023, 2502, paras. 109-114. Quote translated.

and protection of the region as guidelines for subsequent weighing or discretionary decisions" that can be "established by law or as specifications in a spatial plan." [translation] Other requirements of spatial planning include Section 3 (1) No. 4 ROG "spatial planning objectives currently being drawn up, results of formal state planning procedures such as spatial impact assessments, and state planning statements." [translation] Section 5 (3) sentence 2 no. 1 WindSeeG therefore ensures that the legally specified provisions of the SDP comply with the requirements of spatial planning (including the objectives and principles laid down in the MSP).[67] This also applies to provisions in the MSP that relate to multi-use.

Specifically, in the context of conflicts of use or potential for multi-use, the question arises as to the admissibility of specifying areas and sites in the SDP that lie outside priority and reserved areas for offshore wind energy and/or overlap with areas in which the MSP has specified priority or reserved areas for other uses. In the case of objectives and priority areas, a deviation procedure in accordance with Section 19 ROG in conjunction with Section 6 (2) ROG is regularly considered. Within the framework of such a procedure, a deviation from binding spatial planning objectives with regard to a specific individual case (e.g., deviating specifications in parts of a priority area for shipping because, due to the closure of a shipping route in a neighboring country, the need for a connecting shipping route in the German EEZ no longer applies[68]) is possible if the binding effect of the target specification *as such* is not called into question.[69] According to Section 6 (2) sentence 1 ROG, the deviation from the target must be "justifiable from a spatial planning perspective" and must not "affect the basic principles of planning."[70] Although the additional requirement of an atypical individual case is rightly rejected in most cases,[71] the BSH does check this as a precautionary measure in practice.

It is conceivable that the possibility of multi-use in an area of overlap between areas and sites under the WindSeeG and reserved or priority areas that concern other uses could mean that (in the case of priority areas) a deviation from the target is not necessary or only necessary to a lesser extent. This would have to be reflected in the specifications in the SDP and explained in the explanatory memorandum.

The BSH is responsible both for updating the SDP and, pursuant to Section 19 (1) ROG, for target deviation procedures relating to the MSP for the EEZ pursuant to Section 17 (1) ROG.[72] Section 19 (2) ROG gives the BSH the option of deciding on spatially significant planning or measures within the framework of an approval procedure or on target deviations in another procedure.[73]

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67 See BerlKommEnergieR/Kerth, 5th ed. 2022, WindSeeG § 5 para.49.

68 See Site Development Plan 2023 (BSH, Flächenentwicklungsplan 2023 für die deutsche Nordsee und Ostsee, 20.01.2023, https://www.bsh.de/DE/THEMEN/Offshore/Meeresfachplanung/Flaechenentwicklungs-plan_2023/flaechenentwicklungsplan_2023_node.html), p. 104.

69 See Spannowsky/Runkel/Goppel/Goppel, 2nd ed. 2018, ROG § 6 para. 17.

70 See Spannowsky/Runkel/Goppel/Goppel, 2nd ed. 2018, ROG § 6 para. 21 ff. Quote translated

71 Spannowsky/Runkel/Goppel/Goppel, 2nd ed. 2018, ROG § 6 para.22.

72 See Site Development Plan 2023 (BSH, Flächenentwicklungsplan 2023 für die deutsche Nordsee und Ostsee, 20.01.2023, https://www.bsh.de/DE/THEMEN/Offshore/Meeresfachplanung/Flaechenentwicklungs-plan_2023/flaechenentwicklungsplan_2023_node.html) p. 104.

73 Critical on this point: Spannowsky/Runkel/Goppel/Spannowsky, 2nd ed. 2018, ROG § 19 para. 10.

For this reason, the target deviation procedure can take place within the framework of the procedure for updating the SDP.[74] The wording and explanatory memorandum of Section 19 (1) ROG do not specify whether the BSH must submit an application for a deviation from the target "to itself" for this purpose.[75] In practice, the BSH accepts internal "communication and correspondence" as well as statements in the respective draft of the SDP as sufficient for an application.[76] In the case of target deviation procedures pursuant to Section 19 (2) ROG (e.g., in the context of updating the SDP), the approval[77] of the Federal Ministry of Transport and Digital Infrastructure (BMWSB) is also required. For example, a target deviation was implemented in the SDP 2023, which makes provisions that fall within a priority area for shipping.[78]

Multi-use in the draft SDP 2024

The fact that multi-use can already be taken into account under the current legal situation in the SDP is demonstrated by the ongoing update of the SDP, which began on September 1, 2023.[79] Within this framework, the BSH presented a draft for the SDP in July 2024 that addresses the multi-use of sites.[80] For example, some sites designated for wind energy partially overlap with the area reserved for Norwegian Lobster fishing in the 2021 maritime spatial plan (Figure 2). The BSH has formulated several consultation questions in connection with the potential multi-use of these overlapping sites for passive fishery of the Norwegian Lobster.[81] Furthermore, there are overlapping areas of wind energy sites with reserved areas for research in the EEZ of the North Sea from the maritime spatial plan 2021. Where possible, "multi-use should be permitted, and fisheries research should be enabled in the manner and to the extent that has been the case to date."[82] To this end, the draft contains, among other things, detailed specifications (in the form of planning principles) regarding the planning of the OWF layout, which must include corridors

74 See also Site Development Plan 2023 (BSH, Flächenentwicklungsplan 2023 für die deutsche Nordsee und Ostsee, 20.01.2023, https://www.bsh.de/DE/THEMEN/Offshore/Meeresfachplanung/Flaechenentwicklungsplan_2023/flaechenentwicklungsplan_2023_node.html), p. 103.

75 See BT-Drs. 16/10292, p. 23.

76 BSH, Flächenentwicklungsplan 2023 für die deutsche Nordsee und Ostsee, 20.01.2023, https://www.bsh.de/DE/THEMEN/Offshore/Meeresfachplanung/Flaechenentwicklungsplan_2023/flaechenentwicklungsplan_2023_node.html, p. 102. Quote translated.

77 See Spannowsky/Runkel/Goppel/Spannowsky, 2nd edition, 2018, ROG § 19 para. 6.

78 BSH, Flächenentwicklungsplan 2023 für die deutsche Nordsee und Ostsee, 20.01.2023, https://www.bsh.de/DE/THEMEN/Offshore/Meeresfachplanung/Flaechenentwicklungsplan_2023/flaechenentwicklungsplan_2023_node.html, p. 100 ff.

79 See BSH, Laufende Fortschreibung Flächenentwicklungsplan, Stand: 22.09.2024, https://www.bsh.de/DE/THEMEN/Offshore/Meeresfachplanung/Laufende_Fortschreibung_Flaechenentwicklungsplan/lfd_forts_flaechenentwicklungsplan_node.html..

80 BSH, Entwurf Flächenentwicklungsplan, 07.06.2024, https://www.bsh.de/DE/THEMEN/Offshore/Meeresfachplanung/Laufende_Fortschreibung_Flaechenentwicklungsplan/Anlagen/Downloads_Entwurf_FEP/Entwurf_FEP.html;jsessionid=05EDAA1AA6B0FD7272DE6393BFD0586C.live21301.

81 BSH, Entwurf Flächenentwicklungsplan, 07.06.2024, https://www.bsh.de/DE/THEMEN/Offshore/Meeresfachplanung/Laufende_Fortschreibung_Flaechenentwicklungsplan/Anlagen/Downloads_Entwurf_FEP/Entwurf_FEP.html;jsessionid=05EDAA1AA6B0FD7272DE6393BFD0586C.live21301, p. 4 ff.

82 BSH, Entwurf Flächenentwicklungsplan, 07.06.2024, https://www.bsh.de/DE/THEMEN/Offshore/Meeresfachplanung/Laufende_Fortschreibung_Flaechenentwicklungsplan/Anlagen/Downloads_Entwurf_FEP/Entwurf_FEP.html;jsessionid=05EDAA1AA6B0FD7272DE6393BFD0586C.live21301, p. 35 f. Quote translated.

for the passage of research vessels with trawl nets.83 With regard to the laying of submarine cables, the draft also points to the possibility that special regulations for coverage could apply in overlapping areas where multi-use is desired, but that these would first have to be "weighed up and specified in the respective individual approval procedures."84

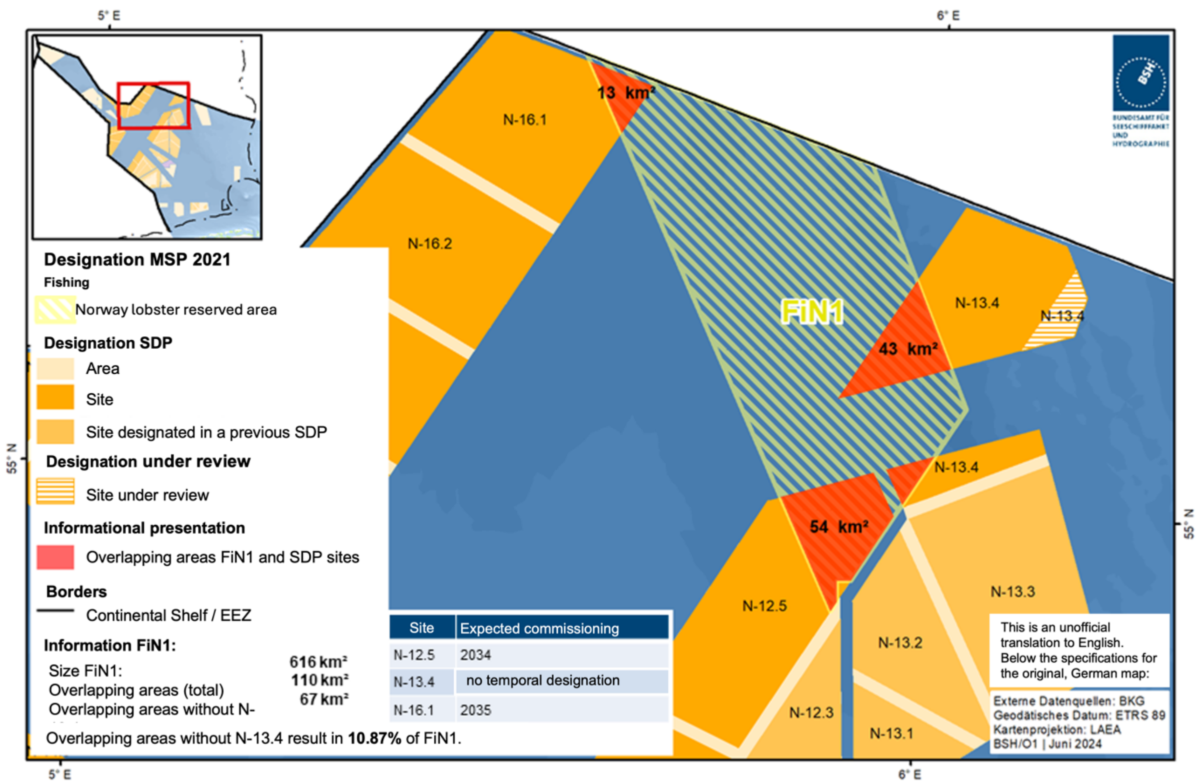

Figure 2 - Overlapping areas Sites for offshore wind energy in the draft area development plan and reserved area for fishing (Norway Lobster) FIN1 in MSP 2021. Own translation based on the BSH translated map legends85

Multi-use in the WindSeeG approval regime

In the multi-stage system of the WindSeeG, the technical planning within the framework of the preparation and updating of the SDP is followed by the central preliminary investigation and suitability assessment of sites (however, only for some of the sites), the tendering process and the subsequent award procedure, and, in the final step, the actual approval procedure (plan approval, plan authorization, or permit). The following section examines the extent to which multi-use of OWFs can be achieved under the current legal situation in this system and what legislative adjustments might be considered to better achieve this goal.

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83 BSH, Entwurf Flächenentwicklungsplan, 07.06.2024, https://www.bsh.de/DE/THEMEN/Offshore/Meeresfachplanung/Laufende_Fortschreibung_Flaechenentwicklungsplan/Anlagen/Downloads_Entwurf_FEP/Entwurf_FEP.html;jsessionid=05EDAA1AA6B0FD7272DE6393BFD0586C.live21301, p. 36, 91 f.

84 BSH, Entwurf Flächenentwicklungsplan, 07.06.2024, https://www.bsh.de/DE/THEMEN/Offshore/Meeresfachplanung/Laufende_Fortschreibung_Flaechenentwicklungsplan/Anlagen/Downloads_Entwurf_FEP/Entwurf_FEP.html;jsessionid=05EDAA1AA6B0FD7272DE6393BFD0586C.live21301., p. 100. Quote translated.

85 Translation of map legends available online at https://www.bsh.de/EN/TOPICS/Offshore/Sectoral_planning/Site_development_plan_2025/_Anlagen/Downloads/Translation-of-map-legends_SiteDevelopmentPlan-EN.html

Central preliminary investigation and suitability assessment

For some of the sites[86] designated for OWF in the SDP, a central preliminary investigation is carried out in accordance with Sections 9 ff. WindSeeG.[87] The most important objectives of the central preliminary investigation pursuant to Section 9 (1) WindSeeG are to provide bidders with the information they need to make a competitive bid in the award procedure and to enable bidders to apply for planning approval after the site has been awarded without having to carry out their own costly and time-consuming investigations.[88] The investigations and explorations to be carried out as part of the central preliminary investigation are listed in Section 10 (1) WindSeeG and also include data that is or may be of fundamental importance for the assessment of multi-use, such as mariculture (marine environment, building ground, wind and oceanographic conditions, shipping).[89] Nevertheless, the investigations are specifically geared towards offshore wind turbines, as evidenced, for example, by the presumption rules on compliance with the state of the art, which refer to standards created specifically for offshore wind turbines.[90] Additional uses are therefore likely to require further investigation.[91] To promote multi-use, if politically desirable, Section 10 (1) WindSeeG could be amended so that, as in the Netherlands,[92] the criteria relevant to additional uses are already taken into account in the central preliminary investigation.

When assessing the suitability of a pre-investigated site (previously: for offshore wind turbines), § 10 (2) sentence 1 no. 1 in conjunction with § 5 (3) sentence 2 no. 1 WindSeeG, the requirements of spatial planning pursuant to § 17 (1) ROG must be taken into account again, albeit within the framework of a case-by-case assessment and on the basis of the greater actual findings obtained during the preliminary investigation.[93] This means that the objectives set out in the spatial plancome into play again.[94] Specifications in the spatial plan concerning the multi-use of OWF can therefore still have a controlling effect at the level of the central preliminary investigation.

At the end of the suitability assessment, suitability is determined by a statutory order issued by the BSH in accordance with Section 12 (5) WindSeeG.[95] In order to ensure compliance with the requirements of Section 10 (2) WindSeeG, i.e. in principle also with the provisions of the spatial

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86 From 2027 onwards, this should generally be 50% of the tender volume or 2000 megawatts per year. See Section 2a (2) sentence 1 WindSeeG; Theobald/Kühling/Toros, 124th ed., January 2024, WindSeeG Section 2a para. 6.

87 See Theobald/Kühling/Schatz/Bartmann, 124th ed., January 2024, WindSeeG preliminary remark on Part 2 Section 2, para. 1.

88 BT-Drs. 18/8860, 281; Theobald/Kühling/Schatz/Bartmann, 124th ed., January 2024, WindSeeG § 9 para. 1.

89 Theobald/Kühling/Schatz/Bartmann, 124th ed., January 2024, WindSeeG § 10 para. 4 ff.

90 See Theobald/Kühling/Schatz/Bartmann, 124th ed., January 2024, WindSeeG § 10 Rn. 10 ff.

91 See also Mochtak, Windenergieanlagen und Marikultur: Rechtliche Fragen der multifunktionalen Nutzung der ausschließlichen Wirtschaftszone der Nordsee, Dissertation, Rostock, 2018, p. 125.

92 See Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzee-loket.nl/en/policy/north-sea-programme-2022-2027/, p. 124.

93 See Theobald/Kühling/Schatz/Bartmann, 124th ed., January 2024, WindSeeG § 10 para. 15 f. (also on the significance of the "double evaluation" of the requirements of § 5 (3) WindSeeG).

94 See BerlKommEnergieR/Kerth, 5th ed. 2022, WindSeeG § 5 margin no. 49.

95 See Theobald/Kühling/Schatz/Bartmann, 124th ed., January 2024, WindSeeG § 12 para. 12 ff.

plan, the suitability determination may contain certain specifications for the subsequent project.[96] It is therefore conceivable that this approach could also be used in future to determine the suitability of the pre-investigated site for multi-use compatible with an OWF and to ensure that multi-use is possible by specifying requirements for the design and operation of the OWF. A corresponding amendment to Section 12 (5) WindSeeG as part of a legislative change would probably not be absolutely necessary for this if the spatial planning scheme and/or the SDP contain sufficiently specific provisions (see, for example, the examples cited from the draft SDP 2024). If the integration of findings and specifications on the multi-use of sites into the statutory instrument is politically desirable, an amendment to the law would nevertheless be advisable in order to clarify the possibility of such content in the statutory instrument on the one hand and to oblige the BSH to do so on the other. Administrative practice in recent years has shown that the legal ordinances pursuant to Section 12 (5) WindSeeG are becoming increasingly less comprehensive,[97] which is likely due to the interdepartmental coordination required for the individual specifications. Against this background, it is rather unlikely that, without a corresponding amendment to the law, specifications in favor of multi-use will be made in the future within the framework of the suitability assessment.

Tendering and qualitative criteria in the award procedure

Multi-use of OWF can also be encouraged within the framework of the tendering and award procedure. Sites whose suitability for OWF has been determined in a central preliminary investigation are then put out to tender and auctioned in accordance with Sections 50 ff. WindSeeG. Sites that have not been centrally pre-surveyed are put out to tender in accordance with Sections 16 ff. WindSeeG. While the bid value is the sole award criterion for sites that have not been centrally pre-surveyed in accordance with Section 20 (1) WindSeeG, bids for sites that have been centrally pre-surveyed are evaluated on the basis of the criteria specified in Section 53 (1) sentence 1 WindSeeG, which are not exclusively financial.

Qualitative criteria, i.e., criteria not linked to the amount of the bid (*non-price criteria*), have considerable potential for indirect control through positive incentives.[98] Qualitative criteria in the areas of sustainability and the environment are suitable, for example, for creating incentives for

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96 Theobald/Kühling/Schatz/Bartmann, 124th ed., January 2024, WindSeeG Section 12 para. 14. See, for example, the contents of the Third Offshore Wind Energy Ordinance (Dritten Windenergie-auf-See-Verordnung) of January 5, 2023 (Federal Law Gazette I No. 8).

97 See for example, the First Offshore Wind Energy Ordinance (Erste Windenergie-auf-See-Verordnung) of December 15, 2020 (Federal Law Gazette I p. 2954) with §§ 1-48 with the Fourth Offshore Wind Energy Ordinance (Vierten Windenergie-auf-See-Verordnung) of February 20, 2024 (Federal Law Gazette 2024 I No. 52) with §§ 1-7.

98 Commission Staff Working Document: Guidance to Member States on auction design for renewable energy, SWD (2024) 300 final, May 13, 2024, p. 9 ff.

environmental protection and ecosystem restoration measures.[99] According to the current concept of the WindSeeG, a maximum of 60 out of a total of 100 evaluation points are currently allocated to the bid value and a maximum of 10 to qualitative criteria.[100]

To date, there is no qualitative criterion that ensures adequate consideration of multi-use and the positive effects for the environment and efficient land use that these ideally entail. However, as part of an amendment to the WindSeeG, a further criterion for the integration or facilitation of multi-use could be added to the catalog in Section 53 (1) sentence 1 WindSeeG, with a particular focus on uses that have positive effects in the areas of sustainability and the (marine) environment. However, duplication with regulatory requirements that already set binding (minimum) standards for OWF should be avoided. Against this background, the European Commission recommends that the "inclusion of non-price-related criteria [...] should lead to a net contribution to the policy objective compared to existing legislation."[101] This is because qualitative criteria can only have a steering effect if they provide incentives to go significantly beyond existing binding standards and are also sufficiently narrow and precise.[102]

In state practice, there is a growing trend towards promoting multi-use through the instrument of qualitative award criteria. However, this is not usually done through an explicit qualitative criterion relating to "multi-use."[103] However, there are examples of qualitative criteria that cover individual forms of multi-use. In addition, the Netherlands is considering introducing qualitative criteria in the areas of "nature, aquaculture, fisheries, safety, or shipping" in the future.[104]

Approval of additional uses

With regard to additional uses on the site of an OWF that must be added for multi-use (e.g., marine aquaculture), the question of the relevant approval regime arises. In this respect, a distinction must be made between uses that are inseparably linked to the OWF and those that have no such link and no other direct and necessary connection to the OWF.

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99 Commission Recommendation of May 13, 2024 on auction design for renewable energy, C/2024/2650, ELI: http://data.europa.eu/eli/reco/2024/1344/oj, p. 4 f.; Commission Staff Working Document: Guidance to Member States on auction design for renewable energy, SWD (2024) 300 final, May 13, 2024, p. 18 ff.

100 See Section 53 (2) to (6) WindSeeG. For more details on the qualitative criteria, see Friton/von Rummel, Ausschreibung von zentral voruntersuchten Flächen – Offshore-Windenergieanlagen nach dem WindSee, EnWZ 2024, 217 (218 ff.); Kirch, Ausschreibung zentral voruntersuchter Flächen über qualitative Kriterien – Praxiserfahrungen und Hinweise zum „Beauty Contest" der Offshore-Windenergie, EnWZ 2023, 351 (353 ff.); Lutz-Bachmann/Liedtke, Neue Ausschreibungen für Offshore-Windenergie, EnWZ 2022, 313 (315 ff.).

101 Commission Recommendation of May 13, 2024 on auction design for renewable energy, C/2024/2650, ELI: http://data.europa.eu/eli/reco/2024/1344/oj, p. 5.

102 See Commission Staff Working Document: Guidance to Member States on auction design for renewable energy, SWD (2024) 300 final, May 13, 2024, p. 16 f.

103 Some literature claims that Belgium has integrated corresponding qualitative criteria into its award procedure. See, for example, James et al., Using Non-Price Criteria in State Offshore Wind Solicitations to Advance Net Positive Biodiversity Goals, 2023, https://www.vermontlaw.edu/sites/default/files/2023-06/iee-tnc_offshore-wind-report_20230606_1644.pdf, p. 49: "Sustainability and Multi-use." However, this contradicts the information provided by the Belgian government. See Economie, Offshore tender – Criteria: Question and answer 5 and 26 May 2023, https://economie.fgov.be/en/belgian-offshore-wind-energy, p. 2.

104 Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, p. 40.

a) Uses inseparably linked to the OWF

Only a few conceivable forms of multi-use involve additional uses that must be linked to the OWF in the approval process. One *example* that comes to mind is *nature-inclusive designs* of OWF components (such as foundations and scour protection) that serve to promote biodiversity.[105] However, as these are generally nature-compatible features of the OWF design itself, the integration of such designs into a project under the WindSeeG does not usually trigger any approval requirements independent of the OWF. For this reason, the issue is also dealt with in the Netherlands, for example, in connection with requirements in the approval process for OWFs and not as a separate additional use.[106] In Germany, too, it would be possible to integrate nature-integrated designs into the "Standard Construction – Minimum Requirements for the Structural Design of Offshore Structures in the Exclusive Economic Zone (EEZ)"[107], with which a project must be compatible in accordance with Section 69 (1) sentence 1 WindSeeG in order to be eligible for approval. Any additional official permission required for a nature-integrated design inextricably linked to the OWF under other specialist laws would be covered by the concentration effect of the plan approval decision or the plan approval of the OWF in accordance with Section 66 (3) sentence 1 WindSeeG in conjunction with Section 75 (1) and Section 74 (6) sentence 2 VwVfG.[108] However, it cannot be ruled out that nature-integrated designs may also require separate approval in individual cases (e.g. under the SeeAnlG) if additional and clearly distinguishable structures are added. This could be the case, for example, with fish hotels anchored to the foundations of wind turbines.[109]

b) Additional uses separable from the OWF

For separate uses of the area of an OWF (e.g., aquaculture, nature restoration, or raw material extraction), the applicability of the WindSeeG approval regulations is ruled out from the outset, at least when considered in isolation, because according to Section 65 (1) WindSeeG, these only apply to the "facilities" specified therein.[110] In the absence of any connection to energy generation by wind turbines, such additional uses are also not "technical and structural ancillary facilities necessary for the operation of the turbines" that could be readily integrated into a project

105 See generally Pardo et al., A synthesis review of nature positive approaches and coexistence in the offshore wind industry, ICES Journal of Marine Science 2023, https://doi.org/10.1093/icesjms/fsad191, 1; Werner et al., Offshore wind farm foundations as artificial reefs: The devil is in the detail, Fisheries Research 2024, https://doi.org/10.1016/j.fishres.2024.106937.

106 Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, pp. 26 and 39.

107 BSH, Standardkonstruktion – Mindestanforderungen an die konstruktive Ausführung von Offshore-Bauwerken in der ausschließlichen Wirtschaftszone (AWZ), 1. Fortschreibung, updated on June 1, 2021, https://www.bsh.de/DE/PUBLIKATIONEN/_Anlagen/Downloads/Offshore/Standards/Standard-Konstruktive-Ausfuehrung-von-Offshore-Windenergieanlagen-Aktualisierung-01-06-21.html;jsessionid=E82E9A8E2A3A396EF22728B2CAA7D365.live21301.

108 See BerlKommEnergieR/Uibeleisen/Groneberg, 5th ed. 2022, WindSeeG § 45 Rn. 19.

109 See Pardo et al., A synthesis review of nature positive approaches and coexistence in the offshore wind industry, ICES Journal of Marine Science 2023, https://doi.org/10.1093/icesjms/fsad191, 1 (6 ff.).

110 German: "Einrichtungen". See also § 1 (1) No. 3 WindSeeG; for the definition, see BerlKommEnergieR/Uibeleisen/Groneberg, 5th ed. 2022, WindSeeG § 44 para. 6 ff.

requiring approval under Sections 65 ff. WindSeeG.[111] Similarly, a facility for additional use cannot simply be added to an existing wind turbine within the framework of a (amendment) planning approval pursuant to Section 66 (1) WindSeeG, because even in this respect, it must still be a facility within the meaning of Section 65 (1) WindSeeG. Conversely, however, an additional use that requires modifications to wind turbines (or their foundations) could trigger the need for a (change) planning approval *in addition* to the approval required for the use itself.[112]

Plants that serve other economic or research purposes fall instead within the scope of the SeeAnlG.[113] For example, plants for commercial aquaculture are to be classified as plants for "other economic purposes" in accordance with Section 1 (2) sentence 1 no. 3 SeeAnlG.[114] In accordance with Section 2 (1) SeeAnlG, they generally require planning approval in accordance with Section 5 SeeAnlG (or, under the conditions of Section 5 (5) SeeAnlG, planning permission as an alternative).[115] As part of the planning approval process, key aspects such as impairments to the safety and ease of traffic[116] and compatibility with existing or planned "cables, offshore connections, pipes, and other lines"[117] and "locations of converter platforms or substations"[118] are also examined.[119] It can therefore be ensured that the additional use does not cause any unacceptable risks to public and private interests. Other considerations include compliance with other requirements under the SeeAnlG and other public law provisions.[120] This also includes compliance with spatial planning requirements.[121] Section 2 (4) sentence 1 SeeAnlG, according to which installations may only be approved, plan-approved or authorized under the SeeAnlG if they do not "significantly impede" the use of the areas and sites specified in the SDP for offshore wind energy generation, the transmission of electricity and the use of other energy generation areas specified in the SDP. According to Section 2 (4) sentence 2 SeeAnlG, deviations from this rule are only

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111 See BerlKommEnergieR/Uibeleisen/Groneberg, 5th ed. 2022, WindSeeG § 44 para. 11, with examples of ancillary facilities. German: „Nebeneinrichtungen“. Quote translated.

112 Mochtak, Windenergieanlagen und Marikultur: Rechtliche Fragen der multifunktionalen Nutzung der ausschließlichen Wirtschaftszone der Nordsee, Dissertation, Rostock, 2018, p. 69.

113 BerlKommEnergieR/Uibeleisen/Groneberg, 5th ed. 2022, WindSeeG § 44 margin note. 12.

114 Schatz/Bartmann, Kommentar: Seeanlagengesetz (SeeAnlG), in: Das deutsche Bundesrecht, 2024, § 1 para. 14. Quote translated.

115 Schatz/Bartmann, Kommentar: Seeanlagengesetz (SeeAnlG), in: Das deutsche Bundesrecht, 2024, § 2 para. 2. Under the old legal situation, only a permit under § 6 SeeAnlG was required, cf. Mochtak, Windenergieanlagen und Marikultur: Rechtliche Fragen der multifunktionalen Nutzung der ausschließlichen Wirtschaftszone der Nordsee, Dissertation, Rostock, 2018, pp. 69 and 85.

116 See § 5 (3) No. 2 SeeAnlG.

117 See Section 5 (3) No. 5 SeeAnlG. Quote translated.

118 See Section 5 (3) No. 6 SeeAnlG. Quote translated.

119 Schatz/Bartmann, Kommentar: Seeanlagengesetz (SeeAnlG), in: Das deutsche Bundesrecht, 2024, Section 5, para. 7 ff.

120 See Section 5 (3) No. 7 SeeAnlG.

121 Schatz/Bartmann, Kommentar: Seeanlagengesetz (SeeAnlG), in: Das deutsche Bundesrecht, 2024, Section 5 para. 26 ff.

permitted if the approval of these installations is required for "compelling reasons of public interest."[122] However, since wind turbines are themselves in the overriding public interest according to Section 1 (3) WindSeeG, such "compelling reasons of public interest" will only be accepted in extreme exceptional cases. This is hardly conceivable in the case of classic multi-use for economic or scientific purposes, as covered by the SeeAnlG.

So far, there are only research projects investigating the potential feasibility of aquaculture within wind farms. According to the current practice of the BSH[123], such projects are facilities within the meaning of Section 1 (2) sentence 1 no. 4 SeeAnlG that "serve marine research purposes."[124] According to Section 6 (1) SeeAnlG, only a permit is required for the construction, operation, and significant modification of such facilities.[125] When deciding on the application for approval, the authority must take into account the objectives of spatial planning as well as the principles of spatial planning and the spatial planning objectives currently being established.[126] If the aforementioned requirements of spatial planning or "other overriding public or private interests" prevent approval, it may be refused in accordance with Section 7 No. 2 SeeAnlG.[127] In addition, § 2 (4) SeeAnlG must also be observed when granting approval. Maritime spatial and technical planning can therefore also have a significant controlling effect within the framework of the SeeAnlG when it comes to approving additional uses in OWF.

Since the BSH is the same authority responsible for the planning approval process under the WindSeeG and the SeeAnlG, the different relevant approval regimes should not cause any major problems in practice—especially if both facilities are applied for simultaneously and by mutual agreement as a single multi-use facility. The BSH can process the two planning approval procedures together, although additional coordination between the responsible departments may be necessary. However, under the current legal situation, it is not convincing to rely solely on the concentration effect of the planning approval procedure under the WindSeeG with regard to the separate planning approval requirement of the SeeAnlG.[128] The concentration effect can only extend to the additional use if it is an inseparable part of the wind turbine and thus also falls under the WindSeeG.

122 See Schatz/Bartmann, Kommentar: Seeanlagengesetz (SeeAnlG), in: Das deutsche Bundesrecht, 2024, Section 2, para. 16; Mochtak, Windenergieanlagen und Marikultur: Rechtliche Fragen der multifunktionalen Nutzung der ausschließlichen Wirtschaftszone der Nordsee, Dissertation, Rostock, 2018, p. 126.

123 See, for example, BSH, Genehmigung zur Errichtung und zum Betrieb von Anlagen für meereskundliche Untersuchungen in der ausschließlichen Wirtschaftszone (AWZ) der Bundesrepublik Deutschland, February 29, 2024 (test facility for the cultivation of mussels and algae and a wave measurement buoy as part of the EU project OLAMUR; available to the author).

124 Schatz/Bartmann, Kommentar: Seeanlagengesetz (SeeAnlG), in: Das deutsche Bundesrecht, 2024, § 1 para. 14.

125 Schatz/Bartmann, Kommentar: Seeanlagengesetz (SeeAnlG), in: Das deutsche Bundesrecht, 2024, § 6 para. 3.

126 See § 6 (2) SeeAnlG.

127 Schatz/Bartmann, Kommentar: Seeanlagengesetz (SeeAnlG), in: Das deutsche Bundesrecht, 2024, § 7 para. 2.

128 However, see Mochtak, Windenergieanlagen und Marikultur: Rechtliche Fragen der multifunktionalen Nutzung der ausschließlichen Wirtschaftszone der Nordsee, Dissertation, Rostock, 2018, p. 69.

Significance of existing approval decisions for OWF for the approval of multi-use

In the case of OWF for which approval decisions have already been issued, the question arises as to whether their legal consequences preclude the subsequent approval of additional use.

a) No blanket exclusion of additional uses

With regard to approval decisions pursuant to the WindSeeG, it should first be noted that "private ownership of the seabed [...] cannot be established in the exclusive economic zone."[129] The EEZ is land that is subject to "exclusive sovereign power of disposal."[130] Accordingly, approval decisions under the WindSeeG do not confer ownership, but merely the exclusive right to construct and operate wind turbines and associated ancillary facilities on the site.[131] This is because the approval decisions serve "to establish the legal conformity of the planned facility in order to overcome a prohibition subject to permission, but not to create ownership rights."[132] The approval decision itself is also not an ownership right protected by Article 14(1) of the German Basic Law (GG).[133]

In addition to the aforementioned approval effect,[134] planning approval decisions (and plan approvals) under the WindSeeG also have a tolerance effect.[135] According to Section 66(3) WindSeeG in conjunction with Section 75(2) sentence 1 VwVfG, a planning approval decision that has become final excludes third-party claims for injunctive relief against the project, for removal or modification of the installations, or for injunctive relief against the use of the installations.[136] This obligation to tolerate applies to both public authorities and private individuals.[137]

For multi-use in OWF, this means that any potential additional use must not contradict the content of the approval decision for the OWF – for example, if the wind turbines or ancillary facilities of an OWF can no longer be used as planned because maintenance work can no longer be carried out as originally applied for. The same applies, if no corresponding provisions have been made

129 BVerfG, Decision of the First Senate of June 30, 2020 - 1 BvR 1679/17 -, https://www.bverfg.de/e/rs20200630_1bvr167917.html, para. 3; see also BerlKommEnergieR/Uibeleisen/Groneberg, 5th ed. 2022, WindSeeG § 45 para. 22. Quote translated.

130 See BVerfG, decision of the First Senate of June 30, 2020 - 1 BvR 1679/17 -, https://www.bverfg.de/e/rs20200630_1bvr167917.html, para. 82. Quote translated.

131 See BVerfG, decision of the First Senate of June 30, 2020 - 1 BvR 1679/17 -, https://www.bverfg.de/e/rs20200630_1bvr167917.html, para. 83.

132 See BVerfG, decision of the First Senate of June 30, 2020 - 1 BvR 1679/17 -, https://www.bverfg.de/e/rs20200630_1bvr167917.html, para. 77. Quote translated.

133 See BVerfG, decision of the First Senate of June 30, 2020 - 1 BvR 1679/17 -, https://www.bverfg.de/e/rs20200630_1bvr167917.html, para. 75 ff.; dissenting opinion Mochtak, Windenergieanlagen und Marikultur: Rechtliche Fragen der multifunktionalen Nutzung der ausschließlichen Wirtschaftszone der Nordsee, Dissertation, Rostock, 2018, p. 139.

134 See BerlKommEnergieR/Uibeleisen/Groneberg, 5th ed. 2022, WindSeeG § 45 para.18; NK-VwVfG/Markus Deutsch, 2nd ed. 2019, VwVfG § 75 para.21 ff.

135 See generally on the toleration effect of planning approval decisions Stelkens / Bonk / Sachs / Neumann / Külpmann, 10th ed. 2022, VwVfG § 75 margin no. 58 ff.

136 BerlKommEnergieR/Uibeleisen/Groneberg, 5th ed. 2022, WindSeeG § 45 margin no. 20.

137 Stelkens/Bonk/Sachs/Neumann/Külpmann, 10th ed. 2022, VwVfG § 75 Rn. 61.

in the approval decision, to the shared use of the OWF or ancillary facilities by another user, for example, the anchoring of mariculture facilities in a foundation of the OWF.[138]

The planning approval procedure under the SeeAnlG also provides sufficient leverage for the competent authority to ensure the compatibility of an additional use applied for under the SeeAnlG with an existing approval decision under the WindSeeG, with the grounds for refusal set out in Section 5 (3) Nos. 2, 5, 6, and 7.[139] Nevertheless, it would be sensible to expand the catalog in Section 5 (3) SeeAnlG to include an explicit requirement of compatibility with existing and planned wind turbines. If a planned additional use does not conflict with the approved operation of the OWF, the approval decision under the WindSeeG is also not a legal obstacle to approval under the SeeAnlG.[140] The content of the approval decision is therefore decisive. A strategy for implementing a multi-use in already approved OWFs therefore requires a systematic evaluation of the content of existing approval decisions.

b) Subsequent interventions in existing approval decisions

If, for whatever reason, the intended multi-use is not compatible with the content of an approval decision for an OWF, the additional use cannot, in principle, be approved by the competent authority without the consent of the plant operator concerned. If the plant operator is interested in integrating multi-use, the operation of the OWF could be adapted accordingly on the basis of contractual agreements, whereby significant changes that also affect the plants themselves may require approval of a change plan in accordance with Section 66 (1) sentence 1 WindSeeG. It is also conceivable that an application for approval of multi-use could be submitted and that the operator of the OWF would not raise any objections in the planning approval procedure under the SeeAnlG, so that approval could be granted, which in turn would have a toleration effect.

Subsequent interventions in approval decisions issued on the basis of the WindSeeG (or the SeeAnlV, insofar as OWF approved under old law are affected) with the aim of enabling (specific) multi-use are governed by general administrative law, unless the WindSeeG provides for deviating or more specific regulations. Once a licensing decision has been issued, the WindSeeG does not give the BSH any low-threshold option to change or revoke this licensing decision with the aim of implementing planning objectives. For example, (subsequent) orders issued by the BSH under the general clause of Section 79 (2) WindSeeG only concern the monitoring of facilities for the enforcement of legal obligations and the prevention of hazards.[141] Even provisions in the spatial planning scheme that favor multi-use cannot enable a subsequent amendment of the approval decision under the WindSeeG. Assuming that the approval decision is fundamentally lawful, the BSH therefore has only the partial revocation pursuant to Section 49 VwVfG as the sole option for unilaterally changing the content of the approval decision. In practice, however, it is unlikely that this instrument will be used.

138 See also Mochtak, Windenergieanlagen und Marikultur: Rechtliche Fragen der multifunktionalen Nutzung der ausschließlichen Wirtschaftszone der Nordsee, Dissertation, Rostock, 2018, p. 140.

139 The same applies pursuant to § 7 No. 2 SeeAnlG to the approval of facilities used for marine research ("other overriding public or private interests").

140 See also Mochtak, Windenergieanlagen und Marikultur: Rechtliche Fragen der multifunktionalen Nutzung der ausschließlichen Wirtschaftszone der Nordsee, Dissertation, Rostock, 2018, p. 126.

141 See BerlKommEnergieR/Kerth, 5th ed. 2022, WindSeeG § 57 para. 8 ff. for the content of the general clause.

Options for future approval decisions

The BSH also has limited scope for maneuver with regard to future approval decisions for sites that have already been planned and preliminarily investigated. From the moment the contract is awarded in the tendering process, the successful bidder has, pursuant to Section 24 (1) No. 1 WindSeeG, the exclusive right to carry out a planning approval procedure on the respective site.[142] This exclusive right would preclude the approval of other uses on the same site (e.g., under the SeeAnlG), unless—as is likely to be the case at this early stage of the procedure—it can be ruled out that the additional use applied for could significantly impair the subsequent project or its planning, which is still to be applied for.

Once the successful bidder has submitted an application for approval (planning approval or plan approval), the legal situation is determined by the version of the WindSeeG applicable at that time, taking into account previous (planning) decisions. According to Section 69 (3) sentence 1 no. 8 WindSeeG, an approval decision requires compliance with "other requirements" under the WindSeeG and other mandatory provisions of public law. This is a matter of weighing up the interests involved.[143] Other mandatory provisions under public law also include spatial planning requirements, in particular the spatial planning objectives and principles as set out in the MSP.[144] If the MSP contains binding specifications (objectives) for multi-use, the BSH must enforce these specifications in its approval decision.[145] If this is not possible, a deviation from objectives procedure may be considered, as already explained. Other requirements to be complied with in the same way under the WindSeeG are the specifications in the SDP, which are binding on the BSH in the approval procedure pursuant to Section 6 (9) WindSeeG.[146]

If multi-use has already been taken into account at the spatial or technical planning level, the BSH must implement the corresponding specifications – such as the minimum distances for the passage of research vessels mentioned above – in its approval decision, unless a target deviation procedure is considered (see above). The respective specifications may relate both to the content of the desired approval decision itself (as in the example of minimum distances) and to separable aspects that can be covered by ancillary provisions pursuant to Section 36 (1) VwVfG. Since the approval decision under the WindSeeG is a *binding* decision, the applicant is entitled to approval if all legal requirements are met. Therefore, ancillary provisions pursuant to Section 36 (1) VwVfG are only permissible to ensure compliance with the legal requirements, including the binding specifications of spatial and technical planning.[147]

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142 See also BerlKommEnergieR/Uibeleisen/Mlynek, 5th ed. 2022, WindSeeG § 24 para.11; BVerfG, decision of the First Senate of June 30, 2020 - 1 BvR 1679/17 -, https://www.bverfg.de/e/rs20200630_1bvr167917.html, para.8.

143 BerlKommEnergieR/Uibeleisen/Groneberg, 5th ed. 2022, WindSeeG § 48 para.42 f.

144 BerlKommEnergieR/Uibeleisen/Groneberg, 5th ed. 2022, WindSeeG § 48 Rn. 69.

145 See Mochtak, Windenergieanlagen und Marikultur: Rechtliche Fragen der multifunktionalen Nutzung der ausschließlichen Wirtschaftszone der Nordsee, Dissertation, Rostock, 2018, p. 128 ff.

146 See also BerlKommEnergieR/Uibeleisen/Groneberg, 5th ed. 2022, WindSeeG § 48 Rn. 69.

147 See Stelkens/Bonk/Sachs/Stelkens, 10th ed. 2022, VwVfG § 36 margin no. 120 ff.; reverse conclusion from Section 69 (10) WindSeeG ("which cannot be prevented or compensated for by conditions or requirements"[translated]).

Multi-use and safety zones around OWF

The additional activities that are possible on sites within OWFs and in their immediate vicinity also depend on the design of the prohibition regime within the safety zones of the respective OWF.

Establishment of safety zones around OWF

In the German EEZ, the BSH establishes safety zones of generally no more than 500 m around individual facilities within the meaning of the WindSeeG by means of a general ruling regulating use (148) pursuant to Section 74 (1) sentence 1 WindSeeG. Safety zones around an entire OWF are also possible and common, in which case the safety zone can also be delimited by straight lines.[149] According to Section 74 (1) sentence 1 WindSeeG, the prerequisite for the creation of safety zones is that they are "necessary" to ensure the safety of shipping or the facilities. Since the establishment of a safety zone (also) to ensure the safety of shipping falls within the remit of the Directorate-General for Waterways and Shipping (GDWS), the consent of the GDWS is required in such cases in accordance with Section 74 (1) sentence 2 WindSeeG. If the above conditions are met, the BSH must establish a safety zone in accordance with Section 74 (1) sentence 1 WindSeeG (wording: "establishes ..." (German: "richtet... ein")). This is therefore a binding decision.[150] Unlike under the now repealed SeeAnlV and Section 10 (1) sentence 1 SeeAnlG, the "whether" of establishing a safety zone is therefore no longer at the discretion of the BSH.[151]

Legal consequences of establishing a safety zone

A safety zone established in accordance with Section 74 (1) WindSeeG is also considered a safety zone within the meaning of Section 7 (1) of the Ordinance on the International Regulations for Preventing Collisions at Sea (KVRV) and may therefore not be navigated in accordance with Section 7 (2) KVRV.[152] This is intended in particular to prevent collisions between ships and the facility.[153] Vehicles used to supply the facilities (in the case of OWF, in particular maintenance and service) are exempt from the prohibition on navigation. Vessels with a hull length of no more than 24 m (this size generally marks the boundary between large and small vessels in maritime law) are also exempt due to their lower risk potential. According to Section 2 (3) KVRV, safety zones established in the German EEZ within the meaning of Section 74 WindSeeG, including the resulting navigation bans, also apply to ships flying foreign flags.

Structure of the navigation ban in the safety zones

The specific design of the regulatory regime in the safety zone is assigned to the GDWS as a task by Section 7 (3) sentence 1 KVRV. However, this must always be done in agreement with the BSH, which can ensure compliance with the requirements of spatial planning and the provisions of the SDP in this context. In particular, pursuant to Section 7 (3) sentence 2 KVRV, the GDWS specifies

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148 See Section 74 (2) sentence 1 WindSeeG.

149 See BerlKommEnergieR/Uibeleisen/Groneberg, 5th ed. 2022, WindSeeG § 53 para.5.

150 BerlKommEnR/Uibeleisen/Groneberg, 5th ed. 2022, WindSeeG § 53 para.6.

151 See on discretionary powers under the SeeAnlV: Theobald/Kühling/Schmälter, 117th ed., July 2022, See-AnlV Section 11 margine note 3; on discretionary powers under international law, see UNCLOS/Proelss, Article 60, para.24.

152 See Ehlers, Recht des Seeverkehrs, 2nd ed. 2022, KVRV § 7 para.1 f.

153 See Theobald/Kühling/Schmälter, 117th ed., July 2022, SeeAnlV § 11 para.4.

the exact requirements and conditions for exemptions for vessels with a hull length of no more than 24 m. Further exemptions are also possible pursuant to Section 7 (2) and (3) sentence 1 KVRV. In general, the GDWS can regulate the details of the navigation ban by means of a general ruling or (individual) administrative act in accordance with Section 7 (3) KVRV. These are determined for reasons of traffic and shipping safety, and differentiated regulations can be imposed for the construction and operating phases of a facility. The prerequisite for this is that such regulations are compatible with the "requirements of safety and ease of traffic." The GDWS has a wide margin of discretion in this regard.[154] Which exceptions to the navigation ban are possible and under what conditions they can be granted depends on the circumstances of the specific individual case and cannot be assessed purely in the abstract. However, according to Section 7 (3) sentence 1 KVRV, all regulations must relate to the navigation ban and serve to ensure the safety of shipping or facilities, i.e., they must have a safety-related purpose.[155]

GDWS administrative practice

The GDWS has so far pursued a regulatory concept that applies a very high statistical safety standard and therefore generally provides for only a few exceptions to the navigation ban.156 According to the GDWS's previous administrative practice, the general orders issued on the basis of Section 7 (3) KVRV include the following regulations, among others: Complete ban on navigation with the exception of vehicles and equipment used for the construction and equipping of the project or for fulfilling and monitoring compliance with the obligations incumbent on the operator; obligation to use a functional AIS; ban on mooring at facilities; requirements for behavior in traffic; obligation to pass directly through the safety zone; specific distance regulations for individual facilities.[157] No general exceptions for activities such as mariculture or nature restoration through artificial reefs, which could be approved in addition to the operation of the OWF at the site (e.g., on the basis of the SeeAnlG, the Hohe-See-Einbringungsgesetz (HSEG) or the BNatSchG).

In contrast, when it comes to fishing, the general rulings contain some exceptions to the navigation ban. The safety zones can be divided into three categories. The general rulings in the first category contain no regulations on fishing and, at the same time, no exceptions to the ban on navigation for fishing vessels.[158] These safety zones may therefore not be navigated by fishing

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154 See Theobald/Kühling/Schmälter, 117th ed., July 2022, SeeAnlV § 11 para.9.

155 See Section 74 (1) sentence 1 WindSeeG ("insofar as this is necessary to ensure the safety of shipping or facilities").

156 See BT-Drs. 19/17344, February 24, 2020, p. 172.

157 See the list of general rulings of the GDWS at: https://www.elwis.de/DE/Seeschifffahrt/Offshore-Windparks/Offshore-Windparks-node.html.

158 Generaldirektion Wasserstraßen und Schifffahrt, Allgemeinverfügung zur Regelung des Befahrens einer Sicherheitszone der Umspannplattform des Windenergievorhabens Baltic Eagle nach § 7 Absatz 3 der Verordnung zu den Internationalen Regeln von 1972 zur Verhütung von Zusammenstößen auf See, dated July 7, 2022 (Baltic-Eagle); Generaldirektion Wasserstraßen und Schifffahrt, Allgemeinverfügung zur Regelung des Befahrens einer Sicherheitszone nach § 7 Absatz 3 der Verordnung zu den Internationalen Regeln von 1972 zur Verhütung von Zusammenstößen auf See, dated March 9, 2022 (Arcadis Ost 1); Generaldirektion Wasserstraßen und Schifffahrt, Allgemeinverfügung zur Regelung des Befahrens einer Sicherheitszone nach § 7 Absatz 3 der Verordnung zu den Internationalen Regeln von 1972 zur Verhütung von Zusammenstößen auf See, dated July 2, 2021 (Amrumbank West und Kaskasi II); Generaldirektion Wasserstraßen und Schifffahrt, Allgemeinverfü-

vessels, which currently rules out the use of the water areas for fishing purposes. In some safety zones, fishing and angling are also expressly prohibited.[159] A single general ruling more specifically prohibits the "use of fishing gear of any kind, in particular bottom trawls, drift nets, gillnets or similar gear."[160] In the second category of safety zones, the GDWS has made use of the option of allowing vessels with a hull length not exceeding 24 m to navigate in these zones, at least during certain periods, but at the same time prohibiting all fishing.[161] These safety zones may only be navigated for the purpose of transit, even by fishing vessels.162 The use of bottom, trawl, and drift nets or similar fishing gear is expressly prohibited. The third category comprises safety zones in which the GDWS permits passive (but not active) fishing with baskets and traps by vessels with a maximum hull length of 24 m, provided that this takes place outside the developed wind farm areas and the passive fishing gear is located on the seabed.[163] However, the use of

gung zur Regelung des Befahrens einer Sicherheitszone nach § 7 Absatz 3 der Verordnung zu den Internationalen Regeln von 1972 zur Verhütung von Zusammenstößen auf See, dated June 8, 2018 (BARD Offshore 1, Veja Mate, Deutsche Bucht und die Konverterplattformen BorWin alpha und BorWin beta); Generaldirektion Wasserstraßen und Schifffahrt, Allgemeinverfügung zur Regelung des Befahrens einer Sicherheitszone nach § 7 Absatz 3 der Verordnung zu den Internationalen Regeln von 1972 zur Verhütung von Zusammenstößen auf See, dated March 21, 2018 (Global Tech I, EnBW Hohe See, EnBW Albatros und die Konverterplattform BorWin gamma); Generaldirektion Wasserstraßen und Schifffahrt, Allgemeinverfügung zur Regelung des Befahrens einer Sicherheitszone nach § 7 Absatz 3 der Verordnung zu den Internationalen Regeln von 1972 zur Verhütung von Zusammenstößen auf See, dated February 15, 2018 (alpha ventus, Borkum Riffgrund I, Borkum Riffgrund II, Trianel Windpark Borkum, Merkur Offshore und Konverterplattformen DolWin alpha und DolWin Gamma); Allgemeinverfügung zur Regelung des Befahrens einer Sicherheitszone gemäß § 7 Absatz 3 der Verordnung zu den Internationalen Regeln von 1972 zur Verhütung von Zusammenstößen auf See (VO KVR) i.V.m. § 60 Abs. 1 der Seeschifffahrtsstraßenordnung (SeeSchStrO) im Bereich des Offshore- Windparks „Nordergründe" im deutschen Küstenmeer, dated February 4, 2016 (Nordergründe); Wasser- und Schifffahrtsdirektion Nordwest, Allgemeinverfügung zur Regelung des Befahrens einer Sicherheitszone nach § 7 Absatz 3 der Verordnung zu den Internationalen Regeln von 1972 zur Verhütung von Zusammenstößen auf See, dated June 6, 2012 (Riffgat).

159 Generaldirektion Wasserstraßen und Schifffahrt - Außenstelle Nordwest -, Allgemeinverfügung zur Regelung des Befahrens einer Sicherheitszone nach § 7 Absatz 3 der Verordnung zu den Internationalen Regeln von 1972 zur Verhütung von Zusammenstößen auf See, dated Oktober 2, 2015 (Nordsee One); Generaldirektion Wasserstraßen und Schifffahrt - Außenstelle Nordwest -, Allgemeinverfügung zur Regelung des Befahrens einer Sicherheitszone nach § 7 Absatz 3 der Verordnung zu den Internationalen Regeln von 1972 zur Verhütung von Zusammenstößen auf See, dated December 22, 2014 (Godewind 01 und Godewind 02).

160 Allgemeinverfügung der Generaldirektion Wasserstraßen und Schifffahrt, Außenstelle Nord, vom 20. März 2015 zur Regelung des Befahrens einer Sicherheitszone nach§ 7 Absatz 3 der Verordnung zu den Internationalen Regeln von 1972 zur Verhütung von Zusammenstößen auf See - Befahrensregelung für die Sicherheitszone um das Offshore-Windenergievorhaben "Sandbank" (Sandbank).

161 Generaldirektion Wasserstraßen und Schifffahrt, Allgemeinverfügung (regarding navigation in the safety zone of the "ENBW Baltic 2" offshore wind farm by vessels with a hull length not exceeding 24 meters), dated June 14, 2016 (Baltic 2); Generaldirektion Wasserstraßen und Schifffahrt, Allgemeinverfügung (regarding navigation in the safety zone of the "Dan Tysk" offshore wind farm by vessels under 24 meters), dated June 7, 2016 (Dan Tysk); Generaldirektion Wasserstraßen und Schifffahrt, Allgemeinverfügung (hinsichtlich des Befahrens der Sicherheitszone des Offshore-Windparks „Butendiek" durch Fahrzeuge unter 24 Meter), dated April 22, 2016 (Butendiek).

162 See BT-Drs. 19/17344, February 24, 2020, p. 172.

163 Generaldirektion für Wasserstraßen und Schifffahrt, Allgemeinverfügung zur Regelung des Befahrens der gemeinsamen Sicherheitszone um die Offshore-Windparks „Wikinger" und „Arkona-Becken Südost", dated trawl nets, drift nets, or similar fishing gear is also prohibited in these safety zones. In addition, distance requirements must be observed (at least 150 m from wind turbines and 1000 m from platforms). Furthermore, commercial fishing vessels may only enter the safety zone if visibility is greater than 500 m and wind force is less than 8 Bft.

Conclusion on the safety zone regime

The current practice of the GDWS in designing the navigation ban in the safety zones of OWFs prevents multi-use of the sites for activities that require separate approval (such as mariculture or nature restoration through artificial reefs), as there is generally no general exemption for activities approved alongside the OWF. In the Netherlands, such exemptions have been integrated into the (areas of) safety zones of OWF where multi-use is to be implemented.[164] The GDWS would not relinquish its responsibility for averting dangers to the safety and ease of traffic, as this issue must also be examined by the BSH in the approval procedure under the SeeAnlG (planning approval, plan approval, and authorization)[165] and the consent of the Federal Waterways and Shipping Administration (WSV) is also required.[166] However, restrictions on uses such as fishing and shipping that do not depend on a separate, area-specific permit would still have to be regulated directly in the general ruling on the use of the safety zone.

Multi-use and nature conservation compensation measures

The relevant regulations on compensation measures under nature conservation law, which currently provide for special privileges for OWFs in the context of compensation if active fishing is prohibited in their safety zone, are also not designed for multi-use of OWFs in the EEZ.

Compensation obligation for OWFs in the EEZ

According to Section 15 (1) of the Federal Nature Conservation Act (BNatSchG), those responsible for interventions in nature and the landscape have a duty to refrain from avoidable damage to these protected resources.[167] In the case of unavoidable damage, Section 15 (2) BNatSchG stipulates an obligation to compensate for the damage through natural compensation measures or replacement measures.[168] Subordinate to avoidance and natural compensation is the compensation payment that must be made if "an intervention in nature and the landscape is permitted even though the unavoidable damage to the natural environment and the landscape cannot be compensated or replaced, either completely or within a reasonable period of time, by natural compensation measures."[169]

March 4, 2022 (Wikinger, Arcona-Becken Südost); Generaldirektion Wasserstraßen und Schifffahrt, Allgemeinverfügung zum Befahren der gemeinsamen Sicherheitszone um die Offshore-Windparks „Nordsee Ost“ und „Meerwind Süd/Ost“ sowie die Konverterplattformen „HelWin alpha“ und „HelWin beta“, dated July 13, 2021 (Nordsee Ost, Meerwind Südost und Konverterplattformen HelWin alpha und HelWin beta).

164 See VIII.3 below.

165 See Section 5 (3) No. 2 and Section 7 No. 1 Alt. 2 SeeAnlG. See Schatz/Bartmann, Kommentar: Seeanlagengesetz (SeeAnlG), in: Das deutsche Bundesrecht, 2024, Section 5 para.18 and Section 7 para.2.

166 See Section 8 SeeAnlG. See Schatz/Bartmann, Kommentar: Seeanlagengesetz (SeeAnlG), in: Das deutsche Bundesrecht, 2024, Section 5 para.18 and Section 8 para.2 f.

167 See Landmann/Rohmer UmweltR/Gellermann, 102nd ed., September 2023, BNatSchG § 15 para.4 ff.

168 See Landmann/Rohmer UmweltR/Gellermann, 102nd ed., September 2023, BNatSchG § 15 para.7 ff.

169 Landmann/Rohmer UmweltR/Gellermann, 102nd ed., September 2023, BNatSchG § 15 para.49.

Wind turbines in the EEZ that were approved before January 1, 2017, or that are permitted on the basis of a surcharge pursuant to Section 34 WindSeeG (concerning existing projects within the meaning of Section 26 (1) WindSeeG[170]) are approved,[171] § 15 BNatSchG pursuant to § 56 (3) BNatSchG does not apply.[172] This means that Section 15 BNatSchG is only relevant for wind turbines in the EEZ that were approved after January 1, 2017, on the basis of a concession under (now) Section 20 WindSeeG (sites not subject to central pre-surveying) or Section 54 WindSeeG (sites that are centrally pre-surveyed). The Federal Compensation Ordinance (BKompV),[173] based on Section 15 (8) sentence 1 BNatSchG, regulates the avoidance and compensation of interventions in the context of projects within the exclusive federal administration, which also includes wind turbines in the EEZ.[174]

Compensation for OWF

The special provision of Section 15 (1) BKompV applies to the assessment and calculation of compensation payments in relation to the construction and operation of wind turbines and ancillary facilities in the EEZ and on the continental shelf. In addition to favorable provisions for calculating compensation ([175]), Section 15 (1) BKompV also contains a special compensation provision concerning the design of the usage regime in the area of OWF. According to this, damage to protected biotopes and soil (including plants and animals found in sediment, i.e., benthos), water, and air is considered compensated if fishing is prohibited in the safety zone belonging to the wind turbine in accordance with Section 74 WindSeeG for the entire duration of the wind turbine's operation.[176] Impairments to plants and animals occurring in water and air “must be addressed by the regulations on European species and area protection.” [translation][177] The compensation regulation also covers converters whose safety zone overlaps with a wind turbine safety zone that meets the above requirements.[178] The ban on fishing does not have to apply to passive fishing with traps and baskets, provided that this takes place outside the safety zone in which the turbines themselves are located.[179] Other passive fishing, e.g. with set nets, longlines or fishing rods, or even innovative fishing gear that may be developed in the future, is therefore currently not permitted.

According to the logic of this regulation, damage to protected resources caused by wind turbines is already compensated for by the collateral benefits under nature conservation law, which arise from the fact that, according to current official practice, other uses that severely damage pro-

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170 See BerlKommEnergieR/Dannecker/Kerth, 5th ed. 2022, WindSeeG § 26 para.1 ff.

171 For a tabular overview of wind turbine approvals in the EEZ to date, see BSH, Raumrelevante Entwicklungen in der deutschen ausschließlichen Wirtschaftszone in der Nordsee und Ostsee Jahresbericht 2023, p. 39 f. According to this, a total of 1430 wind turbines were approved before January 1, 2017.

172 See Landmann/Rohmer UmweltR/Gellermann, 103th ed., March 2024, BNatSchG § 56 para.18 f.

173 Bundeskompensationsverordnung vom 14. Mai 2020 (BGBl. I S. 1088).

174 See BeckOK UmweltR/Schrader, 70th ed. 1.1.2024, BNatSchG § 15 para.92 ff.

175 See Section 15 (1) Nos. 2 and 3 BKompV.

176 See Section 15 (1) No. 1 sentence 1 BKompV.

177 BT-Drs. 19/17344, February 24, 2020, p. 171.

178 See Section 15 (1) No. 1 sentence 2 BKompV.

179 See Section 15 (1) No. 1 sentence 3 BKompV.

tected resources – in particular active fishing (e.g., with bottom, trawl, and drift nets) – are prohibited in the safety zone of the wind turbines.[180] However, the purpose of compensation is not achieved everywhere, as ultimately environmental damage caused by fishing is also compensated for at sites where no fishing took place at all previously. Furthermore, this blanket regulation does not ensure that the previous intensity of fishing is taken into account in relation to the effectiveness of compensation. In addition, the marine nature conservation component pursuant to Section 58 (1) WindSeeG should be mentioned here, which is to be paid by the successful bidder on an OWF site in the amount of five percent of the bid. Although this is not to be understood as compensation within the meaning of Section 15 BNatSchG pursuant to Section 58 (1) sentence 4 WindSeeG, it can nevertheless be invoked as additional political justification for the privileging of wind turbines by the BKompV with regard to the adverse effects on nature attributable to them.

This excludes the joint use of the area of an OWF by fisheries, with the exception of certain passive fisheries in the outer area of the safety zone, if the OWF is to benefit from Section 15 (1) BKompV. Thus, the fate of compensation for the adverse effects associated with the wind turbine is linked to a regulation of the *entire* site within the safety zone, even though the approval of the wind turbine does *not* confer an exclusive right to the overall use of the site. At the same time, the establishment and design of the prohibition regime for the safety zone remain a matter for the authorities, who have discretionary powers in this regard. If this discretion were to be exercised in favor of further fishing activities in the future, the adverse effects associated with the respective OWF would now have to be compensated. With regard to multi-use by fisheries, the explanatory memorandum to the BKompV states that "in the practice of granting fishing permits in offshore wind energy areas [...] the initiatives of the European Parliament and the resulting legal situation in the European Union must be taken into account" and "the practice [...] then adjusted accordingly if necessary" (with the note that the European Parliament is discussing "a so-called multi-use approach" that "has as its subject the coexistence of offshore wind farm operations and fishing").[181]

Compensation for additional uses

Other forms of multi-use, such as mariculture (aquaculture), are possible according to the wording of Section 15 (1) sentence 1 BKompV without the compensation effect for the wind turbine being lost. However, they may have to be compensated for themselves, as the compensation relating to the OWF pursuant to Section 15 (1) sentence 1 BKompV does not cover all uses in the safety zone, but only the OWF. In this regard, Section 15 (2) BKompV clarifies that the applicability of the BKompV in the EEZ and on the continental shelf "in other respects" – i.e., with regard to other projects – remains unaffected. Whether and to what extent compensation for additional use is necessary depends on how it affects the protected resources listed in the BKompV – i.e., whether unavoidable damage to these protected resources is to be expected.[182] It is conceivable that some forms of multi-use cause little damage to protected resources and may even have positive effects on some protected resources. In addition to nature restoration, low-trophic aquaculture (mussels and algae) is one example, as it extracts excess nutrients (this is important in

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180 BT-Drs. 19/17344, February 24, 2020, p. 171 f.

181 See BT-Drs. 19/17344, February 24, 2020, p. 172. Quotes translated.

182 See Section 4 BKompV for an assessment of the current situation and the expected unavoidable adverse effects.

the Baltic Sea, for example) and in turn provides an ecosystem for other species, thereby promoting biodiversity.[183]

Conclusion on the compensation regime

Overall, it can be said that § 15 (1) No. 1 BKompV in its current form is in some respects at odds with the implementation of multi-use of OWF in the EEZ. Active fishing is currently not possible in any form without losing the compensation effect for OWFs under the current BKompV regulation. At the same time, additional uses would have to be compensated for separately, even though they would be located on the same site as the OWFs and within the same safety zone.

Comparative case study: Netherlands

Due to its integration of the multi-use of OWP into maritime spatial planning, the Netherlands can be considered a pioneer in this area and, due to its proximity to Germany, its EU membership, and other comparable conditions (e.g., ecological), is particularly suitable for a legal comparison. The following section outlines how the Netherlands is addressing the challenge of properly regulating multi-use in OWFs.

Multi-use as a basic principle of Dutch maritime strategy

The Netherlands had already established the basic principle for the period 2016-2021 as part of its general maritime spatial planning that multi-use of space – including OWFs – should be promoted as far as possible.[184] However, as far as can be seen, no area-specific provisions regarding multi-use in specific OWFs have been made in the spatial development plan to date. In general, the Dutch government has recognized that it is more cost-effective to consider the possibility of multi-use in an OWF at an early stage of planning than to expand the OWF for additional uses at a later date.[185] To this end, aspects of multi-use are also taken into account during the preliminary investigation of the sites.[186] However, as in Germany, this is no longer possible for many sites, as the respective auctions have been completed and the approval procedures are ongoing or approvals have already been granted.[187]

Area passport (gebiedspaspoort) for multi-use in OWF

The concept of the area passport (*gebiedspaspoort*) was developed for these sites. In contrast to strategic spatial planning, the more detailed area passports – as a local planning instrument – are only published after completion of the precise construction and operating plan for an OWF,

183 Maar et al., Multi-use of offshore wind farms with low-trophic aquaculture can help achieve global sustainability goals, Communications Earth & Environment 447 2023, https://doi.org/10.1038/s43247-023-01116-6; https://helcom.fi/new-criteria-for-sustainable-aquaculture-are-a-best-practice-example-from-helcom/ (North Sea Policy Document 2016-2021 including the Netherlands' Maritime Spatial Plan), p. 25 f.

184 Policy Document on the North Sea 2016-2021 including the Netherlands' Maritime Spatial Plan), https://maritime-spatial-planning.ec.europa.eu/media/12313, p. 95, 99.

185 Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, p. 123.

186 Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, p. 124.

187 Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, p. 123.

on the basis of which the site can be examined for its suitability for multi-use.[188] Approval for additional uses is only possible after the OWF has been completed and commissioned.[189]

For each OWF in which this concept is implemented, there is a guideline that uses area-specific characteristics to show where multi-use ("shared use" or *Medegebruik*) is possible.[190] The guidelines also describe which forms of shared use in the respective OWF have the greatest chance of success, can be best accommodated, and are therefore preferable. These guidelines are primarily planning documents that are not directly binding. The area passport concept has been implemented in three OWFs to date: Borssele,[191] Hollandse Kust Noord,[192] and Hollandse Kust Zuid.[193]

Greater flexibility in safety zones

To ensure that the prohibitions applicable in the safety zones of the OWF do not prevent multi-use, exceptions have been created for activities for which a permit has been granted.[194] However, based on scientific advice, the Dutch government has decided that a radius of 500 m around each wind turbine and a distance of 250 m from the cables laid in the OWF must be maintained in order to ensure safe maintenance of the turbines and ancillary facilities.[195] The 500 m radius around individual wind turbines is based on a maintenance zone of 250 m and a maneuvering zone of 250 m, with passive fishing permitted on the seabed below the maneuvering zone.[196]

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188 Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, p. 123.

189 Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, p. 123.

190 See, for example, Handreiking gebiedspaspoort Borssele, December 10, 2020, https://www.noordzeeloket.nl/@245375/handreiking-gebiedspaspoort-borssele/.

191 Noordzeeloket, Borssele Wind Farm Zone (2024), https://www.noordzeeloket.nl/en/functions-and-use/offshore-wind-energy/free-passage-shared-use/borssele-wind-farm-zone/.

192 Noordzeeloket, Hollandse Kust (noord) wind farm zone including Prinses Amalia Wind Farm (PAWF) (2024), https://www.noordzeeloket.nl/en/functions-and-use/offshore-wind-energy/free-passage-shared-use/hollandse-kust-noord-wind-farm-zone-including/.

193 Noordzeeloket, Hollandse Kust (zuid) Wind Farm Zone including Offshore Wind Farm Luchterduinen (LUD) (2024), https://www.noordzeeloket.nl/en/functions-and-use/offshore-wind-energy/free-passage-shared-use/hollandse-kust-zuid-wind-farm-zone-including/.

194 See Art. 2(2)(b) Announcement prohibiting entry into the safety zones of the Borssele wind energy area in the North Sea, Government Gazette 2021, 13511, https://zoek.officielebekendmakingen.nl/stcrt-2021-13511.html; Art. 2(1)(e) Announcement prohibiting entry into the safety zone of the Hollandse Kust (zuid) wind energy area in the North Sea, Rijkswaterstaat, Government Gazette 2023, 29556, https://zoek.officielebekendmakingen.nl/stcrt-2023-29556.pdf.

195 Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, p. 126.

196 Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, p. 126.

Corresponding distance regulations and additional regulations concerning fishing can also be found in the area passports issued to date.[197]

Approval regime for multi-use

Most additional uses, including mariculture facilities, require a water law permit or license under Dutch law, which was originally based on Article 6(5)(c) of the Water Act (*Waterwet*)[198] (old version) in conjunction with Article 6(13) of the Water Decree (*Waterbesluit*) (old version)[199]. Since 2024, the relevant licensing regulations have been included in Chapter 5 of the new Dutch Environmental Code (*Omgevingswet*).[200] The assessment framework for licensing decisions concerning multi-use, which serves as a guide for authorities and applicants, is described in detail in the Dutch North Sea Programme 2022-2027.[201] One exception is passive fishing, which does not require an area-based permit under the Water Act, but is only permitted within the safety zone of an OWF after registration for a specific site on the area passport, which is subject to certain requirements and conditions.[202]

As in German law, the approval process under the Water Act requires a balancing of interests with regard to the risks of possible interference and damage to the OWF. In this regard, the Dutch government expressly points out that, under Dutch law, a license holder has an exclusive right to *generate wind energy* on the site in question, but not an exclusive right to the *overall use* of the site.[203] Multi-use is therefore possible in principle, provided that the relevant permit holder (of the OWF) does not suffer disproportionate damage or impairment as a result.[204]

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197 See Art. 4(3) Bekendmaking houdende een verbod zich te bevinden binnen de veiligheidszones van windenergiegebied Borssele in de Noordzee, Staatscourant 2021, 13511, https://zoek.officielebekendmakingen.nl/stcrt-2021-13511.html; Art. 4(3) Announcement prohibiting entry into the safety zones of the Borssele wind energy area in the North Sea, Government Gazette 2021, 13511, https://zoek.officielebekendmakingen.nl/stcrt-2021-13511.html.

198 Waterwet (2023), https://wetten.overheid.nl/BWBR0025458/2023-07-01.

199 Waterbesluit (2018), https://wetten.overheid.nl/BWBR0026872/2024-01-01.

200 Omgevingswet (2024), https://wetten.overheid.nl/BWBR0037885/2024-01-01.

201 Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, p. 125 ff.

202 See Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, p. 127.

203 Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, p. 126.

204 Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, p. 126.

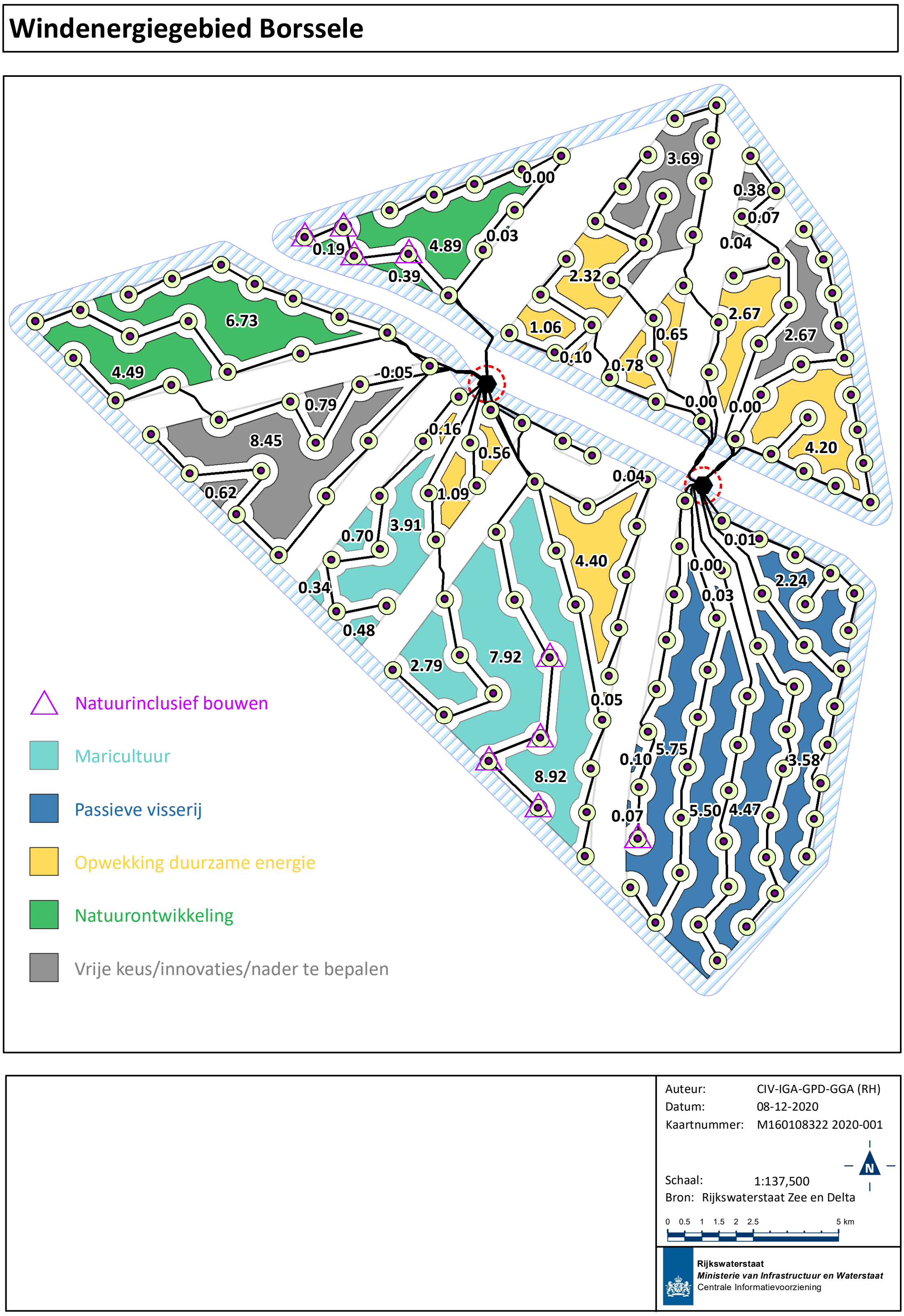

Figure 3 - Borssele Wind Farm Zone area passport. Source: https://www.noordzeeloket.nl/en/functions-and-use/offshore-wind-energy/free-passage-shared-use/borssele-wind-farm-zone

Comparative case study: Denmark

The central Danish instrument for maritime spatial planning is the Danish Maritime Plan (*Danmarks havplan*) of 2023, which was last amended in 2024.[205] The legal basis for the plan is the Maritime Spatial Planning Act (*lov om maritim fysisk* planlægning, MSPA).[206] In addition to the objectives of maritime spatial planning, the MSPA aims, among other things, to promote economic growth, the development of marine areas, and the sustainable use of marine resources.[207] The Danish Maritime Authority (*Søfartsstyrelsen*), which reports to the Ministry of Industry, Business and Financial Affairs (*Erhvervsministeriet*), is responsible for drawing up and updating the maritime spatial plan in accordance with Sections 9 ff. MSPA.[208] The marine spatial plan is legally binding, which is why Danish authorities – with a few exceptions[209] – are not allowed to draw up plans or grant permits that contradict the provisions of the marine spatial plan.[210] This also applies to the approval of activities that are not expressly mentioned in the marine spatial plan.[211]

Areas are defined in the marine spatial plan by four different zones. Development zones (e.g., for OWF, aquaculture, etc.) have the strongest steering effect, as they mean that permits for the respective projects can only be granted within these zones in order to keep other areas free of such projects.[212] In contrast, zones for special purposes (e.g., shipping corridors and infrastructure projects) serve to allocate specific areas for these purposes without simultaneously excluding other areas.[213] Nature and environmental protection zones aim to preserve and improve nature and biodiversity and are designated for existing and future marine nature reserves, for example.[214] Finally, there are the general use zones, which cover all areas of the marine spatial plan that are not designated for specific purposes.[215] In these zones, but also in some of the other three types of zones, projects and activities can be carried out that are not subject to explicit spatial planning in the marine spatial plan. [216] The maritime spatial plan contains specifications

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205 Danish Maritime Plan (Danmarks havplan), status: 2024, https://havplan.dk/en/page/info.

206 Sections 9 ff. Maritime Spatial Planning Act (lov om maritim fysisk planlægning, MSPA), LBK No. 400 of April 6, 2020, https://www.retsinformation.dk/eli/lta/2020/400.

207 See Section 1 MSPA.

208 This task was transferred on the basis of Section 21(1) MSPA.

209 See Sections 15 ff. MSPA. These exceptions relate in particular to the implementation of obligations under EU and international law, as well as urgent approvals and orders.

210 See Section 14(1) MSPA.

211 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 7.

212 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 24.

213 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 32.

214 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 38.

215 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 40.

216 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 40.

for zones for various purposes that overlap in order to achieve the greatest possible flexibility in the future use of the space.[217] This does not always imply the goal of multi-use; rather, the authorities reserve the right to determine the ultimate use of the area in the event of a specific approval procedure.[218]

However, the explanatory notes to the maritime spatial plan also contain comments on multi-use. According to these, the maritime spatial plan identifies significant areas that can be used for multiple purposes.[219] In these areas, it has been determined that there is potential for combining multiple interests.[220] The coexistence of multiple uses is seen as an increasingly important tool, as the desire to use marine areas is growing and the same areas are often considered attractive for multiple purposes.[221] One of the objectives of maritime spatial planning is therefore to promote the simultaneous or staggered use of a marine area for multiple purposes.[222] During the development of the maritime spatial plan, it was therefore examined whether several different types of facilities or activities could be located in one and the same area, possibly on a staggered basis.[223] In the vast majority of cases, however, whether a particular marine area can be used for different purposes depends on a specific case-by-case assessment.[224] Even if an area is designated for multiple purposes in the marine plan, a subsequent specific assessment in connection with the granting of specific permits may therefore reveal that the area cannot in practice be used for one or more of the purposes in question.[225]

217 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 11.

218 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 11.

219 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 7.

220 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 7.

221 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 7.

222 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 11.

223 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 11.

224 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 12.

225 Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 12.

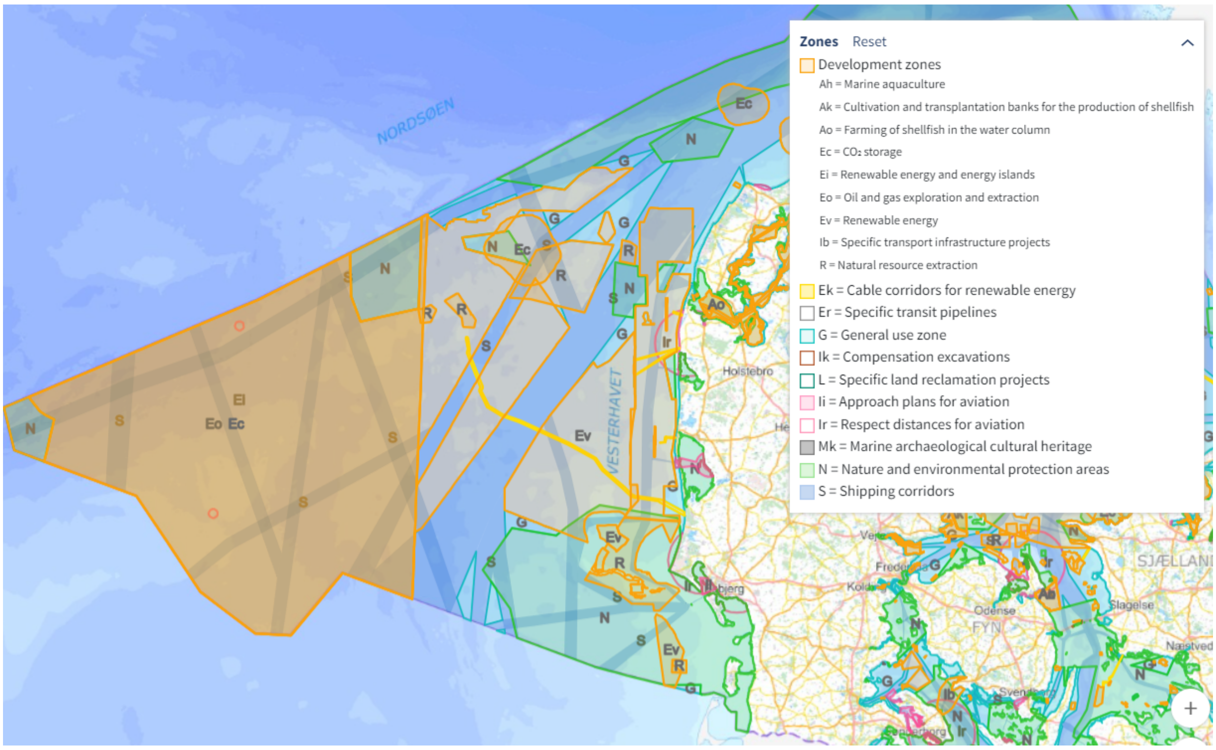


Figure 4 - Excerpt from the Danish maritime plan (Danmarks havplan), 2024, available at https://havplan.dk/en/page/info

Unlike in the Netherlands, Denmark does not have a general licensing regime for activities in the EEZ that applies when no more specific sectoral law applies. Consequently, the respective sectoral laws apply to all uses requiring a license, including multi-use.[226] To date, there are no known cases of multi-use within an OWF in Denmark.

With regard to fisheries, there is a special feature in that an OWF (like other offshore installations that restrict fishing) can only be approved if the requirements of Sections 76 ff. of the Danish Fisheries Act (*fiskeriloven*)[227] are met.[228] This initially involves negotiations with the Ministry of Fisheries.[229] In addition, project developers must negotiate compensation for financial losses with the fishermen affected, or a final decision on the issue of compensation must have been made, or the issue must have been submitted to a decision-making body in accordance with the Fisheries Act.[230] As part of the negotiations, measures can also be agreed upon that mitigate the negative effects of an OWF on fisheries, such as allowing passive fishing in the OWF. [231]

226 See Søfartsstyrelsen, Maritime Spatial Plan: Explanatory Notes, 2023, https://havplan.dk/portal-cache/api/v1/file/en/3fe515c5-8a49-4bf1-b265-7aee28250083.pdf#nameddest=Ev, p. 7.

*227 Fisheries Act (*lov om fiskeri og fiskeopdræt (fiskeriloven)*) LBK No. 261 of March 21, 2019, https://www.retsinformation.dk/eli/lta/2019/261.*

*228 Danish Energy Agency (*Energistyrelsen*), Offshore Wind and Fisheries in Denmark, 2018, https://ens.dk/sites/ens.dk/files/Globalcooperation/offshore_wind_and_fisheries_in_dk.pdf, p. 1 f.*

229 See Section 77(3) of the Fisheries Act.

230 See Section 78(1) of the Fisheries Act.

*231 Danish Energy Agency (*Energistyrelsen*), Offshore Wind and Fisheries in Denmark, 2018, https://ens.dk/sites/ens.dk/files/Globalcooperation/offshore_wind_and_fisheries_in_dk.pdf, p. 2.*

Conclusion and outlook

Since 2023, EU law has provided an important impetus for the integration of multi-use (including) of OWF into maritime spatial planning with Directive (EU) 2018/2001. Under the current legal situation, it is already possible within the framework of maritime spatial and sectoral planning to make MSP and SDP provisions for the multi-use of sites designated for OWF through additional uses such as passive fishing, scientific marine research, nature restoration, or mariculture. The current draft of the SDP 2024 already contains corresponding passages (e.g., on passive fishing).

However, it would be useful to include clarifying additions to the ROG and WindSeeG in this regard, as is already planned for the ROG in the draft law implementing the RED III Directive. Since the approval procedure for OWFs under the WindSeeG – as with the approval of additional uses under the SeeAnlG (insofar as applicable) – must take into account the requirements of spatial planning and the provisions of the SDP, maritime spatial and technical planning can have a significant steering effect on the implementation of concepts for multi-use in OWFs.

In addition, it is conceivable that amendments to the WindSeeG could require the potential for multi-use to be taken into account in future as part of the central preliminary investigation and the subsequent suitability assessment, create binding requirements for nature-integrated designs, and integrate qualitative criteria into the award procedure that favor multi-use. In all of this, however, the special legal weighting for offshore wind energy by the legislator must be taken into account (Section 1 (3) WindSeeG). At the same time, it is clear that the regulatory options outlined primarily concern future OWFs that have not yet been finally planned and approved and are unlikely to have any steering effect on existing OWFs.

In the case of both future and already approved OWFs, the current practice of the GDWS in designing the navigation ban in the safety zones of OWFs also precludes multi-use (e.g., for fishing, mariculture, or nature restoration), as there is generally no exception for activities approved alongside the OWF. In the Netherlands, such exemptions have been integrated into the safety zones of OWFs in order to enable multi-use in specific cases. In any case, where multi-use is possible without unacceptable safety risks based on expert assessments, the GDWS should create corresponding flexibilities in its general rulings in the future. Another special feature related to safety zones is the compensation regulation under nature conservation law in Section 15 (1) No. 1 BKompV, which in its current form would remove the privilege for OWFs if fishing (with the exception of certain passive fisheries) were to be permitted in the safety zone of an OWF.

Overall, a comparative look at the Netherlands shows what an opening of spatial planning for multi-use of OWFs could look like. There, the focus is particularly on newly planned and not yet approved OWFs, as there is even more scope for design in these cases. Whether this will also achieve the desired effect of multi-use in practice cannot yet be conclusively assessed due to a lack of empirical data. The legal admissibility and regulatory promotion of multi-use of OWFs does not necessarily mean that the additional uses in question are practicable or economically viable. This applies in particular to the EEZ, where economic activities involve additional logistical and operational challenges and costs compared to those in coastal waters. Questions of economic viability, practicability, and acceptance among OWF operators are likely to be decisive for the success of multi-use concepts.

2.2. Fundamentals of offshore wind farm use Offshore wind energy

This chapter focuses on the technological development of offshore wind farms (OWF), including the further requirements resulting from their operation and maintenance, particularly with regard to their space requirements and safety aspects. The ongoing innovations and optimizations in this sector are crucial for the realization of the ambitious goals of the Offshore Wind Energy Act.

The law stipulates an increase in offshore wind energy capacity to at least 30 gigawatts (GW) by 2030, to at least 40 GW by 2035, and finally to at least 70 GW by 2045. It is therefore essential to examine in detail both current technological standards and future development trends and their potential implications for land use. The resulting projection of future turbine dimensions and the distances between individual turbines within wind farms are of central importance for the planning of offshore wind farms and for the integration of multi-use. Technical possibilities, safety-related and regulatory requirements are discussed in the following sections insofar as they are relevant to multi-use.

Influence of technological developments in wind turbines

Rotor diameter

Larger turbines can capture a greater amount of wind energy and convert it into electrical energy. This increase in efficiency leads to a higher energy yield per turbine and thus to a reduction in the number of turbines required to produce the same amount of electricity. The resulting reduction in investment and operating costs makes the development of larger turbine types a key objective of the offshore wind industry. The rotor diameter, in turn, influences the distances between the wind turbines. The larger the rotor diameter of the selected turbines, the greater the distances between them. The spatial compatibility of OWFs with potential multi-use can be increased within newly constructed OWFs with modern plant technology compared to existing parks with old plant technology. Their development will therefore be examined in more detail below.

The market for offshore wind turbines is dominated by six wind turbine manufacturers[232]. Based on country of manufacture and installed capacity in GW, these are the following companies:

- Chinese manufacturers: Minyang (MY), Envision, and Goldwind
- European manufacturers: Vestas (V) and Siemens Gamesa Renewable Energies (SG)
- American manufacturer: General Electric Vernova (Haliade)

No significant changes are expected during the period covered by this report, as the development and market launch of a new offshore wind turbine takes more than five years. The analysis is therefore limited to these suppliers.

Figure 6 shows the model series already available on the market with their respective rotor diameters. The wind turbine manufacturers Siemens Gamesa Renewable Energies (SG), Vestas (V), and GE (Haliade) offer wind turbines with rotor diameters of up to 236 m and a rated output of 14 MW. These are expected to be available in 2025, as supply contracts have already been signed.

232 BloombergNEF, source accessed Nov. 2024, https://about.bnef.com/blog/chinas-goldwind-retains-turbine-supplier-lead-as-global-wind-additions-hit-new-high-according-to-bloombergnef/

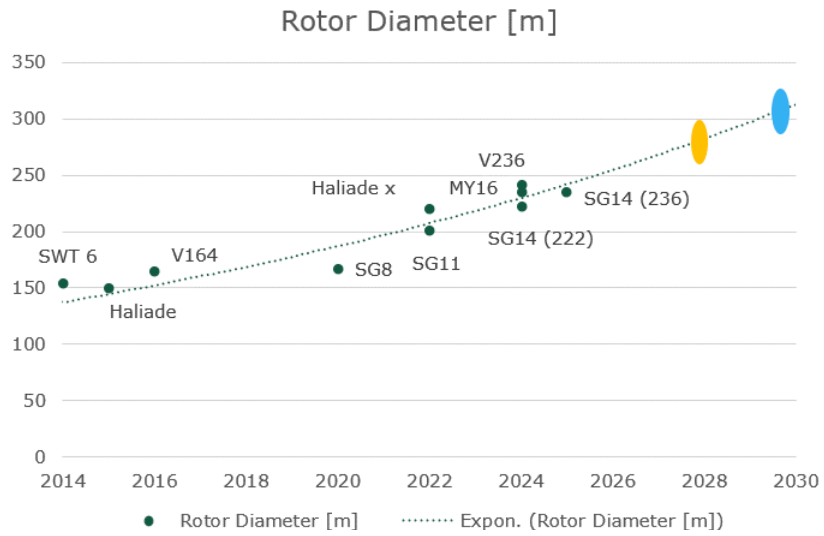


Figure 5 - Wind turbines available on the market plotted by rotor diameter over calendar year. Projections of expected future turbine sizes are marked in blue and yellow

The technological challenges involved in developing larger generations of turbines and other economic factors have presumably led wind turbine manufacturers to either refrain from commenting on the availability of wind turbines with rated outputs above 15 MW or even to publicly suspend development for the time being, as General Electric Vernova has done with its 18 MW plans. Only Mingyang is planning a prototype (MySE 16) for 2024 with a rotor diameter of 260 m and a rated output of 16 MW, and has also announced developments of wind turbines up to 22 MW and 310 m rotor diameter, but without a timetable.

Market expectations for the development of turbines beyond 2025 can be gleaned from several indicators: project concepts after 2025, orders for ever larger installation vessels that can install turbines up to 20 MW in water depths of up to 70 m (Van Oord, 2021), and assumptions made in scientific papers. For example, a study by Fraunhofer IWES on future wind energy yields assumes turbines of up to 22 MW in offshore wind areas starting from the N-11 (SDP) areas (Dörenkämper et al., 2023).

Taking these indications into account, an increase in rotor diameters to 255-275 m by 2028 and to 290-310 m by 2030 is considered likely for rated outputs above 18 MW.

Distances between individual turbines

Based on the above expectations regarding future rotor diameters, an initial estimate of future distances between turbines can be made. This serves as a basis for the assessment of future wind farm layouts.

The distances between wind turbines and thus the layout of the farm are subject to various factors, including economic ones. Forecasts in this regard are therefore subject to unavoidable uncertainties. An approximation is attempted below.

The **minimum distance of 1000 m** between neighboring wind farms, as prescribed in SDP23 for the German North Sea and Baltic Sea (BSH, 2023) for safety reasons, is unlikely to be implemented due to technical restrictions on wind turbines, as it is well below the technical requirements of the turbine manufacturers.

The **minimum distance of at least five times the rotor diameter** required in SDP 2023 roughly corresponds to the technical requirements of the turbine manufacturers (i.e., 1500 m for a wind turbine with a rotor diameter of 300 m). Below this limit, there is a risk that wind turbines will have such a negative impact on each other due to their wake flow that their service life may be shortened. In addition, for reasons of economic optimization, many wind turbines are erected at greater distances from each other in order to reduce energy losses due to wake flow. Particularly along the main wind direction, distances of more than six times the rotor diameter (6d) are often chosen.

In Table 6, the technical minimum distances of 5d and the economic minimum distances of 6d are multiplied by the expected rotor diameters to estimate the expected minimum distances between wind turbines in 2028 and 2030. It shows that **in 2028**, **wind turbines are not expected to be erected closer than 1275 m to each other, and that this value may increase to 1375 m if there is rapid growth in the number of turbines. Assuming positive developments in wind turbine technology and consistent economic conditions, a distance of 1860 m can even be expected in 2030**.

Table 6 - Minimum distances for offshore wind turbines

	d_{min}	d_{max}	$5d_{min}$	$6d_{min}$	$5d_{max}$	$6d_{max}$
2028	255	275	1275	1530	1375	1650
2030	290	310	1450	1740	1550	1860

Impact of planning approval and authorization

As explained in chapter 2.1, the legal framework for multi-use in the OWF varies depending on the project phase. An overview of the life cycle phases and their duration is provided in Figure 7.

Opportunities for multi-use are most diverse at the beginning of the project, as no binding decisions have yet been made that could define the framework. However, this scope for additional uses narrows increasingly with each further development phase of the project, as, among other things, legally relevant specifications exclude certain forms of use.

Figure 6 - Project phases in the life cycle of an offshore wind farm and their estimated duration

The planning approval phase is therefore to be regarded **as a critical milestone** in the course of the project, because this is where the most comprehensive restrictions on possible uses are defined. Up to this point in the project process, multi-use options can be examined and considered. Once planning approval has been obtained and finalized, however, the possibilities for change are severely limited for both the applicant and the approval authority.

The decisions made during the planning approval process are highly binding and determine the future use of the OWF. Measures, concepts, and usage scenarios that were not considered at this stage can only be integrated retrospectively at considerable expense.

For this reason, it is fundamentally important that all potential uses and concepts are thoroughly examined and incorporated into the planning process before this stage of the procedure. After this milestone, changes to existing structures and uses are not only much more difficult to implement, but also require more extensive coordination processes and subsequent approvals. These can have a significant negative impact on the prospects of success of the multi-use project, both in terms of time and money. All parties involved should carefully align their plans with this milestone.

The planning approval process is a complex approval procedure whose completion depends on project planning and administrative processes. Experience shows that the duration of the process after the contract has been awarded is estimated at 1.5 to 2 years. Therefore, it is only possible to estimate the date of planning approval for individual OWF projects by calculating backwards from the expected year of commissioning.

The current commissioning plan can be used to estimate which OWF projects will be approved or granted planning permission at a point in the future. At the time of this report, the SDP 23 for the EEZ in the Baltic Sea and the draft SDP of June 7, 2024, for the EEZ in the North Sea should be used, including the information contained therein regarding the commissioning plan. Since the SDP is subject to ongoing updates, analyses must be updated in accordance with the latest version.

Although the milestone "planning approval" is not described in the SDP, the time frames for the development of an offshore wind farm, from the award of the contract to the end of its useful life, can be roughly estimated on the basis of projects that have been realized to date (see Figure 7) and fee-based information from the 4C Offshore database[233]). After planning approval, a rough estimate of 3-4 years can be assumed for the construction and preparation until the OWF is commissioned. This does not take into account significant deviations from the project plan, which may lead to considerable delays.

As a calculation example, an OWF on site N12.1 with planned commissioning in 2030 would have to be approved by 2027 at the latest in order for commissioning to take place on time. **Possible multi-use plans should be developed accordingly before 2027. In principle, however, the type and scope of multi-use should already be known before the respective site is put out to tender, as this may have an impact on the economic viability of the OWF.** With each passing year, the possibilities for multi-use in the subsequently approved or licensed wind farms are further restricted if this has not already been taken into account. Table 7 provides an overview of the OWFs expected to be commissioned between 2024 and 2023 at the time of reporting.

Table 7 - OWF expected to go into operation between 2024 and 2031

OWF	Status as of June 2024	Expected commissioning	Estimated planning approval
Gode Wind 3	Partially feeding into the grid	2024	2021
Baltic Eagle	Partially feeding in	2024	2021
Borkum Riffgrund 3	Under construction	2025	2022

233 https://www.4coffshore.com/

EnBW He Dreiht	Under construction	2025	2022
Wind anchor	Investment decision	2026	2023
NC 1 (N-3.7)	Investment decision	2027	2024
NC 2 (N-3.8)	Investment decision	2027	2024
Northern Lights I	Purchase strike	2028	2025
Northern Lights II	Reference strike	2028	2025
Gennaker	Grid connection entitlement	2028	2025
Waterfront	Purchase strike	2028	2025
NC 3 (N-3.5)	Investment decision	2029	2026
NC 4 (N-3.6)	Investment decision	2029	2026
Oceanbeat East (N-11.1)	Purchase strike	2030	2027
N-12.1	Reference strike	2030	2027
Oceanbeat East (N-12.2)	Reference strike	2030	2027
O-2.2	Reference strike	2030	2027
N-11.2	Reference strike	2031	2028
N-12.3	Reference strike	2031	2028

Activities in offshore wind farms

Maintenance

In order to determine the sites available in the OWF, it is important to classify the activities during the operational phase of the OWF and to show the site requirements based on the different types of ships used. This subchapter therefore discusses the activities during the operational phase of the OWF at . The focus is on the expected ship movements, as these have the greatest potential for interactions with possible secondary uses. The following section will therefore only deal with remote impacts and work processes on the installations themselves to a limited extent.

For the purposes of this report, offshore work can be roughly divided into the following categories:

- **Preventive and corrective maintenance** for small to medium-sized repairs, which account for a large proportion of ship movements and can be determined relatively accurately in terms of frequency.
- **Large component replacement** (LCR) as part of corrective maintenance should occur very rarely, but must be feasible at all times and requires the largest area of all activities in the operational phase of the OWF. In this analysis, it should be used as a key factor in determining the size of the exclusion zone around the OWF installations.

Figure 8 shows the timing of common maintenance strategies. It should be noted that continuous ship traffic is possible through both predetermined maintenance and immediate corrective maintenance.

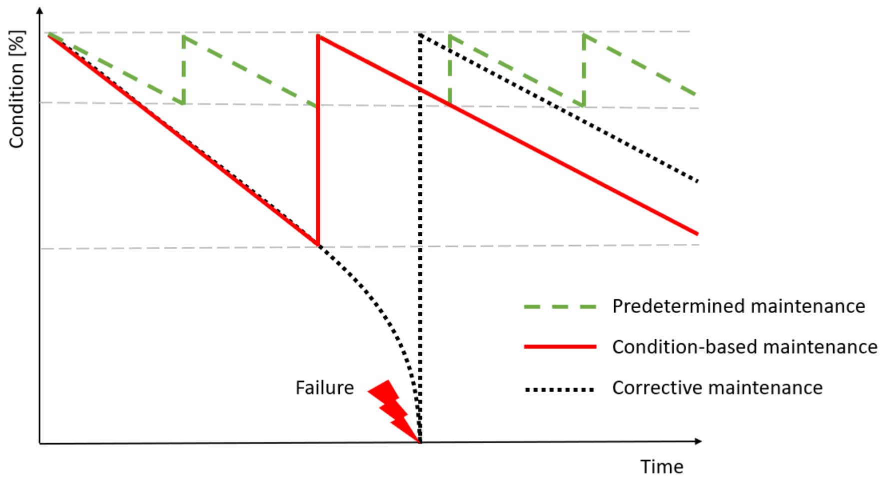


Figure 7 - Maintenance strategies and their influence on plant condition, based on (Damkilde et al., 2015)

Preventive maintenance refers to activities that assess the condition of systems, reduce wear and tear or the probability of failure in order to ensure the smooth operation and longevity of systems. Preventive maintenance is divided into predetermined and condition-based maintenance, the former being determined on the basis of manufacturer recommendations or industry best practices. Predetermined maintenance is scheduled either on the basis of fixed time intervals or number of operating hours. Adhering to a predetermined schedule can minimize disruptions, improve efficiency, and increase safety by identifying and addressing potential causes of failure early on, before a breakdown or repair occurs and the associated downtime of the plant. Condition-based maintenance first assesses the condition of a system and derives the resulting maintenance measures. The aim of condition-based maintenance is to minimize the number of maintenance interventions in the OWF. **The maintenance strategy of the OWF operator determines the extent to which predetermined and condition-based maintenance is carried out**. **This often depends on the age of the OWF**.

In particular, the scope of predetermined maintenance can be precisely determined, and the timing of the work can be specified in advance. The work can be carried out continuously throughout the year or concentrated in an annual campaign (annual maintenance) if the specified intervals allow this. This annual maintenance is usually carried out in the summer months from April to September. Planning begins in the previous year, as a considerable number of technicians and often several ships are required.

Preventive maintenance is crucial for the number and timing of expected ship movements in the OWF.

Corrective maintenance, on the other hand, is carried out in response to unforeseen events. It is reactive and takes place when a failure or malfunction occurs. Depending on the expected consequences, corrective maintenance is carried out immediately or postponed. The aim is to restore safe operation or minimize downtime.

Ship types

The main types of ships used in maintenance operations are summarized here:

- Crew Transfer Vessel (CTV)
- Service Operation Vessel (SOV)
- Jack-up vessel (JUV)
- Heavy Lift Vessel (HLV)
- Remotely Operated Vehicle (ROV)

- Barges
- Tugboats
- Offshore support vessel (OSV)
- Cable Laying Vessel (CLV)

CTVs are vessels that typically transport technicians for maintenance work on OWFs located a short distance from the base port on a daily basis. CTVs enable approximately 12 to 24 technicians, tools, and small spare parts to quickly access the facility. The different types of CTVs have average operating limits of 1.5 – 2.5 m significant wave height.

SOVs are often used in more remote wind farms, as they usually only call at their home port every two weeks and are equipped with a wide range of facilities, including sleeping and recreation areas for technicians and crew, a helicopter landing pad, a crane, and a walk-to-work system to transfer personnel to the turbines. A walk-to-work system is a system that allows technicians to be transferred safely from the SOV to the turbine. To speed up the transfer of 40-60 technicians from the SOV to the turbines, CTVs are often used in addition to facilitate the distribution of technicians to the turbines. The operational limit for SOVs is usually 2.5 m significant wave height.

If shipping traffic is not possible due to weather conditions, but maintenance on the facility is still absolutely necessary, a helicopter can be used as an alternative to the access options described above. However, helicopter accessibility also depends on visibility and wind conditions.

ROVs are often used for underwater maintenance. They are deployed from CTVs, SOVs, or other larger vessels to inspect the condition of structures or submarine cables underwater or to carry out minor corrective maintenance.

For large component replacements, such as a main bearing or a rotor blade of the turbine, so-called **JUVs** or jack-up vessels are used. These can be lifted out of the water on legs and are therefore no longer exposed to the influence of wave movements, which allows precise operation of the heavy-duty crane and enables the safe installation of large, heavy components. Alternatively, **HLVs** are also used for this purpose. These stabilize themselves using dynamic positioning systems that allow the ship to maintain its position and work precisely despite waves and currents. Both JUVs and HLVs can be used in combination with a barge on which the large components are transported. Such barges are not necessarily equipped with their own propulsion system, but can also be brought into the OWF by tugs.

Large component replacement

The safety distance required for possible shared use during the operational phase is essentially defined for offshore wind by the space required for GKT, where JUVs, HLVs, or cable-laying vessels (CLVs) are used. The space requirement is then derived on the one hand from the size of the ships required and on the other hand from the type of ship and its positioning.

The crane height required and the maximum expected weight of the components are decisive factors in selecting the vessels suitable for a GKT. This would be achieved if the entire nacelle were to be replaced. In addition, the water depth and ground conditions are also taken into account, as it must be ensured that JUVs have the appropriate leg length. For the purpose of determining the space requirements of the JUV in terms of ground conditions, the German EEZ can be assumed to be homogeneous, so that the three selection criteria of hook load, hook height, and leg length are used to determine the size of the ships and thus their space requirements.

As a rule, a zone free of cables and other obstacles must be established around each wind turbine, which is required for the positioning of JUVs. It is not possible to install fixed structures in this so-called "jackup zone." The zone usually covers an area with edge lengths of 150-200 m around the wind turbine or the UW.

The location and size of the jackup zone is derived from other technical parameters of the JUV. For example, to ensure that the JUV legs do not sink too deep into the seabed and that the stability of the JUV can be guaranteed during the GKT, they have a contact surface known as a "spudcan." In order to prevent interaction between the JUV and the turbine, a horizontal distance of at least one spudcan diameter must be maintained between the contact surface of the JUV and the infrastructure. (EN ISO 19905-1, 2012)

Depending on the size of the turbine type, the expected jackup zones around the wind turbine or offshore structures vary. In principle, it can be expected that the required size of the jackup zones will also increase with correspondingly larger rotor diameters.

For other users of the wind farm or third-party installations, the SDP planning principles with distances of 500 m apply.

Work on wind turbine foundation structures

The replacement of foundations will not be discussed further, as this report examines multi-use during the operational phase of the wind farm and assumes that work on wind turbine foundation structures would be carried out using the JUV described above and that, in the event of decommissioning, multi-use would be decommissioned beforehand.

Work on wind farm submarine cables n

There are essentially two different methods for repairing submarine cables. Either the entire length of the cable is replaced, or the cable is lifted onto a ship, repaired there, and then laid back on the seabed and buried. The choice of method depends on the length of the defective cable.

When replacing the entire length of cable, the cable is first located and marked so that it can then be exposed, which is done using an OSV. The cable ends are then dismantled in the transition piece. The exposed cable is lifted onto the OSV and removed step by step. The laying of the new cable follows the same steps as the initial installation of the cable, with the difference that the seabed can be assumed to be free of debris and potential ordnance, as these were already cleared before the installation of the wind farm.

The cable is installed in three phases: 1) Preparatory work, which includes preparation in the transition piece and preparation of the seabed. 2) In the second step, the cable is laid, pulled into the transition pieces, terminated, and tested. 3) Finally, the cable is buried. If the cable is repaired rather than replaced, it must first be marked and exposed before it can be lifted onto the OSV to remove the defective segment, replace it with a new cable segment, and splice it to the existing cable. The repaired cable is then lowered, buried, tested, and put into operation.

During the work, the OSV and CLV require a space of 150 m from other structures to ensure safe working conditions. For other users of the wind farm or third-party installations, the SDP planning principles apply with distances of 500 m to enable maintenance work while the wind turbine is in operation.

According to (DNV, 2021), a minimum distance of 50 m must be maintained between parallel cables. To enable cable repair, (DNV GL, 2018) recommends a distance of at least 200 m to adjacent cables on one side at a water depth of up to 50 m. For other users of the wind farm or third-party installations, the SDP planning principles of 110/200 m alternately apply.

Work on the park's internal substation

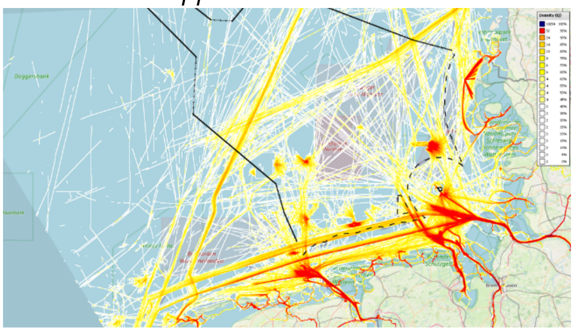
The existing wind farms in the German EEZ have an internal substation (UW) where the electricity is fed in at a voltage level of 33kV and transformed to a voltage of usually 155kV in order to minimize losses during electricity transmission to land. Work on these substations is carried out using the ships already described in the previous chapters, and **the size of the restricted zone required around the substation corresponds to the size of the restricted zone around a wind turbine**.

Shipping: Maintenance and Service

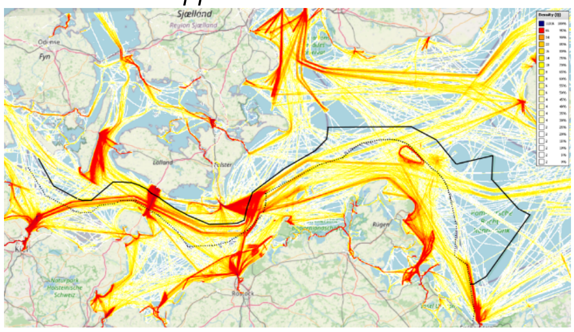
In addition to the space required for the ships needed for maintenance and operation within a wind farm, there is of course also corresponding traffic from these ships in the sea area outside the OWFs.

The following figures show the ship traffic and traffic density of support vessels and fast ferries in separate plots for the year 2022. The density plots show a strong concentration of support vessel traffic from the relevant port locations to the existing offshore wind farms in the North Sea and Baltic Sea. At the same time, however, island supplies and other traffic via the traffic separation zone are also clearly visible here. The map sections for priority areas EN2 and EN4 show a particularly high density of traffic to the converter platforms. Traffic along the priority shipping areas is negligible in this context.

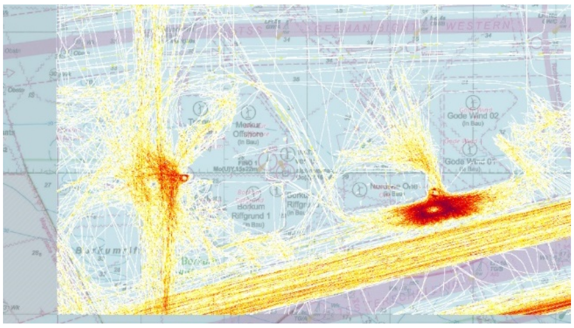
North Sea – Support Vessel:



Baltic Sea – Support Vessel:



Priority area EN2 – Support vessels:



Priority area EN4 – Support vessels:

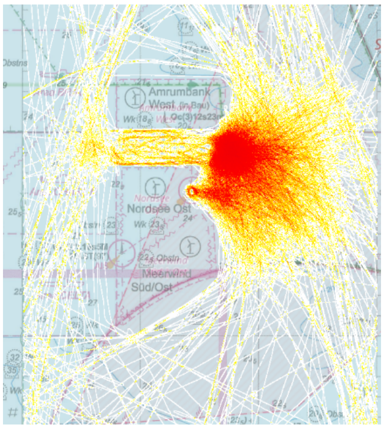
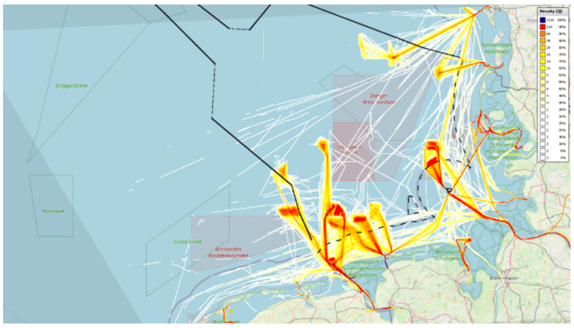


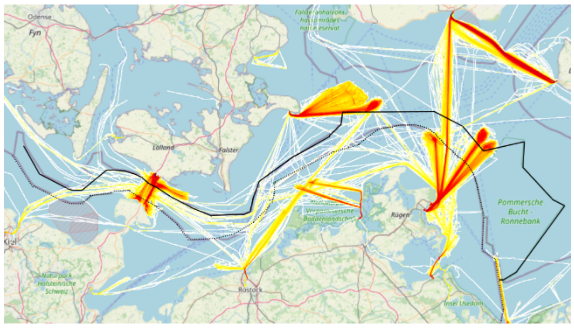
Figure 8 - Traffic density plots based on raw AIS data – support vessels in the North Sea and Baltic Sea; priority areas EN2, EN4 (2022)

The following density plots in Figure 9 show the traffic of "fast ferries." There is a clear concentration of service vessels on the OWFs and the connection to the port locations. The "outliers" that do not head for offshore wind farms are probably incorrectly labeled vessels and can be disregarded in the analysis. The close-ups of EN2 and EN4 show a specific pattern of vessels. The individual wind turbines within the farms are clearly marked, as the traffic density around the piles is particularly high.

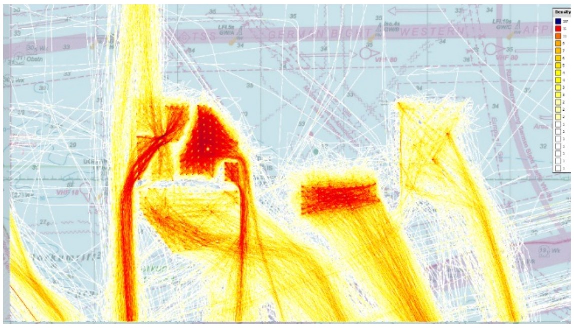
North Sea – Fast Ferry:



Baltic Sea – Fast Ferry:



Priority area EN2 – Fast Ferry:



Priority area EN4 – Fast Ferry:

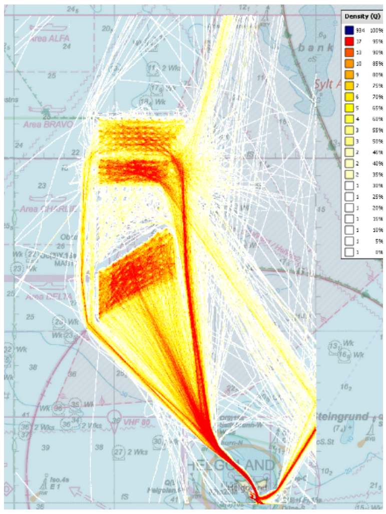


Figure 9 - Traffic density plots based on raw AIS data – Fast Ferries in the North Sea and Baltic Sea; priority areas EN2, EN4 (2022)

Maintenance and service vessels are an integral part of the use and operational logistics of OWFs. They are exempt from the ban on navigating in safety zones. Their movements are taken into account in corresponding safety concepts, which also include restrictions on shipping in extreme weather conditions, for example. Special mooring devices and access systems are already established, which is why functional compatibility and technical feasibility are given and required.

Summary of space requirements for offshore wind

Due to the legally defined expansion targets and the sites designated for the development of OWFs at the time of the report, it must be assumed that the designated sites within the boundaries will be fully utilized. The distances between the turbines, which can be estimated from the size of the turbines, minus the corridors for safety distances from all OWF turbines, including cables and marine traffic, are therefore decisive for the multi-use of OWF sites. The Dutch concept of area passports could, for example, be used to mark certain zones of the OWF for preferred multi-uses (ref. WP1 and WP2).

According to the SDP planning principles, distances of 500 m must be maintained for third-party use. From a purely technical point of view, smaller distances can also be achieved with appropriate precautions and agreements with the operator, as explained in detail in the previous chapters. A better definition of the immediate vicinity around wind turbines, for example with specific mention of access corridors or areas that are required for maintenance work and those that are not (see figures below), increases the scope for multi-use.

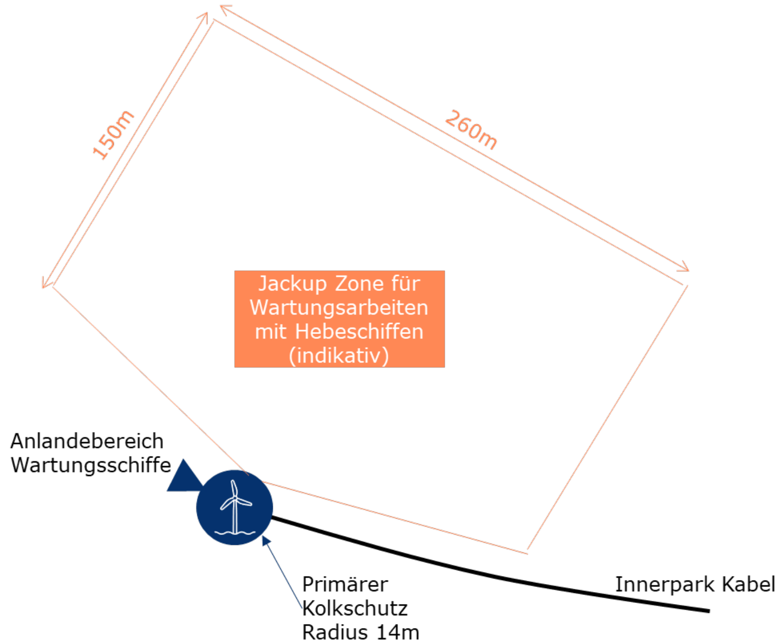


Figure 10 - Example sketch of spatial uses in the immediate vicinity of wind turbines within the safety radius

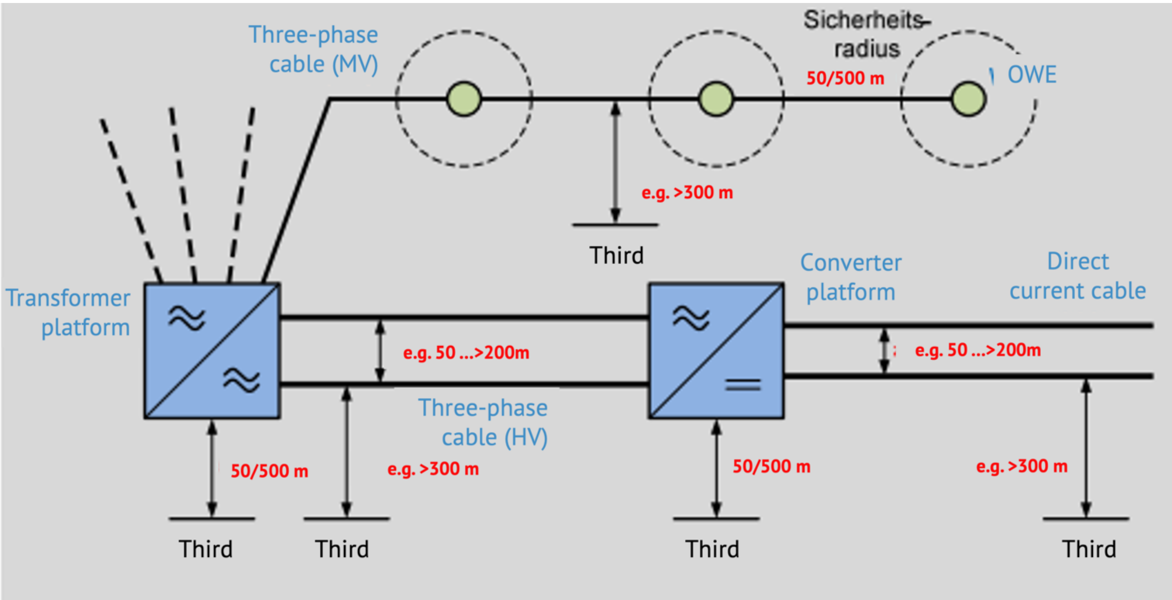


Figure 11 - Example sketch of the more detailed spatial requirements around wind turbines, substation platforms, and cables with recommended minimum distances as implemented in the United Kingdom. The safety radius is recommended to be 500 m during the construction phase and 50 m during the operational phase, with explicit calls for individual coordination. [234]

234 DNV Kema, 2012, study on minimum distances for submarine cables, commissioned by Offshore Forum Windenergie Offshore Wind Energy Foundation. Adapted (translation to English).

Conclusion and outlook

As shown, the spatial conditions and specific location of the area within the EEZ, as well as the degree and timing of the planning approval, are particularly decisive for further analyses of specific requirements for the multi-use of an OWF.

Therefore, the next work package 4 will be based on so-called representative wind farms that differ in particular in these decisive parameters: OWF 1 offshore with new generation of turbines, North Sea, not approved; OWF 2 near-shore, North Sea, existing wind farm approved; and OWF 3 near-shore, Baltic Sea, approved. Coastal refers here to the area of the EEZ closer to the coast. The following chapters will discuss the differences for the respective multi-use combinations where relevant.

2.3. Aquaculture

Aquaculture is the cultivation of aquatic organisms. This can take place on land, near the coast, or in the sea. Like fishing, aquaculture is a traditional form of food production and has been practiced since 3000 BC and in Northern Europe since 500 BC.

The techniques used are very diverse and depend heavily on local conditions. Net cage and line/raft-based forms of aquaculture are particularly suitable for offshore use. **Offshore aquaculture can be divided into low-trophic, high-trophic, or multitrophic systems, depending on whether the organisms being farmed are low in the food chain or dependent on feeding**.

Low-trophic aquaculture

Organisms that feed on nutrients such as plankton, microorganisms, or through filtration are referred to as low-trophic. They do not require feeding, as they filter the nutrients naturally present in the water and thus represent an extremely sustainable form of aquaculture.

- **Shellfish farming,** especially mussels and oysters, is a classic example of low-trophic offshore aquaculture. Shellfish are filter feeders that absorb plankton and other particles from the water, thereby helping to purify it. Since they do not require additional feed, their environmental impact is low and they contribute positively to good marine health. The mussels can be harvested on site in the same aquaculture system without additional impact.
- **Algae farms** are another low-trophic offshore aquaculture. Algae only need light, CO_2, and nutrients from the sea to grow. They also contribute to water purification and thus to good marine health by absorbing excess nutrients such as nitrogen and phosphorus and binding carbon dioxide.
- In **combined low-trophic aquaculture**, algae and mussels are cultivated together, with equally positive environmental effects. By absorbing nutrients from the environment, low-trophic aquaculture could contribute to improving the ecosystem, especially in nutrient-rich waters such as coastal areas and large parts of the Baltic Sea.

In the offshore area of the North Sea, strong currents and waves cause much greater mixing of the water and thus the measurable effect of nutrient removal is low, but nutrients are still removed. Therefore, the nutrient removal aspect should not be ignored in very large facilities in order to ensure consistently good growth of the species farmed in the facility (similar to avoiding "shading" in OWF). Furthermore, algae bind carbon dioxide as they grow and could thus contribute to climate protection.

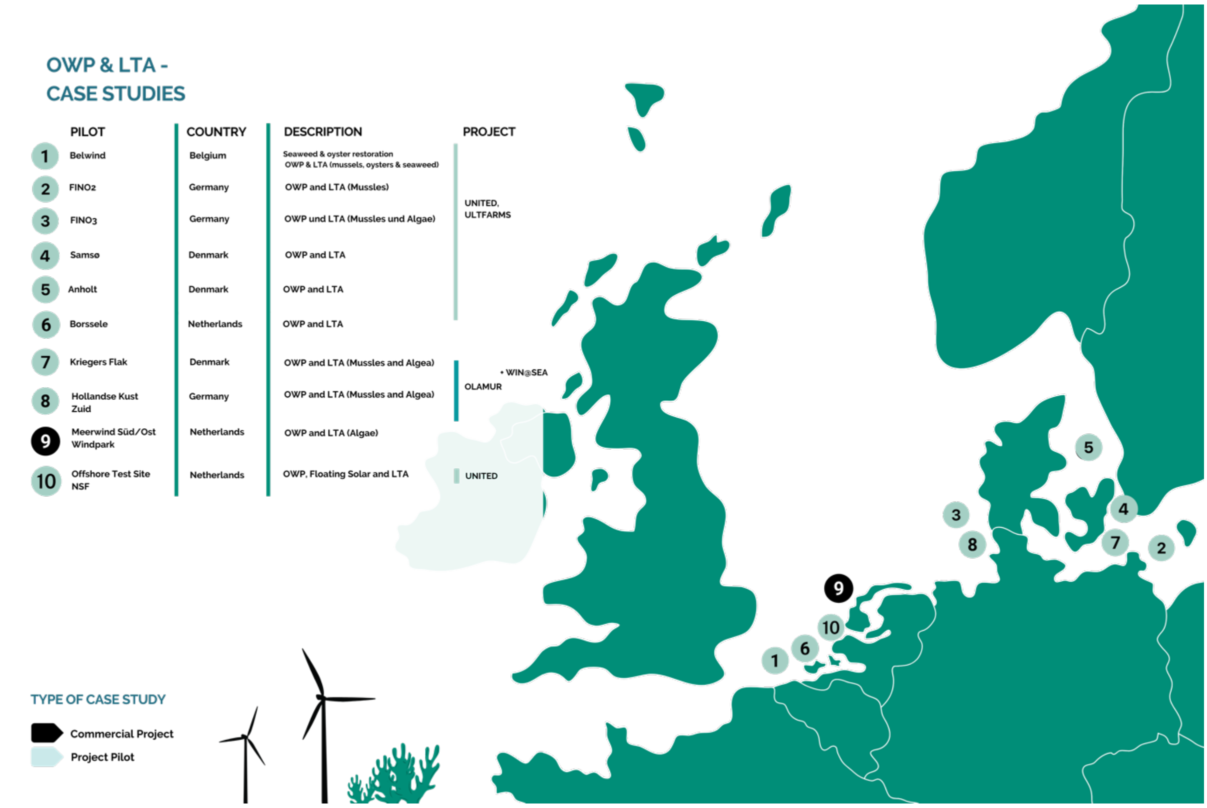


Figure 12 - Pilot and demonstration facilities for low-trophic aquaculture with OWF in the EU (WP1/WP2)

High-trophic (fish) aquaculture

High-trophic organisms are higher up in the food chain and depend on protein-rich food. Typical high-trophic species in offshore aquaculture include salmon and tuna, which are farmed in net pens or floating cages.

Salmon farming is a widespread form of high-trophic aquaculture. Salmon require special, often protein-rich feed. Although salmon farming is economically important, it places higher demands on the environment, as the need for feed and the production of waste can lead to challenges such as eutrophication.

Due to the input of nutrients from feeding and the increased time required for fish care, high-trophic aquaculture must be considered critical and is currently not recommended.

State of knowledge and experience

As can be seen in Figure 13and as described in WP1/WP2, there are already several examples of the combination of OWF and, in particular, low-trophic aquaculture. Various projects (ULTFARMS, UNITED, OLAMUR, The Rich North Sea, MSP4Bio) in Belgium gien, Denmark, France, Italy, and the Netherlands are researching this combination. Aquaculture has been tested in the OWFs Belwind (BE), Borssele II & IV (NL), and Anholt (DK), and there are already several privately funded projects (e.g., by Amazon and Colryut).

Political and legal framework

Low-trophic aquaculture is in line with the main objectives of the EU's Common Fisheries Policy and is supported both by the Strategic Guidelines for a more sustainable EU aquaculture (the so-called "EU Aquaculture Assistance Mechanism") and by the EU Algae Initiative ("EU4Algae"). In particular, the European Green Deal recognizes low-trophic aquaculture production as a source of "low-carbon" protein for human food and feed, as well as fertilizers and soil improvers (e.g., biochar), biopesticides, and drought resistance in crops (e.g., wine and feed production), all of which will be highly relevant for future climate scenarios. The EU mission "Restore our Ocean and Waters by 2030" sees the expansion of low-trophic aquaculture and its promotion within multi-use as an important step towards transforming to a climate-friendly and circular blue circular economy, especially in the flagship region of the North Sea and Baltic Sea.

In all aspects of the multi-use of OWFs by aquaculture in Germany, it should be noted that, according to Section 2 (4) sentence 1 SeeAnlG, facilities may only be approved, plan-approved, or authorized under the SeeAnlG if they do not "significantly impede" the use of the areas and sites specified in the SDP for offshore wind energy generation, the transmission of electricity, and the use of other energy generation sites specified in the SDP (Section 2.5).

This means that aquaculture requirements are given lower priority. This means that, even at the planning stage, all areas of aquaculture use, such as the choice of species to be cultivated based on the specified location, the design of the facility, and operating times, must already be coordinated with the already specified OWF to ensure compatibility.

For multi-use in OWFs, this means that any potential additional use must not contradict the content of the approval decision for the OWF – for example, by preventing the wind turbines or ancillary facilities of an OWF from being used as specified in the planning approval. This once again emphasizes the ideal case of joint planning and application by all users in the same area.

The following context from Chapter 2.1 is also important here. With the grounds for refusal in Section 5 (3) Nos. 2, 5, 6, and 7, the planning approval procedure under the SeeAnlG provides sufficient leverage for the competent authority to ensure that an additional use applied for is compatible with an existing approval decision under the WindSeeG. If a planned additional use does not conflict with the approved operation of the OWF, the approval decision under the WindSeeG is also not a legal obstacle to approval under the SeeAnlG. The content of the approval decision is therefore decisive. A strategy for implementing multi-use in already approved OWFs therefore requires a systematic evaluation of the content of existing approval decisions. In the case of future OWFs, multi-use, particularly low-trophic aquaculture, could in principle already be provided for at the spatial and technical planning level and thus be taken into account in the planning and approval of OWFs.

Spatial requirements and seasonality of use

According to the planned design, relatively limited space will be available for aquaculture in the context of the co-use of aquaculture and wind energy. Even with newer types of future wind farms, the distance between wind turbines is expected to be only approximately 1650–1860 m, which also includes other uses such as submarine cables and shipping traffic for preventive and corrective maintenance (Chapter 2.2.).

In principle, the co-use of OWFs, for example by aquaculture, is at least being considered in legal policy, as outlined in Chapter 2.2: "Recital 27 of Directive (EU) 2023/2413 makes it clear that spatial planning is an essential tool in this context "to identify and manage synergies for land, inland water, and lake use at an early stage." Within the framework of spatial planning, the multi-use of sites (including through changes in use) should therefore be examined, enabled, investigated, and promoted "provided that the different types of use and activities are compatible with each other and can coexist." Furthermore, Article 15b(3) of Directive (EU) 2023/2413, amended in 2023, (EU) 2018/2001 on the promotion of the use of energy from renewable sources,[235] the Member States to "promote" the multi-use of areas necessary for the national contributions to the Union's overall target for energy from renewable sources for 2030 (so-called renewable energy areas[236]). Union law therefore provides an important impetus for the integration of multi-use into maritime spatial planning with regard to OWF. The German government has taken up this impetus in its current draft law implementing the RED III Directive, which also contains provisions on multi-use (in particular, an addition to Section 7 (1) sentence 2 ROG).

As a result, the technical design and operating concept of aquaculture facilities must be adapted to this limited space and the spatial conditions of an OWF if aquaculture is added as a second use to an OWF that has already been approved. Since the spatial requirements of aquaculture facilities are flexible in some cases, this is generally feasible. At the same time, however, particularly in offshore areas, economic reasons require a significantly larger scale of facilities compared to coastal aquaculture facilities (see below).

Individual modules of the facility can be technically adapted to the available space, for example in an offshore wind farm, but overall, the operator must achieve a minimum harvest yield. It is therefore optimal to co-plan both activities before the planning approval or plan approval, 1.5-2 years after the contract is awarded.

Technical overview of aquaculture facilities

Algae, oyster, and mussel aquaculture

Most commercially interesting algae, such as sugar kelp, dulse, kombu, and alaria, are adapted to higher salt concentrations and are therefore suitable for cultivation in the North Sea. Bladderwrack and sea lettuce tolerate low salinity and are therefore generally suitable for cultivation in the Baltic Sea. Cultivation can take place in aquaculture facilities in various forms – line, cloth, and net cultures are already in commercial use worldwide. Buoys with a single-point mooring are in the test phase.

From a biological point of view, mussels and oysters can be cultivated practically anywhere in the German North Sea due to the high salt content, while cultivation in the German Baltic Sea as food is mainly dependent on the salt content (at least 12 PSU). In areas with low salt content, such as parts of the Baltic Sea, mussels only reach a small size and must be further processed before sale. The use of small Baltic Sea mussels for purposes other than human consumption is already being promoted by various parties, which means that a growing market for Baltic Sea mussels can be expected (www.balticmuppets.eu/www.ecopelag.de). Economically, the area is already limited by the distance to the nearest suitable port.

Data on nutrient availability and sufficient larval abundance in offshore areas are still incomplete. However, increased abundance of sessile filter feeders has been observed in wind farms, which is made possible, among other things, by the artificially created habitats. According to simulation

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235 Directive (EU) 2018/2001 of the European Parliament and of the Council of December 11, 2018 on the promotion of the use of energy from renewable sources, ELI: http://data.europa.eu/eli/dir/2018/2001/2024-07-16.

236 See Wulff, Die Umsetzung der Erneuerbare Energien-Richtlinie (RED III) in nationales Recht (The implementation of the Renewable Energy Directive (RED III) into national law), NVwZ 2024, 368 (369 ff.).

models that include all essential parameters, profitable oyster or mussel aquaculture is possible at and in wind farms (Gimpel et al. 2020).

In particular, intensive efforts to reintroduce the European oyster (Ostrea edulis) show great potential for aquaculture of this species in large parts of the EEZ in the North Sea (Merk et al. 2020). Paulson (2022) also concludes that the European oyster should be a priority aquaculture species in the North Sea (see also chapter on nature restoration).

The standard length of a "module" in seaweed and mussel aquaculture is 100 m of line or net and an additional approx. 150 m of anchoring per side at a water depth of approx. 20 m. In greater water depths, e.g., offshore mussel aquaculture at 45 m in Sunny et al. (2024), a correspondingly longer anchorage leads to higher space requirements. Several 100 m long lines/nets can be installed one after the other and anchored at the ends. However, anchoring is necessary between the nets. The length of the anchor chains should be approximately 1.7 times the water depth. Technically, aquaculture is possible for all water depths in the five zones (Fig. 13, interviews). However, shallower water depths are more advantageous for economic reasons. Cultivation is only possible if there is sufficient light in the upper water layers. Therefore, the spatial space requirement is from the water surface (buoyancy body) to a water depth of approximately 10 m.

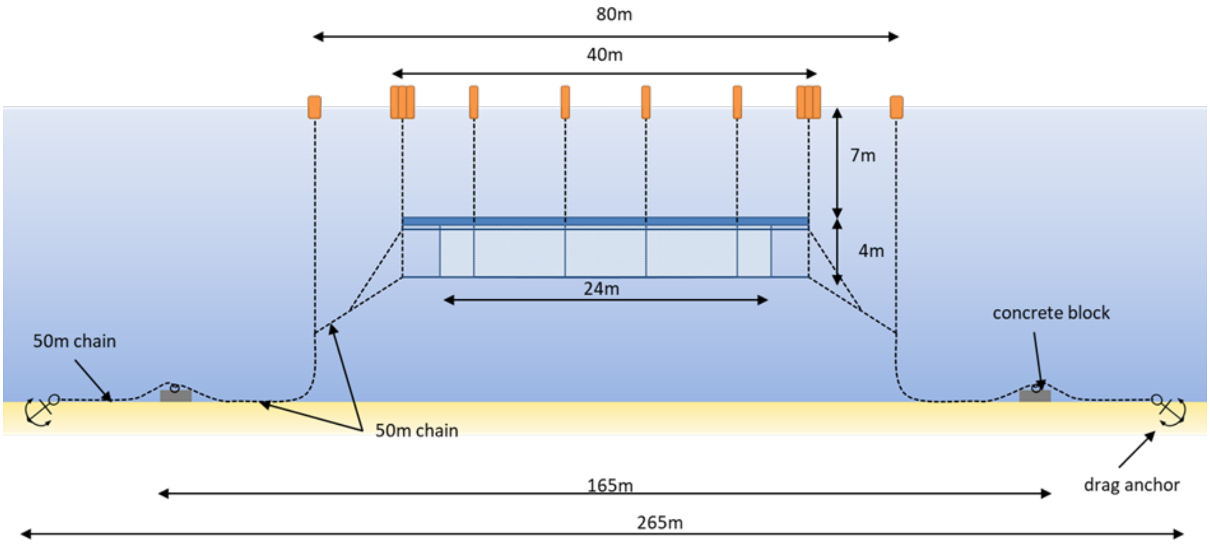

Figure 13 - Design of the anchoring of a mussel aquaculture facility at a water depth of 20 m (ULTFARMS, 2024)

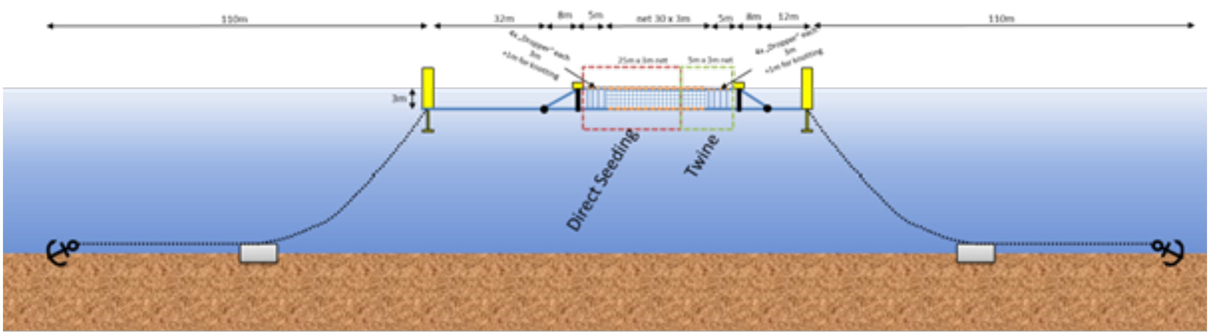

Figure 14 - Design of an offshore algae aquaculture facility anchored at a depth of 20 m (ULTFARMS, 2024)

The space required on the seabed for algae, mussel, and fish farms is determined by the anchoring system. When cultivating oysters, the space required is limited to a water depth of approximately 6 m above the seabed, leaving the water column and surface free for other uses such as shipping or even near-surface aquaculture.

The minimum space requirement for the entire facility to operate economically depends primarily on the distance to the nearest suitable port. Thus, a location closer to the coast can be profitable even with smaller facilities.

Fish aquaculture

The cultivation of fish in aquaculture has long been established offshore at a high technical level in the commercial sector. The most widely used technique is cultivation in net cages. These can be expanded modularly and are already partially automated. The fish stock is usually bred on land and supplied by other companies. From a technical point of view, this means that the majority of the EEZ is suitable for fish aquaculture. From a biological point of view, areas with a minimum water depth of 30 m are suitable. As in chapter 2.2. (Large component replacement), OWFs in the German EEZ with water depths of 40-60 m are suitable in terms of this parameter. Salmonids are one of the most established cultivated species and require a minimum flow velocity of 0.5 m/sec and a maximum water temperature of 19°C.

The spatial extent of the aquaculture facility itself is predominantly in the upper water column. Some facilities can be lowered depending on weather conditions, so that the entire water column must remain free of other uses. Commonly used designs involve anchoring with weights and anchors in the seabed. The system swings at this anchorage up to the maximum length of the anchor chain, but does not drift. Cages with a single-point anchorage are also known and are also used. This also applies to mussel and algae aquaculture facilities.

The space required for the vessels for installation and deinstallation depends on the type of vessel and its maneuverability, for example, approximately 200 m for tugs. Maintenance work and harvesting require a small amount of space, approximately 50 m.

Communication requirements and coordination with aquaculture activities

As explained in more detail in the chapter "Functional compatibility and technical feasibility," some work is time-critical, which therefore requires flexible use of shipping routes in wind farms to ensure accessibility to aquaculture facilities. Projects that are already running successfully or have been completed, such as UNITED and ULTFARMS, show that close and well-coordinated communication between all users is the key to low-risk and safe co-use. Announcements by users of relevant projects, such as ship traffic in the wind farm due to aquaculture activities, as early as possible allow room for any necessary adjustments to their own activities. The procedure should be documented as clear rules for all users and adjusted if necessary. Protocols before and after activities in the wind farm are also recommended for important processes in order to be able to adjust and track impacts or concepts later on.

For safety reasons and to protect against strong currents caused by ship propellers and contamination, a safety distance of 100 m from aquaculture facilities is recommended.

Functional compatibility and technical feasibility

All marine aquaculture activities require infrastructure and logistics offshore, near the coast, and on land. The following section considers aspects of functionality that are or may be relevant to all users in a multi-use scenario.

The biggest cost factor for commercial aquaculture operations, apart from personnel costs, is ship chartering. Activities at sea are also the biggest risk factor in risk management plans. Therefore, from an aquaculture perspective, the following points are important for the possible shared use of a site.

Framework conditions for offshore operations

A prerequisite for all plans for the joint use of an area, including the joint use of ships, is that regulations are compatible with the "requirements of safety and ease of traffic." The GDWS has a wide margin of discretion in this regard. The majority of maintenance work requires a significant wave height of approx. 1.0 m with the types of ships currently available, such as tugs and multi-purpose vessels (25-50 m ship length).

The distance to the nearest suitable port (not to the coastline) with sufficient water depth even at low tide, storage space, and workshop often means long shipping routes and times for relatively short work assignments with correspondingly high costs.

Time requirements for offshore operations

In general, all aquaculture facilities remain offshore all year round and are only partially replaced in the form of maintenance measures. Some offshore work, such as maintenance work, can be carried out flexibly within a limited time frame, but some, such as recurring installations, are tied to seasonal conditions (e.g., the occurrence of mussel larvae). For algae cultivation, the timing of the installation of lines or nets inoculated with pre-grown algae depends on the seasonality of the algae species. For example, inoculated structures for sugar kelp, which is mainly found in the North Sea, are installed at water temperatures below 15°C (at the earliest in the second half of September until January). The algae genus Ulva is a species adapted to the low salinity of the Baltic Sea and is also cultivated in summer.

Once installed, only a few sea voyages per year are required for the operation and maintenance of low-trophic species, mussels, and algae. Mussels are generally cultivated for several years and reach marketable size after 18 months, but a longer cultivation period is possible. During the mussel harvesting season from August to April, the facility must be accessible at least once a month.

The cultivation of oysters is a multi-year process, as oysters take up to 6 years to reach market maturity. This type of aquaculture also requires only a few maintenance trips per year.

This means that the plannable, time-sensitive sea voyages for low-trophic aquaculture species take place between August and April. Ship movements in offshore wind farms take place throughout the year, but are more frequent during the summer months from April to September due to the more frequent weather windows (Chapter 2.2 Activities in offshore wind farms). This would therefore allow for multi-use in terms of the shared use of ships. However, unforeseen events require flexible access throughout the year, albeit with lower probability and frequency.

Fish aquaculture requires more time for offshore operations. Here, too, many processes are automated and controlled by remote monitoring, but "the human presence on site" can only be replaced to a very limited extent. Permanent access must therefore be guaranteed for this use. This requires closer planning of ship movements in the wind farm than in the aquaculture of low-trophic species such as algae and mussels.

Requirements for ships and crew

The requirements for crew and ships vary greatly depending on the application. For example, sensor maintenance can be carried out by personnel with brief training, but handling nets requires experience and appropriate technical equipment on the ship (e.g., crane capacity of 6 tons at full extension). More detailed information on the logistical effort (maintenance intervals, estimated workload on the system) is summarized in the attached fact sheets. In principle, the work can be carried out without anchoring, using manual control alone.

Consequences

The same weather windows, which are limited to individual days, especially in the winter months, would have to be used by all offshore operators at the same time. Very good planning and coordination of predictable ship deployments is therefore a prerequisite in a multi-use concept. The shared use of ships by several offshore users should be thoroughly examined for some weather windows and activities. This would not only reduce spatial conflicts, competition for the limited number of suitable ships available, and risk- , but also lower cost factors. This conclusion confirms the initial findings of this study (WP1, chapter 4.1) as well as the results of the expert interviews and the case studies considered, such as UNITED, ULTFARMS, and OLAMUR. The experience gained from offshore practice, which does not always correspond to theoretical concepts, is particularly valuable here.

Knowledge of as many decisive factors as possible is a prerequisite for safe and economical planning, e.g., for investors. This is already provided for potential wind farm operators in the preliminary investigations, but not for other users such as aquaculture. Chapter 2.5 states that the most important objectives of the central preliminary investigation pursuant to Section 9 (1) WindSeeG are to provide bidders with the information they need to make a competitive bid in the award procedure and to enable bidders to apply for planning approval after the site has been awarded without having to conduct their own costly and time-consuming investigations. The investigations and explorations to be carried out as part of the central preliminary investigation are listed in Section 10 (1) WindSeeG and are specifically geared towards offshore wind turbines. Additional uses are therefore likely to require further investigations. To promote multi-use, Section 10 (1) WindSeeG could therefore be amended so that, as in the Netherlands, the criteria relevant to additional uses are already taken into account in the central preliminary investigation.

Safety aspects

There are a number **of potential safety risks** in offshore aquaculture that can affect both the facility itself and the surrounding marine areas. Based on their potential impact and probability of occurrence, the most relevant risks include ship collisions, drifting of facility components, collisions between ships and the aquaculture facility, and the spread of invasive species, parasites, and diseases.

Ship collisions, in which two or more ships collide at sea, pose a significant hazard. In such cases, serious damage can be caused to the ships involved and, if the ships are unable to maneuver, to facilities (aquaculture and wind farm installations) as well. However, most aquaculture vessels are smaller and have less engine power than OWF service vessels. This further limits the risks to wind turbines.

Another risk is the **drifting of parts of the aquaculture facility**. Strong currents and extreme weather conditions can cause entire structures or individual parts to drift away. This not only poses a danger to shipping, but can also cause damage to the marine environment.

The **collision of a ship with the aquaculture facility** itself is also a significant risk. Such accidents can cause severe structural damage to the facility and potentially lead to ecological disturbances. However, this only occurs if mobile species such as fish or crabs escape as a result. In the case of algae or shellfish aquaculture, ecological disturbances due to damage to infrastructure measures are not to be expected.

In addition, there is a risk that ships or the materials used to construct and operate the facilities may introduce **invasive species**, **parasites**, or **diseases** into the environment. This can occur through ballast water, ship hulls, or construction materials. The uncontrolled spread of such organisms can cause significant damage to local ecosystems and threaten biodiversity.

The severity of the impact of these risks depends heavily on the type of aquaculture facility, the materials used, the technical quality of the design, the frequency of traffic, and the available space. Careful planning, technical testing, and the application of modern technologies are essential to ensure safety and minimize potential environmental impacts. Such risks can be limited, in particular, by imposing basic requirements on aquaculture operators, e.g., that only native organisms may be cultivated.

The avoidance and minimization of potential risks is already covered in large areas by the approval process. The following explanation from Chapter 2.1 forms the basis for this use. It states that facilities serving other economic or research purposes must be approved in accordance with the scope of the SeeAnlG. For example, facilities for commercial aquaculture are to be classified as facilities for "other economic purposes" in accordance with Section 1 (2) sentence 1 no. 3 SeeAnlG. In principle, they require planning approval in accordance with Section 5 SeeAnlG (or, under the conditions of Section 5 (5) SeeAnlG, alternatively planning permission) in accordance with Section 2 (1) SeeAnlG. As part of the planning approval process, key aspects such as impairments to the safety and ease of traffic and compatibility with existing or planned "cables, offshore connections, pipes, and other lines" and "locations of converter platforms or substations" are also examined. It must therefore be ensured that the additional use does not cause any unacceptable risks to public and private interests. Other considerations include compliance with other requirements under the SeeAnlG and other public law provisions.

In principle, however, it should be considered that the risk of ship collisions would be considerably higher for stand-alone aquaculture facilities outside OWF areas. As argued in other EU projects (WP1), the fundamental exclusion of larger ships within OWF areas and their safety concepts may also offer considerable protection for aquaculture facilities.

Environmental impacts

In order to consider the environmental impacts of the combined use of aquaculture and offshore wind, the general interactions between the environment and aquaculture must be examined, at least briefly.

Individual consideration

Fundamentally, a distinction must be made between the environmental impacts of low-trophic and high-trophic aquaculture.

As discussed at the outset, **low-trophic aquaculture** is a form of aquaculture in which mollusks and algae are predominantly cultivated, which feed on low trophic levels or are primary producers (carbon dioxide fixation through photosynthesis). The cultivated organisms are not fed, which eliminates the need for feed procurement, feed transport, and feeding, and the associated environmental impacts. Low-trophic aquaculture includes, for example, the cultivation of mussels, oysters, sugar kelp, bladderwrack, and kelp. **When these organisms are harvested, nutrients are removed from the marine environment and carbon dioxide is fixed organically**, which is why these organisms can also be referred to as extractive organisms (Chopin et al. 2020).

As already described in WP1 and WP2, the vast majority of all current pilot and demonstration facilities for the multi-use of OWFs are limited to those with low-trophic aquaculture. Just recently (summer 2024), the first privately funded EUR 1.5 million 10-hectare algae farm in the Netherlands (North Sea Farm 1) was installed. The money comes from the Amazon Right Now

Climate Fund.237 **In addition to the positive effects – in particular nutrient uptake – the main motivation for providing funding in this case is the potential for carbon dioxide (CO2) uptake by algae.**

The net carbon footprint of *Saccharina latissima* produced offshore, for example, varies between -739 and 3131 kg CO2e/ton of dry matter algae biomass. This illustrates the potential for algae cultivation systems to generate non-financial gains and environmental benefits in the form of climate protection services (Van Duinen et al., 2023). The potential of macroalgae to reduce CO2 is also confirmed by Gao & McKinley (1994). However, the data available for accurate quantification needs to be further improved.

Mussel aquaculture also has the potential to contribute to CO2 reduction. In particular, the salinity determines the extent to which mussels, for example, can contribute to carbon sequestration. In current scenarios, an average of 55 tons and in future scenarios 65 tons per 0.25 ha of mussel farm in a 17-month production cycle are realistic in parts of the Baltic Sea (Vaher et al. 2024). The potential varies greatly from place to place, which means that a location-specific assessment is necessary.

Similarly, reduction effects are sometimes only measurable in the surrounding water at very large farms. Nevertheless, nutrients and CO2 are effectively removed. The amounts removed can be determined from the content in the harvested biomass.

Although there is no nutrient input from feeding, increased sedimentation rates (Callier et al., 2006) have been observed in mussel cultivation in suspended culture due to the excretions of the mussels. However, the effects on the seabed depend on the respective environmental conditions (Chamberlain et al. 2001). In calm waters, nutrients can accumulate in the sediment (concentration from the surrounding water) and the benthic community can change. However, this effect has not always been observed in environments with stronger currents (Chamberlain et al. 2001). The further offshore and the deeper the waters, the less this effect is to be expected. In mussel cultivation, a reduction in water turbidity and thus an increase in light penetration depth has been observed (Cranford, 2019). An increase in light penetration depth allows algae to grow at greater water depths, which is why the joint cultivation of algae and mussels can be economically and ecologically beneficial.

High-trophic aquaculture is a form of aquaculture in which fish are predominantly cultivated. Fish generally feed on higher trophic levels. **The necessary feeding of the fish therefore leads to an input of nutrients**. Unconsumed feed and faeces also lead to increased sedimentation below the fish cages, which, depending on the water depth, current intensity and wave action, can have a more or less negative impact on the seabed and the flora and fauna living there due to the accumulation of nutrients. Environmental impacts are also to be expected from the procurement, production, and transport of feed. In addition, the type of farming—extensive, semi-extensive/intensive, or intensive—plays a major role in the environmental impact. On the positive side, however, it is often argued that fish farming, with appropriate management, reduces **the pressure** on **natural fish stocks**. Furthermore, this can also improve European self-sufficiency in fish products and potentially reduce the pressure on stocks in third countries that are often poorly managed in terms of fisheries. It is recommended that only native species be used in order to prevent the

237 https://www.aboutamazon.eu/news/sustainability/worlds-first-commercial-scale-seaweed-farm-located-between-offshore-wind-turbines-is-now-open-in-the-netherlands.

spread of non-native species. It is also important to mention the possible spread of parasites, which can lead to environmental risks. For this reason, it is generally more difficult to obtain environmental permits (WRRL).

Both low- and high-trophic aquaculture species have been reported to increase the abundance of wild fish and crabs in the immediate vicinity of aquaculture facilities (personal communication from fisheries representatives, interviews, and workshops). **Aquaculture and offshore wind farms therefore appear to serve as feeding grounds and refuges.**

Multi-use effects

Other forms of multi-use besides fishing, such as mariculture (aquaculture of algae, mussels, or fish, for example), are possible according to the wording of Section 15 (1) sentence 1 BKompV without the compensatory effect being lost (Chapter 2.1). However, the additional uses may themselves be subject to compensation.

By combining this with low-trophic aquaculture, the environment within the wind farm can potentially benefit from **positive effects** such as **nutrient reduction, increased light penetration** due to the filtration effect of mussels and algae, and, where applicable, carbon sequestration.

The combined use of vessels for tasks in aquaculture and wind farm facilities can also reduce **noise emissions** from vehicles and generally reduce traffic in the facilities (compared to single use). This reduction **lowers** the consumption of marine diesel and thus also **CO2 emissions.** The use of electric and hybrid vehicles is also conceivable. Due to the consistently exposed locations, the effects of low-trophic aquaculture on the seabed through sedimentation can most likely be ruled out, Nevertheless, special attention is required here, and accompanying monitoring to monitor sedimentation and soil conditions, nutrient concentration, oxygen saturation, and benthic communities is recommended, with a particular focus on indicator organisms for eutrophication. From an environmental perspective, wind power contributes to the reduction of CO_2 emissions and thus supports the energy transition, while sustainable aquaculture simultaneously **reduces pressure on wild fish stocks and increases European self-sufficiency in fish products (personnel commission fisheries representatives)**.

Socio-economic aspects

The combination of low-trophic aquaculture and OWFs in particular offers promising potential from a socio-economic perspective. Even when taking a very conservative view, assuming that only 10% of wind farms in the North Sea would be available for mussel and sugar kelp aquaculture, a significant positive effect has already been calculated in terms of economic efficiency, positive environmental impact, and socioeconomic effects (Maar et al. 2023).

A key advantage lies in the **economic synergies** that can result from the shared use of infrastructure. For example, offshore platforms and maintenance services/vessels can be shared by both sectors, significantly reducing operating costs and leading to more efficient projects. Nevertheless, high initial investments are to be expected due to the necessary technical innovations in the area of plant integration.

The socioeconomic benefits of this combination also extend to social acceptance. Cooperation between the two sectors could help to raise awareness of sustainable marine use among the general public. In addition to creating new jobs in the aquaculture industry, integration promotes new forms of cooperation between fisheries, energy companies, and science, which, in addition to acceptance, can also accelerate the exchange and thus the development of knowledge and innovation.

The **expected yields from aquaculture** vary depending on the organism cultivated and the cultivation technique used. Between 1-5 kg (extensive) and up to 30 kg of fish (intensive) can be produced per cubic meter of water. In the case of sugar kelp and kelp, for example, 6-10 kg of fresh algae can be harvested per meter of cultivation line, which can lead to a considerable yield in large-scale facilities. In commercial net facilities, up to 30 kg of mussels per square meter are currently harvested. The **selling price** of the product depends on the type of organisms farmed (fish/mussels/algae) and the type of end product (fresh/raw, dried/processed). A detailed analysis has also shown that the cultivation of European oysters is particularly promising. A production simulation by AWI and the Thünen Institute south of the wind farm under investigation indicates that the cultivation of these oysters would be particularly profitable there (Gimpel et al. 2020).

Operating costs are highly dependent on the location of the facility, the technical equipment, and the size of the facility. These factors must be carefully considered when planning and evaluating the economic viability of an aquaculture facility.

Conclusion and outlook

Large areas of the German EEZ are suitable for aquaculture. This means that many wind farms are also potential aquaculture areas.

Overall, the combination of aquaculture and OWFs offers the potential to make the use of marine resources more economically and ecologically sustainable without restricting wind power, while also achieving an **additional positive environmental effect in the North Sea and Baltic Sea**. Unlike oyster cultivation (see Nature Restoration below), the positive effects of algae and mussel production result precisely from the removal of this biomass. Although algae cultivation falls under 'blue carbon financing' in many countries, it has not yet been formally classified as a nature conservation or restoration measure, meaning that the positive environmental effects of such cultivation have hardly been mentioned to date. However, appropriate monitoring regulations would need to be introduced to record the positive and negative effects on the environment.

At the same time, new aquaculture facilities can **generate economic and social benefits for coastal regions, particularly in the transformation of traditional occupational groups such as fishing**, and thus make a valuable contribution to regional and global development.

To increase safety, standards for the design of aquaculture facilities would need to be introduced. Agreements to curb the transmission of organisms and germs (e.g., disinfection before moving to another area) between different distant locations are also a way to protect cultivated aquaculture products and reduce negative impacts on the marine environment.

As shown in WP2 and Chapter 2, "Legal Framework," the Netherlands has designated areas for aquaculture in OWFs as part of its "area passports" (Government of the Netherlands, 2023).

As also described in Chapter 2.1, multi-use of OWFs could also be promoted in Germany within the framework of the tendering and award procedure. While the bid value is the sole award criterion for sites that have not been centrally pre-surveyed in accordance with Section 20 (1) WindSeeG, bids for sites that have been centrally pre-surveyed are evaluated on the basis of the criteria specified in Section 53 (1) sentence 1 WindSeeG, which are not exclusively financial. To date, there is no qualitative criterion that ensures adequate consideration of multi-use and the positive effects for the environment and efficient land use that this ideally entails. However, as part of an amendment to the WindSeeG, a further criterion for the integration or facilitation of multi-use could be added to the catalog in Section 53 (1) sentence 1 WindSeeG, with a particular focus on uses that have positive effects in the areas of sustainability and the (marine) environment. Examples of qualitative criteria that cover individual forms of multi-use. In addition, the Netherlands is considering introducing qualitative criteria in the areas of "nature, aquaculture, fisheries, safety, or shipping" in the future (Government of the Netherlands, 2022).

In expert interviews with stakeholders in the offshore sector, such non-price criteria are already being anticipated and preparations are being made in the form of discussions and evaluation of the possibilities.

Future plans for multi-use by OWF operators and aquaculture will ideally result in a joint application. The BSH's responsibility as the planning approval authority under the WindSeeG and SeeAnlG proves to be particularly advantageous in this regard, as it provides a central point of contact for coordination and approval.

Nevertheless, it would be sensible to expand the catalog in Section 5 (3) SeeAnlG to include an explicit requirement for compatibility with existing and planned wind turbines.

The current practice of the GDWS in designing the navigation ban in the safety zones of OWP stands in the way of multi-use of the sites, for example for mariculture, as there is generally no general exemption for activities approved in addition to the OWF. In the Netherlands, such exemptions have been integrated into the (areas of) safety zones of OWF where multi-use is to be implemented.

2.4. Carbon Capture and Storage

In addition to the extraction of raw materials, substances are also introduced into the marine environment.

Carbon dioxide storage is being considered as a possible future use and is explained in more detail below.

The combination of carbon dioxide storage and OWE is also being researched and discussed in other countries, with some concrete sites being earmarked for carbon dioxide storage, but outside OWE areas or as a subsequent use thereof. The Netherlands is planning to store carbon dioxide in an empty gas field, and Denmark has also identified suitable areas with a focus on decommissioned oil and gas fields, as well as undeveloped areas and decommissioned OWE sites (WP2, chapters 2.1, 2.3, 3.6; WP 2 country fiche). The United Kingdom is also investigating multi-use concepts combining carbon dioxide storage and OWE or carbon dioxide storage in decommissioned oil and gas fields (WP2, chapter 2.4). Licenses have already been granted to companies for the latter (WP2 Country Fiche United Kingdom). In Denmark, the Greensand project successfully injected its first CO_2 into the seabed in 2023 and has now successfully completed a pilot phase. There are plans to store larger quantities of CO_2 (400,000 t) in the seabed from the end of 2025/beginning of 2026 and to scale this up by 2030.[238] In Germany, an amendment to the Carbon Dioxide Storage Act (new: Carbon Dioxide Storage and Transport Act - KSpTG) is currently being discussed in order to create opportunities for CCS storage and export (as of 01/2025).[239]

Spatial requirements and seasonality of use

To date, the combined multi-use of offshore wind farms and carbon dioxide storage has not yet been tested in practice. Although this multi-use combination is becoming increasingly important in other countries, such as the United Kingdom, and is being discussed both in expert groups and in political discourse, concrete implementation has not yet taken place. Therefore, all considerations regarding this combination of multi-use are hypothetical in nature and require further practical testing and validation.

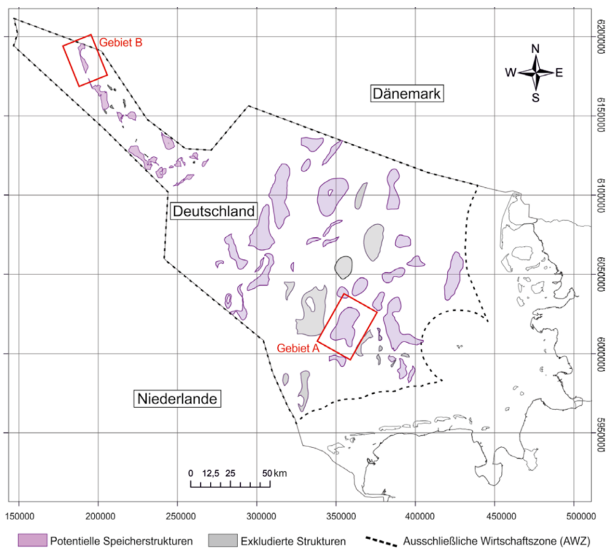

Figure 15 - Potential storage formations (pink) and excluded areas (grey) in the German EEZ (dashed line). Relevant areas in the GEOSTOR project ("Gebiet" A and B) are outlined in red. (Source: BGR, 2024; Wallmann, 2024)

CCS is a process in which CO_2 emissions from industrial processes are captured and then permanently stored underground in geological formations. Offshore, there are a number

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238 INEOS, September 10, 2024, Denmark's first CO2 storage facility is now ready to receive large amounts of CO2, available at https://www.ineos.com/news/shared-news/denmarks-first-co2-storage-facility-is-now-ready-to-receive-large-amounts-of-co2/ ; Greensand, March 8, 2023, Celebrating a world first, available at https://www.projectgreensand.com/en/first-carbon-storage

239 Relevant proceedings in the Bundestag: Act Amending the Carbon Dioxide Storage Act, available at https://dip.bundestag.de/vorgang/gesetz-zur-änderung-des-kohlendioxid-speicherungsgesetzes/312438 ; CO2 Export Enabling Act, available at https://dip.bundestag.de/vorgang/co2-export-ermöglichungsgesetz/313709.

of potential storage sites, particularly in depleted oil and gas fields and in deep saline aquifers. The latter plays a greater role in the German context, as there are few empty oil and gas fields in the German EEZ. This has the advantage that less mechanical disturbance of the rock layers from old boreholes is to be expected. However, due to the geological conditions, carbon dioxide storage in Germany is only relevant in the North Sea. The spatial and seasonal compatibility between carbon dioxide storage and OWFs could prove challenging, as both uses require similar areas. A look at the maps for potential storage sites in the German EEZ (Figure 16) shows that the areas suitable for CO_2 storage in the German EEZ partly coincide with the OWF sites designated in the draft SDP24.

Carbon dioxide storage is generally considered a permanent use, as CO_2 is stored underground for the long term. However, the above-ground infrastructure is only required during the active injection of CO_2. This suggests that the injection phase represents a finite spatial use, while long-term use remains confined to the subsurface. One way to ensure spatial compatibility could be to plan the injection of CO_2 before the construction of the OWF facilities. This could ensure that the above-ground CCS infrastructure is removed or minimized before construction of the wind turbines begins. However, it should be noted that the operating life of carbon dioxide storage is currently estimated at around 30 years. The active operating phase is followed by long-term monitoring of the storage site, which requires specific measurement methods and appropriate infrastructure. CCS monitoring includes, among other things, monitoring pressure, seismic activity, and CO_2 distribution using 3D seismic technology or seismometers placed on the seabed. In addition, potential leaks are monitored using echo sounders or autonomous underwater vehicles to ensure the long-term safety of the storage site.

An alternative form of multi-use carbon dioxide storage and OWF, which appears to be more feasible, could be to separate the above-ground infrastructure spatially, while the CO_2 storage formations are located below the OWFs. This configuration would be possible from a purely spatial point of view, as CO_2 storage takes place 1000-4000m below the seabed, and would allow simultaneous use of the site. However, such a model poses a number of technical and safety-related challenges, which are explained in more detail in the following chapters.

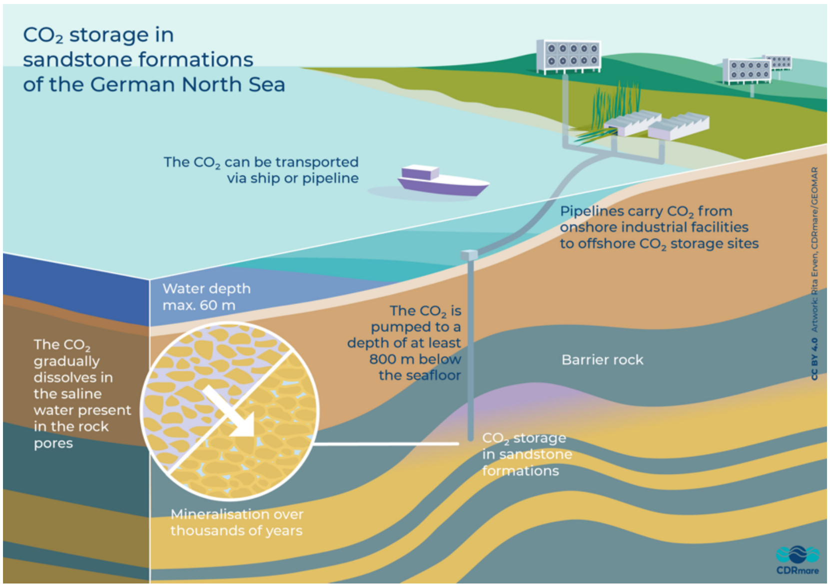

Figure 16 - Visualization of CO_2 storage in the sea by Rita Erven, CDRmare/Geomar from: CDRmare (2025), CO_2 storage in sandstone formations of the German North Sea, available online: https://cdrmar.de/en/infographics/. Graph updated in unofficial translated version.

Functional compatibility and technical feasibility

CO_2 is transported to offshore storage sites either by ship or pipeline. Due to the early stage of the CCS market, it is not possible to provide a detailed analysis of ship and pipeline transport. It can be said that the formation of central logistics hubs, especially in the vicinity of major port locations, is likely. These hubs would play a key role in the efficient organization and transport of captured CO_2 to offshore storage sites. Port locations such as Brunsbüttel could establish themselves as strategically important hubs for the export and transmission of CO_2, as they have the necessary infrastructure and connections to meet the requirements of a large-scale CCS system. In Germany, this is initially planned for Wilhelmshaven. From an economic and logistical point of view, this ultimately implies that large ships with a capacity of approx. 15,000-25,000 m^3will be considered. The spatial requirement implies a minimum draft of 12 m, which is available in this context. If no higher-level hub is formed, smaller ships will probably be used – these are also covered by the draft considered. Once CO_2 injection as part of CCS has been tested and established in the German EEZ, it can be assumed for cost reasons that CO_2 transport will mainly take place via pipelines.

CO_2 can be injected into geological formations beneath the seabed via offshore platforms (similar to oil and gas platforms) or, if transported via pipelines, by pumps placed on the seabed. CO_2 is stored in deep geological structures located 1,000 to 4,000 meters below the seabed. These deep layers offer stable conditions for permanent CO_2 storage. The actual space required on the sea surface is minimal, as storage takes place deep below the ground. Only the infrastructure for injection and monitoring requires space on the sea surface or in the immediate vicinity of the injection sites on the seabed.

The following key aspects must be taken into account when planning CO_2 storage under OWFs:

3D seismic exploration

Accurate seismic exploration of the subsurface is a prerequisite for safe CO_2 storage. However, such geophysical surveys, especially 3D seismic exploration, are difficult to carry out in existing OWFs. One possible solution would be to conduct these surveys at an early stage, before the extensive expansion of OWFs takes place. A political timetable that coordinates the sequence of carbon dioxide storage with that of OWF construction could ensure that the requirements of both uses are strategically integrated into their expansion plans.

Monitoring during and after CO2 injection

Another major challenge is monitoring during and after injection, which will mainly be carried out using passive seismic monitoring. For monitoring, a local seismic monitoring network is usually installed to adjust injection or withdrawal rates and minimize the risk of induced earthquakes. In addition, microseismic analysis can in some cases be an effective tool for monitoring the distribution of gases (or other fluids) in the reservoir and identifying potential leakage paths. However, wind turbines generate background noise that can affect the accuracy of seismic data. Therefore, special considerations must be taken into account when placing measuring instruments to ensure reliable results (Ministry of Economic Affairs, 2022).

At the same time, research is also being conducted into possible synergies between OWFs and carbon dioxide storage. One idea is to use the vibrations transmitted from the wind turbines to the subsoil via their foundations for passive seismic monitoring. These vibrations could potentially be used to monitor CO_2 storage behavior, which could lead to innovative use of existing infrastructure. In this scenario, OWFs could serve not only as a renewable energy source, but also as a support for storage site monitoring.

Induced earthquakes caused by CCS

One potential challenge is the risk of earthquakes that could be caused by CO_2 injection. In Germany, OWFs are not designed for seismic activity, as there are no specific design bases for earthquakes in this context. So far, only level 1 earthquakes have been recorded as a result of carbon dioxide storage, indicating very low seismic activity. However, there is a possibility that increased pressure injections could also cause stronger earthquakes.

This could have a particular impact on the foundation structures of the turbines, as monopiles and jacket foundations in Germany are primarily designed for cyclic loads from wind and waves, but not for sudden seismic events. Increased seismic activity could reduce soil stability, which in soft or sandy sediments could lead to soil liquefaction and thus to a reduced load-bearing capacity of the foundations. Repeated minor vibrations could also lead to material fatigue and microcracks in the load-bearing structures in the long term, while possible resonance effects could increase the vibration load on the monopiles.

One possible strategy to minimize this risk would be to set a maximum pressure limit for CO_2 injection. Policy decisions could be made to ensure that lower pressure limits apply to storage facilities under OWFs. This would reduce the likelihood and severity of earthquakes or leaks, but would also limit the amount of CO_2 that can be stored.

Safety aspects

A significant risk is the potential seismicity induced by CO_2 injection, which could compromise the structural integrity of wind farm foundations. To minimize this risk, continuous seismic monitoring measures are necessary to detect possible tremors at an early stage and adjust injection rates if necessary. In addition, the operation of wind farms, in particular the noise emissions and physical presence of the turbines, poses a challenge for the geophysical measurements required to monitor CO_2 storage. To avoid conflicts, the locations of wind turbines and carbon dioxide storage infrastructure should be carefully coordinated, supported by real-time monitoring systems such as a traffic light system (TLS) that allows storage operations to be adjusted in the event of seismic activity (Ministry of Economic Affairs, 2022).

Another important aspect concerns the maintenance of wind turbines. It must be ensured that both the infrastructure and the safety of workers are guaranteed during maintenance work, especially in areas where CO_2 storage takes place under the wind farms. Occupational safety is a top priority, and any potential hazards posed by CCS must be taken into account in the maintenance plan.

In addition, a general safety risk remains, as many aspects of storage technology have not yet been fully researched. These uncertainties about long-term effects and possible leaks reduce confidence in maritime safety and therefore require even more thorough monitoring and risk assessment to prevent unforeseen incidents.

Environmental impact

Storing CO_2 in the seabed contributes to climate protection by reducing CO_2 emissions into the atmosphere. However, both the injection of CO_2 and the necessary investigations, installation work, and monitoring measures have an impact on the marine environment. Drilling and active seismic monitoring lead to noise emissions, which can have a negative impact on marine mammals. Passive monitoring techniques are being researched to mitigate this impact. In addition, a temporal separation can also be considered here, so that noise-intensive work (e.g., drilling, seismic exploration) that is flexible in terms of time does not take place during periods that are sensitive for porpoises, for example. Even if it is considered low, there is a risk that leaks due to gas escaping could lead to acidification of the soil water around the leak site. Old boreholes in particular are considered potential weak points in this regard. Furthermore, if the pressure in a reservoir becomes too high, a blowout could occur. This risk can be reduced by careful monitoring during injection. The safety risk described above due to induced minor earthquakes represents a further environmental impact that should be considered in a multi-use scenario with OWE.

Socio-economic aspects

CCS plays a central role in climate protection because it captures CO_2 emissions from large industrial sources and stores them safely. In order to achieve climate neutrality, solutions must be found for hard-to-avoid emissions – around 5 to 10% of today's total emissions – in addition to conventional climate protection measures. These emissions come mainly from sectors such as cement and lime production and waste incineration, where decarbonization is difficult to achieve with current technologies.

In addition, CCS offers economic potential by creating new jobs and securing existing ones in emission-intensive industries. It enables the reuse of existing infrastructure, thereby reducing costs in the long term, which can make the transition to a low-carbon economy more socially and economically stable. CCS could play an important role in securing the local economy, especially for regions with a high concentration of industrial companies.

However, it should be noted that CCS is still very expensive at present. The infrastructure for CO_2 capture, transport, and storage requires high initial investments. Costs of around 200 euros per ton of CO_2 are currently expected, while the current CO_2 price under the EU Emissions Trading System (ETS) only covers around 75 euros per ton. Without government subsidies and financial incentives, CCS is therefore difficult to justify economically. In the long term, however, technological advances could bring efficiency gains and cost reductions that make the process more competitive. In combination with OWFs, CCS could offer both opportunities and challenges. On the one hand, additional costs could arise because both technologies would have to be coordinated in the same region, but on the other hand, synergies could lead to efficiency gains. Currently, however, there is little reliable data on the potential impacts and costs of this combination.

Despite the advantages of CCS, there is criticism from environmentalists. They fear that CCS could prolong dependence on fossil fuels and divert investment away from renewable energies.

Conclusion and outlook

To date, there has been no practical experience with storing carbon dioxide in or under OWFs. This combination has not yet been tested and there is a lack of long-term research results. Therefore, considerations on this topic are hypothetical in nature. In the neighboring countries considered in the report, there are projects independent of OWFs to store carbon dioxide in the seabed. Denmark is considering storage under decommissioned OWP sites.

The combination of OWFs and carbon dioxide storage requires careful planning. This should also take into account the timing and the preliminary investigations necessary for storage before a wind farm is constructed. Parallel use of carbon dioxide storage and OWE is conceivable, as storage takes place deep below the seabed. It should be clarified whether the infrastructure for feeding in is located within the wind farm area or outside the OWF, but the storage basin extends under the OWF and maintenance access to the wind turbines must be maintained. If the transport route for the CO_2 to be stored passes through or into an OWF, the transport, which can be by ship or pipeline, must be logistically coordinated with the wind farm. For the combination of OWF and carbon dioxide storage, it is crucial to minimize seismic risks that could compromise the structural integrity of the wind farm foundations. In addition, monitoring systems must be adapted accordingly to account for the influence of the wind farm. Potential synergies, such as the use of wind turbine vibrations to monitor CO_2 storage, could increase the efficiency of CCS, but need to be investigated further.

CCS technology has the potential to make a positive socio-economic contribution by helping to achieve climate neutrality and creating new jobs. However, it should be noted that CCS is currently an expensive technology with high initial investment costs. There are also concerns about the safety of long-term CO_2 storage and possible leaks, which could pose risks to the environment and health.

2.5. Energy

In the preliminary assessment of the compatibility of other forms of energy generation and OWFs, the research revealed potential synergies in terms of multi-use and should therefore be examined in more detail. This is because plants for further energy generation in the form of electricity or hydrogen can be installed between WEAs in order to make efficient use of the water surface and existing structures on the one hand, and to benefit from the existing infrastructure, such as grid connections and maintenance routes, on the other.

The use of OWE, as described in Chapter 2.2 Fundamentals of OWE Use, is not considered here as a possible multi-use of existing OWFs, as it can be assumed that the existing sites will be fully utilized in the context of OWP development and are therefore spatially mutually exclusive.

The following forms of energy use can be combined with OWFs under certain conditions:

Floating solar power plants

Their use in OWFs is a new concept that is attracting increasing interest. While there are no (pilot) projects in Germany yet, WP1 discusses the EU Scores project currently being carried out, in which a 2.6 MW offshore photovoltaic system with grid connection was installed this year (2024) 2 km off the Belgian coast at the Blue Accelerator test site (see Figure 15). Even though the test site is located in Belgium and is also installed very close to the coast, RWE, a German company, is also significantly involved in the project. Another noteworthy aspect of WP1 is that a hybrid floating solar plant with a capacity of 5 megawatts is being installed at the Hollandse Kust West VII OWF. This plant, realized by the Dutch-Norwegian company SolarDuck, is scheduled to be operational in 2026 and is equipped with integrated energy storage solutions.

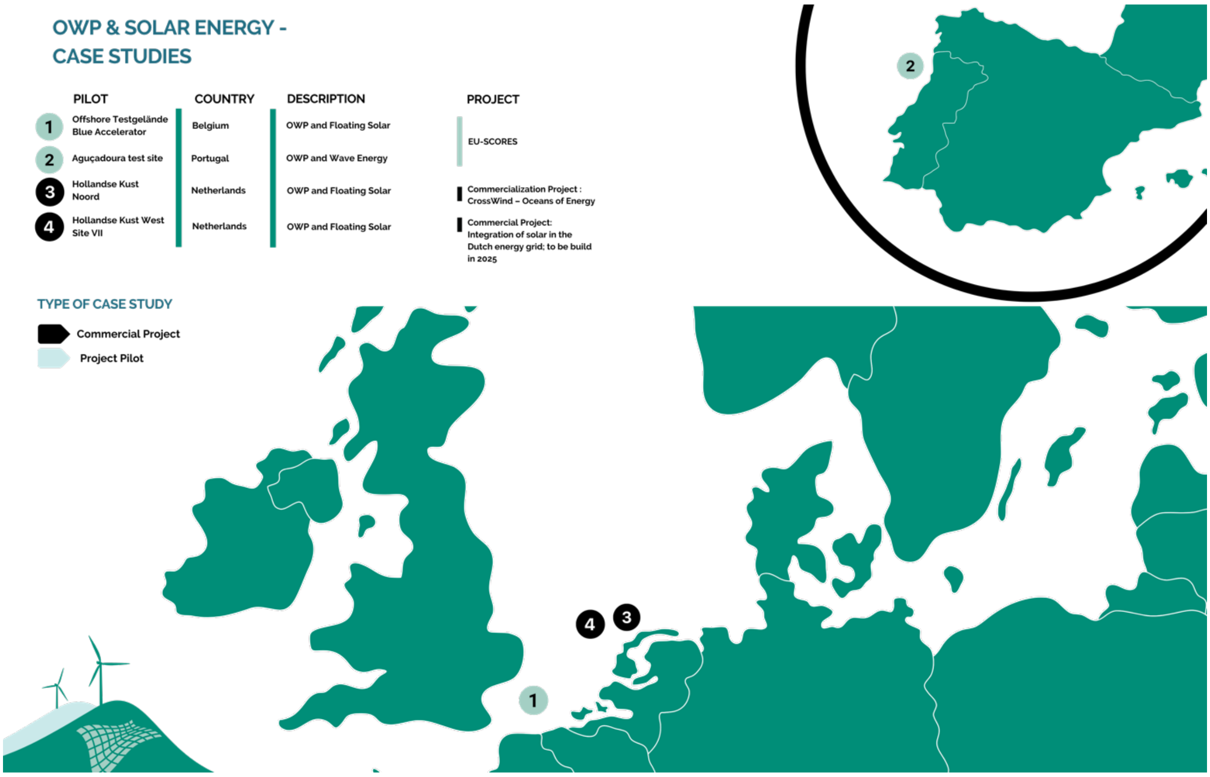

Figure 17- Multi-use combinations of energy – OWF and solar/wave energy plants in Europe

Hydrogen production

This form of use has not been extensively tested and, at the time of writing, is still undergoing intensive research and conceptual analysis, although the proximity to OWFs represents an attractive source of renewable electricity for energy-intensive electrolysis. The WEAs can be used directly to generate electrical energy, which can then be used to split water into hydrogen and oxygen through electrolysis. This process chain can be implemented at sea to minimize energy loss during transport. In the German EEZ, the "AquaPrimus" and "AquaSector" projects, which are being promoted by the German energy supplier and OWF operator RWE as part of the "Aquaventus" initiative, are particularly noteworthy.

Wave energy plants

As described in WP1, there is a test facility for an offshore wave power plant in the German Baltic Sea/Kiel Fjord. The wave power plant was completed in fall 2022, and initial functional tests were then carried out on the assembled prototype in April 2023. As presented in WP1, the EU Scores project aims to combine offshore wind energy with wave energy and floating solar energy. A major demonstration project off the Atlantic coast of Portugal combines wave energy with floating wind turbines, which limits the transferability of the findings to the German EEZ.

Spatial requirements and seasonality of use

Floating solar plants

This form of use primarily requires large contiguous sites of water, with the site depending on the planned capacity of the plant. In the OWF, sites between individual wind turbines, minus safety distances and corridors for marine traffic, are suitable for use.

For clarification, Figure 19 shows a 3D illustration of the possible spatial extent of the 5MW Solar Duck demonstration project in the Hollandse Kust West offshore wind farm of the OWF. To estimate the dimensions, the 15 MW wind turbine with a rotor diameter of 236 m from the manufacturer Vestas, which is planned for the OWF, can be used. This results in a minimum distance of approximately 1.2–1.4 km between individual wind turbines, in which at least two Merganser solar power plants (Figure 20) could be accommodated. In addition, it must be ensured that there is sufficient space around the floating plant for maintenance, access for personnel, and emergency measures. This may increase the space requirements.

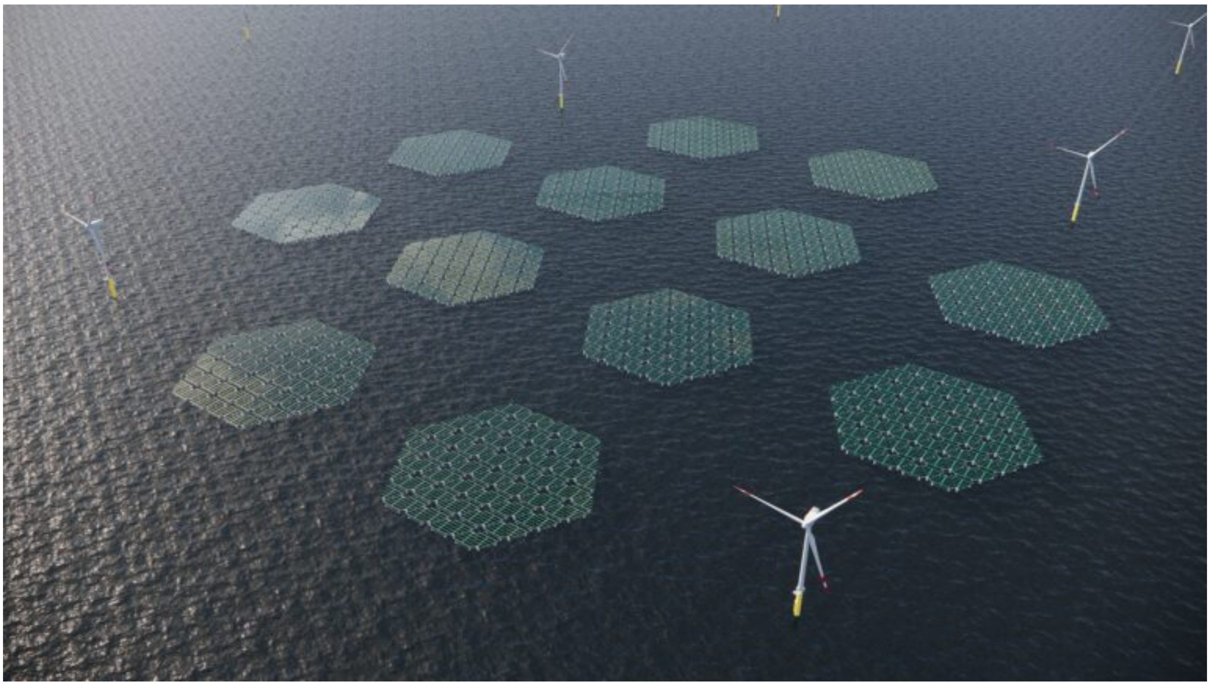

Figure 18 - Visualization of a floating offshore solar plant with offshore wind from Solar Duck (Source: https://solar-duck.tech/solarduck-will-build-largest-offshore-floating-solar-plant-together-with-rwe/, Nov. 2024)

Both maintenance and energy yield are subject to seasonality. In multi-use, the weather-related preference for summer months can lead to increased maintenance costs, although rigid solar systems generally require less maintenance than rotating wind turbines. Energy yield is statistically negatively correlated in summer and winter months, which can lead to more consistent energy production, especially when additional storage technologies are added, as in the case of the Solar Duck Demonstrator.

Figure 19 - Visualization of a floating array (left) and aerial view of the Merganser pilot in the North Sea Farmer test field in the Netherlands (Source: https://solarduck.tech/solarduck-and-rwe-successfully-install-offshore-floating-solar-pilot-merganser-off-dutch-coast/, Nov. 2024)

Hydrogen production

The concepts for hydrogen production in combination with OWF are not yet fully developed, resulting in major differences in the type of integration into the infrastructure, its efficiency, and its technology. Within the scope of this report, only electrolysers directly installed on fixed offshore platforms or wind turbine foundation structures are considered for the EEZ. For economic reasons, floating electrolysers would only be used at greater water depths than those found in the EEZ. The electrolysers installed on the offshore structures use electricity from the wind turbines to split water into hydrogen and oxygen. The hydrogen produced could then be transported to land via pipelines, which would take up additional sea space, or by ship, which would lead to increased marine traffic or requirements for additional shipping corridors.


Figure 20 - Illustration of hydrogen production using existing OWF infrastructure such as wind turbine foundation structures (left) or additionally constructed OWF platforms (right). (Source: https://www.rwe.com/forschung-und-entwicklung/wasserstoff-projekte/aquaventus/)

The smallest spatial requirements and synergies result from combining offshore substation platforms that are planned within OWFs or wind turbine foundation structures. For structural reasons, such systems can only be retrofitted with an additional support structure, which results in higher space consumption.

Seasonality of use results from the maintenance requirements of the plants, which, however, could be partially combined with OWF maintenance and partially leads to increased marine traffic, especially in the summer months.

Wave energy plants

This type of use is mainly located at the water surface and requires varying amounts of space between the wind turbines of an OWF, both vertically and horizontally, depending on the technological concept. Here are some of the most common types that are generally suitable for use in OWFs:

Point absorbers: These buoy-like structures can move freely with the waves and collect energy from the vertical movement of the waves. They have a low visual impact and require little space, making them a good addition to offshore wind farms.
Pelamis (sea snakes): These consist of several sections that are connected to each other in an articulated manner. The wave motion between the segments is used to drive hydraulic pumps, which then generate electricity. Pelamis systems can be installed between wind turbines, but require sufficient space for movement.
Oscillating water columns (OWC): These use airflow moved up and down by waves in a hollow structural component to drive a turbine. OWCs can be incorporated into the structure of offshore wind turbines, reducing construction costs.
Overflow wave energy converters (OWC): These convert the kinetic energy of waves flowing over the structure into energy. They could be well suited for combination with offshore wind turbines, as they can be attached to platforms.
Submerged pressure differential collectors: These devices operate below the water surface and utilize the pressure difference created by passing waves. They can be installed close to the seabed and do not interfere with the use of the surface by wind turbines.

In general, the North Sea offers high potential for wave energy due to its high wave action. Technologies designed for harsh conditions and greater water depths, such as wave absorbers and oscillating bodies, could be preferred here.

An example of the structure and arrangement of a point absorber prototype, including anchoring, is shown in Figure 21.

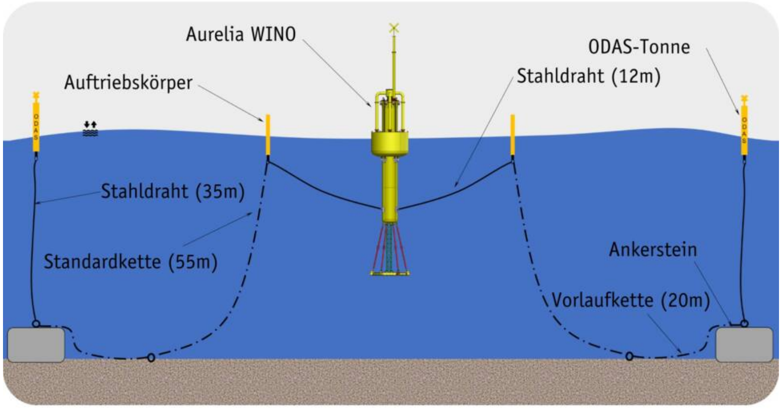

Figure 21 - The prototype of the "Aurelia Wino" wave power plant (right) during installation in the Baltic Sea/Kiel Fjord and graphic (left) of the planned anchoring of the wave power plant in the seabed. Graphic: Julian Pforth (Source: https://www.vdi-nachrichten.com/technik/energie/schwimmendes-wellenkraftwerk-fh-kiel-entwickelt-transport-und-installationskonzept/)

There may be differences in energy production depending on the season, as wave energy potential varies with seasonal weather and sea conditions. In general, waves are more energetic in the winter months than in the summer, which can lead to higher energy yields during these periods. Accordingly, seasonal availability must be integrated into the design and planning of wave energy systems to ensure a reliable energy supply. This again results in an expected increase in shipping traffic with the combined maintenance of OWFs.

Functional compatibility and technical feasibility

Floating solar plants

The system requires a reliable floating and anchoring system that can withstand waves, wind, and weather changes. Therefore, there must be sufficient space in the OWF for the installation of floats and the anchoring infrastructure. Figure 20 on the right shows the mooring systems, also known as mooring lines, which connect the floating bodies to the ground anchors and thus serve to secure the entire system in place. This technology is also used for larger offshore platforms and floating wind turbines and can be considered tried and tested.

A potentially more cost-effective anchoring option could be anchoring to the individual turbines. However, such a solution would have to be considered early in the design process of the wind turbine foundation structure to ensure the structural integrity of the wind turbines and their ability to bear additional loads. In the case of retrofitting in an existing OWF, a technical reassessment of the structural integrity would have to be carried out to ensure that the wind turbines are suitable for this and that their stability is not compromised. At the time of writing, there are no known technological solutions for anchoring floating solar installations to wind turbines.

Further positive synergies arise from the possible shared use of grid connections and maintenance logistics, provided that these are planned jointly.

Hydrogen production

If hydrogen production is included in the design phase of OWF substations, a high degree of functional compatibility is achieved through the shared use of OWF structural and electrical infrastructure.

Wave energy systems

Functionally, wave energy plants that use wind turbine foundation structures as anchor points or can be fully integrated are fundamentally technically compatible, provided they were taken into account in the planning phase of the OWP. Stand-alone solutions with independent anchor concepts do not present any functional conflicts.

Safety aspects

Floating solar plants

Floating installations must be positioned in such a way that they comply with marine safety requirements, particularly in the context of maintenance operations, and that safe access (see landing zone at wind turbine**Error! Reference source not found.**) to the wind turbines is fully guaranteed at all times. The permanent installation of the floating structure gives rise to additional potential accident scenarios, such as the failure of the anchoring system, which could lead to a collision with the wind turbines. To take such failure cases into account, new requirements for the design of wind turbine foundation structures may arise.

Hydrogen production

There is a possibility of an increased risk of ship collisions and damage to people and infrastructure due to increased ship traffic and activities within the OWF.

Operational disadvantages in terms of extreme weather events that could damage infrastructure, as well as high insurance costs and bureaucratic approval procedures that could affect the profitability of projects.

Further pilot studies are necessary to ensure technical maturity for safe upscaling under offshore conditions.

Wave energy plants

Potential conflicts may arise from spatial placement, as wave energy devices require additional space and interference with maintenance operations on wind turbines must be avoided. Marine safety, particularly in the context of maintenance operations, must be ensured and safe access to wind turbines must be guaranteed at all times.

The permanent installation of floating structures gives rise to additional potential accident scenarios, such as the failure of anchoring systems, which could lead to a collision with the wind turbines. To take such failure scenarios into account, new requirements for the design of wind turbine foundation structures may be introduced.

Environmental impact

Floating solar power plants

There are no known specific environmental impacts resulting from multi-use. Rather, these result from individual use per se. The location must be chosen so that the impact on local fauna and flora is minimal. Studies on ecological impacts must be carried out and appropriate distances from sensitive areas must be maintained.

Hydrogen production

Ecological concerns due to potential disruption of marine life from the installation and operation of offshore energy technologies may also arise, especially if none of the existing/planned OWF infrastructure can be used.

Wave energy plants

There are no known specific environmental impacts resulting from multi-use. Rather, these arise from individual use per se.

Socio-economic aspects

Floating solar plants

Since wind and solar energy are complementary energy sources—solar plants produce most energy during the day, while wind energy tends to be more constant at night and during weather-related fluctuations—combining them can lead to a more stable and higher energy yield.

One of the advantages is that periods of low wind energy can be partially compensated for by solar power, resulting in higher and more reliable energy availability overall.

Proximity to power grids is a crucial factor in keeping energy transmission infrastructure costs low. In the Netherlands, for example, regulations limit the expansion of floating solar installations to the maximum possible grid connection capacity (WP2), resulting in better utilization of the infrastructure provided for OWFs.

The maximum potential for energy generation from floating solar installations on OWFs in the German EEZ can be estimated based on the spatially and technically usable site, including consideration of solar radiation. This is exemplified by (Srinivasan, Soori & Gaith 2024) in combination with oil and gas platforms, showing that the example projects with good conditions can lead to a return on investment within 10 years. The "Global Atlas of Marine Floating Solar PV" (Silalahi & Blakers, 2023) highlights the potential of this use in regions with high energy demand, high solar radiation, and low wave heights and wind loads as fundamentally positive.

However, with regard to the German EEZ, the North Sea, which is considered more suitable than the Baltic Sea for multi-use in this report, has unfavorable environmental conditions in this respect. High costs for grid connections and high costs for the implementation of support structures that can withstand the harsh environmental conditions in the EEZ, combined with rather low yields due to low solar radiation, pose considerable economic challenges.

However, solar systems that are directly connected to offshore wind turbines, for example, installed on the wind turbine tower, could circumvent these challenges and thus extend the potential for offshore solar to the entire EEZ covered by OWF. However, this form of use is not sufficiently mature to be considered in the context of the report.

Hydrogen production

If available or planned, the existing or required infrastructure of substation platforms can be used to install the equipment for electrolysis, resulting in cost savings. However, the complexity of integrating and managing different offshore energy sources can lead to increased operating costs.

Electrolyzers can serve as flexible loads that can help stabilize the grid by using excess electricity and curbing production when electricity demand is low or wind energy production is excessive. This is therefore expected to have a positive effect on grid stability and thus increase security of supply.

The combination can also contribute to the creation of an integrated energy supply system that exploits synergies between different energy generation and storage technologies. Economically, with appropriate electricity trading, there are opportunities to increase profits under fluctuating electricity prices, as in the event of large-scale overproduction of wind power, this could be sold in the form of potentially more lucrative hydrogen.

Wave energy plants

The combination of wave and wind energy within a park can increase overall efficiency and contribute to more consistent energy production by utilizing the different generation profiles. Shared infrastructure such as grid connections, maintenance operations, and platforms can also be more cost-effective.

Conclusion and outlook

OWFs generally offer good opportunities to integrate other energy generation technologies, but the economic potential depends heavily on the specific form of use and the synergies with the existing infrastructure. OWF operators could face increased costs to prevent wind turbines from colliding with the largely floating structures or to enable the integration of the systems through structural measures.

2.6. Fishing

In the preliminary assessment of the compatibility of fishing and OWFs, the research showed that active fishing cannot currently be implemented in a justifiable manner due to the high safety risk and the potentially serious consequences, such as wind turbine failure and the resulting cost-intensive repairs, unresolved insurance issues, and liability conditions.

Passive fishing, on the other hand, may be possible under certain conditions. Nevertheless, both types of fishing are examined below in order to do justice to their current socio-economic significance and political relevance.

There are two main categories of fishing: **active** and **passive.** Both methods play an important role in the fishing industry, but differ fundamentally in their approach and technique.

Active fishing describes methods in which the fishing gear is moved towards the target species. This includes trawling, in which a net is dragged behind a ship to catch fish. Another form of active fishing is purse seining, in which a net is placed around a school of fish.

In contrast**, passive fishing** involves fishing gear that remains stationary in the water, with the fish or crabs swimming into the gear themselves. The fishing process therefore consists of the target species moving towards the fishing gear. This includes fishing methods such as fish traps, set nets, and longlines, where bait is attached to hooks and the fish bite. In this case, the fishermen tend to wait, and the catch depends heavily on the behavior and movement patterns of the fish.

Active fishing is often associated with higher energy consumption and larger catches. **Passive fishing**, on the other hand, is less energy-intensive as it does not require continuous movement of the equipment, but it can be less predictable in terms of catch volume, and ecological aspects must also be taken into account.

In practice, both methods are often used, depending on the target species, environmental conditions, and available resources.

Fishing around OWFs is currently not permitted. However, fishermen use every permitted opportunity to get as close as possible to the OWFs and fish there (see also cartographic representation). All of the following statements are based on interviews, surveys, workshops, and research on the experiences and knowledge of commercial fishing gathered outside of OWFs.

As outlined in WP1/WP2, a number of current research projects are investigating possible applications, particularly in relation to passive fishing, that could be implemented within wind farms. The example listed in WP2 in the Denmark country fiche, where trawling is possible along the export cable from the Horns Rev2 OWF to the coast, does not fall within the scope of this chapter, as it is also located outside the OWF itself.

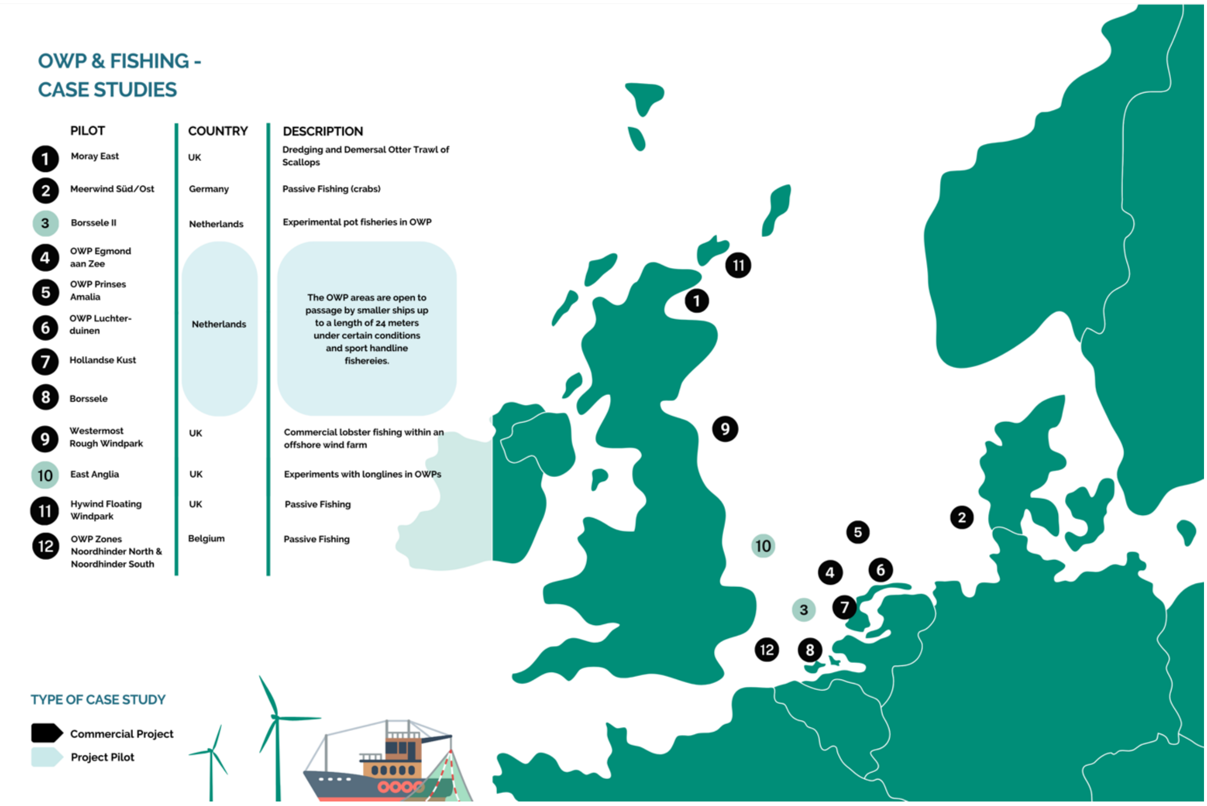

Figure 22 - Pilot and demonstration areas and projects related to OWF and fisheries (WP1/WP2)

Active fishing

Fishing is one of the longest-standing and therefore most traditional uses of marine areas. Fishing takes place throughout coastal waters and in the EEZ. The majority of German fishing vessels in the North Sea and Baltic Sea are small gillnet boats and cutters. In the Baltic Sea, however, fishing is often a sideline, accounting for only about 4% of German catches. In addition to German fishing vessels, vessels from other countries, mainly the Netherlands and Denmark, also use German waters. At the end of 2020, there were 11 registered vessels flying the German flag engaged in large-scale deep-sea fishing, using trawlers and factory ships. The seven deep-sea trawlers flying the German flag, with lengths ranging from 67 m to 133 m, are owned by Dutch or Icelandic companies, operate mostly outside German maritime waters, and account for about half of Germany's catches (BSH 2021).

Pelagic and bottom trawling have long been practiced as active fishing methods in the North Sea and Baltic Sea. They are used both in coastal and offshore areas.

Basically, a net is dragged through the water column or along the seabed to catch mainly pelagic or bottom-dwelling fish or crustaceans. Various types of nets are used for this purpose, which are continuously improved and adapted. Particular attention should be paid to so-called precision fishing, which greatly reduces or even completely avoids bycatch and the capture of unwanted or undersized animals through modifications and adjustments to the fishing gear.

The area of OWFs that is accessible to fishing only for transit but not for active fishing is considered a refuge and sanctuary for flora and fauna. It thus contributes to the wind farm's environmental restoration concept (see chapter 2). These protected areas, where no active or passive fishing takes place, could promote the recovery of stocks. The literature refers to this as a "spillover effect." According to this, fish that can thrive undisturbed in the wind farm area also migrate out of the protected area and can thus be caught by fishermen outside the wind farm. An increased occurrence of cod in OWFs and initial spillover effects for crabs have already been demonstrated by Gimpel et al. (2020). In addition to the protected area, the more diverse food supply in the wind farm may also contribute to an increased fish population. However, spillover effects from OWFs for fish have hardly been proven, if at all, in temperate waters (Gill et al., 2024).

In addition, the safety distance to OWF infrastructure on the seabed, such as submarine cables, required by other users must be maintained. Cutter and coastal fishing vessels with limited maneuvering space would only be able to be used in shared use in coastal OWFs. Long travel times would be uneconomical and risky.

Passive fishing

In Germany, passive fishing takes place in both the Baltic Sea and the North Sea, mainly in coastal areas. It is a traditional, more sustainable method of catching fish such as herring, cod, and flatfish. In the Baltic Sea, fish traps, gillnets, and longlines are often used, while in the North Sea, gillnets (various types of fixed nets) are mainly used in the shallower areas. Small and medium-sized vessels catch flatfish and demersal fish. Fishing with smaller mesh sizes (90 mm) is usually targeted at sole and can result in considerable discard rates of dab. Longline fishing is mainly carried out in the northern North Sea and targets saithe, cod, haddock, ling and tusk. Pot fishing for crab, lobster, and whelk is carried out in coastal areas. Most vessels are small (< 10 m), but catches by larger vessels (> 15 m) can be significant (ICES 2024).

From a legal perspective, the use of reserved areas for offshore wind energy by passive fishing should be permitted in accordance with the provisions (as a principle) in the current spatial planning scheme. Passive fishing with traps and pots should be permitted in the safety zones of wind farms; However, this does not apply to the area bounded by the outer structures of the wind farm or to the immediate vicinity of the outer structures. Sentences 1 and 2 apply insofar as the construction, operation, and maintenance of the wind farms are affected as little as possible and subject to conflicting technical regulations (Section 2.1). In some safety zones, the GDWS permits passive fishing with baskets and traps by vessels with a maximum hull length of 24 m, provided that this takes place outside the built-up wind farm areas and the passive fishing gear is located on the seabed (Section 2.1).

However, there is currently little practical experience with passive fishing in OWFs in the German EEZ. So far, mainly crabs have been caught using traps installed at the edge of the OWP. (Stelzenmüller et al. 2021). Due to safety concerns, insufficiently clarified insurance options, and some environmental issues, passive fishing is not currently taking place directly in OWFs (interview, workshop results). Passive fishing is mainly practiced in coastal areas of the Baltic Sea, using gillnets, traps, and fishing rods to target cod and herring. Most forms of passive fishing would also be suitable for offshore areas, with one exception: gillnet fishing does not appear to be suitable for offshore wind farms, as it poses higher environmental risks such as the entanglement of marine mammals or foraging seabirds.

The reserved area for fishing Norwegian Lobster in the 2021 spatial development plan partially overlaps with some sites designated for wind energy in the draft SDP 2024 (Figure 3). The BSH has included several consultation questions in connection with possible multi-use by passive fishery for the Norwegian lobster, within these overlapping areas (Chapter 2.1). Such multi-use can already be taken into account in the SDP under the current legal situation, as shown by the ongoing update of the SDP, which began on September 1, 2023. In this context, the BSH presented a draft SDP in July 2024 that addresses the multi-use of sites (Chapter 2.1).

A digression to our Danish neighbors also shows that although fishing in Danish wind farms is permitted under certain conditions, for economic reasons there is currently virtually no fishing taking place there. However, this is likely to change if fish prices rise.

Other active fishing practices

Wadennetze/Danish Seine/Snurrewade/Scottish Seine:

This fishing method is a semi-active fishing gear and combines elements of bottom trawling and set net fishing. Seine nets are operated with less pulling force than traditional bottom trawls and could therefore potentially be compatible with offshore infrastructure.

Purse seines:

This technique is mainly used for schooling fish species such as herring or mackerel. The nets enclose schools of fish and are then pulled in from below. This method is currently of little importance to German fisheries, but is used intensively by other EU member states.

Potential and significance in the German EEZ:

Although boat seines/snurrewades and purse seines play only a minor role in German fisheries, they should be taken into account in the context of offshore use. These fishing methods can be operated with comparatively low pulling forces, which can make them potentially safer in the vicinity of wind farms, but also requires calm seas. Particular caution is required when using these methods in rough weather. European fisheries are communitized, meaning that international fishing fleets that have mastered the above-mentioned fishing techniques can already potentially use them in the German EEZ, subject to available quotas.

Commercial shipping – fishing

In general, when fishing in a wind farm, there is very little room for maneuver and therefore no possibility of deviating from the route. The spatial requirements and possible uses are closely related to the vessels used. Deep-sea and coastal fishing are divided into large-scale deep-sea fishing and small-scale deep-sea and coastal fishing. In cutter and coastal fishing, a distinction must be made between coastal fishing with vessels of up to 16 m and small deep-sea fishing, mostly with cutters of approx. 18 to 32 m. Smaller vessels in particular require only a very small space to maneuver and can fish on predetermined "routes" without any problems (results of the 2nd workshop, expert interviews). From the fishing industry's point of view, a distance of 50 m from other uses would be sufficient as a spatial requirement (expert interviews).

Figure 24 shows fishing traffic and traffic density in 2022. The density maps shown below show traffic density based on voluntarily submitted data. It can be assumed that the traffic density of fishing vessels tends to be higher. Currently, all fishing vessels over 12 m in length must have an AIS and switch it on.

The overview plot already shows gaps in the existing or planned OWFs. Fishing boats longer than 24 m are prohibited from passing through the OWFs. Fishing vessels shorter than 24 m are allowed to pass through some safety zones, but are not allowed to actively fish while passing through. In principle, active fishing is prohibited in all safety zones under current law (Section 2.1).

The close-up view of EN2 and EN3 clearly shows that the fishing boats are exploiting the areas around the safety zones and approaching the border – but strictly avoiding the restricted area. Even very narrow and very small sections are being exploited and systematically navigated. The agility of the vessels is evident here, as illustrated by the criss-crossing of their routes. This is also confirmed by the findings of the expert discussions in the workshops. The proximity to the safety zone and the agility of the vessels indicate a fundamental "demand" for fishing within OWFs and thus for an expansion of fishing areas and the shared use of maritime sites. The fundamental demand by the fishing industry, among others, for the controlled opening of OWFs to fishing was also made clear in an analysis by Lasner and Barz (2023). These "open spaces" (priority areas) result from the priority areas for shipping SN1, SN2, SN2, SN11, and SN14. However, it must be emphasized here that approaching these areas does not necessarily mean fishing activity; rather, some of these trips are transit routes to and from fishing grounds.

In principle, a safety zone pursuant to Section 7 (2) KVRV may not be entered in order to prevent collisions at sea. However, the GDWS pursuant to Section 7 (3) sentence 2 KVRV specifies the exact requirements and conditions for exemption for vessels with a hull length of no more than 24 m. Which exceptions to the prohibition on navigation are possible and under which conditions they can be granted depends on the circumstances of the specific individual case and cannot be assessed in purely abstract terms.

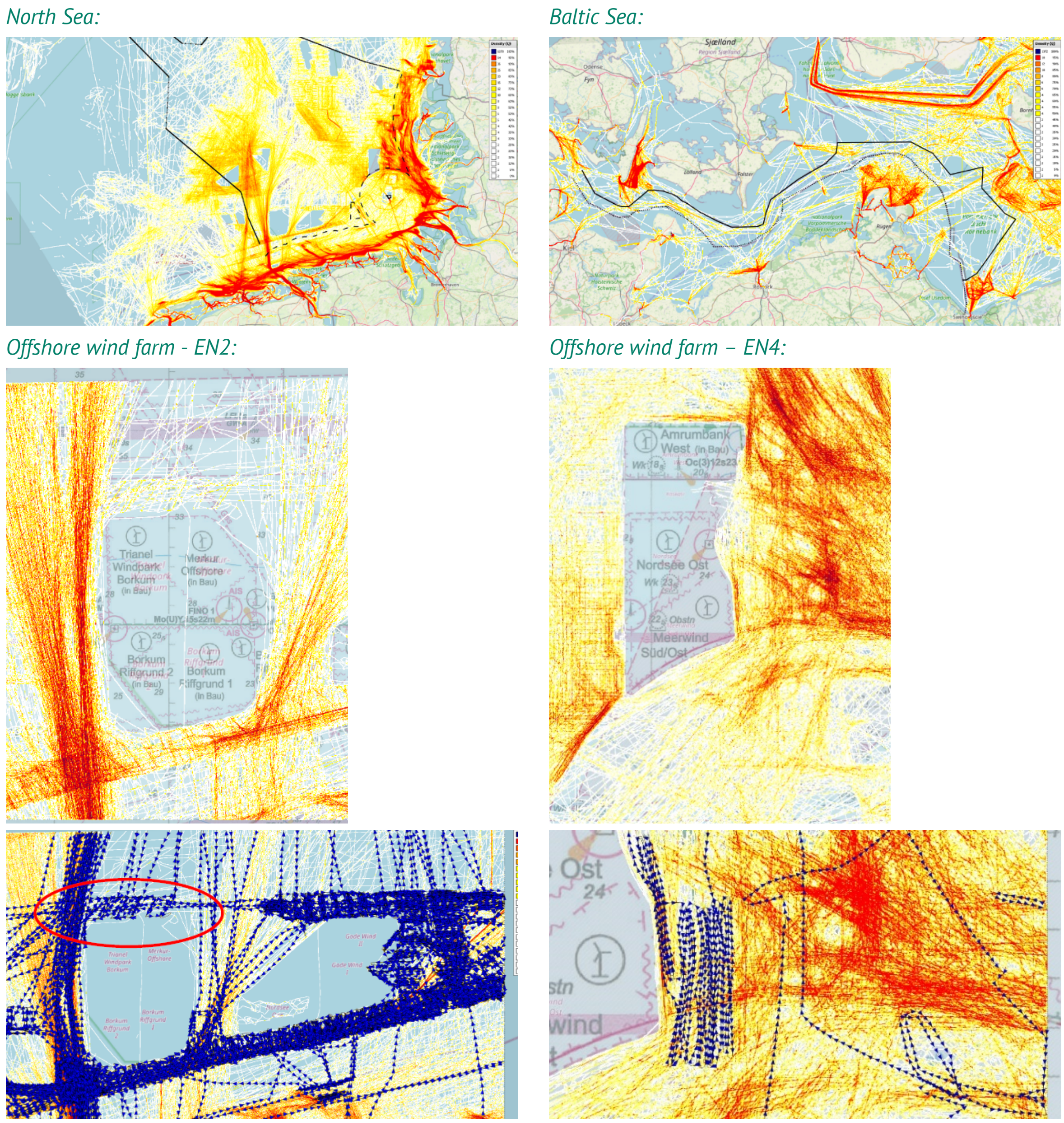

Figure 23 - Traffic density plots for commercial shipping and fishing based on voluntarily transmitted AIS data in the North Sea and Baltic Sea; (2022). The upper maps show shipping traffic from fishing in the German EEZ North Sea (left) and Baltic Sea (right). Red indicates high traffic density and yellow indicates lower shipping traffic. The middle maps zoom in on the EN2 and EN4 wind farms and show usage up to the boundaries of the wind farms. Lower maps: Blue lines represent individual fishing vessels and show the use of the areas adjacent to the wind farm. It must be emphasized that approaching the wind farm does not necessarily mean fishing activity; rather, some of these trips are transit routes to and from fishing grounds.

In addition to questions about the compatibility of fishing vessels within and around the OWFs, the location of the respective OPWs is also decisive in determining their relevance for fishing. For example, catches from German deep-sea fishing in 2020 will be landed exclusively abroad, mainly in the Netherlands, while small-scale deep-sea and coastal fishing landed 40% of catches in German territory. The extent to which OWFs can be used economically for fishing with smaller vessels therefore also depends heavily on the distance to the nearest suitable port.

Western parts of the EEZ further away from the coast are also fished in the North Sea, so there is also interest and likely economic viability in fishing OWFs here.

Functional compatibility and technical feasibility

Time requirements for offshore operations

The time requirements for fishing operations depend primarily on the statutory closed seasons during which fishing is not permitted. These are regulated individually for each target species and each fishing area. Furthermore, fishing operations are based on the natural seasonal occurrence of the species in an area or on environmental aspects, depending on the target species. For example, the Scheveningen Group of EU member states recommended, and the EU Commission subsequently implemented through a delegated act, that bottom fishing in the Sylt Outer Reef NCA be prohibited indefinitely (BSH 2023b).

If fishing is to be part of co-use, unrestricted access to fishable sites during the fishing season must be made possible for the duration of fishing, with a few exceptions. This requires close consultation with wind farm operators and possibly also adjustments to the normal maintenance operation of the turbines. This could interfere with wind farm operations.

Requirements for vessels and crew

Fishing vessels are equipped with very specialised equipment. Some equipment, such as cranes, is also required for other uses such as aquaculture and research.

The knowledge and experience of the crew is of great importance for success and safety. Therefore, with the help of further training opportunities, various synergy effects for the co-use of ships with highly experienced crews are conceivable or are already being implemented in practice. Fishermen carry out research work and are increasingly being commissioned to work on aquaculture facilities.

Passage of fishing vessels

Depending on the type and size of the vessel, fishing vessels can be highly maneuverable. This agility suggests that the combination of fishing vessels and OWFs appears fundamentally plausible from a technical point of view. Traffic density plots have confirmed the maneuverability of individual vessels.

In addition, there are general regulations in the field of fishing that have been issued as part of the GDWS's administrative practice. However, these general regulations contain hardly any exceptions to the navigation ban. A detailed analysis is provided in Chapter 2.1 in the section "*GDWS administrative practice* ". In summary, the safety zones can be divided into three categories. While no exceptions to the navigation ban are granted in category 1, category 2 allows direct passage through the safety zone without any fishing activity. In the third category, however, passive fishing is permitted. The associated conditions are explained in detail in chapter 2.1.

Functional compatibility and technical feasibility for the combination of commercial shipping, fishing, and OWF is generally given for vessels with a maximum length of 24 m.

Fishing vessels operate in different size classes and dimensions. On the one hand, the larger the vessel, the more limited its maneuverability in terms of braking distances and evasive maneuvers. On the other hand, the smaller a vessel is, the more susceptible it is to weather influences and the higher the risk of collisions and damage to wind turbines. Fishing vessels are not necessarily required to be equipped with AIS. This would be mandatory for passing through and operating in safety zones.

Depending on the type of fishing, there are different risks with regard to OWFs. Details can be found in the chapter on fishing.

Safety aspects

The draft implementation of the RED III Directive now includes an amendment to Section 7 (1) sentence 2 ROG, which mentions provisions regarding multi-use. "certain sites of the planning area, including area designations pursuant to paragraph 3, are designated for several compatible uses and functions (multi-use)". In the explanatory memorandum to the law, with regard to the requirement for compatibility of the various uses, it is stated that "multi-use of OWF areas by active fishing [...] should not be excluded" "provided that it is clearly demonstrated that the environmentally compatible and safe expansion and operation of wind power is not jeopardized by multi-use through active fishing (Section 2.3).

Actively fishing vessels have very limited maneuverability. Therefore, safety distances must be strictly observed, and the fishing area must remain completely free of disturbances and unexpected situations, such as other vessels crossing paths. It is not possible to react flexibly to such situations. In wind farms, however, the majority of vessel traffic results from corrective and preventive maintenance. These activities must be guaranteed at all times for safety and economic reasons. This conflicts with the maneuverability of fishing vessels. Another safety risk is the loss of nets or other equipment. These would drift uncontrollably in the OWF. Possible damage to cables, monopiles, and associated sensor technology due to active fishing activities is another risk. For these reasons, active fishing is currently prohibited in all safety zones, and passive fishing is only permitted outside the developed sites of the wind farm. Only in Scotland (Moray East OWF, see also WP1/2) is active fishing with bottom trawls for mackerel permitted. However, special routes without cable lines have been designated here, or the lines have been laid deeper. The fishermen were involved in the planning and implementation of the wind farm at an early stage. This is also due to the different (legal) circumstances in Scotland. Direct transferability to Germany is therefore currently unlikely (Commercial Fisheries Mitigation Strategy - Wind Farm and Offshore Transmission Infrastructure January 2022).

Environmental impact

Any considerations regarding active fishing in wind farms must take into account that the special provision of Section 15 (1) BKompV applies to nature conservation compensation with regard to the construction and operation of wind turbines and ancillary facilities in the EEZ and on the continental shelf. According to this, damage to protected biotopes and soil (including plants and animals found in the sediment, i.e., benthos), water, and air is considered compensated if active fishing is prohibited in the safety zone belonging to the wind turbine in accordance with Section 74 WindSeeG for the entire operating life of the wind turbine (Chapter 2.1).

Bottom trawling poses ecological risks. Contact between the fishing gear and the seabed can damage sensitive habitats. Additional noise emissions from the ships' engines could amplify existing noise emissions (maintenance and service vehicles in offshore wind farms) and lead to additional pollution.

In environmental terms, **pelagic trawling** has less impact on the seabed, but carries the risk of ghost nets and the possibility of overfishing. Here, too, noise emissions play a role that could affect marine life.

From an ecological point of view, **passive fishing** has advantages over active fishing as it causes less disturbance to the seabed. Nevertheless, there is a risk of bycatch and, if gillnets are used inappropriately, the creation of ghost nets, i.e., lost fishing gear that continues to catch fish, marine mammals, and birds unintentionally. The bycatch rate of pots and traps, on the other hand, is close to zero, especially with regard to sensitive species such as marine mammals and seabirds.

Noise emissions are also an issue here, albeit significantly less pronounced than in active fishing. The integration of this method into OWFs shows great potential, as the stationary nature of the fishing gear can be combined well with the permanently installed OWFs, creating synergies for the sustainable use of marine space.

The **foundations and rock fillings** of OWFs provide ideal habitats for sessile, filter-feeding organisms. This attracts cod, which increasingly aggregate at the installations. The fish benefit from a more diverse food supply and are in remarkably good condition. Studies of plankton catches in combination with drift models by the AWI and the Thünen Institute also indicate spawning activity in the wind farm area (Gimpel et al. 2023). This opens up opportunities for fishing.

Interestingly, wind farm areas also appear to serve as **nurseries for crab species**. Young crabs grow up there, while adult animals migrate to surrounding waters, which is described as a spill-over effect that extends up to one kilometer (Gimpel et al. 2020). This effect is already being exploited by fishermen using passive fishing gear. Commercial fishing for crabs in the vicinity of OWFs is already on the rise. However, in order to tap into this market, targeted storytelling would be important to highlight the potential of these species (Stelzenmüller 2021).

Socio-economic a spects

Fishing, whether active or passive, is currently not practiced or only permitted to a very limited extent in wind farms in the German EEZ. Only research projects and small commercial approaches are being tested.

The number of employees in marine fisheries in Germany is around 550. In addition, there are 580 self-employed persons (as of 2023 240), most of whom work in smaller businesses. The number of fishermen has declined in recent decades due to overfishing, stricter catch quotas, and economic challenges for smaller businesses.

For this reason, the Future Commission on Fisheries, which currently has 34 members from **fisheries and trade associations, environmental associations, science, administration, and society,** began its work in April 2024 with the aim of presenting proposals by spring 2025 for concrete and broadly supported measures for sustainable, economically resilient, and thus future-proof German marine fisheries in the North Sea and Baltic Sea. The commission's main topics are possible approaches to the use of existing and future funds from the Offshore Wind Energy Act; innovations for greater sustainability; land use at sea; and the financing and economic viability of measures.241

As also mentioned in the chapter on aquaculture, there are various projects beyond the topic of multi-use that deal with the entire transformation process in the fisheries sector and aim to create new job profiles in addition to traditional active fishing (keywords: fish farmer/sea ranger).

As already mentioned, German fishermen in the North Sea and Baltic Sea mainly use small gillnet boats and cutters. In the Baltic Sea, however, fishing is often only a sideline, accounting for only about 4% of German catches. While passive fishing is a common method in coastal areas, it has hardly been practiced in the EEZ to date (13 out of 1,300 vessels, see WP1).

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240 Thünen: The German fishing fleet: Few large vessels and many small ones

241 As part of the work carried out to date, individual members of the Future Commission have been involved in the survey and interviews/workshops. However, the Future Commission has not issued a statement as a whole due to the ongoing work.

Active and passive fishing

Bottom trawling is an established method in the North Sea and Baltic Sea, in which a net is dragged across the seabed to catch fish and crustacean species living near the bottom. This method creates numerous jobs both offshore (ship crew) and onshore (fish processing, equipment manufacturing). Yields are variable and depend on the season, catch quotas, and the fishing gear used. While bottom trawling is possible in the immediate vicinity of OWFs, it is currently only used to a limited extent in the outer peripheral areas and not in wind farms. However, with the potential opening of OWFs, the costs of monitoring, accident prevention, and regulating possible damage to OWF infrastructure currently appear to be high as a preventive measure.

Pelagic trawling, in which nets are dragged through the water column, is also a proven method for fishing pelagic fish species. It creates jobs in a similar way to other fishing methods and offers varying yields depending on the season and quotas. Pelagic fishing can theoretically be carried out in offshore wind farms, but in practice it faces obstacles, as shared use of the OWF is difficult to coordinate (keeping sites free for emergency operations by the plant operator) and fishing gear poses an additional risk in the event of loss. Therefore, the costs of monitoring, accident prevention, and regulating possible damage to OWF infrastructure in the event of a potential opening of OWFs to active fishing currently appear to be prohibitively high.

Passive fishing, in which stationary fishing gear is positioned in the water, is also a widespread method in the North Sea and Baltic Sea. It is economically significant and contributes to job creation in coastal areas. As with trawl fishing, costs and yields depend on the season, target species, and distance to fishing grounds. This method is particularly attractive due to its lower energy consumption and reduced impact on the seabed. The fishing gear used is also easier to handle and the risk of accidents is lower. However, there is currently little experience with this method in OWFs.

The yield, quantity, and price of fish vary depending on the season, allowable catch, fishing method, and species fished. All types of fishing can create **jobs** for a wide range of skilled workers in various sectors, from equipment to marketing. **Operating costs** vary depending on the type of vessel, fishing gear, and distance to the fishing area.

Fishing vessels (transit)

Permission for fishing vessels to transit through OWFs could result in savings in fuel costs and time, as shorter routes could potentially be used. General provisions issued by the GDWS already allow vessels with a maximum length of 24 m to transit directly through safety zones in some cases.

However, the costs of additional safety measures must be taken into account. Safety infrastructure, monitoring systems, and potentially emergency services can mitigate these risks, but they must be considered as cost factors and currently appear to be very high. Economic efficiency depends on the balance between cost savings and increased operating expenses for both the fishing industry and OWF operators.

Conclusion and outlook

Although OWFs offer the possibility of integrating fishing, the potential depends heavily on the fishing method used.

Bottom trawling and **pelagic trawling** face operational, ecological, and cost-related obstacles (liability in the event of accidents, establishment of preventive measures) as well as massive safety obstacles. Navigation rules in wind farms do not allow active fishing, only the passage of vessels with a hull length of less than 24 m under certain conditions (e.g., a minimum distance of 150 m from wind turbines, visibility greater than 500 m, and wind speeds up to 8 Bft). As shown, only in Scotland, at the Moray East wind farm, is bottom trawling currently permitted (see WP1 and WP2), but this was accompanied by restrictions and technical changes to the cable routing.

Currently, active fishing is prohibited in OWF safety zones, thus ruling out the shared use of an OWF area by the fishing industry, with the exception of passive fishing in the outer area of the safety zone, if the OWF is to benefit from the compensation scheme in Section 15 (1) BKompV.

Based on extensive research, this report presents the current possibilities for multi-use. In principle, therefore, due to the current technical feasibility and the associated risks, safety risks and ecological considerations, as well as the current legal situation (exclusion of fishing as a compensation measure), active fishing as a possible combination within OWFs is no longer considered in this report. However, one approach that is not considered further here due to the current legal situation could be the use of fishing vessels under 24 meters, provided that they can be equipped with new, not yet established fishing techniques that offer both safe operation and a sufficiently large yield for commercial use.

Intensive research into suitable fishing techniques is being conducted in various countries, and a future new situation for this multi-use combination should also be reassessed on the basis of new principles. See also the findings and current figures from the Thünen Institute on employees in the fishing industry (Thünen: The German fishing fleet: Few large and many small).

Already in the planning phase, attention could be paid to planning cable-free routes and fixed routes for frequent ship movements, such as those of crew transfer vessels (CTVs), while at the same time creating open spaces. This would allow the wishes of the fishing industry, as expressed in interviews and workshop results, to be taken into account during implementation.

Passive fishing, on the other hand, already shows potential for sustainable coexistence with OWFs. Stationary methods such as basket fishing and trap fishing have only a minor impact on the seabed. A combination of sustainable fishing methods and renewable energy could lead to a future-oriented use of fisheries with an extremely good environmental balance, especially when compared to terrestrial animal food production.

There are already several examples of this taking place in OWFs. In England, lobsters are caught with traps in the Westermost Rough OWF; experiments with longline fishing are currently underway in the East Anglia 1 OWF. In the Netherlands, trials of basket fishing are taking place in the Amalia Luchterduinen and Borsesele II OWFs. In Belgium, passive fishing is currently taking place in the Noordhinder North & South OWFs. Even in Germany, passive fishing for crab is already taking place near Heligoland in the safety zone of the Meerwind OWF, albeit only as part of research projects.

Integrating passive fishing into the early planning phase of a wind farm—for example, by taking into account cable routes and the routes of crew transfer vessels (CTVs)—would make co-use much easier and safer. From a fisheries perspective, corridors and fixed, predictable routes for frequent ship movements, such as those of CTVs, would be necessary to enable actual co-use with active fishing (interviews, workshop results).

The integration of fishing into wind farms depends on the various factors described above (distance of the wind farm from the nearest port, water depth, etc.). Therefore, specifications and regulations should be tailored to each specific case in detail as part of the approval process.

However, the current practice of the GDWS in designing the navigation ban in the safety zones of OWFs stands in the way of multi-use of the sites, for example through passive fishing in the **developed sites of the wind farm** (Chapter 2).

2.7. Research

In order to gain a deeper understanding of the marine environment, available resources, and ecological processes, both stationary and mobile research play a central role in the EEZ.

Stationary research facilities, such as the permanently installed research platforms Nordsee 1, 2, and 3 (FINO 1, 2, 3) in the North Sea and Baltic Sea, enable continuous monitoring of environmental parameters. They provide long-term data sets that are essential for analyzing changes in marine ecosystems and assessing human impacts, such as fishing and shipping. These stationary systems are capable of taking accurate and reliable measurements over long periods of time, making them an important tool for climate research and monitoring marine resources.

Mobile research units, including research vessels and autonomous underwater vehicles (AUVs), on the other hand, offer a high degree of flexibility. They are designed for specific research questions and used in a targeted manner to collect data that would otherwise be difficult to access. Their mobility enables them to collect data on dynamic processes such as currents, stock surveys or animal population migrations, and short-term changes in water quality.

Due to the drastically changing security situation, the national defense has an interest in having access to the data collected in the course of mobile and stationary research.

Spatial requirements and seasonality of use

Stationary research

The collection of scientific data throughout the EEZ of the German North Sea and Baltic Sea, e.g., by the BSH, the Thünen Institutes, and the European Marine Observation Network (EMODnet), means that the entire EEZ is used for scientific purposes.

For all plans for the joint use of an area, e.g. for research, regulations must be compatible with the "requirements of safety and ease of traffic." This must be given top priority in all aspects, including ship traffic and design. In existing research facilities, this prerequisite for approval is fulfilled and demonstrates the potential compatibility of research and OWFs.

Stationary measuring stations with permanently installed measuring equipment continuously provide important data for marine monitoring and thus contribute to a scientific database that can be accessed by research projects as well as other users (shipping, wind industry, fishermen, aquaculture producers, investors). These include, for example, the MARNET measurement network of the BSH (Federal Maritime and Hydrographic Agency), which comprises various measuring stations in the German Bight and the western Baltic Sea. These stations automatically record marine data such as salinity, temperature, currents, and sea state. The advantage of permanently installed measuring stations is their high temporal resolution (hourly data over a long period of time). The disadvantage is that the data is limited to the location of the measuring station.

The nature of the measuring stations varies. In the North Sea, for example, two unmanned light vessels and two semi-submersible buoys serve as measuring stations, while various types of platforms are used in the Baltic Sea. Smaller data buoys, known as ODAS buoys, are also widely used. These automatically collect and transmit data such as:

- Air temperature
- Air pressure
- Wind direction
- Wind speed
- Sea state
- Wave height

- Sea surface temperature

In addition, there are research platforms in the North Sea and Baltic Sea (FINO) that collect a wide range of oceanographic and meteorological data and have thus established a very valuable long-term database. Two platforms are located in the North Sea (FINO1 and FINO3) and one in the Baltic Sea (FINO2).

The space required is limited to the measuring station with a completely closed safety radius of 100 m, which allows unrestricted access. Around the FINO platforms, there is also a restricted area with a radius of 500 m, in which multi-use is practiced in the form of several simultaneous research projects and the operation of the platforms. Other measuring stations, such as ODAS buoys, require less space depending on their location. It may be necessary to set up a restricted area around the measuring point, but it may also be sufficient to mark the individual measuring point as a hazard zone that must be navigated around at a sufficient distance. The decision on what distances are necessary is the responsibility of the BSH.

Depending on the installation, different vessels are used for operation: from smaller vessels for installing ODAS buoys, to medium-sized to large tugs for installing larger buoys and platforms, and large towing and assembly vessels for installing the FINO platforms and, for example, light vessels.

Operation is automatic, but regular maintenance is required. This can range from simply replacing an ODAS buoy to monthly visits to research platforms to renew paintwork or replace components.

Relocating measuring buoys (e.g., North Sea Buoy 2, Arkona Basin Buoy) is one way to enable stationary research and OWF, but this should be done on as small a scale as possible so that scientifically valuable long-term data series are not interrupted and the data at the new location remain comparable to those from the old location. Continued operation or integration of the measuring equipment into the OWF could provide data on the impact of the OWF on the marine environment, thus enabling a comparison with the situation before the OWF was built.

Mobile research

Much of the mobile research activity in the German EEZ is closely linked to international and European legal obligations. These obligations arise in particular from the Habitats Directive (HD), the Marine Strategy Framework Directive (MSFD), the HELCOM Convention, and the OSPAR Convention.

In the case of marine mammals, monitoring involves collecting data on species listed in Annex II of the Habitats Directive in order to contribute to reporting under Article 17 and to assessing progress towards Good Environmental Status (GES) under the MSFD. Under the OSPAR Convention, the status of harbour porpoises in the North-East Atlantic must be assessed, as they are included in the OSPAR list of threatened species. Population size is a key indicator for reliably assessing trends.

In addition, fisheries research plays an important role. In the German EEZ, the Thünen Institute and the International Council for the Exploration of the Sea (ICES) are of central importance. The spatial overlap between mobile research activities and offshore wind farms is particularly evident in the example of the Thünen Institute's research area, where, among other things, trawl fishing is carried out for long-term data collection. The draft SDP24 illustrates this with the conflict on sites N-11.2 and N-13, which partially overlap with the GB3 research area. In these sites, the Thünen Institute should be allowed to continue its research activities, provided this is compatible with wind energy use. In addition, areas N-9.1, N-9.2, and N-9.3 should allow passage for research purposes. In the Baltic Sea, research area Fo03 overlaps with site O-2.2. For this purpose, the SDP 2023 provides for buffer zones of 400 m around the respective trawl lines.

The spatial requirements for mobile marine research result from two main factors: the physical characteristics of the research vessels used and the requirements of the research methods and equipment employed. The physical characteristics of the vessels, in particular their size and draft, largely determine which areas can be navigated and investigated. The German research fleet is characterized by a wide range of possible applications. The smaller vessels include the **Clupea** (28.8 meters long, draft 2.3 meters), while the **Walther Herwig III** (64.5 meters long, draft 5.5 meters) is one of the largest German research vessels. In between are medium-sized ships such as the **Heincke** and the **Alkor** (both 55 meters long), which can operate flexibly in both coastal regions and the open sea.

In addition, spatial requirements arise from the specific research approaches. While selective water sampling requires comparatively little space, seismic surveys are much more space-intensive due to the deployment of sound sources and hydrophone chains. Fisheries research also requires extensive operating areas to ensure the safe deployment and retrieval of nets. The use of diving robots (ROVs or AUVs) in turn places specific demands on navigational freedom and the safe handling of the equipment during deployment and retrieval.

Research vessels cannot be clearly identified within the AIS identification system, as there is no uniform labeling. They fall into the service category. Meaningful cartographic processing and spatial classification is therefore not possible on the basis of the raw data.

Functional compatibility and technical feasibility

Stationary research

The service life of stationary research facilities is still being tested. The FINO research platforms are used to determine the service life of offshore structures such as wind turbines. Currently, a service life of 25 to possibly 30 years is planned, but after testing the infrastructure, an extension of the service life may be considered in order to minimize new construction, provided that the costs allow this.

The facilities are operated using ships and helicopters. Synergy effects through the shared use of ships, infrastructure, data transfer, logistics, and maintenance of sensors, for example, are useful and already part of everyday practice.

One challenge is the energy supply for the facilities. This is either limited to batteries or must be operated using diesel in the middle of wind farms, for which the foundations have been laid. In the workshops, it was pointed out that the stationary research facilities should be connected to the renewable energy generation plants located in the immediate vicinity of the offshore facilities (FINO 2 is 270 m from the nearest wind turbine).

Mobile research

The space requirements for mobile marine research in offshore wind farm areas are mainly based on the needs of shipping, especially with regard to research voyages. This includes the space required for research activities such as deploying and retrieving measuring instruments, as well as the safe maneuverability of ships in the vicinity of wind turbines. Depending on the research activity, different requirements are placed on research shipping within the safety zones of OWFs. Fisheries research in particular plays an important role in the EEZ.

The spatial overlap between mobile research activities and offshore wind farms is particularly evident in the example of the Thünen Institute's research area, where, among other things, trawl fishing is carried out for long-term data collection. Its integration into the wind farm confirms that functional compatibility with fisheries research can be achieved if the requirements of research activities are already taken into account in the layout of the wind farm.

Depending on the length of the vehicle, technical implementation and functional compatibility are generally possible.

The space required also depends on the type and size of the mobile measuring devices used, which are carried on board the research vessels and can be deployed flexibly.

The most commonly used mobile measuring devices in German marine research include CTD probes (conductivity, temperature, depth), which record vertical profiles of the water column; water samplers for taking water samples at different depths; and trawl nets for biological investigations. Multibeam echo sounders are used to explore and map the seabed, and current meters are used for mobile recording of current conditions. ROVs can be used to conduct investigations of the seabed, underwater structures, or biological diversity. These instruments require a clear working area in which the research vessel can maneuver, anchor, and take measurements safely.

Spatial conflicts between research activities and OWFs occur particularly when conducting towed surveys. Trawl nets can damage underwater cables if they become entangled. At the same time, there is a risk that the nets themselves will be damaged by turbine foundations or scour protection structures.

Another aspect is that OWF areas are closed off during the construction phase for safety reasons, which can lead to the interruption of long-term measurement series. In addition, the construction of the wind farm changes the environmental conditions in these areas. Although measurements can help to understand the environmental impact of OWFs, these areas may no longer be representative of other marine regions and may therefore not be suitable as long-term measuring stations.

Safety aspects

Ship collisions with stationary and mobile research facilities are a major safety concern. A collision with research facilities can completely destroy them, causing financial damage and also representing an irretrievable loss of data and entire seasons.

Further safety aspects arise from the shipping traffic of research vessels (see chapter: Commercial Shipping Research). Fishing research expeditions use significantly smaller trawl nets than those used in commercial fishing. In principle, there is also a risk of loss and dispersal of equipment such as trawl nets, but due to the size and number of operations, this is significantly less likely than in commercial fishing.

The use of ROVs and AUVs can reduce or even completely replace the risk of underwater operations by divers. Diving operations are generally the offshore work with the highest risk.

The essential risks are already excluded or minimized in the approval process for research facilities, whether mobile or stationary, as safe compatibility with shipping traffic and OWFs is tested. See also chapters 11.3 and 2.5.

Environmental impact

Stationary measuring stations and offshore wind farms interfere with the seabed during construction, which can lead to **temporary disturbances** to the underwater world. The anchors seal the seabed to a limited extent, but this is partially offset by the creation of new habitats on the structures. These structures can serve as **new settlement areas** for marine organisms, thus increasing local biodiversity, at least during operation.

A significant advantage of stationary measuring stations is their ability to **continuously** collect **environmental data**. These long-term data sets make it possible to precisely track changes in environmental parameters and indicate climatic changes. The information obtained can be used to **monitor climate change** and help identify trends that could influence future investments. This provides a sound basis for both economic and ecological decisions. However, the location of the measuring station must be critically considered. For long-term measurement series, only stations that are not influenced by offshore wind farms can be considered. For example, an alternative location had to be found for the MARNET buoy in the Arkona Basin due to offshore wind farm planning.

Mobile research also has an environmental impact, depending on the research method selected. For example, sediment is stirred up by trawling, disturbing the benthos, organisms are removed (to a limited extent) from the ecosystem for research purposes, and seismic surveys cause noise emissions.

Socio-economic aspects

The multi-use of offshore wind turbines and research can offer numerous socio-economic benefits and commercial opportunities that can have a positive impact on research and the economy.

A key socio-economic aspect is the **creation of jobs** in areas such as construction, maintenance, engineering, and research. This infrastructure requires a wide range of skilled workers, which can strengthen the local coastal economy in particular. In addition, the data collected by these measuring stations—such as oceanographic and meteorological information—provides valuable **insights for various industries**. Companies involved in fishing, offshore aquaculture, or other maritime industries can benefit from this data by **better planning** their **activities** and **optimizing** their **investments** based on accurate environmental information.

The combination or even retrofitting of offshore wind turbines with permanently installed research platforms/measuring stations/buoys also enables **efficient use of existing infrastructure.** This multi-use **reduces** the **costs** of installing and operating additional wind turbines, measuring station facilities, and aquaculture facilities, for example, as the structures can be used simultaneously for data collection and energy generation. Any site analysis is based on data that is expensive to collect offshore. In the early days of the offshore wind industry, this data was generated by the FINO platforms. The data collected is often made available free of charge for research purposes, which facilitates scientific work. The costs incurred by wind power operators for monitoring requirements or voluntary monitoring activities can be reduced through the shared use of sensors. However, there is also **commercial potential**. For example, companies could offer customized weather forecasts or environmental analyses for a fee based on the interpretation of this data. These services could be tailored specifically to the needs of industries that use marine resources, such as fishing or algae and shellfish farming. Companies could also use the environmental data collected to assess the suitability of locations for various economic activities, which could stimulate long-term investment and create new jobs. Such collaborations have been successfully tested, for example, in the UNITED and ULTFARMS research projects.

In addition to existing research on this topic, the multi-use of OWFs and research also has the potential to contribute to a better understanding of the environmental impact of wind farms.

Long-term studies before, during, and after the construction of OWFs can collect important data that helps to more accurately record and evaluate ecological changes and potential environmental impacts.

Research shipping enables scientific studies and investigations to be carried out in the seas and oceans and contributes to the expansion of knowledge in various fields. They are platforms for the training and development of skilled workers and drive technological development and innovation – the creation of jobs in construction, maintenance, engineering, marine biology, and research is therefore a key socio-economic aspect. The effects are evident in both coastal regions and research institutions.

The topic of research in combination with wind energy is equally important for coastal and offshore wind farms.

Conclusion and outlook

The current spatial development plan for the EEZ already contains initial provisions regarding multi-use with reserved areas for offshore wind energy. One example is an overlap with reserved areas for research, whereby the principle of "multi-use" stipulates that "fisheries research should remain possible in the same form and scope as it has been practiced to date."[242] This currently affects the EO2-West and EN20 wind energy areas, which are also designated as FoN3 and FoO3 reserved areas for research. This is specified in the SDP and promoted through specific measures. For overlapping areas, such as the N-20 area, which corresponds to the EN20 reserved area from the 2021 maritime spatial plan, corridors to be kept clear have been defined. These corridors, with a length of 5 nautical miles and a width of 1.025 nautical miles, ensure that research vessels can carry out their work, such as trawling, safely.

In addition, the SDP24 calls for independent exchange between wind farm operators and research institutions to ensure that long-term research activities such as long-term series are also made possible. In the area of the N-20 reserved area, it is being examined whether the sites must be kept free for fisheries research, provided that their indispensability is proven by the end of 2026.

Overall, the multi-use of stationary research and offshore wind turbines not only offers economic opportunities, but also contributes to the collection of important environmental and climate data. At the same time, careful planning and monitoring can minimize the ecological impact, promoting the sustainability of these projects and creating a balance between economic development and environmental protection.

Offshore structures such as wind turbines can also be used to install sensors, store and transmit data, and provide energy for the operation of research installations. Certain tasks, such as sensor maintenance, could be carried out by wind farm personnel. The resulting reduction in the number of research personnel at the wind farm increases safety. Research can support the operation of wind farms by, for example, taking on monitoring tasks that are required by law or in the economic interest.

Mobile research can be combined with OWFs in terms of time and space. The possibilities for mobile research are determined by the space required for research, the distance between turbines

242 Annex to the Ordinance on Spatial Planning in the German Exclusive Economic Zone in the North Sea and the Baltic Sea of August 19, 2021, under 2.2.2, (3) in Objectives and Principles of Offshore Wind Energy, p. 11, and justification for this, p. 13.

and underwater cables (e.g., for towing lines), as well as the navigation regulations for research vessels (current size limit of 24 m). Overall, this combination is seen as having great potential, even if the impact of the OWP on the marine environment must be taken into account in the interpretation of the research results.

Research vessels often carry out specialized work, such as deploying measuring equipment or collecting samples. These activities may require temporary stationary positioning near the wind turbines, which increases the risk of collisions, but also brings anchoring into play. The regulated anchor distances to submarine cables must be taken into account in the context of safety.

However, the main risks are already excluded or minimized in the approval process for research facilities, whether mobile or stationary, as safe compatibility with shipping traffic and OWFs is checked.

2.8. Cables

The course of a large number of cables already in operation, laid, and planned is shown in the example of the North Sea section in the following**Error! Reference source not found.**.

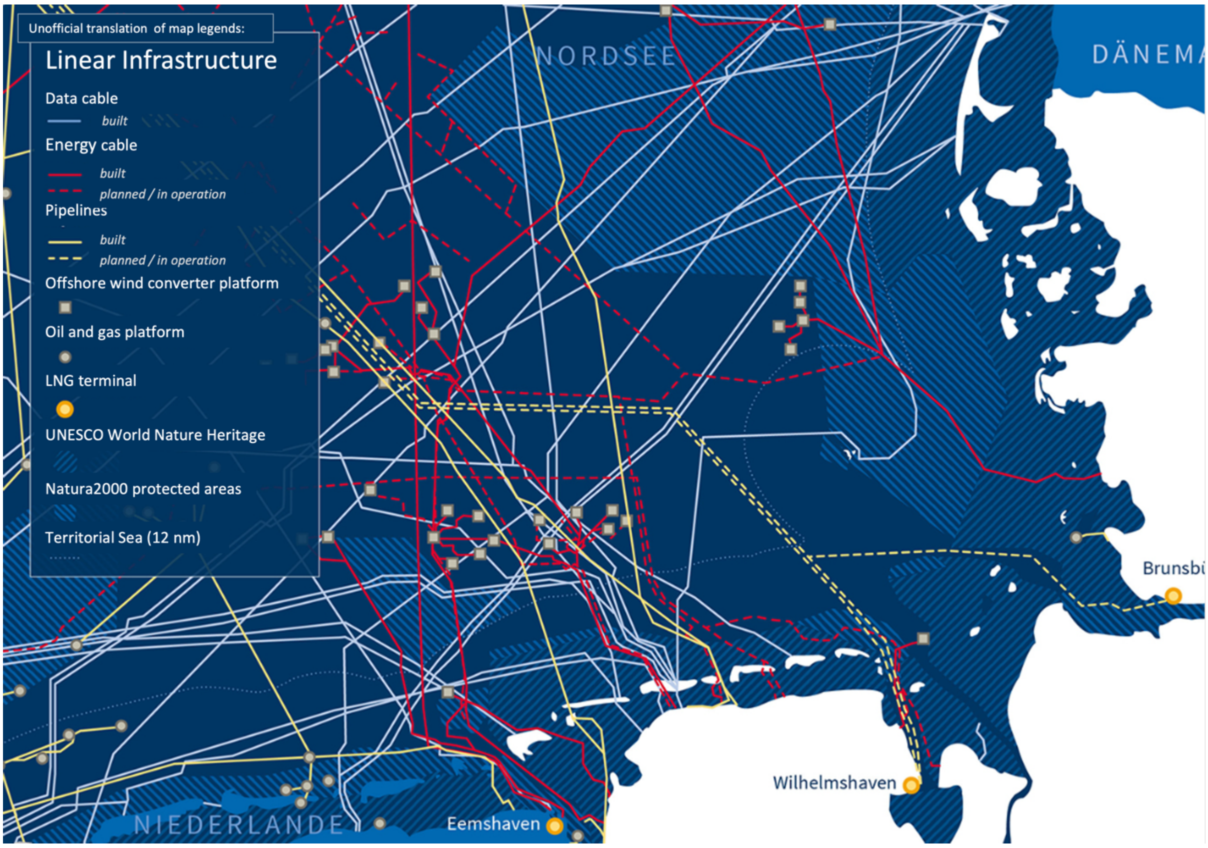


Figure 24 - Existing and planned linear infrastructure in the Wadden Sea and North Sea – Graphic: NABU, sources used in the NABU graphic: Amprion, BSH, BMWK, Cogea, EMODnet Human Activities, FNB Gas e.V., LKN.SH, Lower Saxony Wadden Sea National Park Administration, Tennet, TNO, Rijkswaterstaat Noordzee, VDZ, WWF. Graphic adapted through translation of map legends. (Source: Nov, 2024: https://www.nabu.de/natur-und-landschaft/meere/wattenmeer/35171.html).

Since the laying of pipelines, for example for the transport of hydrogen, oil, and gas, is not compatible with OWFs (see compatibility matrix), the following subchapter on pipelines exclusively considers cables that could be relevant for multi-use within OWFs in the German EEZ. In view of the ongoing expansion of OWFs, there could be an increase in the number of intersections in the future.

The following main cable types can be distinguished:

Data cables

These cables are used to enable data transmission between different countries and continents. They are crucial for global internet and telecommunications networks. Modern data cables typically use fiber optic technology to achieve high transmission rates. Data cables for communication and operational management within the wind farm are common and are usually integrated into the power cables. In terms of multi-use, third-party data cables play a minor role, as they generally follow the bundling principle outside of OWFs.

Export cables

Export cables, or so-called connection lines, connect the OWFs to the onshore power grid. They "export" the electricity generated at sea to the mainland grid. The cables that transport the electricity generated by wind turbines are designed as so-called hybrid cables, i.e., they enable both energy transmission and data transmission, which is necessary for communication and operational management within the wind farm. Hybrid cables combine electrical lines with fiber optic cores.

Interconnectors

Interconnectors are high-voltage lines used to electrically connect power grids between two or more countries or regions. These connections can be made above ground, underground, or via submarine cables and are used to trade surplus electrical energy, increase security of supply, and support the integration of renewable energies.

Interconnectors enable the exchange of electricity over long distances and help to balance differences in electricity generation and consumption. They are a central component of the European energy strategy, with the aim of creating a European internal energy market that promotes the efficient use of energy sources, increased security of supply, and a reduction in CO2 emissions.

They play a key role in promoting cross-border cooperation in the energy sector and can help to reduce price differences between national electricity markets. These cross-border energy cables are laid outside OWFs and cross important shipping routes, as shown in Figure 26 using the example of "NeuConnect." NeuConnect is intended to connect the UK and Germany for the purpose of electricity trading. At the time of writing, a connection to the planned OWFs is uncertain due to regulatory hurdles. This does not involve multi-use with wind farms and therefore does not impose any requirements on spatial use at the time of the expert study.

However, these systems could be used for the integration of OWFs in the future, as they are technically capable of transporting the energy generated at sea to the mainland and thus feeding it into the existing power grid. The direct connection of OWFs in the EEZ is currently still subject to regulatory hurdles in terms of electricity trading. In the Baltic Sea, an initial interconnector project was commissioned in 2020, supplying the Danish region of Sjælland and Mecklenburg-Western Pomerania in Germany with electricity from the two wind farms Kriegers Flak and Baltic 2. The electricity can be transmitted and traded in both directions.

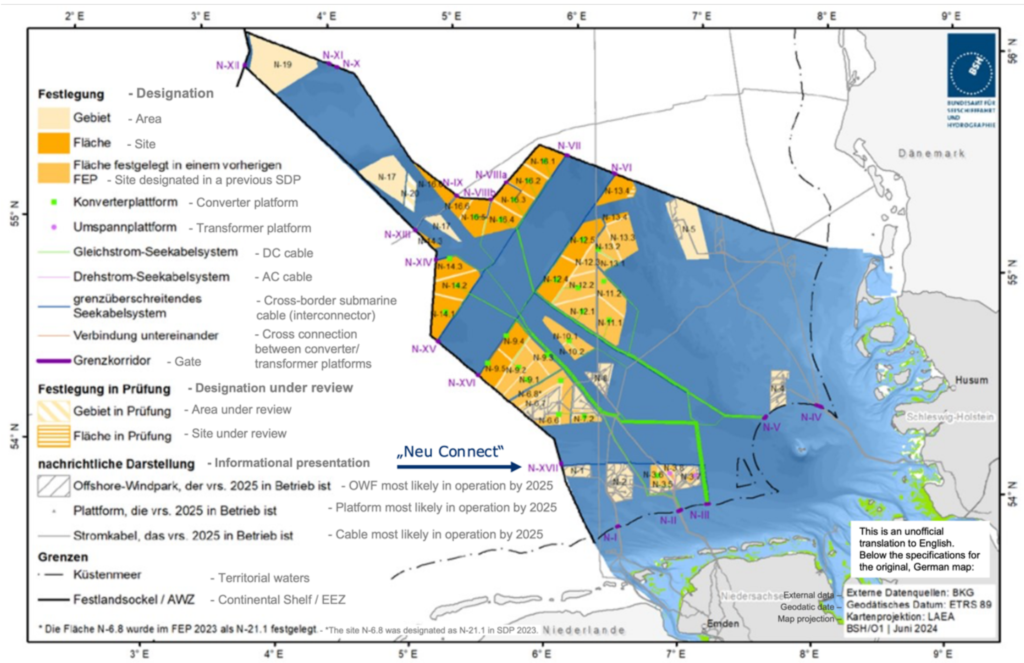


Figure 25 - Route of the cross-border submarine cable (interconnector) "NeuConnect". Unofficial translation of map legends based on https://www.bsh.de/EN/TOPICS/Offshore/Sectoral_planning/Site_development_plan_2025/_Anlagen/Downloads/Translation-of-map-legends_SiteDevelopmentPlan-EN.pdf?__blob=publicationFile&v=2

Figure 26 - The "Combined Grid Solution" has been in operation in the Baltic Sea since 2020 and enables electricity transmission and trading between Denmark and Germany by connecting the Kriegers Flak and Baltic 2 wind farms. Graph adapted through translation of map legend.

Legal framework

Reserved areas are designated for submarine cable use in accordance with AWZROV, in which "the specific spatially significant functions or uses are to be reserved, which are to be given particular weight when weighed against competing spatially significant functions or uses" (ROG § 7). The area designations for submarine cables take into account the principle of international law that gives priority to these uses.

In accordance with the planning principles of the SDP, a distance of 500 m must be maintained between offshore wind farms and third-party cables in order to enable maintenance work to be carried out while the offshore wind farms are in operation.

Spatial- Requirements and seasonality of use

Data cables

As a general rule, third-party data cables should be laid in bundles, i.e., in parallel, and at the required distance of 500 m from the wind turbines. If necessary, they should be integrated into power lines as hybrid cables. The cables to be used are generally maintenance-free. The type of use is not subject to seasonality.

Export cables

At the time of this report, existing OWFs have an internal cable network connected to a transformer platform for voltage increase within the OWF. The transformer platform is connected to an offshore converter station and, via export cables, to the converter station on the mainland. From 2024, newly constructed OWFs will be connected directly to the converter platform. The concept is illustrated in Figure 28 using the OWF He Dreiht as an example. Responsibility for the export cables lies with the transmission system operator and, due to their location within the wind farm, represents an inherently necessary multi-use of the OWF.

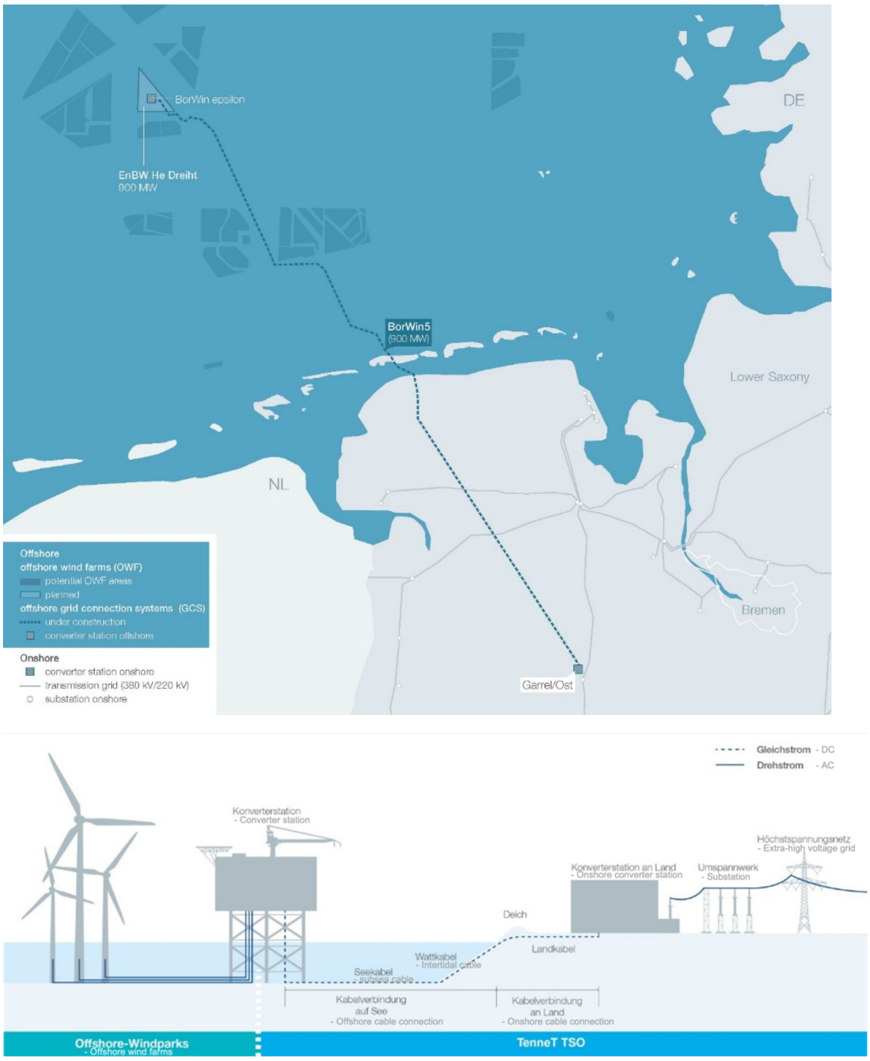


Figure 27 - Connection concept for the He Dreiht wind farm via a 230 km long export line (dashed line) currently under construction. (Source, 11/2024: https://www.tennet.eu/de/news/tennet-feiert-richtfest-ein-deckel-fuer-die-konverterstation-garrelost). Second graph adapted by addition of translations.

The spatial requirements for submarine cables comply with regulations and technical requirements that take into account the functionality and safety of the wind turbines. The minimum distance required in the SDP must always be observed in order to avoid damage or possible crossings. Submarine cables must not cross or come too close to each other, as electromagnetic interference can impair the performance of the cables and even lead to system malfunctions. When cables cross, they can be subjected to mechanical stress due to movements of the seabed or changes in water depth. This could compromise the structural integrity of the cables and possibly lead to damage.

Submarine cables are generally maintenance-free, but there is a risk of damage at crossing points from anchors, fishing, ocean currents, or even in the event of repairs to one of the cables. Submarine cables must therefore be accessible for maintenance work, which is made more difficult by crossing.

It is therefore common practice to plan cable corridors along the edges of OWFs for the long term, taking into account the framework conditions described in the area development plans, as illustrated in Figure 28.

Figure 28 - Excerpt from the grid development plan of the updated version of the NEP 2037/2045 (2023), second draft, as of April 2024. Grid expansion approved or already under construction (green), DC grid expansion planned (purple)

Functional compatibility and technical feasibility

Data cables and export cables are inherent components of OWF operation and are therefore fundamentally functionally compatible and technically feasible.

Safety aspects

In order to reduce the risk of damage to submarine cables and not to impair repair options, due consideration must be given to existing submarine cables when carrying out raw material extraction measures, and an appropriate distance must be maintained from them. The definition of an appropriate distance must be clarified on a case-by-case basis, as it depends on the specific conditions on site, such as water depth.

Environmental

Multi-use does not result in any additional environmental impacts beyond those already associated with the form of use itself.

Socio-economic aspects

The socio-economic aspects can only be considered in conjunction with the OWF in which the cables are located. This is because third-party cables are typically located at the edge of OWFs.

Conclusion and outlook

Within the scope of this report, export cables and data cables play a particularly important role within OWFs. These are an integral part of wind energy use, with a high degree of overlap in interests, provided they are beneficial to the operation of the OWP. Third-party data cables and third-party energy cables do not lead to conflicts as long as the bundling principle is followed outside OWF sites. In the future, pipelines that potentially transport hydrogen and land, and interconnectors are expected to play an increased role, as there is a large overlap of interests between energy producers and energy distribution parties.

2.9. Nature restoration

Nature restoration in the German EEZ will be a greater focus in the coming years, particularly in view of the new EU Regulation on Nature Restoration (EU 2024/1991). This obliges Member States to implement measures for renaturation and ecological improvement. Within the framework of this regulation, Germany will develop a comprehensive action plan that is expected to include targeted restoration projects in the EEZ.

Particularly relevant in the German EEZ are the habitat types gravel, coarse sand and shell grounds, reefs and sandbanks, which are considered in need of protection under the Fauna-Flora-Habitat Directive (FFH) and the Birds Directive (VRL).

This report focuses in particular on reef restoration, considering both geogenic and biogenic reefs (restoration of the European oyster). Restoration is understood here as a nature conservation measure that must be distinguished from commercial activities such as those described in the previous chapter on low-trophic aquaculture. Although the cultivation of mussels and algae in low-trophic aquaculture removes nutrients from the environment and can thus contribute to the required improvement of the ecological status (EU Regulation 2024/1991), it is classified as exploitation and cannot be equated with renaturation measures (LFA, pers. comm. workshop). When restoring reefs in the German EEZ, certain aspects must be taken into account to ensure that the measures are ecologically sound and sustainable in the long term. This includes the use of natural rock from terrestrial areas that are not classified as ecologically sensitive. Other realistic restoration measures in Germany include the renaturation of seagrass beds, the restoration of sandbanks and kelp forests, with the restoration of seagrass beds and kelp forests being particularly relevant in coastal areas. Renaturation measures should take place in the species' typical habitat. When it comes to reintroduction, there is still debate as to whether it makes sense to consider historical settlement areas (e.g., historical oyster beds that are now mudflats) for reintroduction and to cause corresponding ecosystem changes.

As already described in WP1/WP2, a large number of pilot and demonstration projects are currently looking at possible nature restoration measures, both in relation to the reintroduction of the European oyster and the creation of reefs in connection with OWFs.

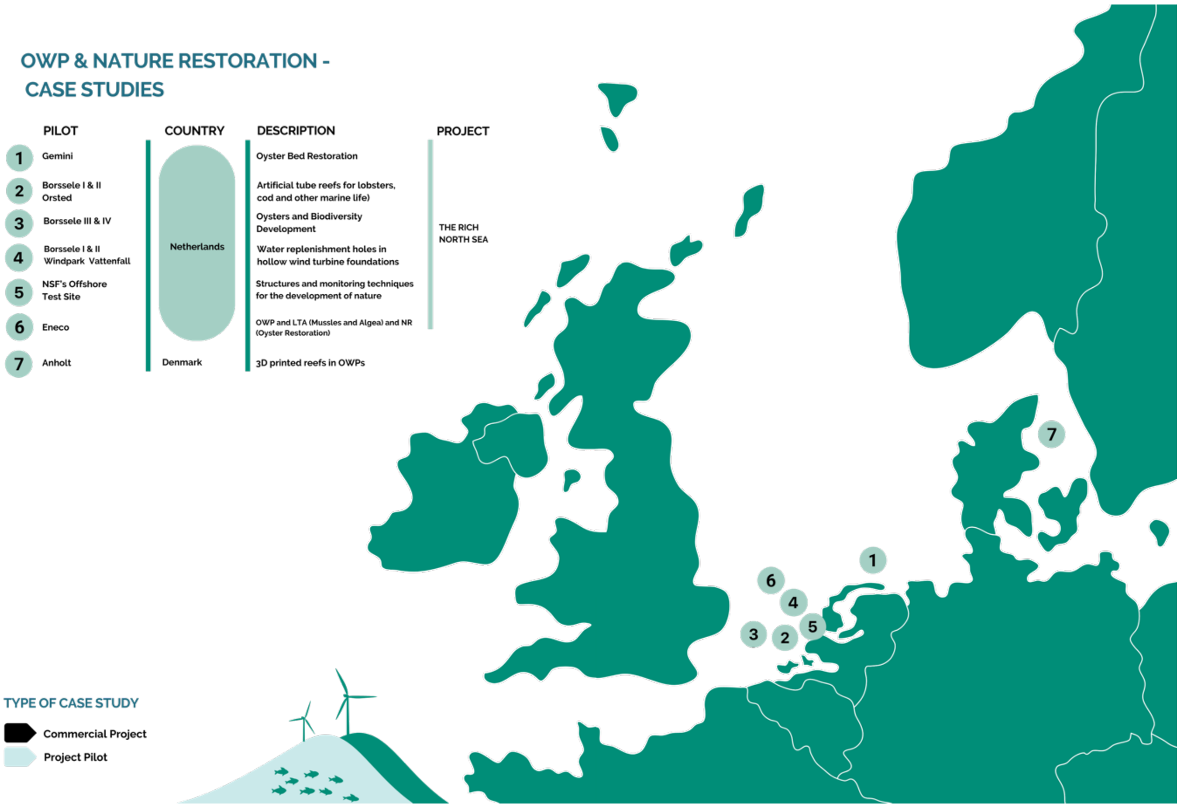


Figure 29 - Pilot and demonstration projects for nature restoration in Europe (WP1/WP2)

Spatial requirements and seasonality of use

Oyster reintroduction

The restoration of the European oyster (Ostrea edulis) is mainly planned in its historical areas of occurrence. These are mainly located in the southern third of the German EEZ, but also extend to the offshore wind farm areas N11, N12, and N13 defined in the SDP24. A detailed description of the environmental parameters required for successful oyster settlement can be found in the chapter on aquaculture.

The timing of when the oysters are dumped into the water is usually determined by favorable weather conditions. In addition, seasonal factors, in particular the oysters' reproductive period, play a decisive role. This reproductive period typically occurs between May and August, which must be taken into account when planning restoration measures.

As part of the ULTFARMS project, the natural restoration of the European oyster is already being tested in Belgian OWFs. In Germany, the reintroduction of the European oyster is currently being investigated in the Borkum Riffgrund nature conservation area as part of the RESTORE project.

Geogenic reefs

Restoration of geogenic reefs is currently planned mainly within marine protected areas in the German EEZ and would therefore not overlap with the areas of the planned OWF sites. However, restoration of geogenic reefs is also possible in other areas of the EEZ. The spatial requirements for the restoration of geogenic reefs therefore include the avoidance of activities that could endanger the structure and integrity of the reef.

Artificial reefs

Depending on the target species, artificial reefs can technically be used anywhere in the German EEZ. This means that the areas of use of OWFs and nature restoration measures overlap, as both require similar sites in the marine environment. Ongoing projects demonstrate the applicability of reefs. Biocompatible materials are being tested, for example, in the Danish project with Orsted/WWF (see WP 1, 10.3), also in connection with the settlement of lobsters and oysters (The Rich North Sea (WP 1, 10.2)). Another natural material, sunken pear trees, led to the formation of biodiversity hotspots in Dutch coastal waters within six months (Dickson et al., 2023).

In general, it is also important to avoid bottom-contacting activities such as trawling or sand and gravel extraction in nature restoration areas. Therefore, OWF areas, where these activities are restricted anyway, offer ideal spaces for nature restoration measures such as artificial reefs.

In Germany, the restoration of oyster and geogenic reefs is receiving more attention from the authorities, which is why these measures are expected to play a greater role than nature enhancement through artificial structures. The importance of these natural reef structures is paramount, as they have historically been present in marine areas and fulfill an important ecological function.

Functional compatibility and technical feasibility

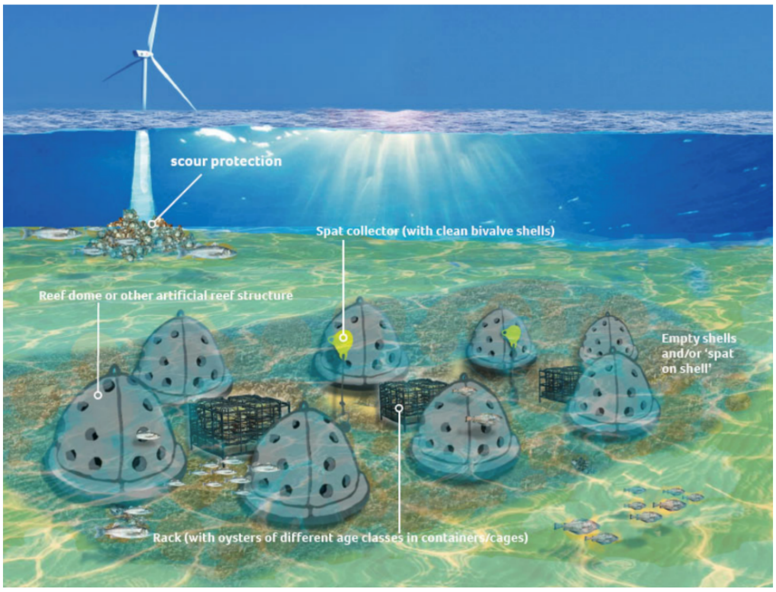


Figure 30 - Layout for a typical offshore pilot project for the settlement of the European oyster. Spat collectors are positioned between reef domes and cages. The drawing is not to scale (Sas et al., 2018)

Reintroduction of the European oyster

The successful restoration of oyster beds requires stable, hard substrates that serve as a foundation for the settlement and growth of oysters. These substrates must be located in areas with low sedimentation to prevent the oysters from being covered by sediment. In addition, habitats must be protected from intensive human use, such as fishing or construction activities, as these could interfere with the settlement and survival of oysters. In this context, it makes sense to carry out restoration measures after the construction of an OWF in the spaces between the turbines or near the scour protection.

The optimal technologies for reintroducing oysters are still being tested and vary depending on the location, current strength, and seabed conditions. As part of the RESTORE project (see also WP1), oysters are first cultivated in a hatchery on Heligoland. When released into the sea, limestone was first spread on the seabed as a solid substrate to provide the oysters with a suitable settlement area. Young oysters that had already settled on artificial reef structures were then released into the sea. In addition, live seed oysters are placed directly on the limestone structures to further promote natural settlement. In the Belgian pilot measures within the framework of the ULTFARMS project, 1.5 m high cages were developed in which different types of stone were placed in the water together with young oysters near the wind turbines. However, technologies for oyster restoration can also resemble the structures of low-trophic aquaculture (see chapter 'Aquaculture').

The actual oyster settlement in the RESTORE project is carried out from a ship, from which the oysters are placed in the sea using a lifting arm and divers. The restoration measures are monitored once a year by taking samples. Similar monitoring is also carried out in other projects, which means that the operational processes of the OWFs are only minimally affected by the nature restoration activities. The oysters can then spread independently.

Geogenic and artificial reefs

The implementation of geogenic and artificial reefs as part of nature restoration in OWFs can take various forms. Different structures and technologies are available to promote biodiversity. The choice of appropriate measures depends on the target species to be supported by these activities.

For lobsters, for example, larger, reef-like structures have proven to be particularly beneficial. Pilot projects show that lobsters also thrive in the scour protection structures around the foundations of OWFs. In the Dutch project "The Rich North Sea" in the Borssele 1 & 2 wind farms, pipes of various sizes were used, and it was observed that lobsters use these artificial structures as habitat. Another example comes from Denmark, where 3D-printed reefs were integrated into the wind farm as part of an ORSTED wind farm project to support the declining cod population. The stones and artificial reef structures are placed using ships equipped with lifting arms. These enable the materials to be deposited on the seabed.

Efficient monitoring, for example using camera systems, reduces the need for regular physical inspection visits, thereby minimizing disruption to the OWF's operation and maintenance activities.

In order to make efficient use of OWF sites for nature restoration projects, these measures should be taken into account as early as the planning phase. In other countries, such as the Netherlands, these criteria are included as part of the non-financial factors in the tendering process. Such integrative planning approaches ensure that ecological measures are integrated into the utilization concepts on an equal footing from the outset.

One key aspect that needs to be investigated further concerns the impact of dismantling offshore wind farms at the end of their operational life. The current position is that all non-natural substrates, including artificial reefs, will be removed, which could have a negative impact on newly created or restored habitats such as oyster beds and stone reefs. If the wind farms are repowered, this could destroy the habitats that have already been restored. This would not only have negative ecological consequences for the marine environment, but could also have political consequences, particularly with regard to compliance with EU requirements and international obligations.

Safety aspects

Safety concerns: During nature restoration measures, such as monitoring or releasing organisms, ships need to operate in close proximity to the wind turbines. This proximity increases the risk of collisions or other accidents, especially in adverse weather conditions or limited visibility. Another risk is that vessels involved in nature restoration measures may have to move in close proximity to the wind turbines and underwater cables.

Safety requirements: Special safety requirements are necessary to address these risks. Vessels operating in OWF areas must have modern navigation systems and precise position monitoring to ensure safe approach to the turbines. In addition, safety zones should be established around the wind turbines, where vessel movements are particularly regulated and monitored.

It is important that ship crews are trained in dealing with the specific conditions in OWFs in order to minimize risks. A coordination system between wind farm operators and those responsible for nature restoration should ensure that the operation of ships and turbines is harmonized to reduce potential hazards.

Socio-economic aspects

Nature restoration measures do not offer OWF operators any immediate financial benefits, but could bring long-term economic returns for society. According to the EU impact assessment, every euro invested in restoration generates a return of between €8 and €38, depending on the ecosystem in question. In addition, the multi-use of nature restoration and OWFs offers opportunities for greater acceptance of offshore wind and contributes to the social responsibility of operators.

As there is no direct business model for offshore wind farm operators, these measures are dependent on external financing. In Germany, a percentage of the auction proceeds from offshore wind farm licenses is to be allocated to marine conservation and environmentally friendly fishing, including structural measures. For tenders from 2023 onwards, the marine conservation component amounts to 3.125% of the bid for centrally pre-surveyed sites or the total amount of the second bid component for non-centrally pre-surveyed sites, while the fisheries component amounts to 1% and a 5.875% transformation component is to be paid (Sections 23, 58 WindSeeG). With regard to fisheries, this is intended to contribute to the acceptance of the further expansion of offshore wind energy. Nature restoration measures therefore benefit in particular from the marine nature conservation component, which is intended to contribute to the preservation and achievement of the best possible condition of the sea and, at the same time, to the acceptance of the further expansion of offshore wind energy. In addition, the EU plans to provide member states with over €100 billion for biodiversity-promoting measures as part of its multiannual financial framework (2021-2027).

Environmental aspects

Both geogenic and artificial reefs form three-dimensional structures that create valuable habitats for numerous marine organisms. Their restoration in the German EEZ contributes significantly to promoting biodiversity by supporting the food web and ecological functions in marine ecosystems. In addition, oyster reefs stabilize the seabed and help improve water quality by filtering suspended solids and nutrients.

When nature restoration measures are implemented in OWF areas, these areas can be viewed by society as places of both energy production and ecological improvement.

In the context of multi-use, the issue of decommissioning should also be considered. It is important to investigate when remaining structures can contribute to a healthier habitat after a wind farm has been decommissioned and when it makes sense to remove them to avoid negative environmental impacts.

Conclusion and outlook

Nature restoration in offshore wind farms offers a promising opportunity to combine the expansion of renewable energy with the protection and restoration of marine ecosystems. Projects to reintroduce oysters and restore geogenic reefs show that these areas can be not only places for energy production, but also important habitats for marine species.

Both spatial and seasonal planning play a crucial role in successfully establishing species such as the European oyster. In offshore wind farm areas, the environment currently benefits from being fishing-free zones, which supports the protection of sensitive habitats, primarily by excluding bottom-contacting, active fishing methods. While active fishing has a significant impact on the marine environment, passive fishing, such as traps or fish traps, has a much lower impact on the seabed and surrounding ecosystems.[243] In passive fishing, however, the anchoring of fishing gear to the seabed must be taken into account. This is done using small to medium-sized weighted anchors, which can cause slight damage to sessile hard substrate organisms living on the seabed in very limited areas. Even though passive fishing has a partially negative impact on biodiversity due to the anchoring and removal of organisms, its lower and, above all, locally limited impact compared to active fishing means that it can potentially be combined with nature restoration measures. Nature restoration, for example through the establishment of oyster beds, has a positive impact on biodiversity. Increased biodiversity can in turn benefit catch rates in passive fishing, as long as populations are not fished beyond their maximum sustainable yield.

In the future, it will be important to reconcile the functionality of restoration measures with the operational processes of wind farms and to develop innovative approaches that maximize ecological benefits. The question remains as to what extent human-made structures can contribute to a healthier marine habitat in the long term after the wind farms have been dismantled. In the long term, such measures could contribute not only to promoting biodiversity, but also to the social acceptance of offshore wind farms, which could further advance the expansion of wind energy.

243 Partially exempt from this is the use of fixed nets, which is less recommended, even though they are superior to active fishing in some environmental aspects and approaches to minimizing bycatch are currently being developed.

2.10. Shipping (recreational traffic)

As already discussed in Chapter 1, this chapter deals in detail only with 'realistically' possible combinations of uses within OWFs. Therefore, this subchapter does not consider any aspects relating to commercial or passenger shipping. Aspects relating to additional ship movements caused by OWFs, either by maintenance or service vessels or by fishing or research, have been listed in these chapters. This chapter therefore only deals with recreational shipping.

Spatial requirements and seasonality of use

The spatial requirements of shipping are determined by a variety of regulations and technical factors. These requirements are determined, among other things, by ship types, traffic volume, and traffic density.

AIS (Automatic Identification System) data from 2022 was used for the spatial evaluation and analysis of shipping. AIS is a digital positioning system that operates in the VHF frequency range. Although smaller ships and recreational boats are exempt from the obligation to use AIS, they can participate in the system on a voluntary basis.

AIS data is continuously collected by both public authorities (such as the WSV) and commercial providers (e.g., FleetMon, Vesseltracker) and is usually offered for a fee. Due to the different focuses of the respective providers, the quality of the available AIS data varies. Based on the available data, traffic density plots were created for all existing forms of shipping. The raw data has not been explicitly cleaned up. Misidentification of ships can therefore lead to incorrect representations.

For each type of use, traffic density plots were then mapped and analyzed for the North Sea and Baltic Sea EEZs and as a "zoom-in" for areas EN2 and EN4. The OWFs contained in the areas can be seen in the following excerpts.

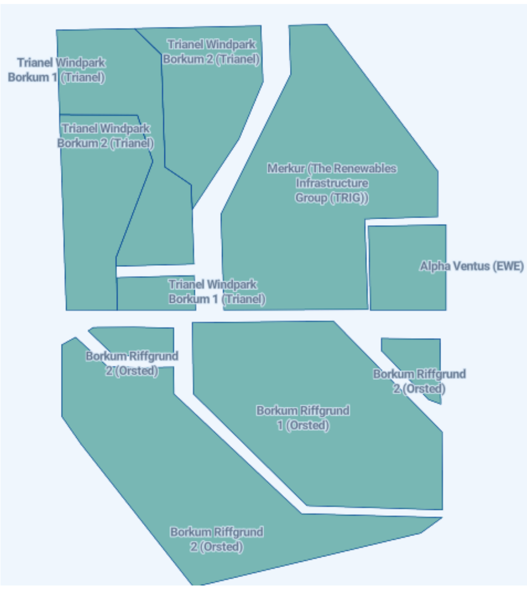
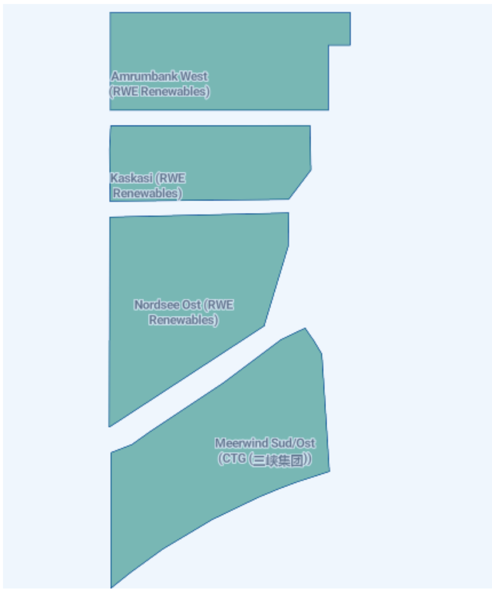
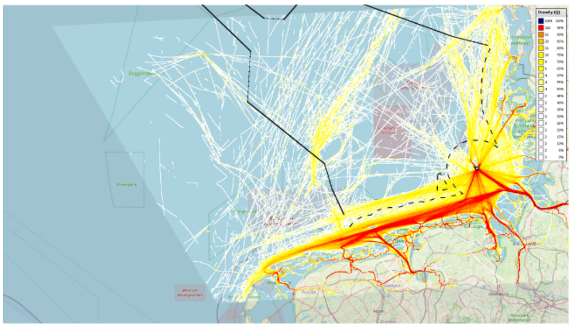
Priority area EN2	Priority area EN4
	

Figure 31 - Selected "zoom-in" excerpts of the traffic density plots for priority areas EN2 and EN4 and the OWFs identified therein. Source: Spinergie 2024

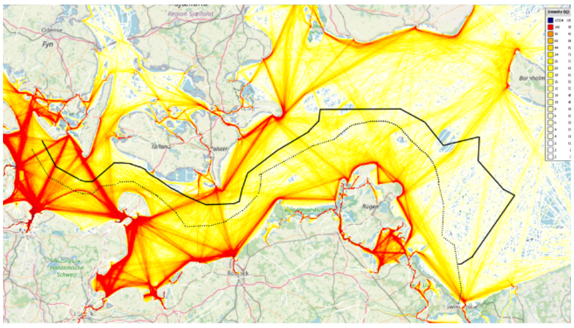
Recreational boat traffic is concentrated in the North Sea, particularly along the coasts and in the area of the North Sea islands (Figure 32[244]). A similar picture emerges in the Baltic Sea, where the increased density is particularly noticeable near the coast and between port locations. In general, the primary spatial distribution shows that the greater the distance from the coast, the lower the traffic density.[245] At present, the overlap with (potential) offshore wind areas is greater in the Baltic Sea region than in the North Sea in terms of spatial requirements.

Within the period under review, there is a significant volume of traffic along the boundaries of EN2 and EN4, whereby safety distances are generally maintained and the area is not crossed. However, recreational boats use the passage directly adjacent to the EN4 traffic safety zone in particular. The potential "demand" for passage through coastal wind farms can be derived on this basis. In this context, it should be noted that recreational boats are not required to be equipped with AIS – traffic density in this area may well be higher than indicated by the density plot. Isolated "outliers" that pass through the safety zone of offshore wind farms are most likely due to incorrect vessel identification.

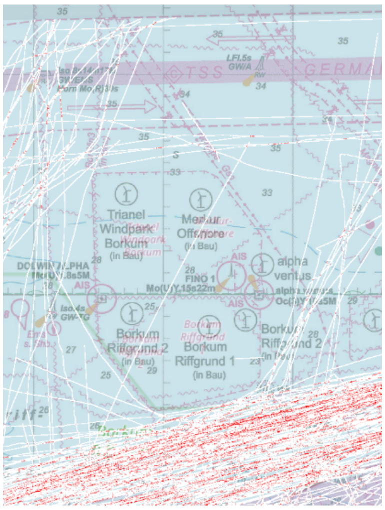
North Sea:



Baltic Sea:



Priority area - EN2:



Priority area – EN4:

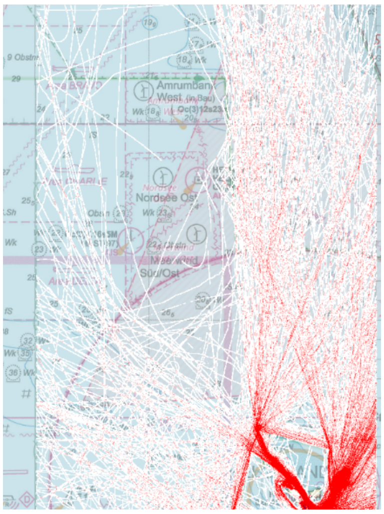


Figure 32 - Traffic density plots for recreational boating in the North Sea and Baltic Sea; priority areas EN2, EN4 (2022)

[244] *Note: The density maps and the associated color coding are dynamic. This means that the highest density is determined from the map section and the associated ship movements. This may lead to a false conclusion when comparing density maps.*

[245] *In this context, it should be noted that AIS reception quality in areas far from the coast may be more limited than near the coast. This can lead to a distorted representation of traffic density. Nevertheless, the result and the key message can be considered plausible and, in this context, appropriate.*

Functional compatibility and technical feasibility

In principle, according to Section 74 (1) sentence 1 WindSeeG, a safety zone of up to 500 m around individual facilities within the meaning of WindSeeG is established in the status quo. The creation of safety zones serves to ensure the safety of shipping and facilities. A safety zone established in accordance with Section 74 (1) WindSeeG is also considered a safety zone within the meaning of Section 7 (1) of the Ordinance on the International Regulations for Preventing Collisions at Sea (KVRV) and may therefore not be navigated in accordance with Section 7 (2) KVRV.[246]

Vessels used to supply the facilities, such as maintenance and service vessels, are exempt from the navigation ban. Vessels with a hull length of no more than 24 m (this size generally marks the boundary between large and small vessels in maritime law) are also exempt due to their lower risk potential.

The GDWS pursuant to Section 7 (3) sentence 2 KVRV specifies the exact requirements and conditions for the exemption of vessels with a hull length of up to 24 m. Which exemptions from the navigation ban are possible and under what conditions they can be granted depends on the circumstances of the specific individual case and cannot be assessed in purely abstract terms.

Recreational boats are generally small and maneuverable and therefore largely fall under the category of small craft with a hull length of no more than 24 m. They are therefore considered agile with corresponding maneuverability in OWFs. They thus tend to pose a lower risk. Accordingly, they may be exempt from the navigation ban in safety zones,

Subject to compliance with various safety requirements (seeSafety aspects), functional compatibility between OWFs and recreational boats is entirely conceivable. The combination is already permitted in some countries, such as Denmark (see WP2). In Germany, there is a partial exemption from the navigation ban and permission for passage for vessels with a maximum length of 24 m, for example in the EnBW Baltic 1+2 parks. However, this is only permitted under certain conditions, such as direct passage through the safety zone and the obligation to use AIS data transmission. Anchoring or mooring at the wind turbines is prohibited, and there are clear regulations/restrictions regarding weather conditions such as visibility and wind strength.

In principle, OWFs with a greater distance between wind turbines (mainly offshore OWFs) are considered to be lower risk in terms of collision risk. On the other hand, weather conditions near the coast may be less severe for recreational boats.

Safety aspects

The GDWS has so far pursued a regulatory concept that applies a very high statistical safety standard and therefore generally provides for only a few exceptions to the ban on navigation in safety zones.[247]

According to the GDWS's previous practice, the general orders issued on the basis of Section 7 (3) KVRV include the following regulations:

- Complete ban on navigation with the exception of vehicles and equipment used for the construction and equipping of the project or for the fulfillment and monitoring of compliance with the obligations incumbent on the contractor;
- Obligation to use a functional AIS;

246 See Ehlers, Recht des Seeverkehrs (Law of Maritime Transport), 2nd edition, 2022, KVRV § 7 Rn. 1 f.

247 See BT-Drs. 19/17344, February 24, 2020, p. 172.

- Prohibition on mooring at facilities;
- Requirements for behavior in traffic;
- Obligation to pass directly through the safety zone;
- Specific distance regulations for individual facilities.[248]

If a recreational boat has a maximum length of 24 m, it can generally be exempted from the navigation ban (see chapter 2.1). Based on the regulatory concept of the GDWS, passage is generally possible, taking into account the above-mentioned aspects.

Recreational boat operators potentially have less nautical experience and knowledge and lack routine compared to professional mariners – this increases the risk of navigation errors and collisions with wind turbines and other vessels. These safety concerns are addressed by regulations governing behavior in traffic and the obligation to pass directly through the safety zone.

Recreational boats are not required to be equipped with AIS, which would severely limit visibility and communication within the OWF – therefore, in the case of a navigation permit, the use of a functional AIS is mandatory. The activity of recreational boats within OWFs can hinder construction and maintenance work, thereby increasing the risk of accidents or collisions. Recreational boats tend to be smaller and less stable in extreme weather conditions – sudden weather changes and/or high waves pose an increased risk in OWFs. Offshore OWFs have a greater distance between wind turbines, but the probability of extreme weather conditions is higher. Reference is made once again to theSpatial requirements and seasonality of use of recreational boats. Specific distance regulations for individual facilities must continue to be observed.

Socio-economic aspects

The combination of recreational traffic in OWF may open up new opportunities in the field of tourism, with the possibility of marketing wind farms as part of the tourist offering and raising environmental awareness.

On the other hand, recreational boats are not required to be equipped with AIS. If passage through safety zones is permitted, AIS equipment is mandatory. This is a cost factor that recreational boat operators must take into account. In addition, possible additional safety measures on the part of the OWF operator could also reduce the economic efficiency of such co-use.

Conclusion and outlook

Due to the small size and flexibility/agility of **recreational boats**, the combination of recreational traffic in OWFs could be compatible, provided that the navigation ban is adjusted, as exceptions must currently be examined on a case-by-case basis – standardization of regulations appears sensible.

In this context, clear safety precautions must be taken to minimize collision risks and ensure navigational safety. Practice already shows multi-use in selected OWFs in Germany under certain requirements.

The smaller and more agile the vehicle and the less time-critical the purpose of the type of use, the more likely it is that concerns can be addressed through comprehensive safety concepts and requirements. This assumption is also reflected in the regulations governing navigation in safety zones, which currently not only exempt maintenance and service vehicles, but also generally

248 See the list of general rulings of the GDWS at: https://www.elwis.de/DE/Seeschifffahrt/Offshore-Windparks/Offshore-Windparks-node.html.

allow vehicles with a hull length of no more than 24 m to be exempt from the navigation ban due to their lower risk potential. In addition to fishing, this also applies to recreational boats.

However, which exceptions to the traffic ban are possible and under what conditions they can be granted depends on the circumstances of the specific individual case and cannot be assessed in purely abstract terms. Standardization of the regulations would be useful in this context.

2.11. Existing conditions

Spatial requirements and seasonality of use

Sunken ammunition

There are considerable quantities of old munitions in the German EEZ that were dumped in the sea after the world wars. Estimates put the amount at hundreds of thousands of tons of conventional and chemical munitions. Much of this contaminated material is difficult to locate, as the dumping sites were often inaccurately documented. This ammunition poses an ongoing threat to maritime activities such as offshore wind farms and requires regular surveys and recovery measures to minimize risk.

The OWFs planned in the SDP24 draft do not overlap with known munitions dumping sites, but there is a risk that munitions may also be present at previously unknown or undiscovered locations on the seabed. Before construction work begins, surveys of the seabed will therefore be carried out to identify and remove any ammunition that may be found. Preliminary surveys for offshore wind farm areas focus on hydrographic analyses of the seabed. Bathymetric data and results from side-scan sonar and magnetometer surveys are compared and, if necessary, verified by ROVs. However, a comprehensive search for obstacles, wrecks, or explosive ordnance is not planned as part of these investigations. A comprehensive investigation only takes place as part of a central preliminary investigation. In the case of an investigation of the site by the wind farm operator (for example, in acceleration areas), seabed investigations are often only carried out in the immediate vicinity of the planned turbine locations and cable routes for economic reasons.

This can lead to problems later on if further use – such as aquaculture or research – is to be integrated into the wind farm area. In such cases, an additional seabed survey would be necessary to identify potential hazards such as munitions contamination. If it is already known before the wind farm is built that a multi-use approach is planned, it would be more efficient from a planning and economic perspective to carry out a more comprehensive seabed survey at an early stage. This would ensure that potential risks for future uses are minimized and safety is guaranteed for all parties involved.

However, it should be noted that early investigation and, if necessary, salvage of munitions contamination entails considerable financial expenditure. These costs could represent a significant burden for additional users such as aquaculture operators or research institutions. The key question of who bears the costs should therefore be clarified at the planning stage in order to avoid financial overburdening. It makes sense to establish clear regulations that take into account the interests of both offshore wind farm developers and potential future users.

In the coming years, the recovery of old munitions in German seas will become increasingly important. The federal government has now pledged €100 million from the federal budget to fund the Federal Environment Ministry's "Immediate Action Program for Old Munitions in the North Sea and Baltic Sea," thereby setting the course for the systematic clearance of old munitions in German seas.

Underwater cultural heritage

The underwater cultural heritage (UCH) in the German EEZ includes a large number of sunken artifacts, including shipwrecks and prehistoric settlements. These sites are of great historical and cultural significance, but at the same time pose spatial challenges for the development of OWFs. There are approximately 3,000 reported shipwrecks in German waters, in addition to 142 prehistoric sites in coastal waters that may extend into the EEZ.

Since many of these UCH sites are inadequately mapped or still undiscovered, there is a risk that planned construction projects will unexpectedly encounter culturally valuable sites. In such cases, agreements on how to proceed have been made with the state authorities responsible for archaeology and monument protection in Lower Saxony, Schleswig-Holstein, and Mecklenburg-Western Pomerania, although these authorities have not yet been officially designated as responsible for the EEZ. Archaeological investigations must therefore be carried out at an early stage to determine the location of such sites and, if necessary, avoid them. Similar to contaminated munitions sites, in the case of a planned OWF, the UCH is only recorded in the context of hydrographic surveys for soil protection in the course of preliminary investigations.

Functional compatibility and technical feasibility

Sunken munitions

For the functional and technical compatibility of OWFs and the recovery of munitions, it is crucial that wind turbines are not erected near munitions sites. These contaminated sites pose a significant safety risk, which is why a thorough investigation of the seabed is necessary before constructing an OWF in order to locate and, if necessary, recover any munitions. Common methods for ammunition recovery include initial probing and identification using magnetometer scans and camera recordings by ROVs, which enable systematic and non-invasive investigation of the seabed. In addition, chemical analysis through water sampling can further assist in the detection of underwater ammunition.

Once identified, the munitions are recovered either by salvage on land or by controlled underwater detonation. Salvage of munitions contamination is one possible disposal measure, but it is complicated by severe corrosion and damaged or missing casings. Some ignition systems are still functional, while others are unusable, making it difficult to accurately assess the potential danger. Therefore, every find must be assumed to be dangerous and appropriate safety measures must be taken. In July 2024, the recovery of war ammunition from the Baltic Sea will begin at three locations in the Bay of Lübeck. New technologies, including remote-controlled underwater vehicles, will be used to safely recover various types of ammunition. The project aims to develop a floating platform by 2026 to systematically recover and dispose of old ammunition.

In some cases, however, targeted detonation is necessary, depending on the type of ammunition and its location. Bubble curtains can reduce sound emissions and thus protect marine mammals. Detonations also require safety zones (depending on the type of ammunition) to protect surrounding infrastructure, such as offshore wind farms, from possible damage.

Underwater cultural heritage

The compatibility of OWFs and underwater cultural heritage poses a technical challenge. In many cases, the installation of foundations, cables, or other infrastructure can be complicated or prevented by the presence of UCH. Modern technologies such as ROVs and sonar devices are used to map the seabed and identify potential sites.

The laying of submarine cables or the construction of wind turbines should be avoided in areas where valuable cultural heritage sites are located. Accurate mapping of such sites is therefore essential in order not to jeopardize the technical implementation of OWF projects while protecting cultural heritage. In the event of discoveries, the procedure must be agreed upon with the relevant state authorities on a case-by-case basis.

Safety aspects

Sunken munitions

Sunken munitions pose a significant safety risk, not only to construction workers but also to the environment. The shells of the munitions corrode over time, which can release toxic substances such as TNT and ADNT, which are both carcinogenic and mutagenic. There is also always a risk of uncontrolled explosions, especially during construction work near contaminated sites. Therefore, comprehensive safety measures must be taken before construction begins to accurately determine the location of the ammunition and clear it.

Socio-economic aspects

Sunken ammunition

The removal of contaminated munitions from the North Sea and Baltic Sea offers economic potential. Private companies are already developing large-scale projects for the recovery and proper disposal of these contaminated sites. However, government support for the clearance of sunken munitions is also crucial. As part of the "Emergency Program for Contaminated Munitions in the North Sea and Baltic Sea," the German government has provided €100 million to finance pilot salvage operations and the development of specialized disposal platforms. This commitment aims to minimize both ecological and economic risks and find sustainable solutions to the problem of contaminated munitions. However, it should be noted that the financial support is not primarily intended to promote economic development, but is committed to protecting the environment and health.

Systematic mapping, monitoring, and recovery in the affected areas would not only increase safety but also pave the way for additional economic activities. Once these contaminated sites have been removed and the area is safe, other economic uses of the sea, such as aquaculture, could be established in these areas. This would not only create new economic opportunities but also expand the sustainable use of the sea. In the long term, optimized and coordinated munitions clearance could thus lead to the development of further economic potential beyond direct recovery. The contaminated sites described are mainly located in the coastal waters of the Baltic Sea; findings should already be available for the OWF in the Baltic Sea in the EEZ. There are unlikely to be any new wind farms beyond the status of the 2024 SDP draft. The above-mentioned program will probably not be relevant for the North Sea EEZ and the additional OWFs planned there. Ammunition recovery is currently still in the hands of the project developers, who have to bear the costs.

Underwater cultural heritage

The recovery and preservation of underwater cultural heritage involves considerable costs. Modern recovery operations, especially for complex and large-scale wrecks, can cost between USD 317 million and USD 1 billion. These enormous expenses make it clear that it is more economically efficient to carry out detailed investigations in advance of offshore projects, such as the construction of wind farms, in order to identify significant UCH sites and avoid them in the planning stage. Such early surveys not only minimize costs and risks, but also protect valuable cultural assets from damage.

A positive side effect is that the extensive investigations carried out as part of OWFs benefit the field of underwater cultural heritage. UCH experts benefit from these surveys, which they would not be able to carry out themselves due to a lack of financial resources. This creates new opportunities for discovering and protecting cultural heritage sites that would otherwise have gone unnoticed.

Conclusion and outlook

Dealing with munitions contamination and underwater cultural heritage is crucial for the construction of OWFs. Thorough surveys of the seabed minimize risks, protect historical sites, and create the necessary knowledge base to allow future uses such as aquaculture in OWFs. Integrating munitions clearance and cultural heritage protection into OWF planning can bring long-term ecological, cultural, and economic benefits. A coordinated approach is essential for the safe and sustainable use of marine space.

3. Other multi-use combinations

3.1. Aquaculture

The decision on what other uses are permitted in an OWF often implies the exclusion of other possible secondary uses. As discussed in Chapter 2, the no-fishing zone within OWFs is currently used for compensation purposes and thus already represents a 'use' in the broadest sense.

It is therefore very important not only to consider the possible combinations of secondary uses with OWF, but also to discuss the extent to which these secondary uses can be combined with each other and, if necessary, develop synergies or conflict with each other.

The example of area passports from the Netherlands shows that areas are not only made available for a single secondary use, but that several secondary uses are permitted (albeit sometimes at other locations within the OWP).

Aquaculture and aquaculture (integrated multi-trophic aquaculture (IMTA)

IMTA is an innovative method for efficiently farming both low-trophic and high-trophic species in offshore environments. It combines organisms at different trophic levels to use waste products from high-trophic species (feces, feed residues) as nutrients for low-trophic species. For example, salmon that are farmed in cages and produce waste can be combined with mussels and algae, which filter this waste and absorb it as nutrients.

As shown in Figure 33, farmed fish are kept in nets or cages and actively fed 1, and their excrement usually overfertilizes the environment (eutrophication). This can be prevented by keeping other organisms in the direction of the current 2, which utilize the excrement. Shrimps, crabs, or sea cucumbers 3 kept in cages eat sinking feces and food particles. Mussels 4 filter out smaller particles. And their excrement in turn benefits algae and invertebrates.

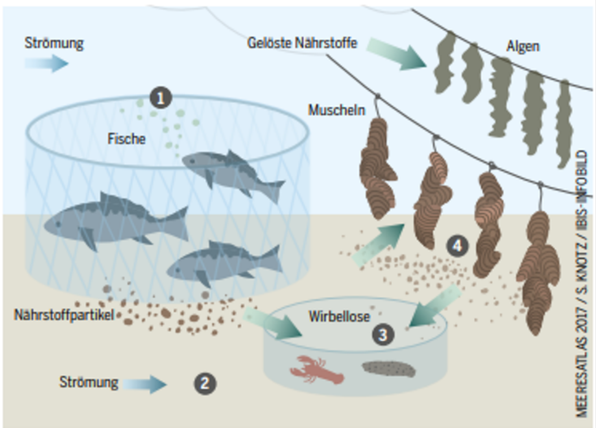


Figure 33 - Petra Böckmann – Meeresatlas – Daten und Fakten über unseren Umgang mit dem Ozean – 2017, p. 12, https://www.boell.de/sites/default/files/web_170607_meeresatlas_vektor_v102_1.pdf.

This form of aquaculture enables more efficient use of resources and helps to minimize or even offset the negative effects of high-trophic farming (dumping of nutrients). Another important aspect is the origin of the fish feed and its ingredients, as there are currently no alternatives to fish oil on the market. Despite its nutrient neutrality, the cultivation of highly trophic components should be critically reconsidered. Low-trophic organisms such as mussels and algae improve water quality by absorbing nutrients from the water that could otherwise lead to overfertilization and pollution. IMTA can play a role in compensating for environmental impacts due to nutrient inputs. As described in the chapter "Legal framework," other forms of multi-use such as mariculture (aquaculture) are possible in OWF, but they may need to be compensated for if significant negative environmental impacts are expected.

Aquaculture and energy (floating solar and wave energy installations)

The combination of floating solar and wave energy plants and low-trophic aquaculture offers an innovative concept for the sustainable use of marine and solar resources. This integrated approach could not only contribute to the generation of renewable energy, but also protect the environment and create economic benefits.

Synergies from this multi-use arise from the dual use of the sites and the use of energy by feeding it into the power grid and to cover the energy requirements of aquaculture, e.g., for sensors. Mussels and fish could be cultivated under the solar panels, and algae could be planted in unshaded areas and next to wave power plants. The structure of the solar installations offers protection and a place of refuge, which can have a positive effect on fish growth and is similar to the natural design of fish enclosures.

Offshore wind farms also provide a structured environment that can serve as a refuge for fish species. These fish can later be caught by fishermen, which supports sustainable fishing. Combining these uses maximizes space efficiency and minimizes competition for marine resources.

Wave power plants can be scaled from laboratory size to very large installations and can be adapted to local conditions and needs. Wave power plants have also been designed solely for supplying energy to aquaculture facilities.

From an economic perspective, floating solar plants and wave power plants offer a stable source of income for investors. Additional income streams are created when the site is also used for aquaculture by an operator. Diversifying income sources can make operators more resilient to economic fluctuations.

Despite the promising opportunities, there are challenges that need to be addressed. The planning and approval of such integrated projects requires close cooperation between various stakeholders, including authorities, environmental organizations, and operators. Careful examination of the environmental impact and clear regulation of land use are crucial to avoid conflicts between the different forms of use.

Overall, the combination of floating solar or wave energy installations and low-trophic aquaculture represents a promising solution for generating renewable energy while sustainably using marine resources. Through integrative management, the benefits of these synergies can be maximized and negative impacts on the environment minimized.

Aquaculture (algae, fish, shellfish) and defense (maritime surveillance) or research (mobile research)

Marine aquaculture in the Exclusive Economic Zone (EEZ) creates a valuable basis for the integration and connection of mobile research and security policy synergies through the integration of fixed structures for the cultivation of algae, fish, and shellfish. Fixed installations used for marine aquaculture can be ideally supplemented with sensor technology and surveillance systems that can ensure seamless maritime surveillance. Such multifunctional use also brings various economic advantages. On the one hand, the shared infrastructure leads to considerable savings in investment and maintenance costs, as separate installations for aquaculture and research or surveillance are no longer necessary and can be replaced by a single system. On the other hand, aquaculture strengthens the economy by creating new jobs, both directly in breeding and processing and in the areas of maintenance, monitoring, and research support, which require high-tech knowledge and specialized training.

The close integration of aquaculture and research also creates ecological benefits, which in turn promote the economic efficiency of farming. For example, algae and mussel farming improve water quality, which has a positive effect on fish stocks and yields. Comprehensive monitoring of environmental conditions—such as temperature, currents, and water quality—by integrated monitoring systems makes resource management more efficient and enables more precise control of aquaculture processes. This not only creates ecological and security policy benefits, but the combination of aquaculture and mobile research or defense can also boost the economy and thus contribute to competitiveness. However, it must be borne in mind that, for reasons of national security, the shared use of infrastructure or the support and maintenance of sensors may not be desirable, which, incidentally, also applies to other forms of use involving sensor technology.

Aquaculture (algae, fish, mussels) and CCS or aquaculture (fish) and hydrogen production

A promising combination results from the parallel use of aquaculture above CO_2 storage sites in the German EEZ. CO_2 is stored in deeper geological formations beneath the seabed. Spatially delimitable uses, in particular uses of the water column, can take place above the storage sites, provided that they do not interfere with the infrastructure necessary for CCS transport, injection, and monitoring, or that the relevant sites are left free. This means that aquaculture facilities such as algae, mussel, and fish farms could use the same marine areas as storage sites. The shipping required to supply aquaculture facilities is also possible, and the anchoring of aquaculture facilities is considered to be compatible without any problems. e use of the areas opens up economic synergies, as both technologies could access shared infrastructure such as moorings or supply lines. At the same time, e parallel use of space creates an ecologically and economically efficient approach that makes sustainable and versatile use of the space in the sea.

The combination of fish farming and hydrogen production shows additional potential economic synergies. Hydrogen production will release oxygen as a by-product, which can be useful for fish aquaculture by introducing the oxygen into the aquaculture facilities, thus compensating for and preventing possible oxygen minima, which can lead to better fish growth. In addition, controlled fish farming offers the opportunity to use the heat and energy generated during hydrogen production to create an ideal habitat for the fish, thus accelerating their growth in a warmer environment. In the EEZ, however, the control and care required for fish farming must always be taken into account in order not to jeopardize animal welfare. It is therefore necessary to critically examine whether fish aquaculture is generally feasible in remote areas of the EEZ.

Conclusion and outlook

The concepts presented for integrating aquaculture with other uses such as renewable energies, CO_2 storage, and research demonstrate the potential for multi-use. These approaches can maximize land use efficiency, create economic synergies, and promote ecological benefits.

Integrated multi-trophic aquaculture (IMTA) is an innovative method that not only optimizes resource use by combining low-trophic and high-trophic organisms, but also reduces negative environmental impacts such as eutrophication. The integration of floating solar and wave energy installations with aquaculture also enables dual use of marine sites, producing energy and improving water quality.

Linking **aquaculture with CO_2 storage** or hydrogen production also opens up economic and environmental benefits. These combinations allow for the efficient use of shared infrastructure and offer innovative solutions for creating ideal breeding conditions. Nevertheless, technical, legal, and environmental challenges must be taken into account.

Particularly noteworthy is the possibility of combining **aquaculture with research** and **maritime surveillance**. The shared use of infrastructure can reduce investment costs and improve the efficiency and sustainability of aquaculture through continuous monitoring. At the same time, integration with security policy applications could create new jobs and strengthen economic competitiveness.

Nevertheless, the implementation of such integrated approaches requires careful planning, close cooperation between all stakeholders, and a comprehensive assessment of environmental and social impacts. Only through integrative and sustainable management can the benefits of multi-use be maximized and potential conflicts minimized. The future of marine use lies in the sensible combination of technologies and approaches to achieve both ecological and economic goals.

3.2. Carbon Capture and Storage

CCS and other uses

As described in detail in Chapter 2.4, CCS is a technology for reducing CO_2 emissions in which CO_2 is captured from industrial processes and stored long-term in geological formations. The successful implementation of CCS requires specialized capture facilities, a suitable transport infrastructure – usually pipelines or ships – facilities for injecting and compressing the CO_2, monitoring systems, and suitable underground storage sites.

There is currently one commercial CCS project in Europe, in Norway, supplemented by pilot projects in Denmark and the Netherlands. Despite this progress, however, knowledge about the integration of CCS into existing and planned marine uses is still limited. A detailed assessment of the compatibility of different forms of use is therefore not yet possible. Further research is needed to identify potential conflicts of use and to address technical and safety-related challenges in a targeted manner.

For a sound assessment of the compatibility of CCS with other marine uses, it is crucial to distinguish between underground CO_2 storage and above-ground CCS infrastructure. CO_2 is stored in deep geological formations, approximately 1000-4000 meters below the seabed. At this depth, interference with other marine uses is largely ruled out, so that underground storage can generally be considered compatible with other uses. Nevertheless, monitoring measures are necessary to monitor seismic activity and ensure the long-term integrity of the storage site. These monitoring measures could be affected by existing maritime infrastructure used for other purposes. In addition, there is a low risk of minor earthquakes induced by CO_2 injection, which could potentially affect the integrity of neighboring infrastructure.

The above-ground infrastructure for CO_2 injection, on the other hand, poses greater challenges. Depending on the technology used, a platform may be required that occupies a safety zone, thus restricting the use of the surrounding space by other actors. CO_2 can be transported either by ship or pipeline. In the case of pipeline transport, burying the pipes offers a way to avoid impacting ground-level activities such as fishing. Further details on the pipe infrastructure can be found in the relevant chapter.

CCS and defense

When planning CCS in connection with military interests, there are important aspects that must be taken into account. In general, military firing ranges cannot be combined with fixed infrastructure such as injection platforms or other maritime facilities. Such structures could interfere with military exercises and maneuvers and pose a security risk. Therefore, no CCS infrastructure should be built in military training areas. The use of sensors to monitor storage sites must be compatible with national defense security interests, which can prove to be a point of conflict, especially in the case of passive seismic monitoring (Chapter 3.7.). Another safety risk is leakage from CCS, as the rising bubbles interfere with the use of sonar. However, the risk of CCS leaks is considered to be very low and also locally limited.

Conclusion and outlook

Due to its depth of around 2000 meters, underground CO_2 storage is fundamentally compatible with other marine uses. Nevertheless, comprehensive monitoring measures are necessary to monitor seismic activity and ensure the long-term safety of the storage sites. Above-ground infrastructure, such as platforms or pipelines, poses greater challenges, as it requires safety zones and can restrict the use of the surrounding area by other actors.

Storage infrastructure is particularly incompatible in military training areas, as fixed installations can hinder military exercises and pose a safety risk. Overall, the integration of CO_2 storage into the German EEZ requires further scientific investigation in order to overcome technical and safety-related challenges and ensure compatibility with other uses. Particular attention should be paid to the conflict between security interests and the use of passive sensor technology to monitor storage sites.

3.3. Fisheries

Fishing (pelagic trawling) and defense (maritime surveillance) or research (mobile research)

Active fishing is a mobile and temporary use of an area. Therefore, this type of use can be combined with stationary uses such as sensor technology for maritime surveillance through specific regulations, such as switched-on AIS. Fishing vessels in offshore areas are required to operate with their AIS systems switched on, making them easily detectable for maritime surveillance.

Active fishing that does not touch the seabed can also be combined with stationary and mobile research. Even fishing that touches the seabed can be combined with scientific data collection using specially developed sensor systems. (https://literatur.thuenen.de/digbib_extern/dn069205.pdf)

Fishing (passive) and pipelines (data cables, pipelines, power cable systems)

The combination of passive fishing and pipeline systems—such as data cables, pipelines, and power cables—in the same marine areas requires specific technical and organizational measures to protect both ecological and economic interests.

Passive fishing gear such as fish traps, which are often permanently positioned in one location, can be anchored and aligned in such a way that they neither endanger the cables and pipelines nor are damaged by them. This requires careful planning of the positioning and anchoring of the fishing gear in relation to the existing pipeline systems.

Securing the pipeline systems by laying them deep in the seabed or covering them with protective covers significantly reduces the risk of mechanical damage. For data and power cables as well as pipelines, sufficiently deep laying is crucial to avoid potential interaction with fishing gear. In addition, such laying ensures that interference from ocean currents or anchor movements is reduced, which minimizes maintenance costs in the long term and increases operational safety.

Close coordination between fishing companies and cable system operators can achieve operation in the EEZ that takes both uses into account and conserves the respective resources. Predefined zones for anchoring and distances from cable routes can also serve as supporting measures here. Overall, the parallel use of the EEZ by passive fishing and pipeline systems represents a model for the multifunctional use of marine areas.

Fishing (passive) and defense (maritime surveillance) or research (mobile research)

Passive fishing can be carried out sustainably and offers potential for meaningful synergies with mobile research. As already demonstrated in active fishing (HyFive project[249]), the installation of sensors on passive fishing gear enables the collection of valuable data on environmental parameters such as temperature, oxygen content, currents, and the general state of marine ecology to supplement mobile research efforts. By combining passive fishing with mobile research units, this data can be continuously collected and analyzed, providing crucial insights into the marine environment and, for example, the dynamics of fish stocks. This data is valuable for the sustainable management of fisheries and also provides scientific insights that can contribute to the further development of fisheries ecology methods and environmental protection.

In comparison, combining passive fishing with maritime surveillance could offer additional safety benefits, for example by integrating echolocation devices to monitor ship traffic and detect intruders early on. However, some uses may not be desirable due to security concerns and confidentiality. Since surveillance systems often collect sensitive information and security data, security policy interests may argue against the simultaneous use of fishing infrastructure in order to prevent unauthorized disclosure or access. There is already good cooperation between the military and science on the joint use of data. Combining this with mobile research is therefore an uncontroversial yet valuable alternative that supports both the economic and scientific use of the EEZ in a sustainable manner.

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249 https://literatur.thuenen.de/digbib_extern/dn069205.pdf https://www.thuenen.de/de/fachinstitute/ostseefischerei/projekte/fischerei-surveytechnik/hydrography-on-fishing-vessels-hyfive

Fishing (bottom trawling) and pipelines (data cables, pipelines, power cable systems) or research (mobile research)

There are concepts for how bottom trawling could take place over pipelines. Minimum depths in the seabed for laid cables are a key issue here. However, the additional costs of laying the cables at greater depths must be taken into account. There is no practical experience of bottom trawling over cables over a longer period of time, so the possible exposure and damage to cables as a result of this use cannot be completely ruled out.

Depending on the type of mobile research, bottom trawling may take place in the same area. However, the vast majority of research questions and measurement data are not affected by bottom trawling.

Conclusion and outlook

The forms of use and possible combinations of fishing with other maritime activities presented here show that multifunctional use of the EEZ is possible through careful planning, technical adjustments, and clear regulations.

Active fishing can be easily combined with stationary uses such as maritime surveillance or mobile research. Thanks to the obligation to use AIS systems, easy integration and monitoring is guaranteed.

Passive fishing also offers great potential for synergies, in particular through the possibility of equipping fishing gear with sensors to provide data for research. This combination contributes both to the sustainable management of fisheries and to the further development of scientific methods. Cooperation with pipeline systems such as cables and pipelines is also possible, but requires precise coordination and technical protective measures to minimize ecological and economic risks.

Bottom trawling poses particular challenges, especially near pipeline systems. Laying cables at greater depths can reduce potential conflicts, but entails additional costs.

Overall, it is clear that multifunctional use of the EEZ can be achieved through cooperation, technical innovation, and targeted zoning. At the same time, specific challenges remain, for example in combination with sensitive defense applications, which are often restricted for security policy reasons. The focus should therefore be on solutions that optimize both the ecological and economic potential of marine areas.

3.4. Research

Mobile research and cables

Conflicts between mobile research and underwater cables arise in particular when trawl nets are used in fisheries research, as nets can collide with cables or pipelines and damage them. This conflict is similar to that with bottom trawling, which was discussed in the previous chapter. Such conflicts can be avoided by burying the cables or carefully planning research activities and cable laying. This is particularly relevant in the case of the Thünen Institute's long-term fisheries research, especially where there are international obligations to continue monitoring time series.

Mobile research and defense

Mobile research can also take place in areas designated as military training areas, provided that certain aspects are taken into account. Close coordination with the national defense authorities is essential, particularly when research installations or measurements detect acoustic, optical, optronic, electronic, electromagnetic, magnetic sensor, or seismic signatures. As part of its national responsibility, the military in particular has a legitimate interest in ensuring that sensitive information about military projects, especially training projects and procedures, as well as signatures of submersible and surface vessels, remain confidential. In addition, coordination of usage is required to take into account the navy's planned training operations. Research activities in these areas must therefore be planned and carried out in such a way that security and confidentiality requirements are fully met.

Conclusion and outlook

Mobile research in maritime areas poses challenges, particularly with regard to underwater cables and military training areas. Conflicts with cables, for example in fisheries research, could possibly be avoided by measures such as burying and/or shielding the cables. In military training areas, close cooperation with the relevant authorities prior to planning is therefore essential in order to meet security and confidentiality requirements. Precise coordination in terms of timing and content enables successful coordination between research and defense. Forward planning and cooperation can effectively minimize potential conflicts between mobile research and other land use claims.

3.5. Cables

Submarine cables and shipping

The following types of submarine cables should be examined in more detail in combination with shipping routes:

Communication cables: These cables are used to transmit data and telecommunications signals over long distances. They consist of several fiber optic cables protected by a layer of plastic, a steel casing, and often a copper or aluminum layer to supply power to the repeaters (signal amplifiers).
Power cables: These cables are used to transport electrical energy over long distances, e.g., between the mainland and islands or between different countries. They consist of electrical conductors, insulating material, and protective layers that are designed to function under high voltage and withstand the harsh conditions on the seabed.

To ensure the optimal route for laying and operating the cables, oceanographic, geological, environmental, and technical (latency for data cables) factors must be taken into account. In busy shipping lanes, there is an increased risk of ships damaging submarine cables when anchoring or becoming entangled in fishing gear. Therefore, cable bundling and protective measures should also be taken into account in route planning to ensure that areas can be fished without damaging the cables.

In water areas affected by fishing and shipping traffic, it is common practice to embed submarine cables to a water depth of 1000-1500 meters as a protective measure. The burial depth is around 0.5-1.0 meters below the seabed, but may be deeper in some specific locations where the anchors of commercial vessels penetrate much deeper. Submarine cables in deep waters (away from the risk of fishing gear and anchors) are usually laid directly on the seabed.

In addition, it is safer and more cost-effective to carry out maintenance and repair work on cables that are not located in busy areas, as there is less risk of collision with ships. Avoiding busy areas can also help to reduce the cost of laying and maintaining submarine cables.

Shared use of space leads to economic conflicts between cable operators and shipping, especially when ships damage cables with anchors or fishing activities. Damage can have a variety of consequences:

- Repair costs: Repairing submarine cables is technically complex and expensive, especially at great depths.
- Business interruptions: Damage can result in loss of income for cable operators due to interrupted data transmission.
- Insurance premiums: More frequent damage can lead to higher insurance premiums for cable operators.
- Navigation risks: Ship operators must avoid known cable locations at sea, which can restrict their route planning and lead to longer travel times.
- Damage claims and litigation: Disputes over liability can lead to lengthy and costly litigation.

There are international guidelines and treaties, such as the International Cable Protection Committee (ICPC) Convention, as well as national laws that outline the obligations of ships with regard to avoiding damage to cables.

Submarine cables and defense

Submarine cables in military training areas are particularly problematic if they are capable of detecting acoustic, optical, optronic, electronic, electromagnetic, magnetic sensor, or seismic signatures. Close and early coordination with the military authorities is therefore essential. As already mentioned, the military in particular has a legitimate interest in ensuring that sensitive information about military measures and plans, especially training plans and procedures, as well as the signatures of submerged and surface vessels, remain confidential.

Conclusion and outlook

For multi-use applications with cables, the risk of damage to cables by shipping is decisive. Damage can result in considerable economic losses due to loss of performance and repair costs. In addition, repair work can have a negative impact on the environment in terms of time and location. Conflicts with submarine cables could possibly be avoided by measures such as burying and/or shielding the cables. In the case of military sea areas being affected, close cooperation with the relevant authorities prior to planning is therefore essential in order to meet security and confidentiality requirements. Precise coordination in terms of timing and content enables successful, forward-looking planning and cooperation. Potential conflicts can thus be minimized. In general, based on the latest technical findings (on information gathering), the option of laying submarine cables outside military sea areas should be the norm in planning.

3.6. Nature Restoration

Nature restoration and raw material extraction (hydrocarbon production)

Once oil and gas production has been completed, offshore platforms can be put to ecological reuse, which constitutes a type 4 multi-use (subsequent use/repurposing) (cf. Schupp et al., 2019). Instead of completely dismantling the structures, the underwater construction is preserved and used as an artificial reef. This sequential multi-use promotes the settlement of marine organisms and contributes to increased biodiversity. This repurposing achieves both ecological and economic benefits, as existing structures can be sustainably integrated into the marine habitat.

This measure can be combined with other nature restoration projects such as the creation of geogenic reefs or, where appropriate, oyster reefs. The conversion of oil and gas platforms to promote artificial reef structures is currently not relevant in Germany, as there are no relevant offshore platforms in the German EEZ. In other countries, such as in the North Sea off the coast of Great Britain and Norway, this practice is being discussed and partially implemented as part of "rigs-to-reefs" programs. In Germany, however, similar considerations could gain importance in the course of the future decommissioning of offshore wind farms. In connection with the decommissioning of offshore wind turbines, it could be examined to what extent underwater structures can be preserved as artificial reefs in order to exploit potential ecological benefits such as the promotion of marine biodiversity. However, it is necessary to make such decisions on the basis of sound scientific research and to comprehensively assess the impact on the marine environment. Targeted management is necessary to ensure that potential ecological benefits are realized by leaving structures in place and that no negative long-term effects arise.

Nature restoration and shipping

Nature restoration in marine ecosystems, such as planting seagrass beds or establishing oyster beds, mainly takes place on the seabed. Shipping, on the other hand, mainly takes place on the water surface. Due to this separation, shipping routes generally appear to be suitable locations for nature restoration projects, as no other bottom-contacting activities normally take place there. This could enable an ideal combination of uses, where shipping and nature conservation measures can coexist without major conflicts. Representatives of the shipping industry have also expressed concerns, particularly with regard to emergency anchoring. In the event of an emergency where a ship has to anchor outside a planned anchorage, the seabed, and thus also restoration projects, could be significantly damaged by the anchoring.

Conclusion and outlook

The issues of nature restoration and raw material extraction, as well as nature restoration and shipping, illustrate that the integration of nature restoration measures into existing or planned offshore uses holds both potential and challenges.

The conversion of offshore structures such as oil and gas platforms into **artificial reefs** offers an innovative way to combine ecological and economic benefits. Such concepts, which are already being applied in international programs such as "Rigs-to-Reefs," could also become relevant in Germany in the future in the context of the decommissioning of offshore wind farms. However, sound scientific monitoring is necessary to ensure that the hoped-for ecological benefits are actually realized without risking long-term negative effects on the marine environment.

In the field of **shipping**, it has been shown that nature restoration projects and shipping routes can coexist in principle, as their spatial use differs greatly. Nevertheless, potential conflicts, such as damage caused by emergency anchoring, must be addressed at an early stage. This requires close coordination between nature conservation and shipping interests in order to develop sustainable solutions that ensure both the safety of shipping and the protection of marine ecosystems.

Overall, it is clear that strategic planning and targeted management are essential to optimally exploit synergies between nature conservation and offshore uses and to minimize potential conflicts.

3.7. Defense

Military surveillance + other sensor technology (research, CCS)

The multi-use of maritime surveillance and other sensor technology at sea, for example for monitoring CCS projects, raises important military security issues. The use of such sensors, especially when they passively record noise signatures, touches on sensitive areas of national security. In particular, if these sensors are capable of recording submarine movements or other sensitive military activities, there is a risk that critical data could be captured and exploited by unauthorized parties. Such information could jeopardize national security, which is why close coordination between civilian actors and the military is necessary.

On the other hand, the availability of such data, when shared with the military or collected directly by military sensors, can improve surveillance capabilities. This could provide the military with more information about the maritime domain, thereby strengthening overall security. Such cooperation would be particularly useful in enabling comprehensive surveillance and control over sensitive maritime areas. Environmental data that has already been collected is made available to the national defense, so this type of multi-use and cooperation is already established.

Another important issue is the protection of critical maritime infrastructure such as cables and pipelines. These infrastructures not only offer potential for monitoring the surrounding area, they also represent a possible target for attack. In the event of an attack or sabotage, these systems could easily be compromised, which in turn would have an impact on national security and security of supply.

Conclusion and outlook

Military maritime areas, especially training areas for submarine diving and firing, are fundamentally incompatible with fixed infrastructure for other offshore uses, as such installations can impede or hinder military maneuvers and also pose security risks from the installation or structure itself or from the use of sensor technology. Nevertheless, there may be potential synergies between defense and other marine uses, particularly in the field of sensor technology. However, close cooperation between civilian and military actors is essential to protect sensitive data, such as submarine movements and their signatures, from unauthorized access while at the same time meeting national security interests. At the same time, sharing sensor technology can strengthen the monitoring and protection of critical maritime infrastructure, thereby helping to detect and ward off threats at an early stage.

Annex

Digression: Floating Wind

Fixed foundations were generally preferred for water depths of up to 50 meters (Bjørni et al., 2023), while wind farms currently in the planning stage are planning fixed foundations for water depths of up to 75 meters. The main reason for this is that they are technically simpler and more cost-effective to install in shallower water depths compared to floating turbine foundations, which also require a minimum depth for the anchoring to be effective. The most commonly used bottom-fixed foundations, such as monopiles and jacket foundations, require less complex structures and installation procedures than floating structures. As illustrated below, this significantly reduces costs.

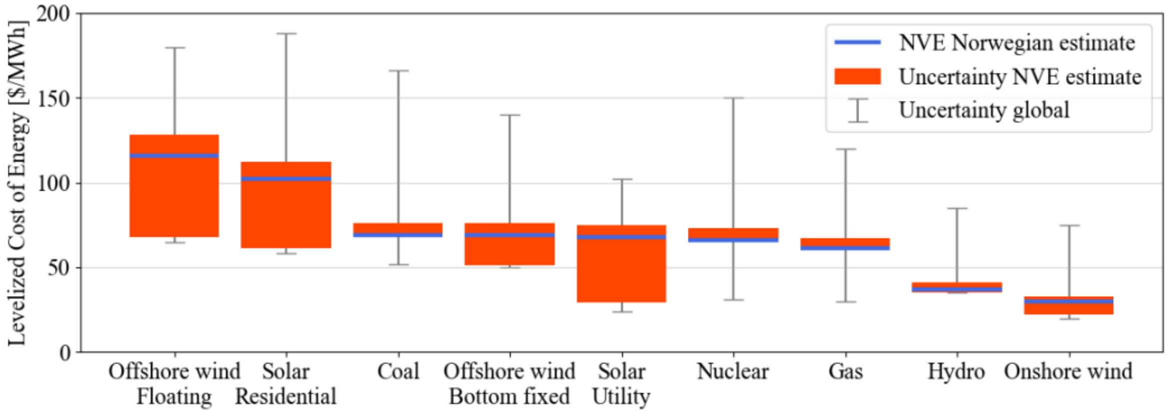

Figure 34 - Comparison of levelized cost of energy for different energy sources from (Bjørni et al., 2023)

In addition, established forms of use have a longer operating history, thus more predictable performance and confidence in their structural integrity. This often makes it easier to secure investment and approvals for projects with fixed foundations. The advantages of floating structures come into play with increasing water depth, when the technical and economic challenges of fixed foundations increase exponentially, making floating foundations a more advantageous solution.

As can be seen in Figure 35, the maximum water depths in the extreme north-west of the German EEZ are 50-60 m, approximately 200 km from the mainland. Floating wind is therefore not considered a realistic form of offshore wind energy use in the German EEZ.

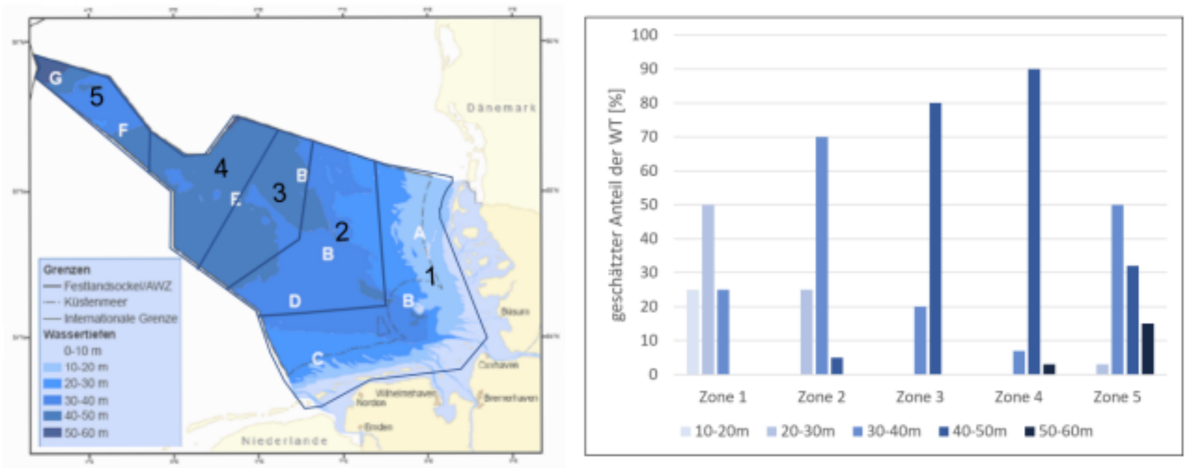

Figure 35 - Water depths in the German North Sea (Hoffmann et al., 2022). Water depth ("Wassertiefen") in zones 1-5 of the German EEZ (right), with estimated proportion in % (left graph, y-axis).

References

Amazon (2024). https://www.aboutamazon.eu/news/sustainability/worlds-first-commercial-scale-seaweed-farm-located-between-offshore-wind-turbines-is-now-open-in-the-netherlands, accessed on December 2, 2024

Bauer, J., & Köppel, J. (2017). Auswirkungen der Offshore-Windenergie auf Seevögel, Fische und Benthos: Eine Synopse der aktuellen Fachliteratur. *Naturschutz und Landschaftsplanung, 49*(2), **50–62.** https://www.nul-online.de/artikel.dll/nul02-17-inhalt-50-62-1_guztcmjyg4zq.pdf

Bjørni, F. A., Lien, S., Midtgarden, T. A., Santos, L. C., & Jiang, Z. (2023a). Life cycle cost analysis of a floating wind farm in the Norwegian Sea. IOP Conference Series: Materials Science and Engineering, 1294(1), 012006. https://doi.org/10.1088/1757-899x/1294/1/012006

Bonizzoni, S., Hamilton, S., Reeves, R. R., Genov, T., & Bearzi, G. (2022). Odontocete cetaceans foraging behind trawlers, worldwide. *Reviews in Fish Biology and Fisheries*, *32*(3), 827-877.

Brandt, M. J., Dragon, A. C., Diederichs, A., Bellmann, M. A., Wahl, V., Piper, W., et al. (2018). Disturbance of harbour porpoises during construction of the first seven offshore wind farms in Germany. *Marine Ecology Progress Series, 596*, 213–232. https://doi.org/10.3354/meps12560

BSH. (2023a). Flächenentwicklungsplan 2023 für die deutsche Nordsee und Ostsee.

BSH. (2023b). Raumrelevante Entwicklungen in der deutschen ausschließlichen Wirtschaftszone in der Nordsee und Ostsee Jahresbericht 2021. Hamburg, 76 S. + Anhang.

BSH. (2023c). Vorentwurf Flächenentwicklungsplan. September.

BSH, Dörenkämper, M., Meyer, T., Baumgärtner, D., Borowski, J., Deters, C., Dietrich, E., Fricke, J., Hans, F., Jersch, T., Leimeister, M., Neshati, M., Pangalos, G., Quiroz, T., Quistorf, G., Requate, N., Schalk, K., Schmidt, J., Schnackenberg, M., … Zotieieva, H. (2023). Weiterentwicklung der Rahmenbedingungen zur Planung von Windenergieanlagen auf See und Netzanbindungssystemen Endbericht. www.iwes.fraunhofer.de

Böckmann, P. In: **Meeresatlas - Daten und Fakten über unseren Umgang mit dem Ozean** (2017), P. 12. https://www.boell.de/sites/default/files/web_170607_meeresatlas_vektor_v102_1.pdf

Callier, M. D., Weise, A.M., McKindsey, C. W., Desrosiers, G., (2006). Sedimentation rates in a suspended mussel farm (Great-Entry Lagoon, Canada): MEPS Vol. 322, https://doi.org/10.3354/meps322129

CDRmare (2024). Kohlendioxid-Speicherung im tiefen Untergrund der deutschen Nordsee. CDRmare Research Mission, pp. 1-8, DOI 10.3289/CDRmare.06_V4

Chamberlain, J., Fernandes, T. F., Read, P., Nickell, T. D., Davies, I. M. (2001). Impacts of biodeposits from suspended mussel (Mytilus edulis L.) culture on the surrounding surficial sediments. ICES Journal of Marine Science, Volume 58, Issue 2, Pages 411–416, https://doi.org/10.1006/jmsc.2000.1037

Chopin, T., & Tacon, A. G. J. (2020). Importance of Seaweeds and Extractive Species in Global Aquaculture Production. Reviews in Fisheries Science & Aquaculture, 29(2), 139–148. https://doi.org/10.1080/23308249.2020.1810626

Cranford, P.J. (2019). Magnitude and Extent of Water Clarification Services Provided by Bivalve Suspension Feeding. In: Smaal, A., Ferreira, J., Grant, J., Petersen, J., Strand, Ø. (eds) Goods and Services of Marine Bivalves. Springer, Cham. https://doi.org/10.1007/978-3-319-96776-9_8

Daly, E., & White, M. (2021). Bottom trawling noise: Are fishing vessels polluting to deeper acoustic habitats? Marine Pollution Bulletin, 162, 111877.

https://doi.org/10.1016/j.marpolbul.2020.111877

Damkilde, L., Larsen, T., Walbjørn, J., Sørensen, J., Buliga, A., & Plauborg, J. (2015). LEX Project. Handbook - terms and definitions v. 4.

Deutsche Stiftung Meeresschutz (2022). https://www.stiftung-meeresschutz.org/themen/schutz-gebiete/doggerbank-briten-verbieten-grundschleppnetzfischerei/, accessed on 7 November 2024

Dickson, J., Franken, O., Watson, M. S., Monnich, B., Holthuijsen, S., Eriksson, B. K., ... & Bouma, T. J. (2023). Who lives in a pear tree under the sea? A first look at tree reefs as a complex natural biodegradable structure to enhance biodiversity in marine systems. *Frontiers in Marine Science*, *10*, 1213790.

DNV. (2021). DNV-RP-0360 Subsea power cables in shallow water. October.

DNV GL. (2018). dnv-gl_report_agow_minimum-distances-of-subsea-cables_2018-11-14.

DNV KEMA Energy & Sustainability. (2012). Study on minimum distances for submarine cables.

Dr. Michael Naumann, Claudia Schnabel, Joachim Fritz, & Dirk Djuren. (2013). Creation of building ground sections in the German North Sea. https://www.gpdn.de/media/765

Dörenkämper, M., Meyer, T., Baumgärtner, D., Borowski, J., Deters, C., Dietrich, E., Fricke, J., Hans, F., Jersch, T., Leimeister, M., Neshati, M., Pangalos, G., Quiroz, T., Quistorf, G., Requate, N., Schalk, K., Schmidt, J., Schnackenberg, M., Schwegmann, S., ... Zotieieva, H. (2023). Further development of the framework conditions for planning offshore wind turbines and grid connection systems Final report. www.iwes.fraunhofer.de

EN ISO 19905-1. (2012). EN ISO 19905-1.

Gao, K., & McKinley, K.R. (1994). Use of macroalgae for marine biomass production and CO2 remediation: a review. Journal of Applied Phycology 6: 45-60.

Garcia, M., & Liu, Y. (2018). Seasonal variations in phytoplankton blooms in the Southern Ocean. Journal of Marine Science, 72(5), 1123-1139. https://doi.org/10.1016/j.jmarsci.2018.06.011.

Gimpel, A., Stelzenmüller, V., Haslob, H., Berkenhagen, J., Schupp, M.F., Krause, G., Buck, B.H. (2020). Offshore wind farms: An opportunity for fisheries and nature conservation. Braunschweig: Johann Heinrich von Thünen Institute, 6 p, Thünen à la carte 7, DOI:10.3220/CA1580724472000.

Gimpel, A., Werner K-M, Bockelmann F-D, Haslob H, Kloppmann MHF, Schaber M, Stelzenmüller V (2023). Ecological effects of offshore wind farms on Atlantic cod (Gadus morhua) in the southern North Sea. Sci Total Environ 878:162902, DOI:10.1016/j.scitotenv.2023.162902.

Government of the Netherlands, North Sea Programme 2022-2027, https://www.noordzeeloket.nl/en/policy/north-sea-programme-2022-2027/, accessed on 24 September 2024.

Government of the Netherlands (2023). The North Sea Agreement. https://www.noordzeeloket.nl/publish/pages/184533/the_north_sea_agreement.pdf, accessed on February 3, 2025.

Hoffmann, S., Quiroz, T., Widerspan, V., & Schenk, A. (2022). Ad-hoc Analyse: Entwicklung der OWEA-Gründungsstrukturen hinsichtlich Gründungsdurchmesser und Kolkschutzmaßnahmen / Flächenversiegelung 18. Mai 2022. www.iwes.fraunhofer.de

ICES. 2020. Workshop on fisheries Emergency Measures to minimize BYCatch of short-beaked common dolphins in the Bay of Biscay and harbour porpoise in the Baltic Sea (WKEMBYC). ICES Scientific Reports. 2:43. 354 pp. http://doi.org/10.17895/ices.pub.7472

ICPC. (2012). ICPC Recommendation Recommendation No. 13 The Proximity of Offshore Renewable Wind Energy Installations and Submarine Cable Infrastructure in National Waters. 9, 1–16.

Kastelein, R. A., Gransier, R., Marijt, M. A. T., & Hoek, L. (2015). Hearing frequency thresholds of harbor porpoises (*Phocoena phocoena*) temporarily affected by played back offshore pile driving sounds. *Journal of the Acoustical Society of America, 137*(2), 556–564. https://doi.org/10.1121/1.4906261

Kastelein, R. A., Helder-Hoek, L., Covi, J., & Gransier, R. (2016). Pile driving playback sounds and temporary threshold shift in harbor porpoises (*Phocoena phocoena*): effect of exposure duration. *Journal of the Acoustical Society of America, 139*(5), 2842–2851. https://doi.org/10.1121/1.4948571.

Lasner, T., & Barz, F. (2023). Küstenfischerei 2045 - Erste Zielbilder der Zukunftswerkstatt. Zeitschrift für Fischerei 3(4): 1-19. DOI: 10.35006/fischzeit.2023.22

Maar, M., Holbach, A., Boderskov, T., Thomsen, M., Buck, B. H., Kotta, J., Bruhn, A. (2023). Multi-use of offshore wind farms with low-trophic aquaculture can help achieve global sustainability goals. Commun Earth Environ (Communications Earth & Environment) 4(1): 1-14; doi 10.1038/s43247-023-01116-6

Marine Conservation Institute. (2022). The importance of marine protected areas. Retrieved from https://marine-conservation.org/what-we-do/program-areas/mpas/

Merk, V., Colsoul, B., & Pogoda, B. (2020). Return of the native: Survival, growth and condition of European oysters reintroduced to German offshore waters. Aquatic Conservation (Aquatic Conservation: Marine and Freshwater Ecosystems). 30(11): 2180-2190; doi 10.1002/aqc.3426

Ministry of Economic Affairs and Climate Policy - Netherlands. (2022). Safety Study CCS and Offshore Wind Farms.

Morizur, Y., Berrow, S., Tregenza, N., Couperus, A., & Pouvreau, S. (1999). Incidental catches of marine mammals in pelagic trawl fisheries of the northeast Atlantic. Fisheries Research, 41(3), 297–307. https://doi.org/10.1016/s0165-7836(99)00013-2

Moray Offshore Windfarm (East) Limited (2022) Commercial Fisheries Mitigation Strategy Wind Farm and Offshore Transmission Infrastructure; https://marine.gov.scot/sites/default/files/commercial_fisheries_mitigation_strategy_redacted.pdf

Nabe-Nielsen, J., van Beest, F. M., Grimm, V., Sibly, R. M., Teilmann, J., & Thompson, P. M. (2018). Predicting the impacts of anthropogenic disturbances on marine populations. *Conservation Letters, 11*(2), e12563. https://doi.org/10.1111/conl.12563

Nachtsheim, D. A., Viquerat, S., Ramírez-Martínez, N. C., Unger, B., Siebert, U., & Gilles, A. (2021). Small Cetacean in a Human High-Use Area: Trends in Harbor Porpoise Abundance in the North Sea Over Two Decades. *Frontiers in Marine Science, 7*, 606609. https://doi.org/10.3389/fmars.2020.606609

National Oceanic and Atmospheric Administration (NOAA). (2023). Understanding El Niño: Oceanic and atmospheric conditions. Retrieved from https://www.noaa.gov/education/resource-collections/ocean-coasts/el-nino

Paulson, S. (2022). Optimizing Shellfish Aquaculture for Multi-Use Spaces Within Offshore Wind Farms in the Dutch. University of Groningen, Netherlands, Faculty of Science and Engineering, Science Business and Policy (SBP).

Renewable Energy Agency, I. (2016). Floating Foundations: A Game Changer for Offshore Wind Power.

Renewable UK. (2013). Guidelines for the Selection and Operation of Jack-ups in the Marine Renewable Energy Industry. 2, 15–16.

Sas, H., van der Have, T. M., Kamermans, P., & Lengkeek, W. (2018). *Flat oyster pilot design in North Sea offshore wind farm*. Sas Consultancy, Bureau Waardenburg, Wageningen Marine Research. Commissioned by Stichting De Noordzee and Natuur & Milieu.

Silalahi, D. F., & Blakers, A. (2023). Global Atlas of Marine Floating Solar PV Potential. Solar, 3(3), 416–433. https://doi.org/10.3390/solar3030023

Srinivasan, C. V. C., Soori, P. K., Gaith, F. A. (2024). Techno-Economic Feasibility of the Use of Floating Solar PV Systems in Oil Platforms. Sustainability 2024, 16(3), 1039; https://doi.org/10.3390/su16031039

Smith, L. E., & Johnson, M. P. (2020). The effects of ocean acidification on coral reef ecosystems. Marine Ecology Progress Series, 656, 1-14. https://doi.org/10.3354/meps1334.

Stelzenmüller, V., Gimpel, A., Haslob, H., Letschert, J., Berkenhagen, J., Brüning, S. (2021). Sustainable co-location solutions for offshore wind farms and fisheries need to account for socio-ecological trade-offs. Sci Total Environ 776:145918, DOI:10.1016/j.scitotenv.2021.145918.

Sunny, R. C., Fredriksson, D. W., Tsukrov, I., Zhu, L., Bowden, M., Chambers, M., & Silkes, B. (2024). Design considerations for a continuous mussel farm in New England Offshore waters. Part I: Development of environmental conditions for engineering design. *Aquacultural Engineering*, 102476.

The Crown Estate. (2012). Submarine cables and offshore renewable energy installations Proximity Study.

ULTFARMS, 2024. https://ultfarms.eu/

UNITED, 2024. https://www.h2020united.eu/

Vaher, A., Kotta, J., Stechele, B., Kaasik, A., Herkül, K., Barboza, F.R. (2024). Modelling and mapping carbon capture potential of farmed blue mussels in the Baltic Sea region. Science of the Total Environment 947: 174613.

Van Duinen, R., et al. (2023). Algae and Climate. Publication Office of the European Union. https://doi.org/10.2926/208135.

Wallmann, K. (2024). CCS unter der Nordsee: Technische Herausforderungen und Perspektiven. Vortrag. Abgerufen von http://www.fze.uni-saarland.de/AKE_Archiv/AKE2024F/Vortraege/AKE2024F_6Wallmann_CCS-unterNordsee_21ppt.pdf

Welcker, J., & Vilela, R. (2020). ProBIRD – Auswirkungen von Offshore-Windparks auf Seevögel. Endbericht. *BioConsult SH*. Retrieved from https://www.bioconsult-sh.de/fileadmin/user_upload/Publikationen/2020/ProBIRD_Endbericht_20201026_Links_BSH.pdf

Witteveen+Bos Raadgevende Ingenieurs. (2019). Cost Evaluation of North Sea Offshore Wind. Retrieved from https://northseawindpowerhub.eu/files/media/document/Cost-Evaluation-of-North-Sea-Offshore-Wind-1.pdf