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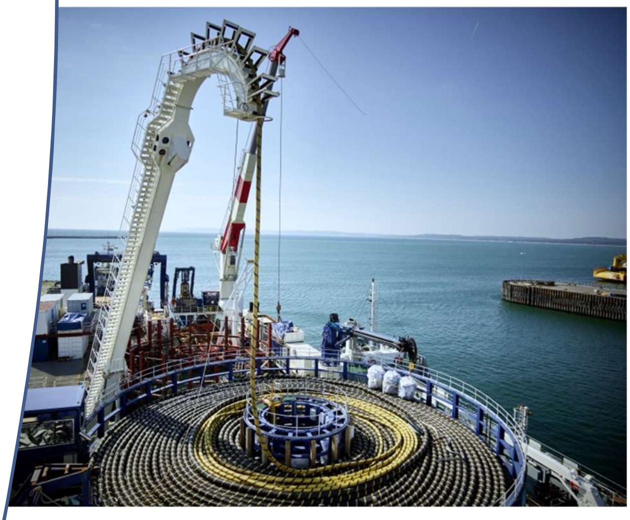
Preliminary Draft of the Side Development Plan 2020 for the North Sea and Baltic Sea



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List of abbreviations

AC	alternating current
BfN	Federal Agency for Nature Conservation
BFO	Federal Offshore Grid Plan
BFO-N	Federal Offshore Grid Plan North See
BFO-O	Federal Offshore Grid Plan Baltic Sea
BGBl	Federal Law Gazette
BKG	Federal Agency for Cartography and Geodesy
BMIE	Federal Ministry of the Interior, for Building and Community
BMVBS	Federal Ministry of Transport, Building and Urban Affairs
BNatSchG	Act on nature conservation and landscape management (Federal Nature Conservation Act)
BNetzA	Federal Network Agency für Electricity, Gas, Telecommunications, Post and Railway
BSH	Federal Maritime and Hydrographic Agency
DC	direct current
EEA	European Environmental Agency
EEG	Act for the expansion of renewable energies (Renewable Energy Sources Act)
EEZ	Exclusive Economic Zone
EnWG	Act on the supply of electricity and gas (Energy Industry Act)
FEP	Site Development Plan
GDWS	General Directorate for Waterways and Shipping
GW	gigawatt
kV	kilovolt
MW	megawatt
NEP	Network Development Plan
nm	nautical mile
NVP	grid connection point
O-NEP	Offshore Network Development Plan
OWP	offshore wind farm
PlanSiG	Act to ensure proper planning and approval procedures during the COVID 19 pandemic
ROG	Spatial Planning Act

SRÜ	United Nations Convention on the Law of the Sea
TSO	Transmission System Operator
UVPG	Act on Environmental Impact Assessment
VDE	A ssociation for Electrical, Electronic & Information Technologies
VSC	voltage sourced converter
WindSeeG	Act for the development and promotion of offshore wind energy
WindSeeG-E	Draft of a law amending the Wind Energy at Sea Act and other regulations
WTG	wind turbine

1 Introduction

Following the publication of the Site Development Plan 2019 (FEP 2019) on 28 June 2019 in accordance with the provisions of the German Act on the Development and Promotion of Offshore[1] Wind Energy (WindSeeG), a new site development plan (FEP) has been drawn up on the basis of the plan approved by the Cabinet on 3 June 2019. On the basis of the Draft Act amending the Offshore Wind Energy Act and other provisions adopted by the Cabinet on 3 June 2020,[2] and in particular due to the increased expansion path of 20 gigawatts (section 1 para. 2 WindSeeG Draft (hereinafter WindSeeG-E)[3] Offshore Wind Energy by 2030 provided for therein, it is necessary to update and amend FEP 2019. The draft law (WindSeeG-E) also provides for a long-term target of 40 GW by 2040.

In the context of this update of the FEP, it is expected that areas up to and including zone 3 of the exclusive economic zone will be defined. It is planned to define sites for the implementation of 20 GW by 2030. The definition of areas and sites will ensure a sufficient, plannable expansion path until around 2035 and will also make it possible to incorporate the results of the spatial planning procedure for the exclusive economic zone, which is currently running in parallel.

On 9 October 2019, the Federal Cabinet had already adopted the detailed Climate Protection Programme 2030 for the implementation of the Climate Protection Plan 2050, with the aim of increasing the expansion of offshore wind energy to 20 GW in 2030.

According to the agreement signed on 11 May 2020 between the Federal Government, the coastal federal states and the transmission system operators 50Hertz, Amprion and TenneT for the implementation of 20 GW of offshore wind energy by 2030, it is considered necessary to continue the FEP until the end of 2020, taking into account the spatial plans for the exclusive economic zone, which are currently being updated, and the spatial plans of the coastal states (Bundesministerium für Wirtschaft und Energie, 2020).

As far as the legal framework conditions are available, the process is to be completed by the end of 2020.

Procedure in the context of this preliminary draft

In this preliminary draft, not all chapters of the FEP 2019 are fully updated for better readability. In addition, some of the sub-chapters have been omitted.

The draft FEP 2020 will contain the relevant sub-chapters with necessary amendments, additions or revisions.

In the context of this preliminary draft, therefore, reference is made at the relevant places to the respective chapters of the FEP 2019 and with the indication that necessary (further) changes, additions or updates (in the following for all three terms: revision) of the chapters are provided for in the draft of the FEP 2020.

Chapters 4 and 5, which are the main focus of the preliminary draft, are elaborated in detail.

[1] Act of 13 October 2016, Federal Law Gazette I p. 2258, 2310, last amended by Article 2 of the Act of 25 May 2020, Federal Law Gazette I p. 1071.

[2] Available at https://www.bmwi.de/Redaktion/DE/Downloads/E/entwurf-eines-gesetzes-zur-aenderung-des-windenergie-auf-see-gesetzes.pdf?__blob=publicationFile&v=6

[3] Act of 13 October 2016, Federal Law Gazette I p. 2258, 2310, last amended by Article 2 of the Act of 25 May 2020, Federal Law Gazette I p. 1071.

2 Process for the expansion of offshore wind energy

2.1 Site development plan

The following summary presents the individual procedural steps in the updating of the FEP.

Overview of the process steps

- Notification of initiation, expected scope and conclusion of the procedure
- Preparation of the preliminary draft and scope of the environmental assessment
- Participation of authorities and the public
- Notification of the North and Baltic Sea countries
- Delivery of the joint opinion of the TSOs
- Hearing date, if necessary according to § 5 para. 6 PlanSiG
- Definition of the scope of the environmental assessment
- Preparation of the draft FEP and draft environmental report (SEA)
- Participation of authorities and public (national and international)
- Discussion date, if necessary in accordance with § 5 para. 1 PlanSiG
- Review of the environmental report (SEA) in the light of national and international comments
- Consideration of the review in the draft FEP
- Coordination with the BfN, the GDWS and the coastal countries
- Establishing agreement with the BNetzA
- Publication of the FEP and the environmental report by the end of 2020
- Sending a summary statement to the North and Baltic Sea countries involved

For further information, reference is made to Chapter 2 of the FEP 2019. A further revision will be made in the draft of the FEP 2020.

2.2 Investigation of sites

Reference is made to Chapter 2.2 of the FEP 2019. A revision is made in the draft of the FEP 2020.

2.3 Call for tenders

Reference is made to Chapter 2.3 of the FEP 2019. A revision is made in the draft of the FEP 2020.

2.4 Plan approval

Reference is made to Chapter 2.4 of the FEP 2019. A revision is made in the draft of the FEP 2020.

2.5 Interfaces with other instruments of network planning

Reference is made to Chapter 2.5 of the FEP 2019. A revision is made in the draft of the FEP 2020.

2.6 Existing spatial planning and planning

Reference is made to Chapter 2.6 of the FEP 2019. A revision is made in the draft of the FEP 2020.

2.6.1 Exclusive Economic Zone

In the EEZ, the legal basis for the preparation of maritime spatial planning plans has been in place since 2004 (see Chapter 2.6.1.2).

In the wake of the resolutions on the energy system transformation in June 2011 and the associated changes in legislation, the BSH was given the task of drawing up and regularly updating a sectoral plan for offshore electricity grids in the German EEZ, the Federal Offshore Grid Plan (see Section 2.6.1.1).

2.6.1.1 Federal Offshore Grid Plans

Reference is made to Chapter 2.6.1.1 of the FEP 2019.

2.6.1.2 Spatial plans

For sustainable spatial development in the German EEZ of the North and Baltic Seas, the BSH is carrying out the preparatory steps for the updating of the spatial plans on behalf of the BMIB. As early as 2009, the BSH drew up the spatial plans for the German North Sea and Baltic Sea EEZs on behalf of the then Federal Ministry of Transport, Building and Urban Affairs (BMVBS).

The BMVBS regulation on spatial planning in the German EEZ in the North Sea of 21 September 2009 (BGBl. I p. 3107) came into force on 26 September 2009. On 19 December 2009, the BMVBS regulation on spatial planning in the German EEZ in the Baltic Sea of 10 December 2009 (BGBl I p. 3861) came into force.

In marine spatial planning, the international provisions of the United Nations Convention on the Law of the Sea (UNCLOS) must be observed in particular. In addition to the scientific and economic use of the oceans, the interests of shipping and nature conservation are particularly relevant. With regard to offshore wind energy, both spatial plans contain, among other things, the objectives and principles of spatial planning for offshore wind energy (3.5) and submarine cables (3.3).

In the process of preparing the spatial plans, a Strategic Environmental Assessment was also carried out to identify, describe and evaluate the mainly significant environmental impacts on the protected assets.

The existing plans are currently in the process of being updated (see background information below).

background information: Status of the updating procedure of the spatial plans for the German EEZ in the North and Baltic Sea

The updating of the spatial plans for the German EEZ in the North Sea and Baltic Sea began in summer 2019 when the Federal Ministry of the Interior, Building and Community informed the public and the public bodies concerned about the updating of the spatial plans in accordance with § 9 para. 1 ROG. Public authorities had the opportunity to provide information on the plans and measures they intend to implement or have already implemented, as well as on their timing, and to make relevant information available.

Technical discussions and workshops on relevant sectors and protection interests followed in autumn 2019. In January 2020, the concept for the further development of the spatial plans was published, which set out conceivable solutions through three planning options with different priorities. This was intended to facilitate early participation and exchange on requirements, possible conflicts, but also synergies and approaches to solutions - as a basis for the preparation of a comprehensive draft plan. The publication of the first draft of the spatial plan is scheduled for september 2020. Completion of the revision procedure is planned for 2021.

Due to the parallelism of the updating procedures of the spatial plans and the FEP, the processes are interlinked in order to ensure the consistency of the definitions of the respective plan within the respective framework.

<u>Essential contents of the concept for the revision and further development of the spatial plans:</u>

- Definition of priority areas for offshore wind energy, at least 20 GW

- Definition of reserved areas for offshore wind energy for medium to long-term expansion
- Adjustment of the priority area shipping (shipping route 10) to the real shipping traffic, thereby extending the areas N-9 to N-13 in a north-western direction. This extension is reflected in all three planning options and is accordingly also reflected in this preliminary draft of the FEP.
- Establishment of nature reserves and, in some cases, the main distribution area divers and porpoises as priority or reserved areas

Further information can be found on the BSH website.[4]

2.6.2 Lower Saxony

Reference is made to Chapter 2.6.2 of the FEP 2019. A revision is made in the draft of the FEP 2020.

2.6.3 Schleswig-Holstein

Reference is made to Chapter 2.6.3 of the FEP 2019. A revision is made in the draft of the FEP 2020.

2.6.4 Mecklenburg-Western Pomerania

Reference is made to Chapter 2.6.4 of the FEP 2019. A revision is made in the draft of the FEP 2020.

3 Starting Position

Reference is made to Chapter 3 of the FEP 2019. A revision is made in the draft of the FEP 2020.

4 Leading lines and basic principles

4.1 Introduction

The strategic planning of the expansion of offshore wind energy and the associated grid topology for the transmission of electricity is of enormous importance for the supply of renewable energy. With the increase of different uses in the German EEZ, the space available for future uses and infrastructures is becoming increasingly scarce.

In the interests of systematic and efficient planning, the BSH was given the statutory mandate to designate areas and sites for offshore wind energy, as well as corresponding routes and locations for the necessary network topology. As a result of this coordinated process, the measures in the German EEZ are defined in a spatially and temporally binding manner.

The definition of planning principles and standardised technology principles for the North Sea and Baltic Sea EEZs is a mandatory prerequisite for the concrete determination of the space requirements of the entire network topology within the FEP. The aim of establishing standardised technology principles and planning principles is to create a basis for systematic and

[4] See https://www.bsh.de/DE/THEMEN/Offshore/Meeresraumplanung/Fortschreibung/fortschreibung-raumordnung_node.html

coordinated overall planning. Otherwise, it would not be possible to determine the required space requirement with the necessary precision for the most space-saving planning possible. In addition to determining the space requirement as precisely as possible, standardised technical principles also serve to ensure cost efficiency and the demand-oriented expansion of connecting lines, which is in the interests of the national economy.

The starting point for defining the standardized technical principles (4.3) is the technical grid connection concept, the further details of which are described in Section 4.2

The planning principles build on the objectives and principles of the spatial plans for the North Sea and Baltic Sea EEZs. An overall assessment of the uses of the areas has already been carried out when the 2009 spatial plans were drawn up. For the current status of the update of the spatial plans in the German EEZ, please refer to Section 2.6. The relevant objectives and principles at the level of spatial planning are predominantly adopted as planning principles in the FEP and are checked, concretised and weighted among themselves in their significance with regard to their applicability to the regulatory issues addressed in the FEP on the basis of the concerns and rights presented.

The definition of standardised technology principles and planning principles is already based on a consideration of possibly affected public interests and legal positions (cf. explanatory memorandum on the individual specifications and principles), so that the definition of standardised technology principles and planning principles also includes a "preliminary examination" of possible alternatives.

4.2 Connection concepts

According to section 17d (1) sentence 1 EnWG, the responsible TSO has to ensure the grid connection of OWPs or construct and operate them according to the specifications of the NEP and FEP pursuant to section 5 WindSeeG. The task of this plan is to define the necessary routes and locations for the entire grid topology in the German EEZ up to the border of the 12 nm zone within the existing framework conditions in terms of space and time with regard to the calendar years of commissioning.

A key factor in determining and securing the space required for the network to connect the offshore WTGs is above all the definition of the connection concept. The spatial planning for the components of the connecting lines is then carried out on the basis of standardised technical principles (4.3) and planning principles (4.4).

It became clear already during the initial set-up procedure of the BFO that the definition of standardised technical specifications is an indispensable prerequisite for the spatial planning of the network connections in order to determine the required space with the necessary precision for the most space-saving spatial planning. According to § 5 para. 1 No. 11 WindSeeG, standardised technical principles are to be laid down for the purpose of planning in the FEP. In addition to the main objective of the specification, which is to achieve uniformity in the planning of the plants by means of standardising specifications in order to use the space in the area as efficiently as possible and to create planning security for grid and wind farm operators and suppliers, costs are also to be reduced as far as possible.

With regard to the technical connection concepts, the FEP distinguishes between the North Sea and the Baltic Sea.

4.2.1 Standard concept North Sea: Direct current system

The standard concept in the North Sea is a direct current system. Reference is made to Chapter 4.3.1

In principle, the length of the route for connecting an area or region to the onshore grid connection point (NVP) appears to be the decisive factor in the selection of the appropriate transmission technology for connecting OWPs to the grid. For line lengths of more than 100 km, additional reactive power compensation equipment must be regularly provided for three-phase connections. The transmission losses also increase with the length of the cable system. These losses are significantly lower with HVDC transmission. For the North Sea EEZ, route lengths of more than 100 km are to be expected in the future, with increasing distance from the coast also significantly higher.

When using HVDC transmission, the relatively high system capacity of the collective connection means that several OWPs can be connected with an HVDC grid connection system consisting of a converter platform and a DC submarine cable system. This means that a significantly smaller number of cable systems are required compared to a connection using three-phase technology, thus reducing the space required for the cable systems.

The grid connections of OWPs in the North Sea EEZ are therefore carried out in HVDC as standard, and reference is made to the summary of the connection concept in the Figure 1.

4.2.1.1 DC system: Connection between converter platform and offshore wind farms: Standard concept 66 kV

In the 66 kV direct connection concept, the lines connecting the converter platform to the offshore WTGs (so-called park-internal cabling) are designed on the basis of three-phase current technology with a voltage of 66 kV. This eliminates the transformer platform and the 155 kV or 220 kV intermediate voltage level between the transformer and converter platform. The converter platform is connected to the NVP on land via direct current transmission. However, despite the possible omission of a transformer platform, a separate platform may be required for maintenance and accommodation purposes of the OWP.

The suitable transmission technology for the connections between the converter platform and the OWP depends on the length of the route between the converter platform and the WTGs to be connected. For the EEZ, route lengths of about 20 km have often been observed so far. Losses and the need for reactive power compensation increase with longer distances and the resulting longer cable lengths. In addition, the space requirement on the converter platform increases with the length of the cable system due to the necessary reactive power compensation. In connection with the cost differences between direct current (DC) and three-phase (AC)cable systems, as stated in the O-NEP, a central location of the converter platform with the shortest possible three-phase cables should be aimed for.

In view of the areas eligible from 2026 (see Chapter 5.1) and the areas in close proximity to each other in these areas, the 66 kV direct connection concept appears to have advantages from a spatial, environmental and nature conservation point of view compared with the connection concept with a transformer platform. In addition, a study commissioned by the TSOs showed that the 66 kV direct connection concept is more cost-efficient as an overall concept than the connection concept with a transformer platform (at a voltage of 155 kV).[5]

In the long term, an increase in the voltage level for the direct connection concept, for example to 110 kV, seems conceivable. Particularly in the

[5] See https://www.amprion.net/Netzausbau/Aktuelle-Projekte/Offshore/Anbindungskonzept-BorWin4.html

case of large contiguous areas in combination with the standard transmission capacity of 2,000 MW and future WTGs with correspondingly higher nominal capacity, a reduction in the number of submarine cable systems required appears to be expedient. However, the direct connection of WTGs with a voltage greater than 66 kV required for this would have to be examined. The FEP will accompany this question and, if necessary, take it up again in an update.

4.2.1.2 Direct current system: Connection between converter platform and offshore wind farms: Alternative concept 220 kV

If at least two areas to be connected are located far apart from each other in an area, the connection concept with transformer platform of the BFO-N 16/17 can be advantageous, since a smaller number of submarine cable systems is required and the increased voltage results in less transmission losses than with the 66 kV direct connection concept. However, in order to further reduce transmission losses and the number of submarine cables required, a connection using the 220 kV voltage level is specified as an alternative to the 66 kV direct connection concept. This connection concept basically corresponds to the 155 kV connection concept with transformer platform known from BFO-N 16/17, but the transmission voltage is raised to 220 kV for the reasons mentioned above.

For individual areas, it is therefore possible to deviate from the standard concept and to define a connection concept with transformer platforms if the spatial conditions are appropriate. Reference is made to the specifications in Section 5.2.1

4.2.1.3 DC system: interface between TSO and OWP

The responsibility for connecting the WTGs to the converter platform lies with the OWP project executing agency. The primary interface or ownership boundary between TSO and OWP promoter is the entrance of the 66 kV submarine cable systems on the converter platform (cable termination of the 66 kV submarine cables). The entry of the 66 kV submarine cable systems on the platform follows the direct-pull-in concept, according to which the submarine cable systems are routed to the substation. For this purpose, the OWP project executing agency guarantees a free length of the submarine cable after cable entry on the platform of up to 15 m depending on the requirements of the TSO.

It is foreseeable that the 66 kV direct connection concept will require increased coordination in the preparation and implementation of the respective individual approval procedures. The shared use of the converter platform due to the interface between the TSO and the OWP promoter at the entrance to the 66 kV submarine cable systems requires close coordination and clear responsibilities for planning, construction, operation, maintenance, repair and dismantling between TSOs and OWP promoters and, if necessary, between different OWP promoters connecting their offshore WTGs to the same converter platform. For the parties involved, there is an absolute necessity for cooperation. This applies in particular to the exchange of information on project deadlines, the mutual transfer of necessary information and details on the platform and the components to be installed on it. In all phases, both sides have to inform each other about project-relevant developments and coordinate dates. Reference is made to the implementation schedule in accordance with § 17d Para. 2 EnWG.

It should be noted that the co-use of the converter platform by the OWP project executing agency only covers the co-use necessary due to the technical interface on the converter platform. The OWP developer must therefore be able to carry out the measures required for grid connection on the converter platform in good time. On the other hand, the TSO must coordinate and carry out the measures necessary to prepare for grid connection with the OWP project developer at an early stage. A separate platform of the OWP developer for residential and maintenance purposes may therefore be necessary.

With regard to the alternative concept with transformer platform presented, the interface specification corresponds to the specification in BFO-N 16/17.

To define the interface, please refer to the consultation questions at the end of this section.

Summary

- Definition of the 66 kV connection concept as the standard for the North Sea EEZ
- Deviation from the standard concept is possible in case of spatial requirements in an area
- If deviation is necessary, specification of the connection concept of BFO-N 16/17 with a transmission voltage of 220 kV
- Cable termination of the 66 kV submarine cable systems serves as an interface between the transmission system operator and the OWP project developer

4.2.2 Standard concept Baltic Sea: three-phase system

The TSO obliged to connect the OWPs in the Baltic Sea to the grid has so far pursued a connection concept based on three-phase technology. When using three-phase technology, OWPs are connected to the grid by combining the electricity generated by the individual WTGs of one or more parks on a transformer platform and from there via a three-phase submarine cable system directly ashore and on to the NVP. In contrast to the standard concept in the North Sea (HVDC transmission), no separate converter platform is required for the grid connection itself. However, a higher number of cable systems is required to dissipate a given power output when using three-phase technology due to the lower transmission capacity of three-phase submarine cable systems. Due to the low wind farm capacity in the German Baltic Sea EEZ expected for commissioning from 2026 compared to the capacity of an HVDC transmission system, a connection by means of a direct current system would probably lead to permanent vacancies. Offshore connection lines in the Baltic Sea will therefore be constructed according to the connection concept based on three-phase current technology as known from BFO-O 16/17. Reference is made to the summary of the connection concept in the Figure 2

In contrast to BFO-O 16/17, the planning and construction of the transformer platform is not carried out by the OWP project executing agency or the successful bidder on a site, but by the TSO obliged to connect. The responsibility for connecting the WTGs to the transformer platform lies with the OWP project executing agency.

4.2.2.1 Three-phase system: interface between TSO and OWP

The primary interface or ownership boundary between TSO and OWP promoter is the entrance of the in-park submarine cable systems on the transformer platform (cable termination of the submarine cables). The entry of the 66 kV submarine cable systems on the platform follows the direct-pull-in concept, according to which the submarine cable systems are routed to the substation. The OWP project executing agency guarantees a free length of the submarine cable after cable entry on the platform of up to 15 m depending on the requirements of the TSO; in case of compelling technical reasons, a deviation is possible by agreement between the TSO and the OWP project executing agency.

It is foreseeable that with this modified connection concept there will be an increased need for coordination in the preparation and implementation of the respective individual approval procedures. Due to the shared use of the transformer platform at the entrance to the park's submarine cable systems, due to the interface between the TSO and the OWP project executing agency, close coordination and clear responsibilities are required in the planning, construction, operation, maintenance and repair, possible repairs and dismantling between TSOs and OWP project executing agencies and, if necessary, between different OWP project executing agencies that connect their offshore WTGs to the same transformer platform. For the parties involved, there is an unrestricted need for cooperative collaboration. This applies in particular to the exchange of information on project deadlines, the mutual transfer of necessary information and details on the platform and the components to be installed on it. In all phases, both sides have to inform each other about project-relevant developments and coordinate dates. Reference is made to the implementation schedule in accordance with § 17d Para. 2 EnWG.

It should be noted that the co-use of the transformer platform by the OWP project executing agency only includes the co-use necessary due to the technical interface on the transformer platform. The OWP project executing agency must therefore be able to carry out the measures required for grid connection on the transformer platform in good time. On the other hand, the TSO must coordinate and carry out the measures necessary for the preparation of the grid connection with the OWP project executing agency at an early stage.

Due to the planning and construction of the transformer platform by the TSO, it is necessary that the voltage level of the OWP promoter's in-park submarine cable systems arriving at the transformer platform is known at an early stage. For this reason - as in the North Sea - the voltage level of the park-internal submarine cable systems is set at 66 kV.

To define the interface, please refer to the consultation questions at the end of this section.

Summary

- Definition of the three-phase current connection concept as standard for the Baltic Sea EEZ
- Responsibility for planning, construction and operation of the transformer platform and submarine cable system at the transmission system operator
- Cable termination of the park's submarine cable systems serves as an interface between the transmission system operator and the OWP developer
- Voltage level of the submarine cable systems within the park 66 kV

4.3 Standard technical principles

4.3.1 Direct current system North Sea

For the grid connection of the OWPs in the North Sea for the EEZ area, a connection concept based on HVDC transmission will be used analogous to the previous grid connections, see Chapter 4.2.1

4.3.1.1 Direct current system: self-commutated technology

The existing grid connection systems in the North Sea, which are planned within the framework of the FEP, will be implemented using self-commutated (so-called VSC - voltage sourced converter) technology. This variant was already defined as standard in the BFO-N and can be described as established.

In contrast to the classic, grid-commutated technology, the self-commutated HVDC transmission can rebuild a grid without having to provide reactive power from the connected three-phase system. This feature is necessary to independently rebuild the transmission after a grid fault, to control it in normal operation and to stabilize the surrounding three-phase grid. For further justification for the specification of self-commutated technology, please refer to Section 5.1.2.2 of BFO-N 16/17.

4.3.1.2 DC system: transmission voltage +/- 320 kV for zones 1 and 2; transmission voltage +/- 525 kV for zone 3

The existing grid connection systems in zones 1 and 2 of the North Sea, which are planned within the framework of the FEP, will be implemented with a transmission voltage of +/- 320 kV. This variant was already defined as standard in the BFO-N and can be described as established. A transmission voltage of +/- 525 kV will be specified for future grid connection systems for areas far from the coast in zone 3, beginning with area N-9.

The definition of a uniform voltage level for DC systems (consisting of the converter on the converter platform and the DC submarine cable system) serves to create a standard for the connection systems, especially for the converter platform. Based on the definition of framework parameters, manufacturers and grid operators can develop standardized solutions and perspectively advance planning at an early stage - if necessary, also independent of location. The aim is to achieve a certain degree of uniformity in the planning of the plants by means of standardising specifications, thus accelerating the planning process, achieving planning reliability for grid and wind farm operators and suppliers and reducing costs. A uniform voltage level also prepares a possible connection of the offshore connection lines to each other.

In order to enable the planning and implementation of interconnections of the offshore connecting lines with each other in the most spatially compatible manner possible, the highest possible capacity of the DC system and therefore also the highest possible system voltage are aimed for. So far, a manufacturer-independent transmission voltage standard of +/- 320 kV has developed on the market. Limitations of the capacity result mainly from the available cable technology and the space requirements of the converter platform.

Due to the possibility of increasing the power to be transmitted with an increased voltage level and thus making connection systems more efficient, it is necessary, in view of the large contiguous areas in zone 3 of the North Sea EEZ and the severe spatial restrictions on the routing of connecting lines on land, to reduce the number of systems as far as possible and maximise their respective transmission capacity.

In the consultations on the FEP 2019 installation procedure, the question of the technology availability of offshore grid connection systems with a transmission voltage of +/- 525 kV was addressed. In summary, it can be concluded from the comments received that the technology is expected to be available from around 2030. The 3rd interim report of the research contract accompanying the FEP until the end of 2020 also comes to a comparable conclusion. In their joint statement on the second draft of the FEP 2019, the TSOs first pointed out that a realisation in 2029 was "not feasible" and a realisation in 2030 "critical". However, the confirmation of the NEP 2019-2030 has shown that this is possible and necessary to achieve the expansion target of 20 GW by 2030. In a recently signed agreement between the federal government, the coastal states and the transmission system operators 50Hertz, Amprion and TenneT to implement 20 GW of offshore wind energy by 2030, it is also considered necessary to commission the first offshore grid connection system with a transmission voltage of +/- 525 kV in 2029 (Bundesministerium für Wirtschaft und Energie, 2020).

For these reasons, a standard transmission voltage of +/- 525 kV is specified for DC systems connecting areas in zone 3 of the North Sea (areas N-9 to N-13).

4.3.1.3 Direct current system: standard power 900 MW for zones 1 and 2; standard power 2,000 MW for zone 3

The specification of a standardised transmission capacity of the DC connection systems formed the central basis for the spatial planning at BFO-N. Based on a standard output of 900 MW, the space required for the transmission of the installed wind energy output was determined.

The FEP also defines a standard capacity for HVDC transmission systems in the North Sea. However, a heterogeneous picture of the availability of areas, especially for zones 1 and 2, is apparent, which can lead to an individual definition of the transmission capacity of a connection system for these areas. However, a standard transmission capacity of 900 MW per connection system must not be undercut. With regard to the areas and surfaces in zone 3, however, it seems sensible to define the highest possible standard capacity in order to minimise the number and thus the space for converter platforms and lines for the transmission of wind energy.

A standard transmission capacity of 900 MW is set for the HVDC systems in zones 1 and 2 of the North Sea EEZ. In zone 3 of the North Sea EEZ, a standard transmission capacity of 2,000 MW is set for the offshore connection systems.

The aim of increasing the standard output compared to the BFO-N 16/17 is to minimize the number and thus the space required for converter platforms and routes for wind energy output. Based on this specification of framework parameters, manufacturers and grid operators can develop standardised solutions and perspectively advance planning at an early stage - if necessary also independent of location.

In the preparation procedure for the FEP 2019, the TSOs have indicated that the transmission capacity of +/- 525 kV HVDC transmission systems is limited to less than 2,000 MW, provided that the maximum permissible sediment warming (2 K criterion, cf. planning principle 4.4.4.8) is observed. A corresponding review with heating calculations was carried out within the framework of an accompanying research contract with the BSH. According to this, the transmission of 2,000 MW with cable cross-sections already in use in the EEZ appears possible in compliance with the 2 K criterion. Due to increased nature conservation requirements in the coastal waters of the North Sea, further measures may be necessary in these areas to meet the 2C criterion. However, a transmission of 2,000 MW in compliance with the 2C criterion is also possible in coastal sea areas. Reference is made in this respect to the above-mentioned agreement of 11 May 2020 (Bundesministerium für Wirtschaft und Energie, 2020).

4.3.1.4 Direct current system +/- 525 kV: Version with metallic return conductor

HVDC transmission systems with a transmission voltage of +/- 525 kV and a transmission power of 2,000 MW are to be designed as bipoles with metallic return conductors for the purpose of increasing reliability and better controllability. With the help of this design, in the event of failure or unavailability of one pole, the system can be operated with the remaining pole as a monopole, which allows at least a transmission of a maximum of 50 % of the transmission power. In contrast to the direct current connection systems previously installed in the North Sea EEZ, the bipole version with metallic return conductor requires an additional cable, so that three cable systems have to be installed in a bundle. Reference is made to the consultation questions at the end of the section.

4.3.1.5 DC system +/- 525 kV: Connection on the converter platform / switch panels to be provided

For the connection of offshore wind farms to a converter platform, the responsible transmission system operator must provide sufficient switchgear panels and J-Tubes. The number of switch bays and J-Tubes is determined depending on the connected load. For a connected load of 1,000 MW, 12 switchgear bays and J-Tubes each are to be provided. This results in 24 switchgear bays and J-Tubes per converter platform, which are used to connect offshore wind farms.

The number of J-Tubes and switch bays available for connecting offshore wind farms to a converter platform is often the subject of coordination between OWP project developers and the responsible TSO. For the purpose of long-term standardisation and equal treatment, it is expedient to define the J-Tubes and switchgear cubicles available for a certain connection capacity at an early stage in the FEP. Reference is made to the consultation questions at the end of the section.

4.3.1.6 Direct current system +/- 525 kV: Requirements for connections between each other / switch panels to be provided

The FEP makes spatial specifications for connections between converter platforms, reference is made to chapter 5.11

Interconnections can help to ensure system security. In principle, a connection of the connecting lines by three-phase or direct current systems is possible, but currently only three-phase current technology can be used for the connections. The necessary components for the direct current connection among each other are not yet available.

Control panels are used to connect the three-phase submarine cable systems from the OWPs or the three-phase connection of connecting lines to each other. These switchgear panels must be designed for the respective application, especially with regard to the reactive power compensation that may be required, and must provide the technical requirements for connections between platforms. To ensure a possible three-phase connection between platforms, two switchgear cubicles must therefore be provided on each converter platform with a transmission voltage of +/- 525 kV. Reference is made to chapter 5.11

In order to be able to use these switch panels and to pull in associated submarine cables on the converter platform, the corresponding technical requirements must be met (in particular, sufficient J-Tubes).

4.3.1.7 Direct current system: 66 kV direct connection concept

As explained in Chapter 4.2.1.1, the 66 kV direct connection concept is defined as the standard connection concept for connecting offshore wind turbines to the converter platform. The connections are implemented in three-phase technology with a transmission voltage of 66 kV.

Since the concept involves connecting offshore WTGs directly to the converter platform without an intermediate transformer platform, the offshore WTGs must meet the requirements for connection to the converter platform, for example by having an output voltage of 66 kV. For further technical connection requirements, please refer to the offshore grid connection regulations of VDE (VDE-AR-N 4131).

Summary

- Design of the HVDC transmission systems in self-commutated VSC technology
- Standard transmission voltage: +/-320 kV in zones 1 and 2; +/- 525 kV in zone 3
- Standard transmission capacity: 900 MW in zones 1 and 2; 2,000 MW in zone 3
- Design of the direct current systems +/- 525 kV with metallic return conductor
- Direct current system +/- 525 kV: Provision of 12 switchgear panels and J-Tubes per 1,000 MW OWP connected load
- Direct current system +/- 525 kV: Create conditions for connections between each other by providing two switch panels per platform
- Connection of offshore wind turbines to the converter platform in 66 kV three-phase current technology

4.3.2 Three-phase system Baltic Sea

For the grid connection of the OWPs in the Baltic Sea for the EEZ area, a connection concept based on three-phase current technology is used, analogous to the design of the previous grid connections, see Chapter 4.2.2

4.3.2.1 Three-phase system: transmission voltage 220 kV

The existing grid connection systems in the Baltic Sea, which are planned within the framework of the FEP, will be constructed with a transmission voltage of 220 kV using three-phase current technology. In BFO-O 16/17, this variant was already defined as standard and can be described as established (cf. Section 4.2.2).

The definition of a uniform voltage level for the three-phase system serves to create a standard for the connection systems, both with regard to the components of the transformer platform and the submarine cable systems. It also provides a clear planning basis for OWP project developers. This is intended to accelerate - planning procedures, achieve planning reliability for grid and wind farm operators and suppliers and reduce costs - also for the benefit of consumers.

Two of the grid connection systems already implemented by the TSO in the Baltic Sea area to connect offshore wind energy projects in the area of cluster 3 of BFO-O 16/17 and in the coastal sea are based on a transmission voltage of 150 kV. For the other three implemented systems for the connection of OWP projects in the area of area O-1 an increase of the transmission voltage to 220 kV was implemented.

By designing for a voltage level of 220 kV, the highest possible transmission power per cable system - for the three-phase connection - can be realized and the transmission task can be fulfilled with as few cable systems as possible.

4.3.2.2 Three-phase system: Standard power 300 MW

Three-phase systems currently in operation and under construction in the Baltic Sea have a transmission capacity of 250 MW at a transmission voltage of 220 kV. During the consultations on the preliminary draft and draft of the FEP 2019, it was argued on the one hand that projects with transmission capacities of 350 MW to 400 MW at the same transmission voltage would already be realised internationally. On the other hand, the TSO responsible for the Baltic Sea points out that there is no operating experience for these power ranges and that planning law restrictions such as the so-called 2 K criterion (cf. planning principle 4.4.4.8 of FEP 2019) must be taken into account, especially in view of the heterogeneous soil conditions prevailing in the Baltic Sea.

A standard capacity of 300 MW is therefore set for three-phase systems in the Baltic Sea.

Summary

- Standard transmission voltage 220 kV
- Standard transmission capacity 300 MW

4.3.3 Cross-border submarine cable systems

4.3.3.1 Bundled direct current submarine cable system

Cross-border submarine cable systems are to be implemented in HVDC transmission. Due to the significantly lower losses and the absence of the need for reactive power compensation compared to the three-phase submarine cable system, all known projects for cross-border submarine cable connections through the German North Sea EEZ are already being planned as direct current connections. Due to the limited space available, cross-border submarine cable systems must also be designed with the highest possible transmission capacity.

The connections are to be made in each case with outgoing and return conductors, which are laid bundled together so that the magnetic fields of the conductors compensate each other to a large extent. This generally allows a magnetic flux density to be achieved which is significantly below the average strength of the earth's magnetic field and prevents significant effects on protected objects. As a result of the development of offshore wind energy, cross-border connections between OWPs such as the Kriegers Flak Combined Grid Solution are now being established in addition to "classic" cross-border submarine cable systems connecting terrestrial networks. These connections can be implemented as three-phase connections due to the shorter route length and the need for a consistent connection concept (cf. Chapters 4.2.1 and 4.2.2) and are therefore not covered by the present specification. Consideration of the overall system

The planning and construction of cross-border submarine cable systems must take into account the various provisions of this plan, especially for the grid connection of OWPs. To this end, the approval procedure for cross-border submarine cable systems must set out how they can be included in grid planning without adversely affecting the expansion targets for offshore wind energy. From this point of view, it makes sense to examine on a case-by-case basis whether and to what extent cross-border submarine cables can connect OWPs. For this reason, the technology used in particular must be examined and its compatibility with the overall grid must be weighed against other advantages (such as higher transmission capacity).

In the course of the FEP update, the development of an international offshore grid will continue to be monitored, including both the cross-border submarine cable systems and the connecting lines for offshore wind energy. Prior to a possible integration of the cross-border cable systems into a meshed offshore network, technical as well as regulatory issues would have to be clarified in addition to the question of economic efficiency.

Table 1: Overview of the standardised technology principles

Standardized technology principles	North Sea		Baltic Sea
	Zone 1 and 2	zone 3	zone 1
Network connection system			
Standard connection concept	Direct current (DC)	Direct current (DC)	three-phase current (AC)
Converter technology	Self-commutated (VSC converter)	Self-commutated (VSC converter)	-
Standard transmission voltage	+/- 320 kV DC	+/- 525 kV DC	220 kV AC
Standard transmission power	900 MW	2,000 MW	300 MW
Design of the direct current system	*Not applicable*[6]	with metallic return conductor	*Not applicable*[5]
Number of control panels and J-Tubes to be provided per 1,000 MW OWP connected load	*Not applicable*[5]	12	*Not applicable*[5]
Number of switch fields to be provided per connection	*Not applicable*[5]	2	*Not applicable*[5]

[6] As the definition in question only refers to the direct current system +/- 525 kV, it is not applicable in zones 1 and 2 of the North Sea and in the Baltic Sea.

Connection to offshore wind farm			
Standard connection concept	Direct connection (AC)	Direct connection (AC)	Direct connection (AC)
Standard transmission voltage	66 kV	66 kV	66 kV
Alternative concept	Connection via transformer platform	Connection via transformer platform	*Not applicable*[5]
Transmission voltage Alternative concept	220 kV	220 kV	*Not applicable*[5]
Cross-border submarine cable systems			
Transmission technology	Direct current (DC)		
Relocation	Bundled laying		

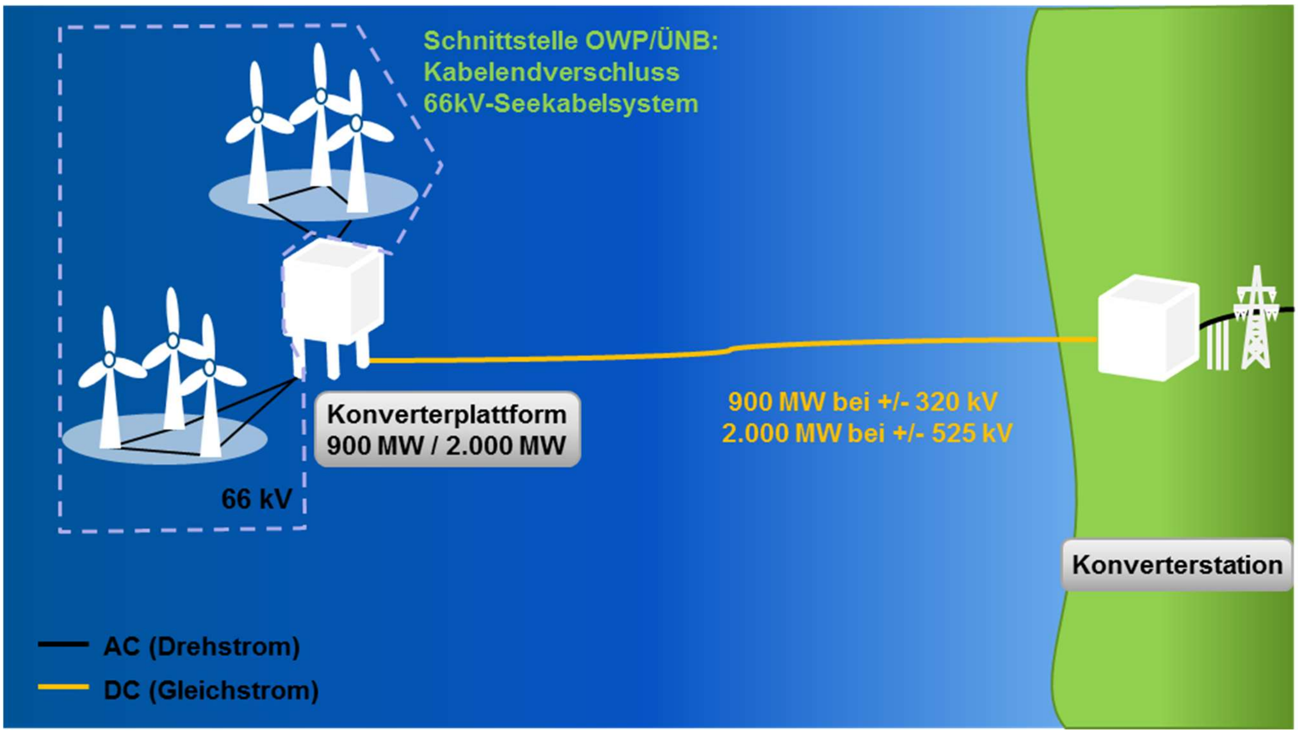


Figure 1: Schematic diagram of the North Sea connection concept

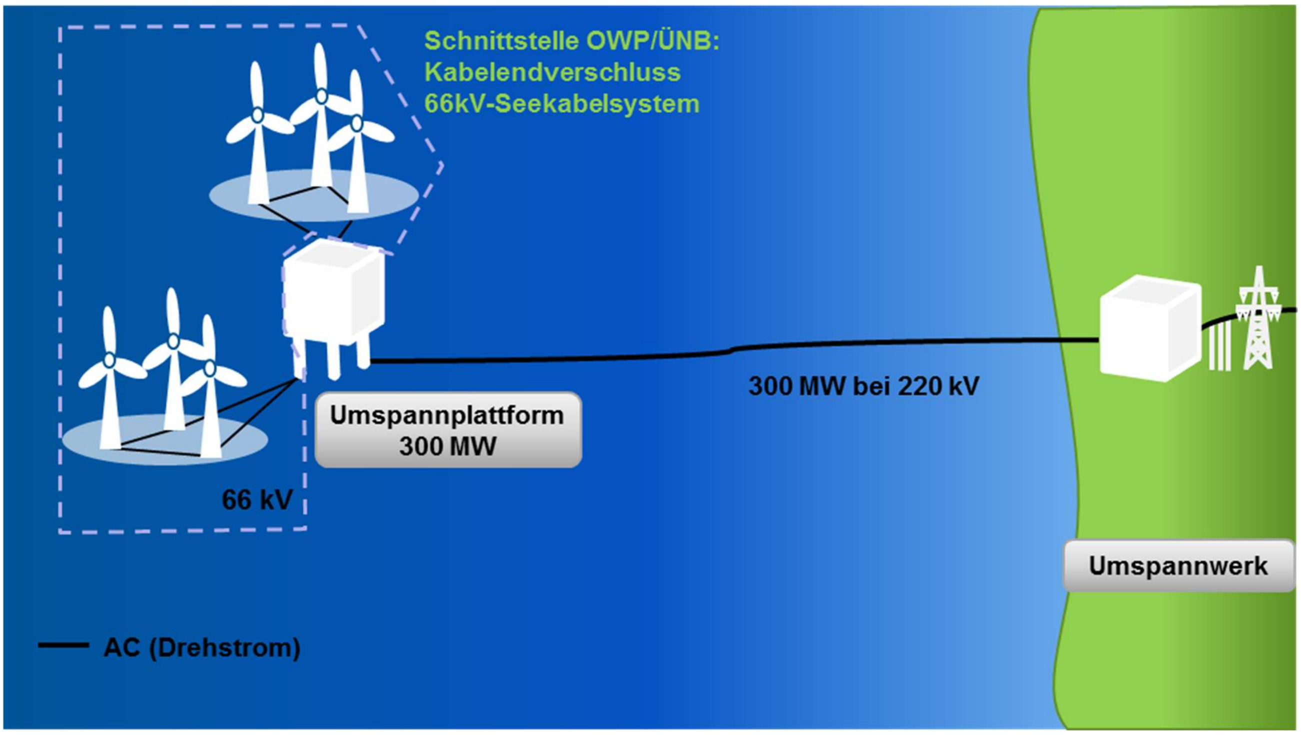


Figure 2: Schematic diagram of the Baltic Sea access concept.

Questions for consultation

4.2.1.3 DC system: interface between TSO and OWP

The TSOs have proposed changes to the definition of the interface between TSOs and OWPs in the North Sea as part of the update procedure. In the following, these proposals are presented unchanged (italics, blue).

The primary interface or ownership boundary between TSO and OWP promoter is the entrance of the in-park submarine cable systems on the converter platform (cable termination of the in-park submarine cables). Depending on the platform design, the interface can be either at the gas-insulated switchgear (GIS) or at a plug-in connection.

The park-internal submarine cable systems on the converter platform are pulled in using the[7] direct-pull-in concept. Depending on the platform variant of the TSO, the park-internal submarine cable systems are either routed directly to the GIS or to a plug connection pre-installed on the platform. The plug connection forms the transition point between the park-internal submarine cable system and a pre-installed platform cable connection leading to the GIS. The OWP project executing agency carries out the submarine cable entry and termination with a suitable plug for the pre-installed plug connection on the platform.

For the connection of the submarine cable, the OWP project executing agency guarantees in both variants a free length (from cable hang-off) of the submarine cable after direct pulling in on the platform. The dimensioning of the required free length of the submarine cable is carried out in individual cases according to the requirements of the TSO and can reach up to the maximum length possible according to the state of the art using direct pull-in, but is at least 15 m.

<u>Explanation of the proposed wording:</u>

(1) Paragraph 1: the transfer of ownership between the OWP promoter and the TSO should initially be formulated openly, as this has not yet been finalised.

2) Paragraph 2a: Specification of the direct pull-in concept (background: avoidance of misunderstandings)

3) Paragraph 2b: Enabling technology alternatives with regard to cable entry; corresponding introduction of an additional transfer point for submarine cable systems on the platform (background: current market developments in platform design from the tender for BorWin5 by TenneT and the FEED study by Amprion)

4) Paragraph 3: definition of a minimum free length of submarine cable of 15 m by direct draw-in and definition of a qualitative upper limit (state of the art) in order to allow slightly higher free lengths of submarine cable for 2-GW platforms if necessary (background: draw-

[7] *The direct pull-in procedure is defined as pulling the cable onto the platform up to the GIS or to the pre-installed plug connection without "following up" the submarine cable.*

in of at least 24 submarine cables for 2-GW platforms requires larger spatial dimensions on the converter platform)

F.1 Are there justified reservations on the part of the consultation participants against a more open definition of the interface, which also allows connection by means of plug-in connection?

F.2 Is the minimum length of submarine cable on the platform of 15 m proposed by the TSOs coherent and feasible?

F.3 Are there other aspects that should be taken into account when weighing up the proposals?

4.2.2.1 Three-phase system: interface between TSO and OWP

TSOs have also proposed changes to the definition of the interface between TSOs and OWPs in the Baltic Sea. In the following, these proposals are presented unchanged (italics, blue).

The interface or ownership boundary between TSO and OWP promoter is at the gas insulated switchgear (GIS) on the substation platform. The OWP project developer is responsible for the pulling-in and installation of the park's internal submarine cable systems on the transformer platform to the GIS.

Explanation of the proposed wording:

1) The ownership interface between the OWP promoter and TSO is uniform at the cable termination of the OWP promoter's cable system to the GIS, and thus corresponds to the assignment of the asset systems (cable system / GIS).

2) The submarine cable systems up to the GIS will be installed by the OWP project executing agency, although it is not necessary to specify the installation procedure.

3) It is not necessary to specify a minimum free length of submarine cable in the absence of the specification of the collection procedure for the OWP developer in the Baltic Sea. In particular, a free length of the submarine cable from cable-hang-off to GIS of only 15 m would be uneconomical and inefficient in view of the resulting need to adapt the platform design, as experience from previous projects in the Baltic Sea has shown.

F.4 Is the waiver proposed by the TSOs of the explicit mention of the collection procedure for the OWP developer reasonable?

F.5 Should the limitation of the length of the submarine cable to 15 m be abandoned, as proposed by the TSOs?

F.6 Are there other aspects that should be taken into account when weighing up the proposals?

4.3.1Direct current system North Sea

F.7 The connection systems from zone 3 with a transmission voltage of +/- 525 kV must be designed with a metallic return conductor. From the point of view of the consultation, are there any participating aspects that should be given special consideration in such a design?

F.8 Are there findings on how the additional cable changes electromagnetic fields compared to the variant without metallic return conductor?

F.9 Are there any reasons for not specifying a design with a metallic return conductor for crossing islands in territorial waters?

F.10 In your opinion, does the decision to provide switchgear panels and J-Tubes depending on the OWP connection capacity make sense in principle?

F.11 Is the specified number of 12 switch panels and J-Tubes per 1,000 MW OWP connected load sufficient?

F.12 From the point of view of the consultation participants, is it necessary to provide for the possibility of additional switch panels and J-Tubes if required?

4.4 Planning Principles

Reference is made to Chapter 4.4 of the FEP 2019. A revision is made in the draft of the FEP 2020.

Editorial changes to individual planning principles are also planned.

Questions for consultation

Consideration of cultural goods

The planning principle 4.4.1.7 of the FEP 2019 specifies the consideration of cultural heritage sites at the planning level. Up to now, the consideration of cultural objects has been carried out on a case-by-case basis in the downstream procedures. There are no generally valid distance specifications which would allow consideration at the planning level. Without generally valid distance specifications, it is not possible to implement the planning principle in the FEP specifications.

F.13 Which distances to known sites of cultural objects should be assumed within the spatial definitions of the FEP? For submarine cable systems, is a distance of the maximum known extent of the site of discovery plus the maximum intervention width of the installation equipment on the planning level considered sufficient?

4.5 Possibilities deviations

Reference is made to Chapter 4.5 of the FEP 2019. A revision is made in the draft of the FEP 2020.

4.6 Planning horizon

Reference is made to Chapter 4.6 of the FEP 2019. A revision will follow in the draft of the FEP 2020.

4.7 Determination of the expected generation capacity

4.7.1 Aim of the generation capacity determination

The aim of determining the expected installed capacity is to ensure that the expansion of offshore wind turbines and offshore connection systems run in parallel and thus achieve the expansion target for offshore wind energy set out in the Renewable Energy Sources Act. On the basis of this definition, the necessary capacity of the offshore connection line for an orderly and efficient use and utilisation of offshore connection lines can thus be determined and a corresponding definition for connecting this site can be provided.

In addition, by determining the expected generation capacity, the tender volume on the respective site is predicted. However, the actual determination of the share of the respective site in the tender volume is only made in the course of the preliminary investigation or suitability test and determination of the respective site in accordance with § 12 Paragraph 5 WindSeeG. For this reason, the generation capacity as determined in the course of the preliminary investigation may deviate from the specifications of the FEP in individual cases.

Compared to BFO 2016/2017, the requirements on the accuracy of the generation capacity - determination are significantly increased for these reasons. In addition, the various surfaces differ very significantly in their characteristics. While the areas near the coast in Zones 1 and 2 of the EEZ are mainly smaller sites whose expected generation capacity is in many cases determined by the available connection capacities, separate conditions apply to the areas in Zone 3 of the EEZ in the North Sea. There is a relatively large scope for planning here, but at the same time these are much larger areas whose efficiency is mainly determined by internal shadowing effects. The approach of the methodology described below is to take sufficient account of the different conditions in each site, while at the same time providing a simple and transparent procedure for determining the expected generation capacity.

In principle, the methodology described here corresponds to the procedure already described in the FEP 2019. However, against the background of the findings on long-range wake effects (see info box) and the changed areas in zone 3, there is a need for revision with regard to the level of the power density to be applied.

4.7.2 Methodology of generation capacity determination

The power density of a wind farm (expressed in MW/km²) results from the ratio of the nominal power of the WTG to its base site, which is spanned by the external WTGs. The power density is therefore the determining parameter for determining the generation capacity in advance on any given site. The distance of the individual WTGs from each other is the main factor influencing the power density. In the Figure 3 the methodology of the power determination, which is further described in the following, is shown schematically. The methodology is equally applicable to the North Sea and Baltic Sea EEZs.

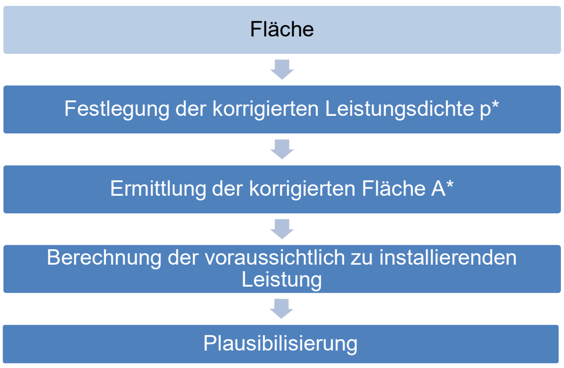


Figure 3: Schematic representation of the methodology of the generation capacity determination

4.7.3 Determination of the corrected power density

In order to enable a comparison of sites of different geometry and size, the following chapters were written in (Borrmann, Rehfeldt, Wallasch, & Lüers, 2018) introduced the parameter of corrected power density. To calculate the corrected power density, the site of the wind farm is mathematically extended by an additional border in the amount of half the average distance between the turbines. This means that each wind turbine placed on this site takes up the same calculated site and sites cut to different sizes can be compared. The corrected power density now relates the total installed power of the wind farm to the corrected site and is always lower than the nominal power density, since the former always relates to a correspondingly larger site. In the following chapters, unless otherwise mentioned, the term power density refers to the corrected power density.

Figure 4 shows an example of the nominal site (blue border), which is defined by the concrete plant locations in relation to the corrected site (red border).

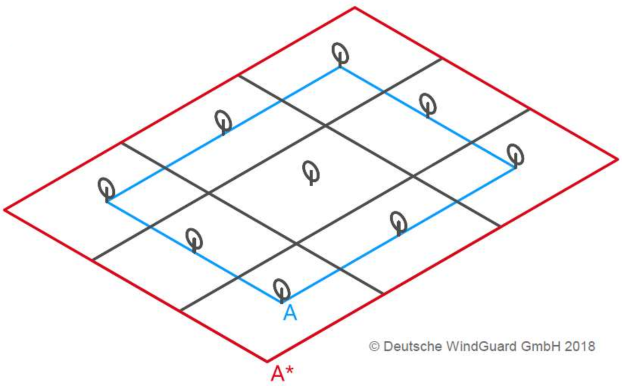


Figure 4: Representation of the corrected site A* in relation to the nominal site A (Prognosis, 2019)

From the WindSeeG, the following competing objectives can be derived when determining the expected generation capacity, which have to be weighed against each other when determining the power density to be applied:

- Increase in installed capacity and achievement of objectives: The objective of the WindSeeG pursuant to section 1(2) is to increase the installed capacity of offshore wind turbines in order to achieve the expansion targets. The WindSeeG-E provides for an expansion target of 20 GW for the year 2030 and 40 GW for the year 2040. Against the background of the limited availability of areas in the German EEZ, it must be taken into account when determining the expected installed capacity that these expansion targets can be achieved with the available areas. In addition, the FEP makes stipulations according to § 4 para. 2 no. 2 WindSeeG with the aim of expanding electricity generation from offshore WTGs in a space-saving manner. A possible indicator for the efficiency of the site is the expected amount of electricity produced per unit of site (energy density). With a higher power density, the energy density increases, also taking into account increasing losses due to wake effects.
- Cost efficiency: According to § 1 Par. 2, the expansion of offshore wind energy should be cost-efficient. A lower power density leads to a reduction of losses due to wake effects within and in adjacent wind farms and thus, in a certain range, to a reduction of electricity generation costs. From a cost efficiency point of view, a lower power density within a certain range is therefore advantageous.
- Efficiency of the grid connection: According to § 5 para. 4 WindSeeG, the aim of the definition of sites in the FEP is also the efficient use and utilisation of the offshore connection lines. When determining the expected capacity to be installed, inefficiencies such as residual capacities on grid connection systems or cross area connections must be avoided. For the areas in zone 3, this means that the determination of the expected capacity to be installed is

based on the standard capacity of the grid connection systems, especially for the sites in zone 3.

The methodology for determining the expected generation capacity was an essential part of the consultation of the FEP 2019, where it already became clear that the methodology should allow a differentiated consideration of the areas in zones 1 and 2 as well as zone 3.

4.7.3.1 Power density in zones 1 and 2

Decisive for determining the expected installed capacity for the areas in zones 1 and 2 is the efficient utilisation of the existing and planned grid connection systems. For this reason, a higher corrected power density of 10 MW/km² was assumed for areas in zones 1 and 2. If in individual cases there is strong shading by surrounding wind farms, the corrected power density can be reduced to 9.5 MW/km².

4.7.3.2 Power density in zone 3

Areas N-9 to N-13 in zone 3 of the North Sea EEZ will be developed entirely within the target system.

Compared to the presentation in the FEP 2019, the areas N-9 to N-13 have been significantly enlarged in a north-western direction in this preliminary draft. Reference is made to chapter 5.1 thus very large areas with a large number of wind energy turbines, which are mostly developed in one piece with comparable technology. Compared to the areas in zones 1 and 2, the losses due to wake effects of the turbines are much more significant. Under consideration of the above-mentioned objectives, it should be consulted whether the power density to be applied to the sites in zone 3 should be reduced from 9 MW/km² (FEP 2019) to 8 MW/km² or whether it should remain unchanged (see info box and questions for consultation). The following power density to be applied is taken as a basis for the determination of the expected generation capacity in the respective site categories within the scope of this preliminary draft:

Table 2: Power density to be applied

Site category	Power density to be applied (corrected) [MW/km²].
Sites in zones 1 and 2	10
In case of strong shading by surrounding wind farms	9,5
Sites in zone 3	8

background information: Trailing effects of offshore wind farms

What are lag effects?

The capacity utilisation of a wind farm (usually measured in full load hours) depends not only on the wind conditions but also on various factors, e.g. the technical design of the wind turbine (ratio of rotor area to rated power), the availability of the turbines or the operating concept. The wind turbine extracts kinetic energy from the air flow during power generation and also ensures that the air layers are swirled in the wake of the turbine. These so-called wake effects ensure that less kinetic energy is available to a leeward plant - thus reducing the utilization of the plant. The kinetic energy is regenerated by an exchange of flow with neighbouring air layers. These effects have been the subject of scientific studies for some time and are already being taken into account in the planning of offshore wind farms. Calculation models used so far are well suited to calculate the internal shading losses within a wind farm and assume that the complete kinetic regeneration of the air flow up to a maximum of 30 km in the wake of a wind turbine has taken place. However, current findings from research projects based on measurements of wind speeds in the German Bight show that in individual situations there are wake patterns of wind farm clusters with a range of 50 km and more (Platis, et al., 2018). Apparently, the prevailing flow conditions, especially the stability of the wind flow, have a significant influence on the range of the wake effects.

What new findings are there?

Current research projects aim to improve the calculation models in order to enable these long-range wake effects to be taken into account when planning offshore wind farms. As there is little experience with the large-scale expansion of offshore wind energy to date, this makes it difficult to reliably quantify the possible losses in future wind farms. In various research projects, including (Platis, et al., 2018), (Snowman, Rott, Dörenkämper, Steinfeld, & Kühn, 2020) and (Agora Energiewende et al., 2020) the effects of long-range wake effects on the efficiency of offshore wind farms were investigated using measurement campaigns and various calculation models. Among other things, a clear correlation between power density and the expected losses due to wake effects was shown. Within the scope of the measurement campaigns, long-range wake effects were proven, but these were always individual situations. Within the scope of these measurement campaigns, significantly shorter wake effects were also recorded under similar wind conditions. Further research is needed for a reliable estimation of the influence of long-range wake effects on the energy yield.

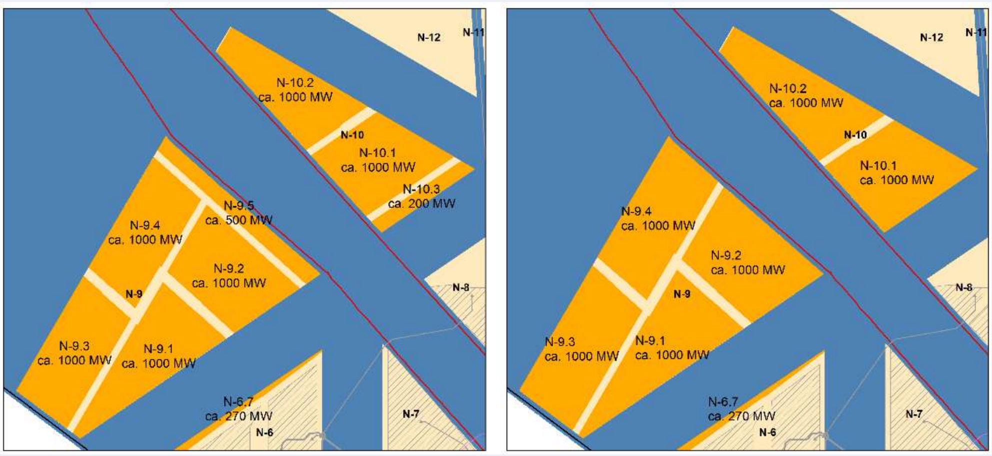
What influence does the size of the wind farm have on efficiency?

There is a significant correlation between the amount of yield losses due to wake effects and the size of the wind farm and the distance between the turbines. The larger the area or its power density (i.e. the number of turbines per unit area), the greater the amount of kinetic energy that is extracted from the air flow and the lower the kinetic energy available to the turbines in the wake.

What does this mean for determining the expected generation capacity in zone 3?

As explained in Section 4.7.3 when determining the expected installed capacity, the objectives of increasing installed capacity and cost efficiency mentioned there must be weighed up against each other while ensuring the efficient use and capacity utilisation of interconnectors. For this purpose, in the following section a determination of areas and grid connections with a power density of 9

MW/km² to be applied analogous to the FEP 2019 and a power density of 8 MW/km² to be applied will be carried out as an example and these determinations will be reviewed with regard to the mentioned objectives.

	Scenario 1: Power density 9 MW/km²	Scenario 2: Power density 8 MW/km²
Areas and installed capacity	At a power density of 9 MW/km², this results in a total capacity of approx. 4,500 MW in area 9 and approx. 2,200 MW in area N-10, which makes it possible to define the following sites N-9.1: 1,000 MW N-9.2: 1,000 MW N-9.3: 1,000 MW N-9.4: 1,000 MW N-9.5: 500 MW N-10.1: 1,000 MW N-10.2: 1,000 MW N-10.3: 200 MW A possible layout of the sites in areas N-9 and N-10 is shown in the Figure left).	At a power density of 8 MW/km², this results in a total capacity of approx. 4,000 MW in area N-9 and approx. 2,000 MW in area N-10, which makes it possible to define the following sites N-9.1: 1,000 MW N-9.2: 1,000 MW N-9.3: 1,000 MW N-9.4: 1,000 MW N-10.1: 1,000 MW N-10.2: 1,000 MW A possible layout of the sites in areas N-9 and N-10 is shown in the Figure right).
	 Figure 5: Possible site layout in the N-9 and N-10 areas at a power density of 9 and 8 MW/km² respectively	
Network connection	Two sites each with a capacity of 1,000 MW could be connected using the standard concept for the North Sea (DC connection with +/- 525 kV transmission	The expected capacity to be installed in the N-9 and N-10 areas will allow efficient connection with the standard concept for the North Sea (DC

	voltage and 2 GW transmission capacity): NOR-9-1 (2,000 MW) NOR-9-2 (2,000 MW) NOR-10-1 (2,000 MW) For the remaining sites with 500 MW and 200 MW each, development with the standard connection concept would not be possible and solutions would have to be found for each individual case.	connection with +/- 525 kV transmission voltage and 2 GW transmission capacity). This would allow the development with three standard grid connection systems: NOR-9-1 (2,000 MW) NOR-9-2 (2,000 MW) NOR-10-1 (2,000 MW)
Objective 1: Increase in installed capacity and achieveme nt of objectives	In view of the relatively small area potential available in the German EEZ, a low power density to be applied would lead to a reduction of the total potentially available power and the possible electricity production per unit area (energy density). In the interests of efficient land use, the power density should therefore be set as high as possible (§ 4 para. 2 no. 2 WindSeeG). With a reduction of the power density from 9 to 8 MW/km², the expected installed capacity in the N-9 and N-10 areas will be reduced by approx. 700 MW.	
Objective 2: Cost-efficiency	In order to weigh up this objective, a simulation of the expected operating results and the losses due to internal wake effects for different power densities was carried out for the areas in zone 3. These are rough calculations that only allow a qualitative comparison of the location quality due to internal park shadowing effects. It should be noted that possible losses due to long-range wake effects, as they are the subject of the above-mentioned research projects, are not yet taken into account. Figure 6 shows the relative efficiency (i.e. the capacity utilisation of the individual turbines) of the turbine locations in relation to the location with the highest efficiency for the areas N-9 and N-10. It becomes clear that the efficiency of the inner locations decreases the more strongly compared to the outer locations at a higher power density. As a result, the potential electricity production in the area per installed megawatt of capacity (energy density) decreases with a higher power density and the specific costs of the electricity generated increase.	

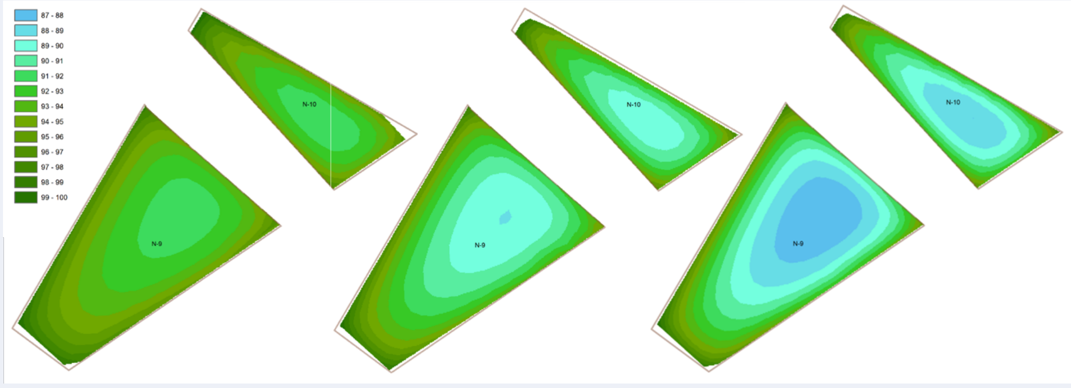


Figure 6: Relative efficiency of the turbine sites in areas N-9 and N-10 at a corrected power density of 7 MW/km², 8 MW/km² and 9 MW/km²

Possible losses due to wake effects could also occur to a greater extent in the large, closely spaced areas N-11 to N-13 (see Figure 7). In comparison to the areas N-9 and N-10, these are areas with significantly larger dimensions, which are also in close spatial proximity. Here, too, the simulation shows that the efficiency of the inner locations could decrease at a higher power density.

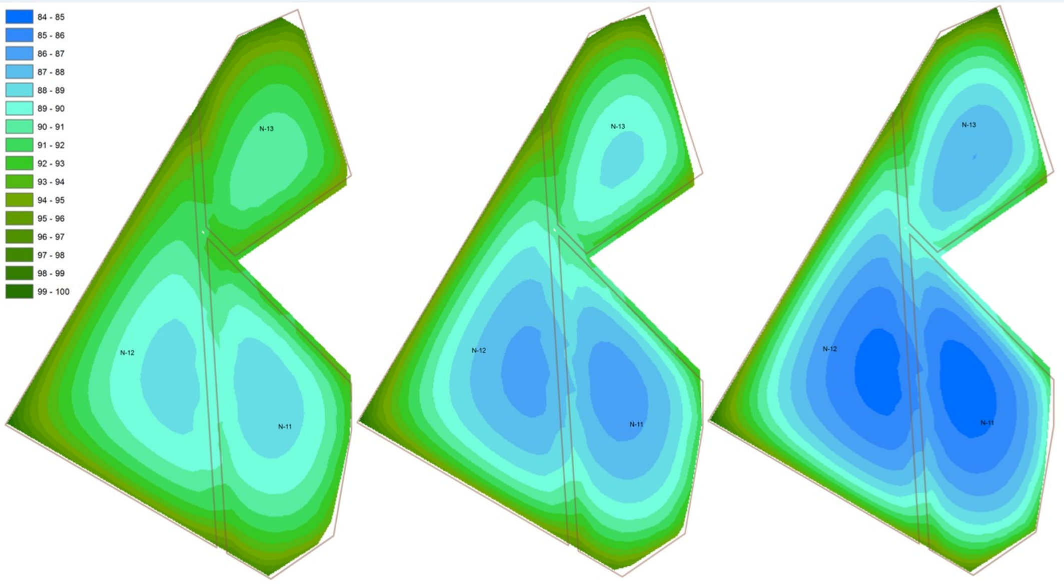


Figure 7: Relative efficiency of turbine sites in the areas N-11 to N-13 at a corrected power density of 7 MW/km², 8 MW/km² and 9 MW/km²

Objective 3: Efficiency of grid connection

Against the background of the efficient planning and operation of the offshore grid connections, it would be preferable to develop the areas in the N-9 and N-10 areas with the standard connection concept with 2,000 MW transmission capacity.

A deviation from the standard connection concept in combination with a cross-area connection of relatively small areas would probably lead to an increase in the transmission costs of electricity.

Conclusion	With a view to increasing the installed capacity and achieving the expansion targets (Objective 1), it would be advantageous to set the power density to be applied at 9 MW/km². Nevertheless, it has been shown that, given the current layout of the N-9 and N-10 areas, setting the power density to be applied at 8 MW/km² could have advantages with regard to the efficiency of electricity generation (Objective 2) and grid connection (Objective 3).

consultation questions:

F.14 After weighing the above-mentioned objectives, which of the variants presented for the power density to be applied for zone 3 do you consider appropriate?

F.15 Should the possible quality of the location be taken into account when designing the sites within the zones? How could this be done and what aspects would have to be taken into account?

F.16 Do you think it makes sense to individually determine the power density in areas or sites with significant differences in site efficiency in order to achieve an adjustment of the expected losses due to lag effects? (Example: Reduction of power density in area N-11 with simultaneous increase of power density in areas N-12 and N-13)

4.7.3.3 Determination of the corrected site

In order to enable a comparison of the different sites, the corrected site is calculated. For this purpose, the site defined in the FEP is extended by an additional border, which corresponds to half the average distance of the WTGs from each other.

For the calculation of the corrected site, it is therefore assumed for simplification purposes that the reference installations are positioned in a regular grid on the site. In addition to the power density as the determining factor, the rotor diameter and the ratio of rated power to rotor area (specific power of the wind turbine, in W/m²) are also input variables for the calculation. The buffer distance is thus calculated as follows:

Calculation of the buffer distance x

$$x = \frac{1}{4} \cdot d_{Rotor} \cdot \sqrt{\pi \cdot \frac{p_{WEA}}{p^*}}$$

d_{Rotor}	Rotor diameter in m
p_{WEA}	specific output of the WTG in Watt / m² rotor area
p^*	corrected power density in MW/km²

For the calculation of the buffer distance, therefore, in addition to the corrected power density, the definition of the rotor diameter as well as the specific power of the reference systems is necessary. For this purpose, technology scenarios were examined in the accompanying expert report and during the consultation of the FEP, the participants were asked about the possible development of plant technology from 2026.

With regard to the expected rotor diameter of the turbines to be erected in the target system, the consultation resulted in a relatively high bandwidth. Taking into account the feedback from the consultation and the results of the accompanying research contract, the rotor diameter of the reference installation is set at 220 m.

As already mentioned in (Borrmann, Rehfeldt, Wallasch, & Lüers, 2018) analysed, the specific output of offshore wind turbines erected in the past in European wind farms shows a range of 300 to 500 W/m². A clear tendency towards turbines with a very high or very low nominal output in relation to the rotor diameter could not be determined so far. The consultation process did not produce a uniform picture either. In order to calculate the corrected site, the specific output of the reference plant is therefore set at 400 W/m². The assumptions for the calculation of the corrected site are summarised in the following table:

Table 3: Input parameters for calculating the corrected site

Parameters	Value
Corrected power density	site-specific
Rotor diameter	220 m
Specific power of the WTG	400 W/m²

Depending on the categorisation according to Table 2 in the buffer distance by which the respective site is extended to calculate the corrected site. If the corrected site s overlap with other corrected sites or with the sites of existing wind farms, the corrected site must be reduced accordingly.

The expected generation capacity for the respective site is now calculated by multiplying the corrected site by the respective corrected power density.

4.7.3.4 Plausibility check of the expected generation capacity

The next step is a plausibility check of the generation capacity determined according to the procedure described above. This check takes place in three steps:

Available grid connection capacity

The first step is to check whether the determined power can be dissipated via the existing or planned grid connection systems. If the determined capacity of the sites exceeds the possible grid connection capacity, the expected capacity to be installed must be reduced accordingly for the respective site.

Review of possible wind farm layouts

Due to specific restrictions, e.g. by maintaining distances between turbines and neighbouring wind farms, existing or planned cable systems or similar, it may not be possible to realise the full determined output on the individual sites. For this reason, a realisation of the expected generation capacity is examined for the sites defined in the FEP using the plant parameters shown in Table 3 with an even distribution of the plants over the site, while maintaining the distances between the plants which are usual in practice. If this does not seem possible, the determined power is reduced accordingly.

4.8 Criteria for determining the site and the chronological order of their tendering

Reference is made to Chapter 4.8 of the FEP 2019. A revision is made in the draft of the FEP 2020.

5 Rules

5.1 Areas for the installation and operation of offshore wind turbines

According to § 5 para. 1 no. 1 WindSeeG, the FEP contains definitions of areas for the construction and operation of offshore wind turbines.

A total of 13 areas in the North Sea EEZ and three areas in the Baltic Sea EEZ for offshore WTGs are currently identified in this plan, with areas N-4 and N-5 under consideration for possible subsequent use. The areas are numbered N and O for the North Sea and the Baltic Sea respectively and 1 to 13 for clarity.

The definition and delimitation of the areas is based in particular on the provisions of spatial planning and the consideration of other public and private interests. With regard to spatial planning, in addition to the valid 2009 spatial plan, the changes resulting from the concept for updating the spatial plans published and consulted in January 2020 were also taken as a basis. Further information can be found in chapter 2.6.1.2).

Overviews of approved uses and protected areas as well as areas defined by spatial planning can be found in BFO-N 16/17 (Chapter 12) and BFO-O 16/17 (Chapter 11). Reference is made to Chapter7 of the FEP 2019. The definition of the areas was largely taken over from the O-NEP or the BFO. The areas N-1 to N-4 and all areas of the Baltic Sea are located in zone 1 of the O-NEP. The areas N-5 to N-8 are located in zone 2, while the areas N-9 to N-13, which are located in zone 3 of the O-NEP, have been extended in a north-western direction in accordance with the concept for the revision and further development of the spatial plans. The concept provides for an adaptation of the priority area shipping (shipping route 10) to the real shipping traffic. This extension is reflected in all three planning options (A - C) and is accordingly also reflected in this preliminary draft of the FEP. Reference is made to chapter 2.6.1.2

Table 4: Overview of areas for offshore wind energy

Area	Size [km²]	Zone classification of the O-NEP
North Sea		
N-1	approx. 79	1
N-2	approx. 223	1
N-3	approx. 311	1
N-4	approx. 152	1
N-5	approx. 125	2
N-6	approx. 249	2
N-7	approx. 163	2
N-8	approx. 170	2
N-9	approx. 454	3
N-10	about 197	3
N-11	approx. 355	3
N-12	approx. 494	3
N-13	approx. 270	3
Baltic Sea		
O-1	approx. 134	1
O-2	approx. 101	1
O-3	approx. 30	1

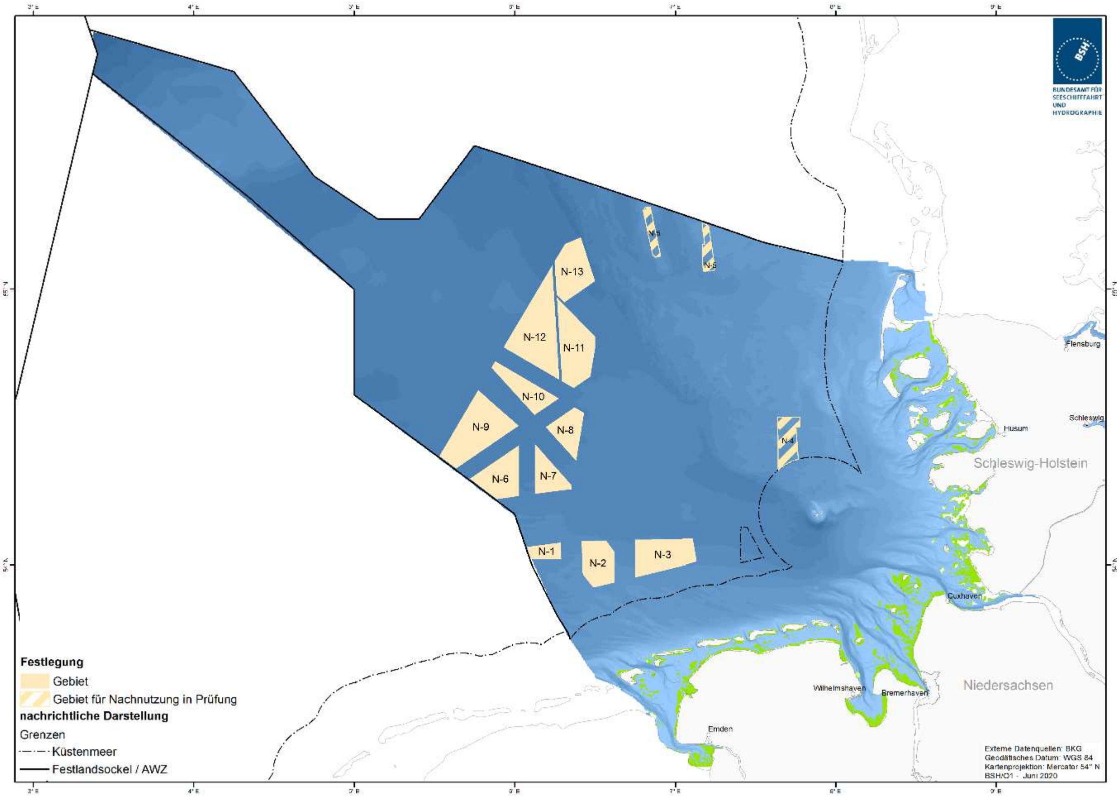


Figure 8: Areas in the German North Sea EEZ

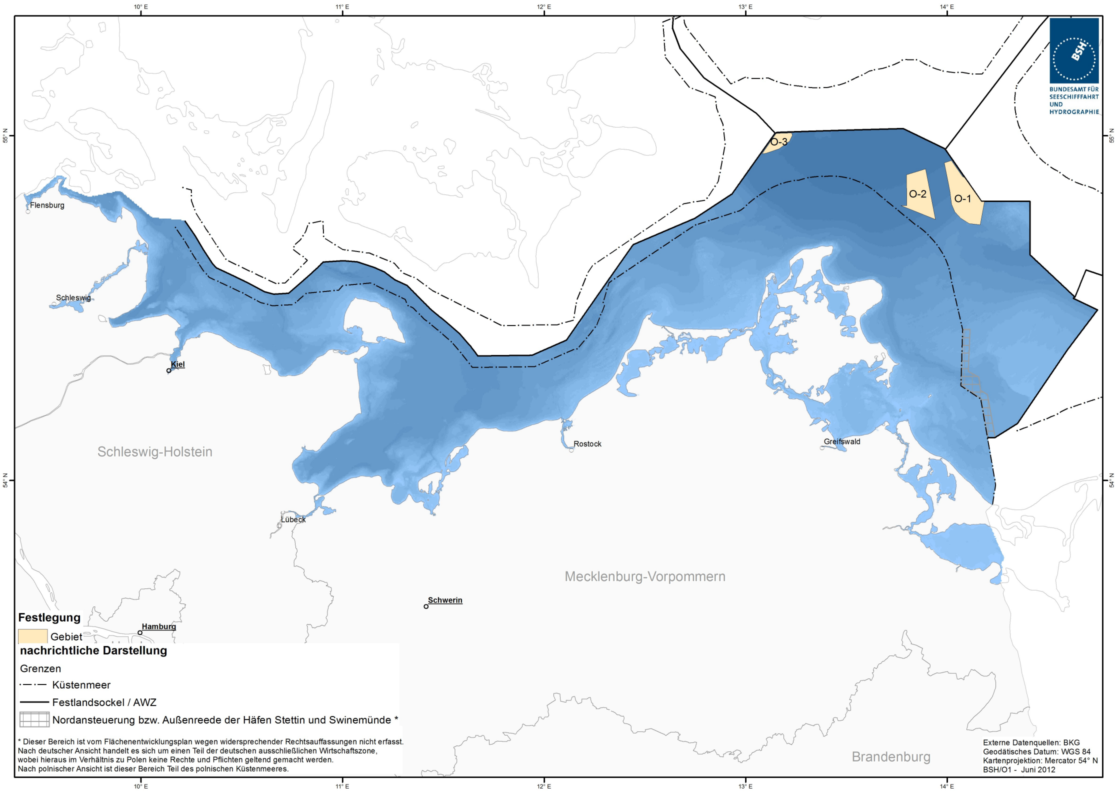


Figure 9: Areas in the German Baltic Sea EEZ

5.1.1 Definition of areas and sectoral planning framework

Reference is made to Chapter 5.1.1 of the FEP 2019. A revision is made in the draft of the FEP 2020.

5.1.2 The areas in detail

For the spatial descriptions of the areas **N-1 to N-8** and **O-1 to O-3,** reference is made to the FEP 2019. A revision is made in the draft of FEP 2020.

Area N-9 is delimited by shipping routes 6 and 10 and the area reserved for pipelines ('Norpipe'). For navigation route 10 (see background information in chapter 2.6.1.2) the situation from the published and consulted concept for the updating of the spatial planning is used as a basis.

Area N-10 is located between shipping routes 4, 6 and 10 and the reserved area of the pipeline ('Europipe 1'). For shipping route 10 (see background information in chapter 2.6.1.2), the situation from the published and consulted concept for updating the spatial plans is taken as a basis.

Area N-11 is bordered by shipping routes 4, 5 and 6, the cross-border sea cable system "NorNed" and the nature conservation area "Sylter Außenriff - Östliche Deutsche Bucht".

Area N-12 is delimited by shipping routes 4 and 10 and the cross-border sea cable system "NorNed". For navigation route 10 (see background information in chapter 2.6.1.2), the situation from the published and consulted concept for updating the spatial plans is taken as a basis.

Area N-13 is [8]limited by shipping route 10 and the nature reserve "Sylter Außenriff - Östliche Deutsche Bucht" as well as the main distribution area divers. For shipping route 10 (see background information in chapter 2.6.1.2), the situation from the published and consulted concept for updating the spatial plans is used as a basis.

[8] The distance to the main distribution area divers corresponds to the avoidance distance or aversive habitat loss of 5.5 km.

Table 5: Summary overview of the areas in the FEP 2019

[A revision is made in the draft of the FEP 2020].

Area	Cluster designation in the BFO	At present, additional considerable recognizable aspects compared to the designation of clusters in the BFO (§ 5 para. 3 sentence 3 WindSeeG) Currently discernible conflicts of use
North Sea		
N-1	Yes	No
N-2	Yes	No
N-3	Yes	No
N-4 (re-use under examination)	Yes	Location in the main distribution area divers.
N-5 (re-use under examination)	Yes	Reduction of the designated Cluster 5 to the operating OWPs "Dan Tysk" and "Sandbank". The "Butendiek" project is presented for information purposes as a wind farm due to its location within the protected area. Location in the main distribution area divers. Additional significant identifiable aspects and conflict of use.
N-6	Yes	No
N-7	Yes	No
N-8	Yes	No
N-9	Yes	No
N-10	Yes	No
N-11	Yes	No
N-12	Yes	No
N-13	Yes	No
Baltic Sea		
O-1	Yes	No
O-2	Yes	Bird migration Safety and ease of navigation
O-3	Yes	Area has been reduced in size compared to the designated cluster.

5.2 Sites for the construction and operation of offshore wind turbines

Pursuant to Article 5 para. 1 no. 2 WindSeeG, the FEP shall determine sites in the areas defined in Chapter 5.1 for the construction and operation of offshore wind turbines. § Article 5 para 4 does not conclusively regulate criteria for the determination of sites (see Chapter 4.8). The draft bill for the amendment of the Wind Energy at Sea Act and other provisions[9] adopted by the Cabinet on 3 June 2020 provides in § 5 para 5 WindSeeG-E that the areas as well as the sites and the chronological order shall be determined in such a way that a sites with an expected installed capacity of

- about 1 gigawatt per year in the years 2021 to 2023,

[9] Available at https://www.bmwi.de/Redaktion/DE/Downloads/E/entwurf-eines-gesetzes-zur-aenderung-des-windenergie-auf-see-gesetzes.pdf?__blob=publicationFile&v=6

- about 3 gigawatts in 2024 and
- about 4 gigawatts in 2025,

whereby deviations are permitted as long as the expansion target for 2030 is reached.

The sites are numbered from 1 to 8 after the letter N or O for the North Sea and Baltic Sea and from 1 to 13 for the area (example: N-9.1 for site 1 in area N-9 in the North Sea).

5.2.1 Determination of sites

Within the framework of the FEP, taking into account the OWP projects that will be commissioned by 2025 and the planning horizon until 2030, initially only sites in areas N-3, N-6, N-7, N-9, N-10 and O-1 will be designated. Reference is made to Chapter 4.6Assuming that the wind farm projects in the areas N-1, N-2 and N-4 as well as O-3, which are already in operation or which have been awarded a contract within the framework of the transitional tenders, are still in operation or will be in operation until 2025 if the conditions are met, no sites in these areas will be designated. The examination of the projects that have been awarded a contract under the transitional tendering procedure is reserved for the respective individual approval procedure in accordance with the applicable regulations. Reference is made to Chapter 6.

Table 6: Overview of areas and sites for offshore wind energy

Area	Site	Size of site [km²]	Connection concept
North Sea			
N-1	-	-	-
N-2	-	-	-
N-3	N-3.5	approx. 29	66 kV
	N-3.6	approx. 33	66 kV
	N-3.7	approx. 17	155 kV[1)]
	N-3.8	approx. 23	155 kV[1)]
N-4[2)]	-	-	-
N-5[2)]	-	-	-
N-6	N-6.6	approx. 44	66 kV
	N-6.7	approx. 16	66 kV
N-7	N-7.2	approx. 59	66 kV
N-8	-	-	-
N-9	N-9.1	approx. 100	66 kV
	N-9.2	approx. 105	66 kV
	N-9.3	approx. 105	66 kV
	N-9.4	approx. 101	66 kV
N-10	N-10.1	approx. 96	66 kV
	N-10.2[4)]	approx. 93	66 kV
Baltic Sea			
O-1	O-1.3	approx. 25	AC connection
O-2	O-2.2[5)]	approx. 20	-
O-3	-	-	-

[1)] Sites N-3.7 and N-3.8 will be connected to the NOR-3-3 connection system, which will go into operation as early as 2023 and will therefore be connected using the 155 kV connection concept.
[2)] Sites N-4 and N-5 are under consideration for possible subsequent use. Reference is made to chapter 5.1
[4)] The sites N-10.2 is not fully required to achieve 20 GW.
[5)] The determination of the site O-2.2 is questionable. Reference is made to chapter5.1.2,5.2.2 and 7

North Sea

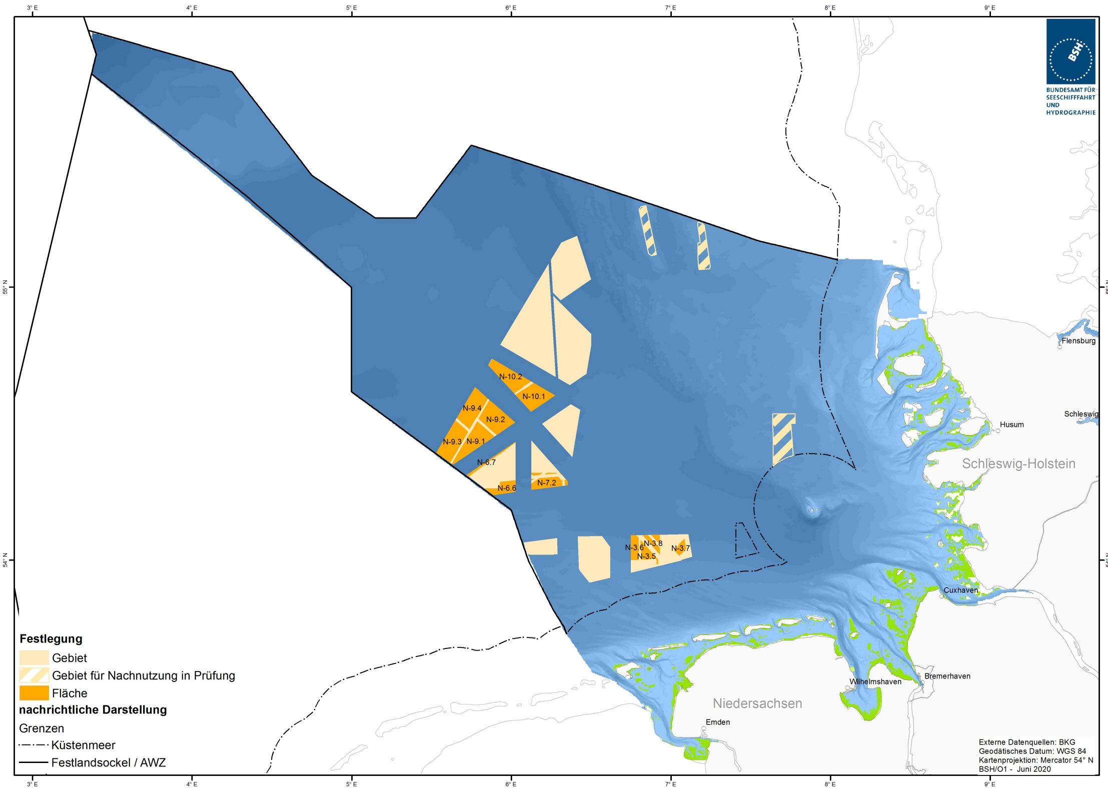


Figure 10: Areas and sites in the German North Sea EEZ

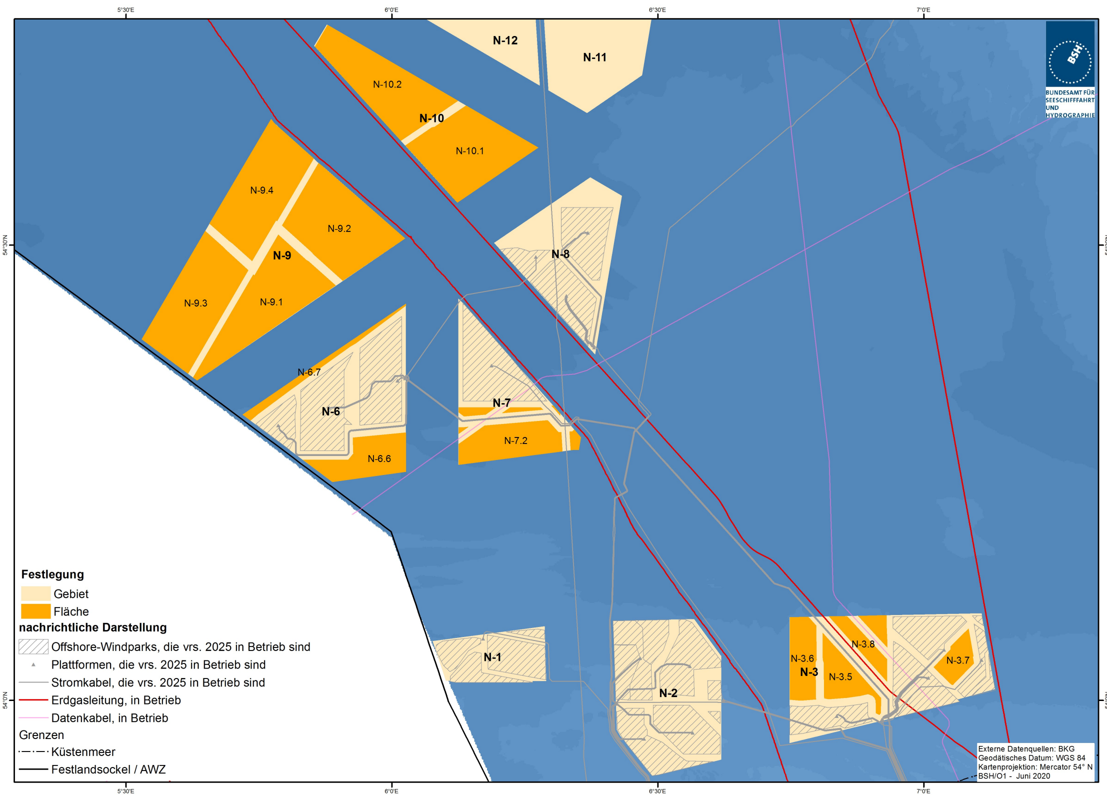


Figure 11: Sites in areas N-3, N-6, N-7, N-9 and N-10 in the German North Sea EEZ

For the spatial descriptions of the sites in areas N-3 to N-7, reference is made to the FEP 2019. The adjustments proposed in Chapter 5.11 for interconnections and replanning of the cross-border submarine cable systems will result in some slight increases in the sites. The revision in this respect is carried out in the draft of FEP 2020.

In area N-9, four sites of approximately equal size will be identified under this plan. Site N-9.1 is located in the south-western portion of Area N-9 and is bounded to the south by Shipping Route 6. To the north is the site N-9.2, which extends to the Conduit Reservation Area, which surrounds the "Norpipe". Sites N-9.3 and N-9.4 are bounded to the south by sites N-9.1 and N-9.2, to the north-west by shipping route 10, which was amended in the spatial planning update plan, and to the north by the "Norpipe".

For the N-10 area, two sites have also been identified in this plan. The area is divided into two sites of approximately equal size. N-10.1 follows this area in a south-easterly direction and is bordered by "Europipe 1" and shipping routes 4 and 6. N-10.2 is limited in the west by "Europipe 1", in the north-west by the shifted shipping route 10 and in the north by shipping route 4. It should be noted that the N-10.2 site is not fully required to reach 20 GW.

Baltic Sea

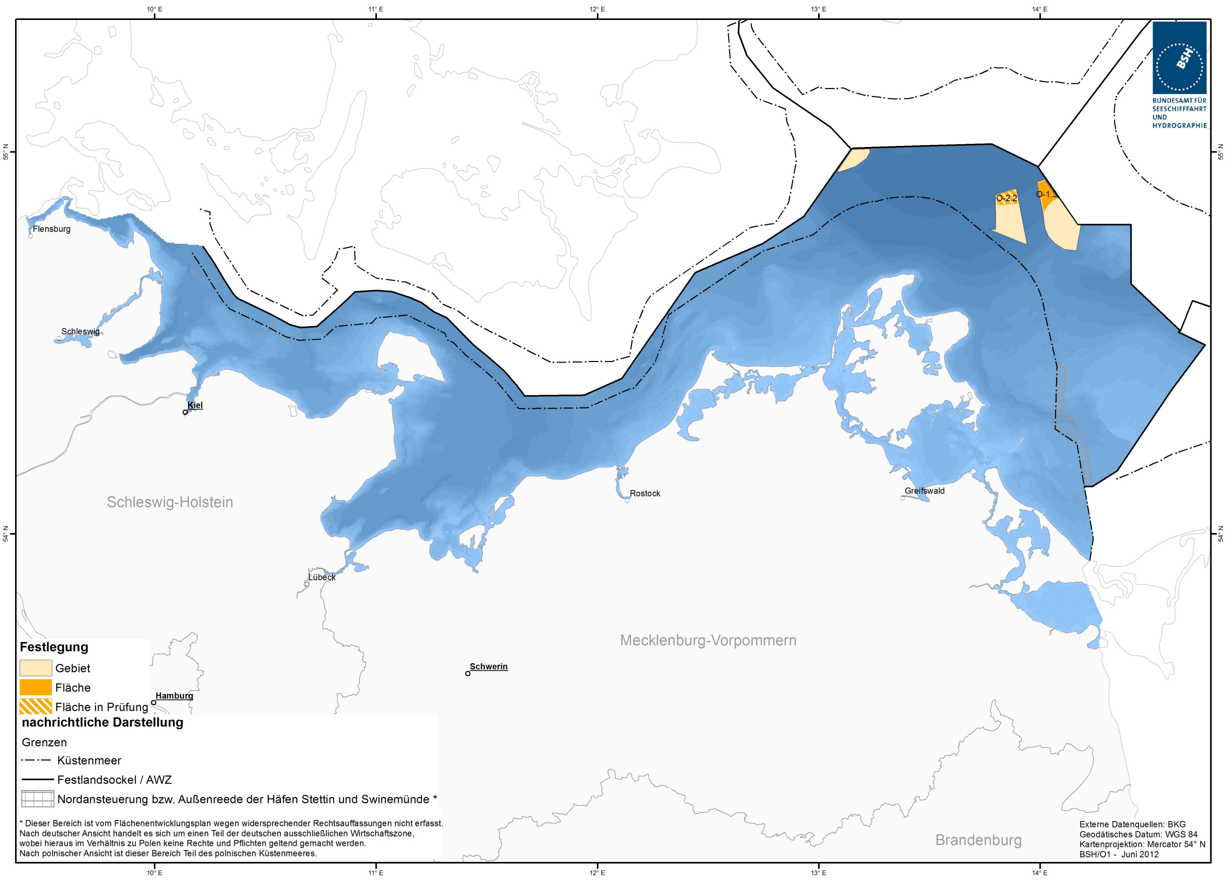


Figure 12: Areas and sites in the German Baltic Sea EEZ

For the spatial descriptions of sites O-1.3 and O-2.2 (under examination), reference is made to the FEP 2019.

5.2.3 Relevant criteria for deciding against the establishment of an site

For the determination of the sites in the FEP, the WindSeeG stipulates in § 5 para. 4 criteria to be applied in a non-exhaustive manner. One or more criteria may result in parts within areas not being defined as sites. Reference is made to chapter 8.

For the methodology of the application of the criteria and the description, please refer to Chapter 4.8.

Reference is made to the site comparison under nature conservation aspects in the context of the assessment of spatial alternatives in the environment report (Chapter 9.3.2) of the FEP 2019. Reference is made to the drafts of the environmental reports still to be prepared within the framework of this update and to be consulted in the later process.

The following table summarises the areas in which no sites are defined on the basis of the criteria listed in 4.7.2.

Table 7: Overview of the relevant criteria for the decision against a zoning

Area	Site	Decisive criteria for the decision against a determination of a site
North Sea		
N-5	-	Criterion (4)
N-8	-	Criterion 2
Baltic Sea		
O-11)	-	Criteria 4 and 6
O-21)	O-2.2	Criteria 2, 4 and 6

[1)] Reference is made to Chapter 6, which shows available grid connection capacities for pilot wind turbines in areas O-1 and O-2. For information on possible conflicts of use, please refer to the FEP 2019 and the environmental reports. Whether and where exactly the construction and operation of pilot offshore wind energy turbines is permitted will be decided solely by the approval procedure for pilot offshore wind energy turbines to be carried out later.

<u>Sites in area N-5</u>

The designation of the sites N-5.4 designated in the preliminary draft of the FEP 2019 and the drafts of the FEP 2019 cannot be considered due to nature conservation and environmental concerns.

An extension of the area N-5 for the use of offshore wind energy beyond the OWPs "Butendiek", "Dan Tysk" and "Sandbank" in operation at the time of this review, and specifically in relation to the area N-5.4 described in the drafts of the FEP 2019 under review, is, according to the current state of knowledge, not only incompatible with the prohibition under § 44 para. 1 No. 2 BNatSchG, but also with § 5 para. 3 No. 2 WindSeeG.

The exclusion of the N-5.4 site is based on the extent of the cumulative after partial effects of the OWPs already identified from the area of the main distribution area divers in the German North Sea EEZ. The observed loss of 19% of the feeding and resting habitat within the main distribution area divers, which is valuable for the conservation of the local grebe population, in connection with the statistically significant decrease in the abundance of grebes, prohibits a possible increase in the area of intervention for reasons of ensuring the protection of the grebe species.

In accordance with the precautionary principle under Art. 3 UVPG, and in order to exclude a significant disturbance within the meaning of Art. 44 para. 1 No. 2 BNatSchG with the required degree of certainty, further cumulative effects from the construction of further offshore wind turbines in the N-5 area must be avoided.

The precautionary principle is an environmental law principle of paramount importance. It demands that measures should not only intervene in the event of imminent damage caused by specific environmental hazards, but should start to reduce the risk before a hazard arises. This standard is also supported by the wording of the technical legal § 5 para. 3 sentence 2 no. 2 WindSeeG "Endangerment of the marine environment". This results in the obligation to take precautionary environmental measures that are as far-sighted and planned as possible and that aim to prevent environmental hazards or even damage from arising in the first place. Particularly in the case of complex or not yet fully researched interrelationships, an environmental hazard can arise as a result of a cumulative effect of the contribution to the causation of damage, which may be harmless on its own. Thus, the installation of only one wind energy plant - or even a single OWP - should be considered unproblematic by everyone, but the large number of plants or projects must lead to a different approach and treatment. The application of the precautionary principle makes it possible to take action in the event of a concern - based on real evidence - about possible environmental damage (Cow Beer & Prall, 2010).

The site N-5.4, which is still under consideration in the drafts of the FEP 2019, will be excluded from the further planning of offshore wind turbines to be commissioned from 2026 on, based on the results of the assessment of the cumulative adverse impacts on the conservation status of the local population of divers.

The assessment of the area, or of a potential site within that area, has shown that loon populations are biologically highly sensitive, that the main distribution area divers is of high importance for the maintenance of the local population and that the adverse effects of avoidance behaviour are intense and permanent.

In order to avoid a deterioration of the conservation status of the local population due to the cumulative effects of the wind farms, it is necessary to keep the area of the main distribution area divers currently available to divers, outside the impact zones of already implemented wind farms, free from new wind farm projects with commissioning from 2026.

The BSH comes to the conclusion that a significant disturbance within the meaning of Article 44(1)(2) of the Federal Nature Conservation Act (BNatSchG) as a result of the implementation of the plan can be ruled out with the necessary certainty if it is ensured that no additional habitat loss will occur in the main distribution area divers.

Due to the considerable cumulative effects on the diver, which cannot be ruled out, the realisation of further wind farm projects in the main concentration area already posed a threat to the marine environment within the meaning of § 5 Para. 3 S. 2 No. 2 WindSeeG - irrespective of the question of admissibility under species protection law. One of the reasons for this is that the main distribution area divers is an important functional component of the marine environment with regard to sea birds and resting birds. For this reason, a designation beyond the OWPs "Butendiek", "Dan Tysk" and "Sandbank" in operation at the time of this review and specifically with regard to the site N-5.4 as presented in the drafts of the FEP 2019 under review is not permissible.

Reference is made to Chapter 8 of the FEP 2019 and to Chapters 4.12.4 and 5.2.2.1 of the North Sea Environmental Report of the FEP 2019.

The expertise on the distribution and occurrence of red-throated and black-throated divers in the German North Sea (BioConsult SH GmbH & Co. KG, 2020) will be examined and taken into account in the context of the continuation of the FEP. It is pointed out that the Bundesverband der Windparkbetreiber Offshore e.V. (Federal Association of Offshore Wind Farm Operators) is planning a workshop to discuss the results with nature conservation associations and authorities.

Reference is made to the draft environmental reports still to be prepared in the context of this update and to be consulted in the subsequent process.

In any case, a conflict of use within the meaning of § 5 para. 4 sentence 2 no. 4 WindSeeG between the use of offshore wind energy and nature conservation in technical and environmental law matters has become apparent with regard to the possible designation of land in this area.

Sites in area N-8

In area N-8, no site will be defined on the basis of criterion 2 (see Chapter 4.8.2.2 of the FEP 2019), since, taking into account the low expected installed capacity of the possible site, it seems spatially difficult and not efficient to construct a separate offshore connection line for this site. Across-area connection to area N-7 or N-6 is not possible, as it would involve numerous crossings. This would also considerably impede the connection and thus the development of the areas in zones 3 to 5 of the O-NEP and possibly lead to undesirable splinter planning. Reference is made to Chapter 7

Sites in area O-1

In the southern part of the area O-1, no site is defined due to conflicts of use (criterion 4, see Chapter 4.8.2.4 of the FEP 2019) and the expected capacity to be installed (criterion 6, see Chapter 4.8.2.6 of the FEP 2019). The southern part of the area is largely built-up. Reef structures can also be found there. Due to the small-scale possible sites, an (economical) operation of an independent wind farm does not seem possible.

A further examination of the safety and ease of navigation in the northern part of the area is required. In this context, in particular the results of the expert opinion on the traffic police suitability of the area to be examined in the course of the preliminary investigation as well as the results of the suitability test in the German EEZ in the North and Baltic Seas are to be used in addition.

Sites in area O-2

For the area O-2, due to conflicts of use (criterion 4, see Chapter 4.8.2.4 of the FEP 2019), it will be examined whether the site O-2.2 is defined. In this context, reference is additionally made to chapter 4.2.2 of BFO-O 13. The site O-2.2 is also under examination with regard to the safety and ease of navigation. In this context, the results of the expert opinion on the traffic police suitability of the areas in the German EEZ in the North Sea and Baltic Sea to be examined in the course of the preliminary investigation as well as the results of the suitability test are to be used in particular, as this area is included in the analysis of shipping traffic. The same applies to a more detailed examination of bird migration. Reference is made to chapter 4.12.5 and 9.3.2 of the FEP 2019 Baltic Sea Environmental Report.

With regard to the actual buildability (criterion 5, see Chapter 4.8.2.5 of the FEP 2019), serious and permanent obstacles to approval have not yet been identified, but the information available to date for the area of the Arkona Basin indicates that soft to mushy silt, sometimes more than 10 m thick, is present in this area, which is underlain by sediments up to about 30 m thick - consisting of soft to stiff clays, silt and fine sands as well as stiff to solid bedload marls. The basis of the glacial and postglacial sediments are again thick chalk deposits. In this context, it should be noted that state-of-the-art foundations for wind turbines and connecting lines have not yet been tested in the affected area.

In addition, there is a need for discussion and clarification of questions that cannot yet be conclusively assessed, for example on the subject of bird migration (cf. already Chapter 4.2.2, BFO-O 16/17 and BFO-O 2013), so that the definition of the O-2.2 area will be further examined within the framework of the continuation of the FEP.

There is one project in area O-2 that was awarded under the second transitional tender. Any knowledge gained from the planning approval procedure to be conducted in area O-2 will be taken into account within the framework of the updating of the FEP.

In the southern part of the O-2 area, no site is defined, not even on the basis of the expected capacity to be installed (criterion 6, see Chapter 4.8.2.6 of the FEP 2019). In addition to the criteria mentioned above, a (economical) operation of an independent wind farm in the southern part of area O-2 does not seem possible due to the small-scale possible site. Also on the basis of criterion 2 (see chapter 4.8.2.2 of the FEP 2019), there is no specification, because in consideration of the small expected installed capacity, it does not seem efficient to construct a separate offshore connection line for this possible area. Reference is made to the Figure 12as well as to chapter 7

5.3 Expected generation capacity

Pursuant to Article 5 para. 1 no. 5 WindSeeG, the FEP shall determine the capacity of offshore WTGs to be installed in the defined areas and on the defined sites. For the determination of the generation capacity on the respective sites, reference is made to the methodology introduced in chapter 4.7

Table 8 the expected generation capacity on the sites defined in section 5.2. The expected generation capacity on surfaces which are shown as "under test" according to the explanations in Section 5.2 is not specified.

Table 8: Overview of the power expected to be installed on the sites for offshore wind turbines

Area	Site	Expected generation capacity [MW]
North Sea		
N-3	N-3.5	420
	N-3.6	480
	N-3.7	225
	N-3.8	433
N-6	N-6.6	630
	N-6.7	270
N-7	N-7.2	930
N-9	N-9.1	1.000
	N-9.2	1.000
	N-9.3	1.000
	N-9.4	1.000
N-10	N-10.1	1.000
	N-10.2[1)]	1.000[1)]
Baltic Sea		
O-1	O-1.3	300

[1)] The N-10.2 site is not fully required for 20 GW.

For an illustration of the extent to which the generation capacity for the individual areas deviated from the power calculated according to Chapter 4.7.2 refer to the following section.

5.3.1 Plausibility check of the expected generation capacity

In accordance with the method of generation capacity determination described in Chapter 4.7.2 a plausibility check of the determined generation capacity is performed in a final step. Essential test characteristics are the capacity of the connection systems and the feasibility with regard to possible wind farm layouts. The

Table 9 shows the determined power as well as the corrected power density applied for the individual areas and indicates the areas for which the expected generation capacity deviates from the power determined in this way when determining the power.

For site N-3.7, the expected installed capacity is reduced to 225 MW, as the planned connection line does not allow for a higher capacity. The installation of an additional AC connection line is not possible due to spatial restrictions.

Site N-6.7 will be reduced to an expected installed capacity of 270 MW, as a higher capacity does not appear feasible against the background of the distances to be maintained to the turbines of neighbouring wind farms.

In the site O-1.3, the expected capacity to be installed is limited to a maximum of 300 MW according to the standard Baltic Sea connection concept. The construction of an additional connecting line is not planned due to the low capacity utilisation.

It is envisaged that the draft FEP 2020 will provide a more comprehensive description of the reasons for an adjustment in generation capacity.

Table 9: Plausibility check of the determined power

Site	Corrected power density [MW/km²].	Determined generation capacity according to chapter 4.7 [MW].	Adjustment of the generation capacity due to plausibility check
North Sea			
N-3.5	9,5	approx. 420	-
N-3.6	10	approx. 480	-
N-3.7	9,5	approx. 280	Reduction to 225 MW (max. capacity of the AC connection line)
N-3.8	9,5	approx. 440	Reduction to 433 MW (max. capacity of the DC connection line)
N-6.6	10	approx. 630	-
N-6.7	10	approx. 470	Reduction to 270 MW (plausibility check of the layout)
N-7.2	10	approx. 1060	Reduction to 930 MW (max. capacity of the DC connection line or NVP Büttel)
N-9.1	8	approx. 1,000	-
N-9.2	8	approx. 1,000	
N-9.3	8	approx. 1,000	
N-9.4	8	approx. 1,000	
N-10.1	8	approx. 1,000	
N-10.2	8	approx. 1,000	
Baltic Sea			
O-1.3	10	approx. 420	Reduction to 300 MW (max. capacity of the connection line)

5.4 Specifications for the territorial sea

Reference is made to Chapter 5.4 of the FEP 2019. A revision is made in the draft of the FEP 2020.

5.5 Chronological sequence of tenders for the sites

Pursuant to § 5 Paragraph 1 No. 3 WindSeeG, the FEP shall determine the chronological order in which the sites specified are to be put out to tender pursuant to Part 3 Section 2 WindSeeG, including the designation of the respective calendar years.

In order to determine the chronological order, the WindSeeG stipulates in § 5 para. 4 criteria to be applied, which are not exhaustive. Regarding the methodology of the application of the criteria as well as the description, reference is made to chapter 4.8

The draft law on the amendment of the Wind Energy at Sea Act and other provisions adopted by the Cabinet on 3 June 2020 provides in § 5 para. 5 WindSeeG-E that the areas as well as the sites and the chronological order shall be determined in such a way that sites with an expected installed capacity of

- about 1 gigawatt per year in the years 2021 to 2023,
- about 3 gigawatts in 2024 and
- about 4 gigawatts in 2025,

whereby deviations are permitted as long as the expansion target for 2030 is reached. The specifications in the FEP are intended to ensure that sites are put out to tender in the bidding deadlines from 2026 onwards, which will guarantee a steady expansion. There must be at least enough months between the calendar year of the invitation to tender for an site and the calendar year of the commissioning of the subsidised offshore wind turbines on this site so that the realisation deadlines according to § 59 WindSeeG can be met.

As described in point 4.8.1, the chronological order of the sites is firstly determined by applying criterion 1 and then criteria 2 to 8.

5.5.1 Chronological sequence of tenders for the sites

Applying criteria 1 to 8 and taking into account the guidance given in Chapter 4.8 the chronological order of the sites to be tendered for is established as shown in the Table 10

Due to spatial conditions for connection to the NOR-3-3 network connection system existing in 2026, sites N-3.8 and N-3.7 are located in chronological order before sites N-3.6 and N-3.5, which are also located in area N-3.

Within the framework of the consultation of the FEP 2019, a more comprehensible presentation of the determination of the chronological sequence, in particular with regard to the availability of offshore connection lines, NVPs and grid expansion on land, was requested. In order to comply with this request, Chapter 5.5.2 describes in more detail the information currently available to the BSH and how it is taken into account.

Table 10: Overview of the chronological order of sites to be tendered using criteria 1 to 8

Calendar year Tender	Calendar year Commissioning	Site designation	Network connection system	Expected generation capacity [MW]	Total expected generation capacity [MW]
2021	2026	N-3.7	NOR-3-3[1)]	225	958
		N-3.8	NOR-3-3[1)]	433	
		O-1.3	OST-1-4[1)]	300	
2022	2027	N-7.2	NOR-7-2[1)]	930	930
2023	2028	N-3.5	NOR-3-2[1)]	420	900
		N-3.6	NOR-3-2[1)]	480	
2024	2029	N-6.6	NOR-6-3[1)]	630	2.900
		N-6.7	NOR-6-3[1)]	270	
		N-9.1	NOR-9-1[1)]	1.000	
		N-9.2	NOR-9-1[1)]	1.000	
2025	2030	N-9.3	NOR-9-2[1)]	1.000	4.000
		N-9.4	NOR-9-2[1)]	1.000	
		N-10.1	NOR-10-1[1)]	1.000	
		N-10.2[2)]	NOR-10-1[1)]	1.000	
Total target system					9.688

Expected stock 2025	10.800
Projected stock in 2030	20.488

[1)] Reference is made to the confirmation of the network development plan 2019-2030 and to the preparation, review and confirmation of the network development plan 2021-2035

[2)] The N-10.2 site is not fully required for 20 GW.

5.5.2 Representation of the review of the time sequence based on references to offshore connecting cables, grid connection points and the network expansion on land

As described in section 4.8 criterion 2 serves on the one hand to avoid vacancies. On the other hand, when determining the chronological order, criterion 2 is used to check whether the corresponding connecting lines and NVPs are likely to be available, taking into account the planning and the actual development of networks on land in the years when the sites are put into operation. This assessment is based on the NEP 2019-2030, information from coastal countries and information from the TSOs on the planning and implementation periods of the NVPs and connection systems.

For the purposes of this review, the following information is available on offshore connecting lines with a commissioning date of 2026 and the corresponding NVPs, taking into account the planning and actual development of networks on land.

General notes

According to the second draft of the NEP 2019-2030, the total implementation period of a DC grid connection system is approx. 11 years and of an AC grid connection system 9.5 years. However, the confirmation of the NEP 2019-2030 shows that the duration may be less for specific connection lines.

According to the TSOs' comments of 29 August 2018 in the context of the FEP 2019 set-up procedure, a TSO could in principle realise a maximum of one offshore connection line per year. In order to achieve the expansion target of 20 GW by 2030, however, two connection systems must be implemented by one TSO in 2030. In this respect, reference is made to the agreement between the federal government, coastal states and TSOs (Federal Ministry of Economics and Energy, 2020) and the preparation, verification and confirmation of the NEP.

Information on interconnectors, network interconnection points and the planning and actual development of networks on land

The following information on connecting lines and NVPs available to connect the sites defined in Chapter 5.2 and their earliest possible completion is available.

North Sea

- The NEP 2019-2030 confirms six connecting lines for the German North Sea EEZ - partly subject to future consideration of the sites to be developed in an update of the FEP - with a completion date up to and including 2030. Furthermore, the NEP 2019-2030 confirms three offshore connecting systems with a planned completion after 2030, subject to the proviso that the potential sites to be developed by the corresponding connecting systems are defined as sites in an update of the FEP. Reference is made to the further explanations in the NEP 2019-2030. Reference is made to
- Figure 13: Extract of the confirmation of the NEP 2019-2030, page 13
- and
- Figure 14: Extract of the confirmation of the NEP 2019-2030, page 13

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Baltic Sea

- The NEP 2019-2030 confirms a connecting line for the German EEZ of the Baltic Sea with a completion date of 2030. Reference is made to
- Figure 13: Extract of the confirmation of the NEP 2019-2030, page 13
- Regarding the test field connection, please refer to chapter 5.4

It should be noted that the FEP does not define NVPs for network connection systems. The specification of the expected NVP serves the purpose of spatial planning and the determination of the chronological order of the sites within the framework of the FEP update. The NVPs are identified by the TSOs in the course of the preparation of the NEP and are checked and confirmed by the BNetzA in the subsequent procedure.

2. Die nachfolgenden Offshore-Anbindungssysteme werden einschließlich dem geplanten Zeitpunkt ihrer Fertigstellung und ihres Netzverknüpfungspunktes wie folgt **bestätigt**:

Anbindungssystem	geplanter Zeitpunkt der Fertigstellung	Netzverknüpfungspunkt
OST-7-1 (Testfeldanbindung)	2024	Gemeinde Papendorf
OST-1-4	2026	Suchraum Gemeinden Lubmin/Brünzow/Wusterhusen/Kemnitz
NOR-7-2 (BorWin6)	2027	Büttel
NOR-3-2 (DolWin4)	2028	Hanekenfähr
NOR-6-3 (BorWin4)	2029	Hanekenfähr
NOR-9-1	2029	Unterweser
NOR-10-1	2030	Unterweser
NOR-12-1	2030	Wilhelmshaven 2

Die Bestätigung der Offshore-Anbindungssysteme NOR-10-1 und NOR-12-1 steht unter dem Vorbehalt, dass die potenziellen Flächen, die durch die entsprechenden Anbindungssysteme erschlossen werden sollen, in einer Fortschreibung des Flächenentwicklungsplans als Flächen festgelegt werden.

Die Beauftragung des Testfeldanbindung OST-7-1 steht unter dem Vorbehalt, dass in einer Fortschreibung des Flächenentwicklungsplans der räumliche Umriss des Testfelds festgelegt wird.

Das Anbindungssystem NOR-9-1 ist mit einer Übertragungskapazität in Höhe von 2 GW zu realisieren unter dem Vorbehalt, dass in einer Fortschreibung des Flächenentwicklungsplans für das Anbindungssystem NOR-9-1 eine entsprechende Übertragungskapazität festgelegt wird.

Figure 13: Extract of the confirmation of the NEP 2019-2030, page 13

3. Die nachfolgenden Offshore-Anbindungssysteme mit einer geplanten Fertigstellung nach 2030 werden wie folgt unter dem Vorbehalt bestätigt, dass die potenziellen Flächen, die durch die entsprechenden Anbindungssysteme erschlossen werden sollen, in einer Fortschreibung des Flächenentwicklungsplans als Flächen festgelegt werden:

Anbindungssystem	Netzverknüpfungspunkt
NOR-11-1	Suchraum Gemeinden Ibbenbüren / Mettingen / Westerkappeln
NOR-11-2	Wehrendorf
NOR-13-1	Heide/West

Figure 14: Extract of the confirmation of the NEP 2019-2030, page 13

Review of the chronological order, taking into account the availability of offshore interconnectors, NVP and onshore grid development

The review of the chronological order, taking into account the availability of offshore interconnectors, NVPs and onshore network development, concludes that, on the basis of the information currently available, no adjustment of the chronological order appears necessary.

Regarding NOR-7-2 and NOR-3-2, reference is made to the FEP 2019, chapter 5.5.2, as well as to the NEP 2019-2030.

Questions for consultation

5.5 Chronological order of the sites to be tendered

From the specified chronological order of the sites to be put out to tender, it can be seen that in future it will be necessary to connect a total of up to 2,000 MW of OWP connected capacity on one converter platform within one calendar year. Due to the specified expected installed capacity for sites in the N-9 and N-10 areas of 1,000 MW, it is also to be expected that two different OWP developers will have to ensure the connection on one converter platform in one calendar year.

F.17 In the view of the participants in the consultation, are there important aspects that lead to the expectation that the connection of a total of 2,000 MW from different OWP project developers on one converter platform within one calendar year is not feasible?

5.6 Calendar year of commissioning for offshore wind turbines and connecting lines

According to § 5 para. 1 no. 4 WindSeeG, the FEP shall determine the calendar years in which the offshore wind turbines and the corresponding offshore connection line shall be put into operation.

Concerning the calendar years in which the offshore wind turbines subsidised on the defined sites are to be commissioned, reference is made to Chapter 5.5.

When determining the calendar years of commissioning for offshore WTGs, it is assumed that the commissioning of offshore WTGs and the commissioning of the associated grid connection system can in principle take place in the same calendar year. This also corresponds to the objective of § 4 par. 2 no. 3 WindSeeG, according to which the wind turbines are to be developed in synchronism with the grid connection systems.

Assuming the information given in Chapter 5.5 the calendar years of commissioning for offshore connecting lines are as shown in the following table.

Reference is made to the NEP 2019-2030 and the preparation, review and confirmation of the NEP 2021-2035.

Table 11: Overview of calendar years of commissioning for offshore connecting lines, taking into account the notes listed in Chapter 5.5

Name	Calendar year of commissioning	Transmission capacity [MW]
OST-1-4	2026	300
NOR-7-2	2027	930[1)]
NOR-3-2	2028	900
NOR-6-3	2029	900
NOR-9-1	2029	2.000
NOR-9-2[2)]	2030	2.000
NOR-10-1[2)]	2030	2.000

[1)] It should be noted that for the transmission capacity for the NOR-7-2 offshore connection line, it is assumed that, with an expansion target of 20 GW, there is no limitation by a statutory expansion path of 700 to 900 MW per tender year. (see Chapter 5.2)

[2)] It is noted that the NEP 2019-2030 has confirmed two connecting lines (NOR-10-1 and NOR-12-1) for the German North Sea EEZ for the calendar year of commissioning 2030, subject to future consideration of the sites to be developed in an update of the FEP. However, since sites in the extended areas N-9 and N-10 are to be defined, the connecting lines NOR-9-2 and NOR-10-1 would be necessary. Reference is made to the preparation, examination and confirmation of the NEP 2021-2035.

The draft law amending the Wind Energy at Sea Act and other provisions adopted by the Cabinet on 3 June 2020 provides for the designation of the calendar years in which the offshore wind turbines and the corresponding offshore connection line, which are to be commissioned on the designated sites, are to be put into operation.

Subject to entry into force, the following questions arise for the determination of calendar years, including the designation of the exact quarters.

Questions for consultation

F.18 Does it seem possible that the offshore connection line and the offshore wind turbines in zones 1 and 2 will be commissioned in the same quarter? If not, what are the reasons for not doing so? If not, how many quarters should there be between the commissioning of the offshore line and the offshore wind turbines?

F.19 In view of the consultation question in section 5.5 how much time should be allowed between the commissioning of the offshore connection line and the offshore wind farm in zone 3?

5.7 Locations of converter platforms, collection platforms and substations

According to § 5 Paragraph 1 No. 6 WindSeeG, the FEP shall determine the locations of converter platforms, collection platforms and, as far as possible, transformer stations.

Converter or transformer platforms are only defined in those areas where sites are also designated. Transformer platforms are only defined to the extent that they are necessary for the connection concept. Consequently, no transformer platforms are specified for the 66 kV direct connection concept in the North Sea.

For the spatial descriptions of the converter platforms in areas N-3 to N-7 and the transformer platforms in areas O-1 and O-2, reference is made to the FEP 2019. A revision is made in the draft of FEP 2020.

Compared to the FEP 2019, the platform NOR-3-2 was shifted by about 1.3 km to the north in order to define a location outside of an ice-age trough running there.

In area N-6, in contrast to the FEP 2019, a connection with the 66kV connection concept is also planned for sites N-6.6 and N-6.7. The reasons for this are explained in the following consultation box.

A 66 kV development is also planned for area N-9. The NOR-9-1 converter platform is planned to be located centrally between sites N-9.1 and N-9.2. The NOR-9-2 converter platform is planned to be located centrally between sites N-9.3 and N-9.4.

In Area N-10, a converter platform, NOR-10-1, is planned to be located centrally between the two sites of the area.

Questions for consultation

5.7 Locations of converter platforms, collection platforms and substations

In the FEP 2019, the so-called alternative concept for the connection system NOR-6-3 was defined for the connection of the sites N-6.6 and N-6.7. The background of the specification was that the standard 66 kV connection concept without transformer platform seemed to be disadvantageous due to the large spatial distance between the two sites to be connected, and that a comparatively large number of 66 kV cable systems would be required to connect the northern site N-6.7 with little available space.

The transmission system operator Amprion, which is obliged to connect the grid, has commissioned various expert opinions on this issue which indicate the feasibility of connecting the grid with the 66 kV connection concept. The mentioned expert opinions can be viewed on Amprion's website under the link https://www.amprion.net/Netzausbau/Aktuelle-Projekte/Offshore/Anbindungskonzept-BorWin4.html.

In a first study, which was completed at the end of 2018, a cost-benefit comparison was initially made on behalf of all TSOs between the 155 kV connection concept with transformer platform known from BFO-N 16/17 and the 66 kV direct connection concept. The results showed that the 66 kV direct connection concept has a clear economic advantage.

With regard to the specific case of the NOR-6-3 connection system, reference has already been made to the N-6.6 and N-6.7 sites to be connected, which are far apart. In a further expert opinion commissioned by Amprion, it was examined whether a connection especially of the northern site N-6.7 is possible in view of the existing spatial restrictions. The study comes to the conclusion that a connection of the site with three or even four 66 kV cables is possible. Different variants are proposed. In the opinion of the BSH, variant A2 with two 66 kV cables running west and one east of the OWP "BARD Offshore 1" is to be preferred (see Figure 15 below from the expert opinion). With regard to this variant, the experts come to the conclusion that at two bottlenecks between the existing BARD Offshore 1 and Veja Mate OWPs, planning principle 4.4.1.6 (consideration of existing uses) of the FEP 2019 is not met or not complied with. The distance of 500 m to be maintained according to the planning principle would have to be undercut by up to 150 m, the smallest distance to an existing use would therefore be 350 m. With regard to the safety zones mentioned in the expert opinion, it should be noted that the safety zones concerned have not yet been defined. The site N-6.6 will be defined in such a way that a parallel routing to the existing connection systems of the "Deutsche Bucht" wind farm with two 66 kV cables is possible while maintaining the distances specified in the plan.

For the site N-6.7, a capacity of 270 MW to be installed is specified. Due to the comparatively large spatial distance, it seems questionable whether this capacity can be dissipated with only three 66 kV cables. In a further study, this question was also investigated on behalf of Amprion. Based on a load flow calculation, the experts concluded that a connection with three 66 kV cables up to a maximum route length of approx. 38 km is possible without restrictions of the OWP on the site N-6.7. In order to avoid unacceptably high voltages, the NOR-6-3 converter had to be operated in a targeted manner, but this did not lead to any restrictions for the OWP. The line losses for the OWP are slightly higher for the variant with three 66 kV cables compared to the connection with 220 kV and a transformer platform originally specified in the FEP 2019. The experts point out, however, that these additional costs would be more than compensated by the savings of the transformer platform (see question below).

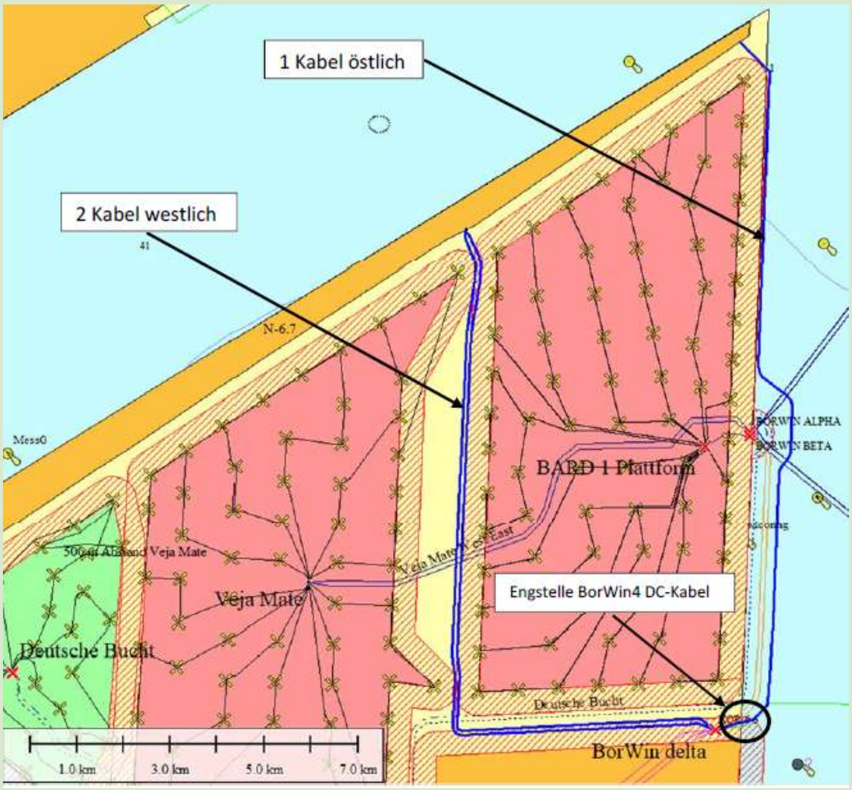

Figure 15: Spatial representation of the so-called variant A2 with three 66 kV cables to connect the site N-6.7. source: (eos Project GmbH, 2019)

On the basis of the new findings presented compared to the FEP 2019, the BSH comes to the conclusion that a conversion of the NOR-6-3 connection system to the 66 kV connection concept is advantageous overall and is specified in this preliminary draft. Even if 66 kV cables are not spatially defined in the FEP, it is pointed out that a limitation to a maximum of three cables for the connection of the N-6.7 site seems to be expedient. In particular, by defining the 66 kV connection concept, the aim of standardisation and comparability of sites and connection systems can be taken into account. Nevertheless, as already mentioned, there are some boundary conditions which require special consideration or examination.

For this reason, the BSH requests that the following consultation questions be answered:

F.20 From the point of view of an OWP, is it understandable that although higher line losses occur with the conversion to the 66 kV connection concept for the N-6.7 site, these are compensated for by the elimination of the transformer platform?

F.21 From the point of view of the participants in the consultation, are there any reasons that speak against defining the 66 kV connection concept for the NOR-6-3 connection system?

5.8 Routes or route corridors for offshore connecting lines

According to § 5 Para. 1 No. 7 WindSeeG, the FEP determines routes or corridors for offshore connecting lines. The connection concepts listed in chapter 4.2 are used for this purpose.

For the spatial descriptions of the routes to the converter platforms in areas N-3 to N-7 and to the transformer platforms in area O-1, reference is made to the FEP 2019. A revision is made in the draft of FEP 2020.

The direct current connection NOR-9-1 of the sites N-9.1 and N-9.2 leads from the converter platform in a straight line to shipping route 6 and from there parallel to area N-9 to the pipeline "Europipe 1". From there, it runs parallel to this until shipping route 2, where NOR-9-1 runs parallel to NOR-7-2 until "Europipe 2" and then runs parallel to this until border corridor N-III. The direct current connection system NOR-9-2 covers the sites N-9.3 and N-9.4. Starting from the converter platform, it runs first north to the edge of the area N-9 and from there parallel to the area along the adapted shipping route 10 up to "Norpipe". After crossing the pipeline, the system runs on the eastern side of the pipeline parallel to the systems NOR-7-1 and NOR-6-3 up to shipping route 1 and from there eastwards to border corridor N-II.

In area N-10, a DC connection system is planned for the development of sites N-10.1 and N-10.2. This system NOR-10-1 leads from the planned converter platform to the east to the edge of the area. From there it runs parallel to the shipping route 4 to the "Cobra-Cable" and then parallel to this to the "Europipe 1". From there NOR-10-1 runs parallel to NOR-9-1 to border corridor N-III.

A three-phase current system, which is also under test, is planned for site O-2.2, which will run on the eastern edge of the area parallel to the systems already existing there for boundary corridor O-I.

5.9 Gates to coastal waters

Reference is made to Chapter 5.9 of the FEP 2019. A revision is made in the draft of the FEP 2020.

5.10 Routes and route corridors for cross-border power lines

Reference is made to Chapter 5.10 of the FEP 2019. A revision is made in the draft of the FEP 2020.

5.11 Routes and route corridors for connections between installations

According to § 5 Paragraph 1 No. 10 WindSeeG, the FEP should contain routes or route corridors for possible connections of offshore plants, connecting lines and cross-border power lines as well as locations of converter platforms among each other. Thus, the regulation according to § 17a (1) sentence 2 no. 6 EnWG is adopted for the BFO. The so-called interconnections are submarine cable systems which can connect the individual connection systems (according to the direct current or three-phase current connection concept) and thus the OWPs with each other and which contribute to ensuring system safety, increase the feed-in-safety by means of (partial) redundancies in order to reduce failure damage and increase system safety, and are compatible with an efficient network expansion. The FEP only ensures the spatial conditions for possible connections between each other. The decision as to "whether" and "when" a connection among each other is implemented shall be determined on a case-by-case basis within the framework of a damage reduction concept to be submitted to the BNetzA by the network operators, and shall be subject in particular to economic efficiency.

The spatial requirements for connections between each other must be ensured for new grid connections from zone 3 onwards, starting with grid connection NOR-9-1. Reference is made to chapter 4.3.1.6 these connections between each other in the North Sea are planned with two submarine cable systems.

The basis for the significantly reduced number of defined connections between platforms compared to the FEP 2019 is a comprehensive and individual examination of the connections defined so far. The findings of the expert opinion accompanying the FEP on the economic efficiency of such connections were also taken into account. The results will be recorded in a report and published in the course of the year. In addition, actual conditions on the existing and planned platforms were taken into account on the basis of a communication from the transmission system operators. It has been shown, for example, that the actual realisation of connections between each other in zones 1 and 2 is in many cases made difficult or prevented by the fact that no necessary prerequisites, such as switchboards and J-Tubes, are available on the platforms concerned. Retrofitting is usually not possible because the platforms are already in operation or at an advanced planning stage. In addition, spatial effects, particularly on neighbouring sites or existing or planned projects, were also included in the assessment.

As a result, it appears that the interconnections between the connections in zones 1 and 2 of the North Sea and in the Baltic Sea, which were still defined in the FEP 2019, should not be further defined in the FEP. For the grid connections in zone 3 with a standard transmission capacity of 2 GW, however, connections between platforms up to a route length of approx. 20 km could be useful. In addition to the more obvious economic viability compared to the connections in zones 1 and 2, the possible early consideration of connections between each other in zone 3 speaks in favour of such a procedure.

In zone 3 of the North Sea, therefore, a spatial connection between the currently planned converter platforms NOR-9-1 and NOR-9-2 must be ensured by means of two parallel submarine cable systems. This route runs from NOR-9-1 between sites N-9.1 and N-9.2 in a northerly direction, then bends to the west, where it runs between sites N-9.1 and N-9.4 and then leads to the NOR-9.2 converter between sites N-9.3 and N-9.4.

Table 12: Overview of train paths defined in the FEP for connections between installations

Platform A	Platform B
North Sea	
NOR-9-1	NOR-9-2
Baltic Sea	
-	-

Questions for consultation

5.11 Paths and path corridors for connections between installations

F.22 In the view of the participants in the consultation, are there any weighty arguments against deleting connections between each other in zones 1 and 2 or against establishing connections between each other up to a route length of approx. 20 km in zone 3?

6 Rules for pilot offshore wind turbines

Reference is made to Chapter 6 of the FEP 2019. A revision is made in the draft of the FEP 2020.

7 Areas for other forms of energy generation

Pursuant to § 5 Para. 2a WindSeeG, the FEP may define areas for other forms of energy generation apart from areas.

According to § 3 No. 8 WindSeeG or WindSeeG-E, areas for other forms of energy generation is an area outside of areas where offshore wind energy turbines and other energy production plants which are not connected to the grid can be erected in spatial context and which are subject to the approval procedure. According to § 4 Para. 3 WindSeeG, the aim of the definition is to enable the practical testing and implementation of innovative concepts for energy generation not connected to the grid in a spatially ordered and space-saving manner.

In this preliminary draft, therefore, two areas in zones 1 and 2 are presented for discussion.

In the longer term and taking into account the continuation of spatial planning, it can be examined whether the designation of further areas is also possible, e.g. in zones 4 and 5. Due to the limited space in the EEZ, there may be competition between grid-bound and off-grid energy production.

In territorial waters, areas for other forms of energy generation can only be defined if the responsible country has designated the other energy production areas as a possible subject of the FEP.[10] Reference is made to the administrative agreement between the BSH and the Federal State of Mecklenburg-Western Pomerania on definitions in territorial waters.

If an area for other forms of energy generation is actually not used or is only used to an insignificant extent, a later FEP may lift the definition of the areas for other forms of energy generation and instead define areas and sites.

[10] Available at: https://www.bsh.de/DE/THEMEN/Offshore/Meeresfachplanung/Flaechenentwicklungsplan/_Anlagen/Downloads/FEP/Flaechenentwicklungsplan_Verwaltungsvereinbarung_BSH_Mecklenburg_Vorpommern.html?nn=1653366

Questions for consultation

7 Areas for other forms of energy generation

The draft law amending the Wind Energy at Sea Act and other regulations adopted by the Cabinet on 3 June 2020 provides that areas for other forms of energy generation can be specified for a total of 25 to 70 square kilometres. In addition, spatial as well as technical specifications for other energy generation plants, for lines or cables that carry energy or energy sources from them can be made or, in the event of a shortage of routes, such lines or cables can be excluded.

The following options for designation as areas for other forms of energy generation are possible and will be consulted in the context of this preliminary draft. Both are located in distance zones 1 and 2 of the North Sea and Baltic Sea. These options involve sites that are too small for a separate grid connection. Due to the proximity of the coast, the areas in distance zones 1 to 3 should initially be reserved for grid-bound energy generation. Areas in distance zones 4 and 5 of the North Sea could possibly be considered for the designation of further areas for other forms of energy generation, but in this respect the current update of the spatial plan for the German North Sea EEZ must be awaited (cf. background information in Chapter 2.6.1.2).

For a better overview, the areas for other forms of energy generation are named with the letters SEN or SEO for area for other forms of energy generation in the North Sea and Baltic Sea and numbered consecutively.

The area for other forms of energy generation SEO-1 is under review due to possible conflicts of use with regard to nature conservation issues, in particular bird migration. Reference is made to the comments on area O-2 in chapter 5.2.2

Name	Location	Size	Distance from the coast
SEN-1	EEZ North Sea	approx. 28.8 km²	zone 2
SEO-1	EEZ Baltic Sea	approx. 7.8 km²	zone 1

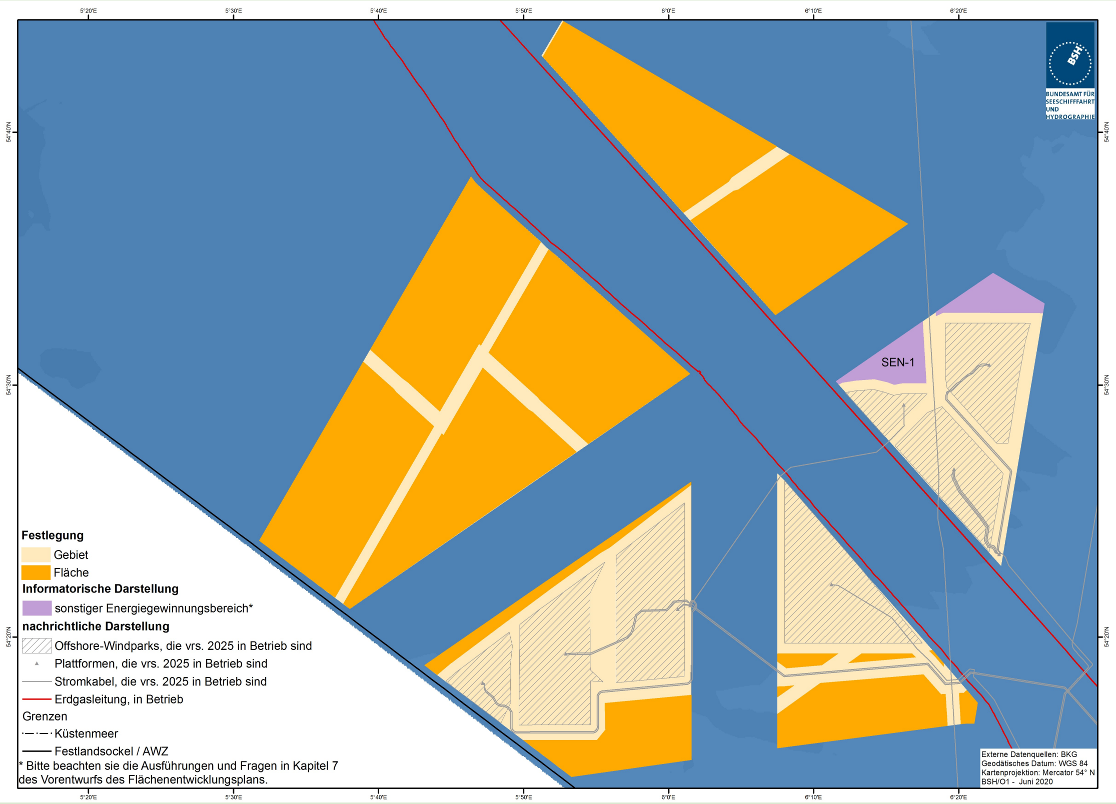

Figure 16: Option for consultation of area for other forms of energy generation in the German North Sea EEZ

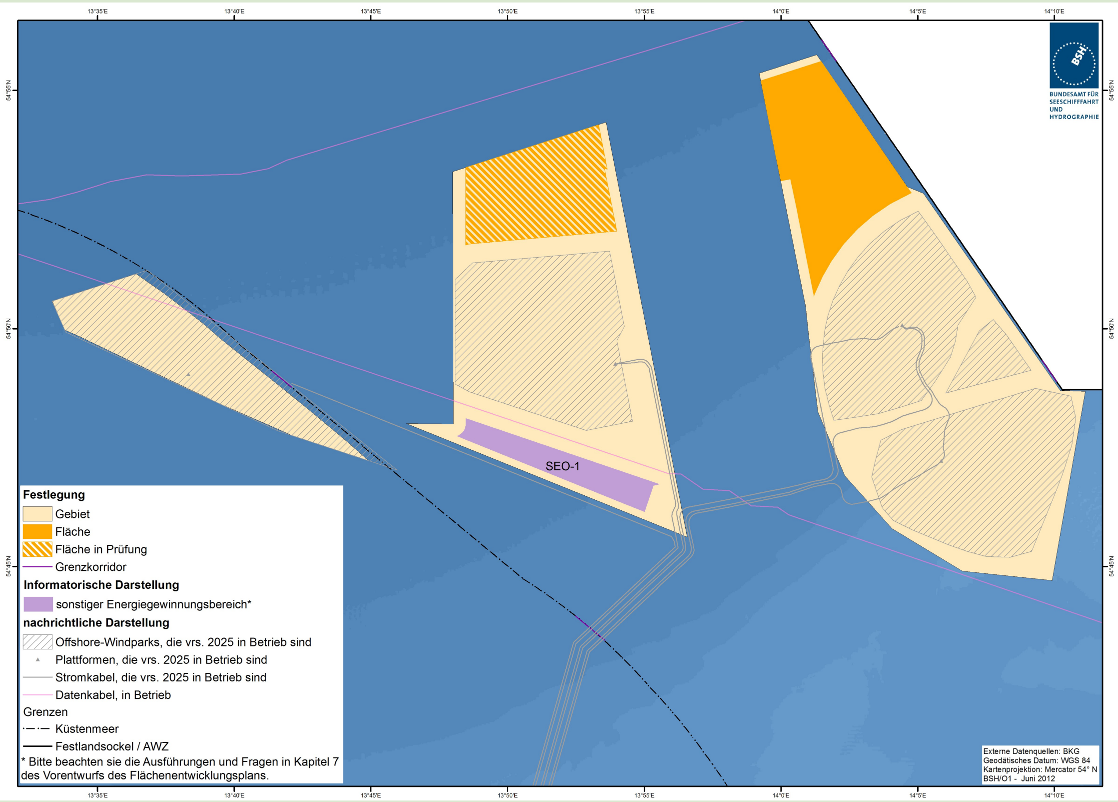

Figure 17: Option for consultation of areas for other forms of energy generation in the German Baltic Sea EEZ

Areas for other forms of energy generation must be defined outside the areas defined in Chapter 5.1- A corresponding adjustment of the areas is made after consultation of the preliminary draft within the framework of the draft FEP 2020.

Spatial specifications for lines that discharge energy or energy sources from areas for other forms of energy generation

North Sea

The construction of own cables and pipelines for the transport of energy or energy carriers from areas for other forms of energy generation in the German North Sea EEZ shall be excluded for the area for other forms of energy generation defined here. One of the reasons for this is that the possibility of constructing a separate power cable, e.g. to connect a land-based electrolysis plant to the areas for other forms of energy generation, is an inefficient connection option from a spatial point of view in relation to the capacity of a standard connection in the North Sea with 2 GW transmission capacity. This is particularly true in view of the limited number of possible route corridors in the North Sea when crossing the coastal sea. In order to achieve the medium and long-term expansion targets for offshore wind energy, the available corridors should be reserved for grid-bound wind energy, especially in the North Sea. This also applies to a greater extent to the construction of a private pipeline with a comparatively low transmission capacity, which would require even more space due to the greater distance requirements.

The BSH asks for answers to the following consultation questions:

F.23 Do you see further potential for areas for other forms of energy generation in the coastal sea of the Baltic Sea?

F.24 Is there any possibility in the Baltic Sea, taking into account the spatial conditions, in particular in the territorial sea, of constructing its own lines to carry off energy or energy sources from the areas for other forms of energy generation?

F.25 Is a minimum size necessary for the economic operation of any area for other forms of energy generation?

F.26 Do the consultation participants see a need to define smaller areas for other forms of energy generation (less than 7 km²), e.g. for the construction of individual plants not connected to the grid?

F.27 For the purposes of the environmental impact assessment, can it be assumed that energy is produced by wind turbines? If not, what assumptions should be used for the environmental assessment? Which assumptions should be applied for an electrolysis platform?

8 Conformity of the rules with private and public concerns

Reference is made to the FEP 2019. A revision, also concerning other energy production areas, is made in the draft of the FEP 2020.

9 Summary consideration

[will be executed after consultation]

10 Summary environmental declaration and monitoring measures

[will be executed after consultation]

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12 Annex: Maps (information purposes)

Reference is made to the FEP 2019.

13 Appendix: Summary table

Calendar year Announcement	Calendar year Commissioning	Site designation	Expected generation capacity [MW]	Total exp. generation capacity [MW]	Network connection system			
					Name	Commissioning year	Transmission capacity [MW]	Connection concept
2021	2026	N-3.7	225	958	NOR-3-3[1]	2023	900	155 kV
		N-3.8	433		NOR-3-3[1]	2023	900	155 kV
		O-1.3	300		OST-1-4[1]	2026	300	AC connection
2022	2027	N-7.2	930	930	NOR-7-2[1]	2027	930	66 kV
2023	2028	N-3.5	420	900	NOR-3-2[1]	2028	900	66 kV
		N-3.6	480		NOR-3-2[1]	2028	900	66 kV
2024	2029	N-6.6	630	2.900	NOR-6-3[1]	2029	900	66 kV
		N-6.7	270		NOR-6-3[1]	2029	900	66 kV
		N-9.1	1.000		NOR-9-1[1]	2029	2000	66 kV
		N-9.2	1.000		NOR-9-1[1]	2029	2000	66 kV
2025	2030	N-9.3	1.000	4.000	NOR-9-2[1]	2030	2000	66 kV
		N-9.4	1.000		NOR-9-2[1]	2030	2000	66 kV
		N-10.1	1.000		NOR-10-1[1]	2030	2000	66 kV
		N-10.2[2]	1.000		NOR-10-1[1]	2030	2000	66 kV
Total target system				9.688				
Expected stock 2025				10.800				
Projected stock in 2030				20.488				

[1] Reference is made to the NEP 2019-2030 and the preparation, review and confirmation of the NEP 2021-2035.

[2] The N-10.2 site is not fully required for 20 GW.

14 Annex: Informational illustration of a long-term development path (scenario framework 2021-2035)

The draft scenario framework for the NEP 2021-2035 of the transmission system operators contains three probable paths (so-called scenarios) for a development of the expansion of offshore wind energy. The scenario framework is the basis for the preparation of the NEP according to § 12b EnWG for the determination of the expansion requirement in the transmission grid and is approved by the BNetzA after a consultation and examination according to § 12a (3) EnWG.

The middle scenario B 2035 of the draft scenario framework 2021-2035 envisages an expansion of offshore wind energy of 30 GW by 2035. With scenario B 2040, the scenario framework contains an outlook beyond 2035 until 2040, whereby the scenario is based on scenario B 2035 with regard to expansion until 2035. Scenario B 2040 envisages an expansion of offshore wind energy of 40 GW by 2040.

In the preparation procedure of the FEP 2019, it was demanded with reference to the scenario framework 2019-2030 that the FEP should already show a corresponding scenario before a legal adaptation. In order to comply with this demand in the FEP update and for the purpose of long-term planning, a long-term scenario is presented here **for information purposes only,** which gives an outlook on the sites available in the areas N-11 to N-13 after the target year 2030, without, however, naming concrete tender or commissioning years.

For this purpose, the power was determined using the methodology for determining power in Chapter 4.7.2 on the sites in the N-11 to N-13 areas. Reference is made to the questions for consultation. This scenario thus represents the theoretical total potential of zone 3 that would result from a complete development of the areas defined in the FEP and amounts to a total of about 30 GW. To connect these sites, five additional grid connection systems would be required.

With regard to other potential areas in zones 4 and 5, reference is made to the update of the spatial plan for the German North Sea and Baltic Sea EEZ.

Reference is made to the challenges and prerequisites for the implementation of the scenarios listed in FEP 2019.

Reference is also made to the preparation, review and approval of NEP 2021-2035.

Table 13: Informational presentation of the sites potentially available in zones 1-3 beyond 2030 based on the scenario framework 2021-2035 (30 GW to 2035)

Calendar year Tender	Calendar year Commissioning	Site designation	Network connection system	Expected generation capacity [MW]	Total expected generation capacity [MW]
After 2025	After 2030	N-12.1/N-12.2	NOR-12-1	2.000	10.000
		N-12.3/N-12.4	NOR-12-2	2.000	
		N-11.1/N-11.2	NOR-11-1	2.000	
		N-11.3/N-12.5/N-13.1	NOR-11-2	2.000	
		N-13.2/N-13.3	NOR-13-1	2.000	
Expected total potential in zones 1-3					approx. 30,400[1)]

[1)] Additional potential could result from the development of open spaces in area O-6. However, this is subject to the actual availability of the land.