PERMIT APPLICATION IN ACCORDANCE WITH THE SWEDISH EXCLUSIVE ECONOMIC ZONE ACT AND THE SWEDISH CONTINENTAL SHELF ACT

CONSULTATION DOCUMENT
THE BALTIC OFFSHORE EPSILON WIND POWER PLANT AND ASSOCIATED INTERNAL CABLE NETWORK IN SWEDEN'S EXCLUSIVE ECONOMIC ZONE, BALTIC SEA

Njordr OFFSHORE WIND

2022-07-05

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Project information

Baltic Offshore Epsilon

Project owner: Njordr Offshore Wind AB – a collaboration between Vindkraft Värmland and Njordr

Report: Before the application for a permit according to the Act on Sweden's Exclusive Economic Zone and the Act on the Continental Shelf - Consultation document - the Baltic Offshore Epsilon wind power plant and associated internal cable network

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Other geographical information comes from: EMODnet, the Swedish Energy Agency, the Swedish Armed Forces, the Swedish Agency for Marine and Water Management, HELCOM, the Swedish County Administrative Board, the Swedish Environmental Protection Agency, SGU [Geological Survey of Sweden], the Swedish Forestry Agency, the Swedish Transport Administration, Vindlov.

Cover image: Offshore wind farm.

Photo: Shutterstock

Translation from Swedish to English: Tia Villar, Acolad

ABOUT THE CONSULTATION DOCUMENT

According to the provisions laid down in Section 6 of the Swedish Environmental Impact Assessment Ordinance (2017:966), the planned activity is assumed to have a significant environmental impact, which means that what is known as a scoping consultation must be carried out. This consultation document has been prepared as a basis for a scoping consultation for Baltic Offshore Epsilon, a project being developed by Njordr Offshore Wind AB.

A scoping consultation follows the provisions set out in Ch. 6. Section 30 of the Swedish Environmental Code and consultation must be carried out with the county administrative board, the supervisory authority and the individuals who can be assumed to be particularly affected by the activity, as well as the other government authorities, the municipalities and the general public who can be assumed to be affected by the activity.

A consultation document is not to be confused with an Environmental Impact Assessment that is drawn up at a later stage of the permit process. The purpose of the consultation is to inform authorities, individuals and the public about the planned project and to give an overall account of the environmental impacts that the planned activity is adjudged likely to give rise to, while the forthcoming Environmental Impact Assessment examines the environmental impacts further.

This consultation document presents an overview of what the forthcoming Environmental Impact Assessment should contain and which environmental impacts will be examined further. A full environmental impact assessment is expected to be completed in 2024 and an application for a permit according to the Swedish Exclusive Economic Zone Act and the Swedish Continental Shelf Act is scheduled to be submitted in 2024.

As the project is located in the Swedish Exclusive Economic Zone, and in an area that may affect the interests of other nations, consultations will also be held on the basis of the Espoo Convention, the convention on environmental impact assessments in a cross-border context.

Stakeholders identified as part of the consultation group are listed in Appendix 2.

Report compiled by

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YOUR VIEWS ARE IMPORTANT

Through the consultation procedure, authorities, individuals and the public are given the opportunity to contribute information and submit opinions about the planned activities. Njordr Offshore Wind AB now intends to obtain opinions regarding the content and design of the Environmental Impact Assessment to examine the planned activity's location, scope and design, and to assess the environmental impacts the planned activity can be assumed to have, directly or indirectly.

We want written consultation statements so that we can compile them in the most objective and correct way possible into a consultation report and work them into the forthcoming Environmental Impact Assessment.

Consultation statements are submitted via email to njordr.samrad@ecogain.se
or by post to:

Ecogain AB
Baltic Offshore Epsilon
Att: Administrator
Östra Hamngatan 17
411 10 Gothenburg
SWEDEN

We need your consultation statements by August 31, 2022.
Mark the email or letter *Baltic Offshore Epsilon*.

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SUMMARY

Njordr Offshore Wind AB intends to apply for a permit under the Swedish Exclusive Economic Zone Act (1992:1140) and the Swedish Continental Shelf Act (1966:314) to construct the Baltic Offshore Epsilon wind power plant within Sweden's Exclusive Economic Zone. At most, 184 wind turbines are planned with a maximum total height of 330 meters.

The project is expected to have a number of positive environmental impacts. The main one is that the wind power plant will produce a large amount of renewable electricity that helps mitigate the impact of climate change. In addition to this, the artificial reef structures that the foundations of wind turbines create can benefit benthic organisms and also fish who feed on these organisms. Disturbances to wildlife from trawling and shipping within the project area are reduced.

The planned activity is assumed to have a significant environmental impact and scoping consultations must therefore be held. This consultation document forms the basis for the consultation process and will be followed by an Environmental Impact Assessment (EIA). The consultation document contains an example of the layout of the wind power plant, i.e. how the placement of the wind turbines within the project area could look.

The project area for Baltic Offshore Epsilon is located approximately 31 kilometres from land (Gotska Sandön, Gotland Municipality). The project area is located in a marine area with few designated and protected competing interests.

Detailed investigations, mainly concerning seabed conditions, natural values, birdlife and marine archaeology will be carried out within the framework of the work to prepare the Environmental Impact statement. The investigations, together with opinions from the consultation, will form the basis for the final design of the wind power plant and form the basis for the Environmental Impact Assessment that is drawn up as the basis for the permit application.

Based on the information now available, our assessment is that the project's most significant negative environmental impacts consist of a possible impact on marine wildlife, migratory birds and navigation. The assessment may change based on the results of planned investigations.

1. INTRODUCTION

This chapter provides an introduction to the project and the planned activities. Applicable legislation, the various stages of the permit process and the consultation procedure that the project is undergoing are also examined.

1.1 Background

Sweden has drawn up energy policy goals which state, among other things, that Swedish electricity production in 2040 must be 100 percent renewable and that by 2045, there must be no net emissions of greenhouse gases into the atmosphere. Wind power is an important part of the transition to a more ecologically sustainable society, through the efficient use of electricity and a transition to renewable energy types using technology that is environmentally acceptable. In 2021, wind power accounted for 17 percent of the country's electricity production, which corresponds to 27 TWh (Swedish Energy Agency, 2021a).

In January 2022, the Government developed an electrification strategy with the aim of being able to lay the foundations for realising extensive electrification that contributes to reaching the climate targets. It describes several long-term scenarios in relation to the development of the electricity system up to 2045, envisaging different levels of future electricity use. The scenarios with the highest degree of electrification point to a possible doubling of electricity demand, from today's approximately 140 TWh to approximately 280 TWh by 2045. Around 75 percent of the increased electricity demand is estimated to come from electrification in industry, where the plans for fossil-free iron and steel production alone could mean an increased electricity demand of 75–80 TWh by 2045 (Government, 2022).

All energy production, including production of renewable electricity, has a climate and environmental impact. Climate and environmental impacts arise above all through the manufacture of wind turbines and associated infrastructure and the impact on the local environment, through the location of the plant. Transmission and distribution also have an impact. What is decisive in a sustainable, renewable electricity system is therefore how efficient energy use is at the locations where the electricity is used. "By changing in a sustainable way, it is possible to maintain a high standard of living and prosperity, without risking catastrophic climate change or depletion of biodiversity" writes the Swedish Society for Nature Conservation in its report *Fossil-free, renewable, flexible. The sustainable energy system of the future* (2019).

The Swedish Society for Nature Conservation shares the Swedish Energy Agency's view that wind power in Sweden should be greatly expanded to ensure a completely renewable energy system, but that expansion must take place with consideration for biodiversity. Wind power plants should be located in areas where they do not threaten high natural or environmental values (Swedish Society for Nature Conservation, 2019).

On a global scale, IPBES, the UN Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, sees five major factors influencing biodiversity: land use, resource extraction, climate change, pollution and the problem of invasive species (IPBES, 2019). In Sweden, the issue of the joint planning of measures for biodiversity and climate impacts has been raised by the Swedish Environmental Protection Agency and SMHI [Swedish Meteorological and Hydrological Institute] in the report *Climate change and biodiversity - conclusions from IPCC and IPBES from a Swedish perspective* (2020). It is emphasized here that there is a need for comprehensive societal changes to deal with ongoing losses of biodiversity and climate change. Through strategies for sustainable land use, synergies are created between climate measures, the preservation of biodiversity and the structure and function of ecosystems (Swedish Environmental Protection Agency and SMHI, 2020).

The latest report from the UN's climate panel IPCC (2022) contains the sharpest warning yet from the UN about the catastrophic impact of climate change on people and ecosystems. More than three billion people are very vulnerable when the climate changes and the impacts will be felt sooner than the researchers expected. The report also describes how wind power and solar power are the investments with the greatest potential to reduce emissions by 2030.

The Swedish Energy Agency has estimated that around 50 TWh of offshore wind power should be planned in order to reach the government's goal of 100 percent renewable energy by the year 2040 (Swedish Agency for Marine and Water Management, 2022a), assuming a 20 TWh expansion of offshore wind power (Energy Swedish Agency, 2021b). In connection with the decision on maritime spatial plans, the government has also tasked the Swedish Energy Agency, the Swedish Agency for Marine and Water Management together with several other central authorities, to jointly produce planning documents to enable a total of 120 TWh of offshore wind power (Swedish Agency for Marine and Water Management, 2022b).

In 2018, approximately 0.67 TWh of offshore wind power was produced according to the Swedish Energy Agency (Swedish Energy Agency, 2019). Today, three offshore wind farms have been built: Lillgrund, Bockstigen and Kårehamn.

Njordr Offshore Wind AB is now investigating the possibility of installing wind power infrastructure in the Swedish Exclusive Economic Zone in the Baltic Sea in an area located approximately 31 kilometres north-east of Gotska Sandön, 67 kilometres east of Långviksskär in the Nämndöskärgården national park and 60 kilometres north of Fårö on Gotland. The sea depth in the project area varies between approximately 70 and 180 meters, with depths of over 100 meters dominating.

With its location, the project has good opportunities to contribute to meeting the ever-increasing need for renewable energy in a region that currently has difficulty producing its own electricity and where the opportunities for land-based wind power are limited.

1.2 Applicable legislation and consultation

Planned activities require the government's permission according to the Act (1992:1140) on Sweden's Exclusive Economic Zone. During the permit process, Chapters 2–4, Chapter 5 and Sections 3–5 and 18 of the Swedish Environmental Code are applied, a specific environmental assessment must be carried out and an EIA must be drawn up by the operator, see Tabell 1.

A government permit is also required for internal cable networks belonging to the wind power plant, according to the Swedish Act (1966:314) on the Continental Shelf, for surveys before the laying of underwater cables and pipelines on the continental shelf, see Tabell 1.

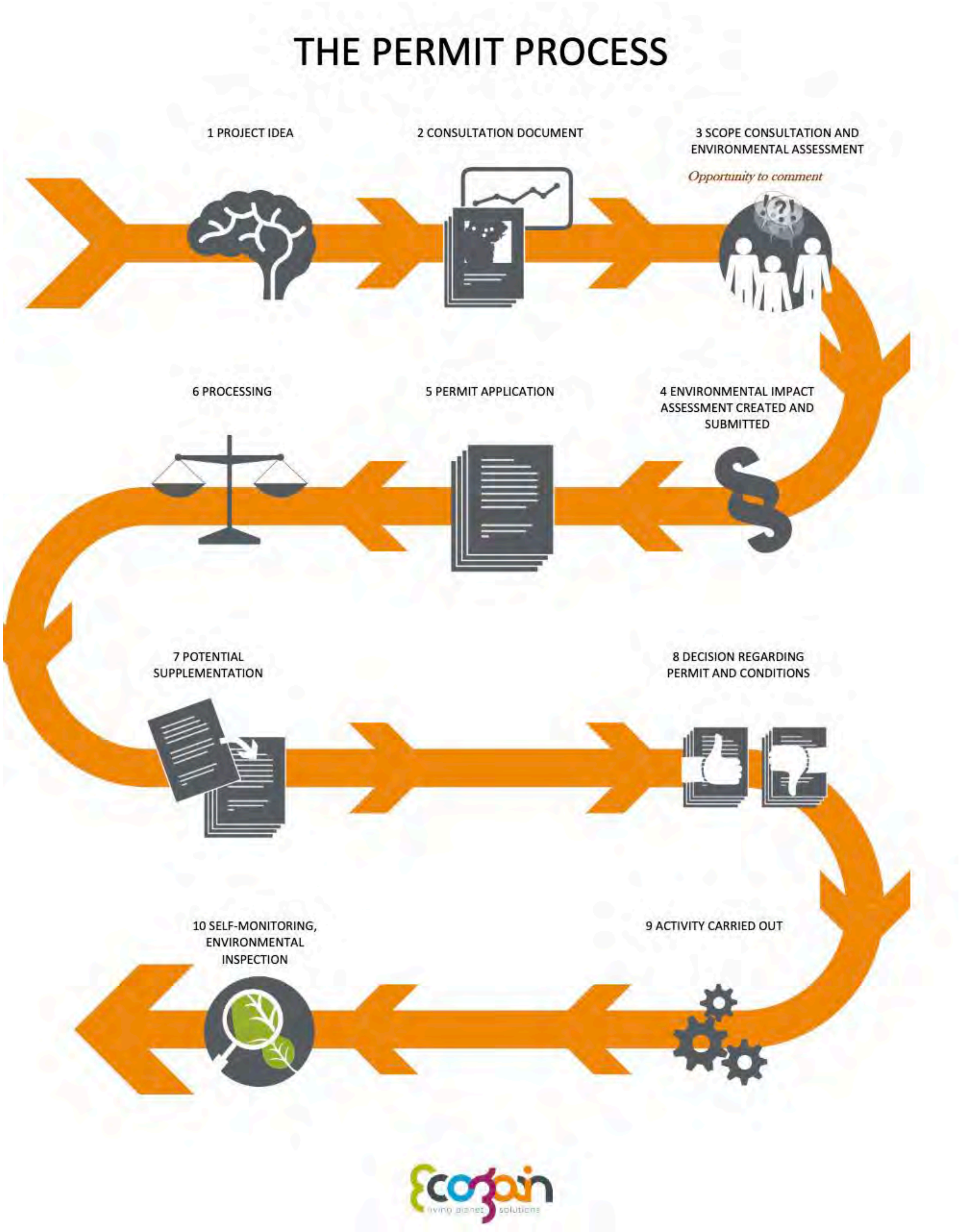
According to Section 6 of the Swedish Environmental Assessment Ordinance (2017:966), the planned activity is assumed to have a significant environmental impact, which means that the consultation procedure must begin with a scoping consultation. A survey consultation has therefore not been carried out.

This document forms the basis for a scoping consultation, which, according to provisions laid down in Ch. 6. Section 30 of the Swedish Environmental Code, must be held with the county administrative board, the supervisory authority and the individuals who can be assumed to be particularly affected by the activity, as well as with the other government authorities, the municipalities and the general public who can be assumed to be affected by the activity.

The Act (1992:1140) on Sweden's Exclusive Economic Zone states that it is the county administrative board in the county where Sweden's maritime territory is closest to the proposed activity that is responsible for the review. For the Baltic Offshore Epsilon project, this means the County Administrative Board in Gotland County.

According to Ch. 6. Section 28 of the Swedish Environmental Code, a specific environmental assessment means that the operator consults on how the EIA should be defined, identifies, assesses and documents the environmental impacts of the planned activity in the EIA and that the licensing authority then completes the environmental assessment. The various stages of the permit process are presented schematically in Figur 1.

Through the consultation procedure, authorities, individuals and the public are given the opportunity to contribute information and submit opinions (consultative statements) relating to environmental impacts.



Figur 1 Schematic view of the permit process.

Njordr Offshore Wind now intends to obtain information and opinions regarding the content and design of the EIA, to examine the planned activity's location, scope and design, and to assess the environmental impacts the planned activity can be assumed to have, directly or indirectly. The environmental impacts may be positive or negative, temporary or permanent and occur in the short, medium or long term in relation to:

- population and human health
- animal or plant species that are protected according to Ch. 8 of the Swedish Environmental Code and biodiversity in general
- land, soil, water, air, climate, landscape and cultural environmental values
- land and water management and the physical environment in general
- other management of materials, raw materials and energy
- other parts of the environment.

We would like you to submit written consultation statements so that we can compile them in the most objective and correct way possible into a consultation report and work them into the forthcoming Environmental Impact Assessment.

Planned activities are considered in more detail in Chapter 2.

1.2.1 The scoping of the consultation

Establishment of the Baltic Offshore Epsilon wind power plant also requires other permits in addition to those specified in Section 1.2 *Applicable legislation*. These will be applied for and examined separately and are not covered by this consultation document, see Tabell 1.

Tabell 1 Compilation of permits hitherto identified that are intended to be sought for the project and which legislation regulates this.

Activity	Permit according to legislation	When
Wind power plant	The Act (1992:1140) on Sweden's Exclusive Economic Zone. During the permit process, Chapters 2–4, Chapter 5 and Sections 3–5 and 18 of the Swedish Environmental Code are applied, a specific environmental assessment must be carried out and an EIA must be drawn up by the operator.	This consultation and forthcoming permit application
Internal cable network belonging to the wind power plant	The Swedish Act (1966:314) on the Continental Shelf, for surveys before the laying of underwater cables and pipelines on the continental shelf.	This consultation and upcoming permit application
Survey of the seabed	Application for a permit according to the Swedish Act (1966:314) on the Continental Shelf, alternatively notification to SGU.	Separate application/notification

Connection of the wind farm to land outside Sweden's territory	The Swedish Act (1966:314) on the continental shelf, for the laying and operation of connection cables on the continental shelf from the wind farm (from the substation) to the connection to the overground network, within the Exclusive Economic Zone and the territorial waters.	Separate application
Connection of the wind farm to land within Sweden's territory	Swedish Electricity Act (1997:857) (concession) for laying down and operating connection cables and/or overhead lines within the territory of Sweden.	Separate application
Laying and operation of connection cables and/or overhead lines within the territory of Sweden	The Swedish Environmental Code (1998:808)	Separate application
Grid connection Svenska Kraftnät [Swedish Power Grid]	Permit for and option to connect to the main network.	Separate application

1.3 Administrative tasks

Tabell 2 describes the administrative tasks that form the basis of this consultation document.

Tabell 2 Administrative tasks

Operator	Njordr Offshore Wind AB
Organisation Registration Number	559308–6019
Postal address (head office)	Lantvärnsgatan 8, 652 21 Karlstad, SWEDEN
Contact	Niklas Sondell, project manager Njordr Offshore Wind AB
Tel	+4670 - 218 50 64
Name of facility	Baltic Offshore Epsilon
Location	Marine area North Baltic Sea and South Kvarken, sub-area Ö204, marine area Central Baltic Sea, sub-area Ö232, Sweden's Exclusive Economic Zone

2. LOCATION INVESTIGATION AND PROJECT DESCRIPTION

To begin with, this chapter examines how the location for the planned activity has been selected. It also examines the extent, dimensions and technical conditions of the planned wind power plant.

2.1 Location investigation

Since planned activities are automatically assumed to have a significant environmental impact, future EIAs should suggest alternative locations, if such are possible, and various design alternatives that have been investigated within the framework of the project. A zero-option must also be considered. In the current case, no specific alternative locations have been developed, but based on a selection process, which is described in Section 2.1.1 *Choice of location* below, the most suitable location for the wind power plant has been selected. The method for choosing the location will be described in more detail in the EIA.

The Swedish Environmental Code states in its portal paragraph that land, water and the physical environment must be used in order to ensure effective management from an ecological, social, cultural and socio-economic standpoint. Swedish energy policy goals further state that wind power must be expanded on a large scale and that the expansion must take place in several locations at the same time.

To be able to bear common costs, for example for grid connection, any suitable area for wind power expansion requires good wind conditions, few competing interests, but also good opportunities for large-scale operation.

2.1.1 Choice of location

The proposed location for Baltic Offshore Epsilon is based on a comprehensive suitability analysis of the Swedish part of the Baltic Sea in relation to future energy needs, technical and commercial feasibility, environmental conditions and impact on the surroundings and other potential conflicting interests. The goal has been to identify the few places that maximise the climate and environmental benefit while minimising the impact on nature and the environment, as well as any negative consequences for human health.

The analysis is based on a basic mapping of the potential wind resource (see Section 3.4 *Wind resources),* technical and commercial feasibility and conflicting interests. Distance to land, seabed depth and economic conditions have also been important aspects when choosing a location.

In addition to this, a variety of parameters have been taken into account in the location process. These include:

- Navigation - focus on adaptation to actual maritime traffic
- Defence - known staging areas, training areas and national interests have been avoided
- Fishing - avoids conflicts with national interests
- Net fishing - areas of high intensity have been avoided
- Porpoises - areas of less importance to porpoises
- White-tailed eagle and black guillemot – estimated populations used as a proxy for important seabird areas
- Nature restrictions (natura2000, reserves, etc.) – outside and with buffer distance
- Aviation – outside areas in conflict with aviation
- The Swedish Agency for Marine and Water Management – maritime spatial plans are used to avoid areas of conflict
- Sea depth – deeper water with deep seabed-fixed anchorage or floating foundations
- Lack of oxygen – areas with occasional or constant lack of oxygen on the seabed are given precedence
- Wind resource - detailed wind mapping
- Low-risk areas – the known areas have been avoided
- Electricity grid – strategic placement in relation to needs and for interconnection with other countries
- Need for energy – focus on regions with a large production deficit
- Visibility – turbines as far as possible hidden from the mainland below the horizon
- Disturbance to the public – far out to sea, reduces disturbance in addition to visibility
- Commercially feasible – far out to sea in deep water requires large wind farms

2.2 Main option

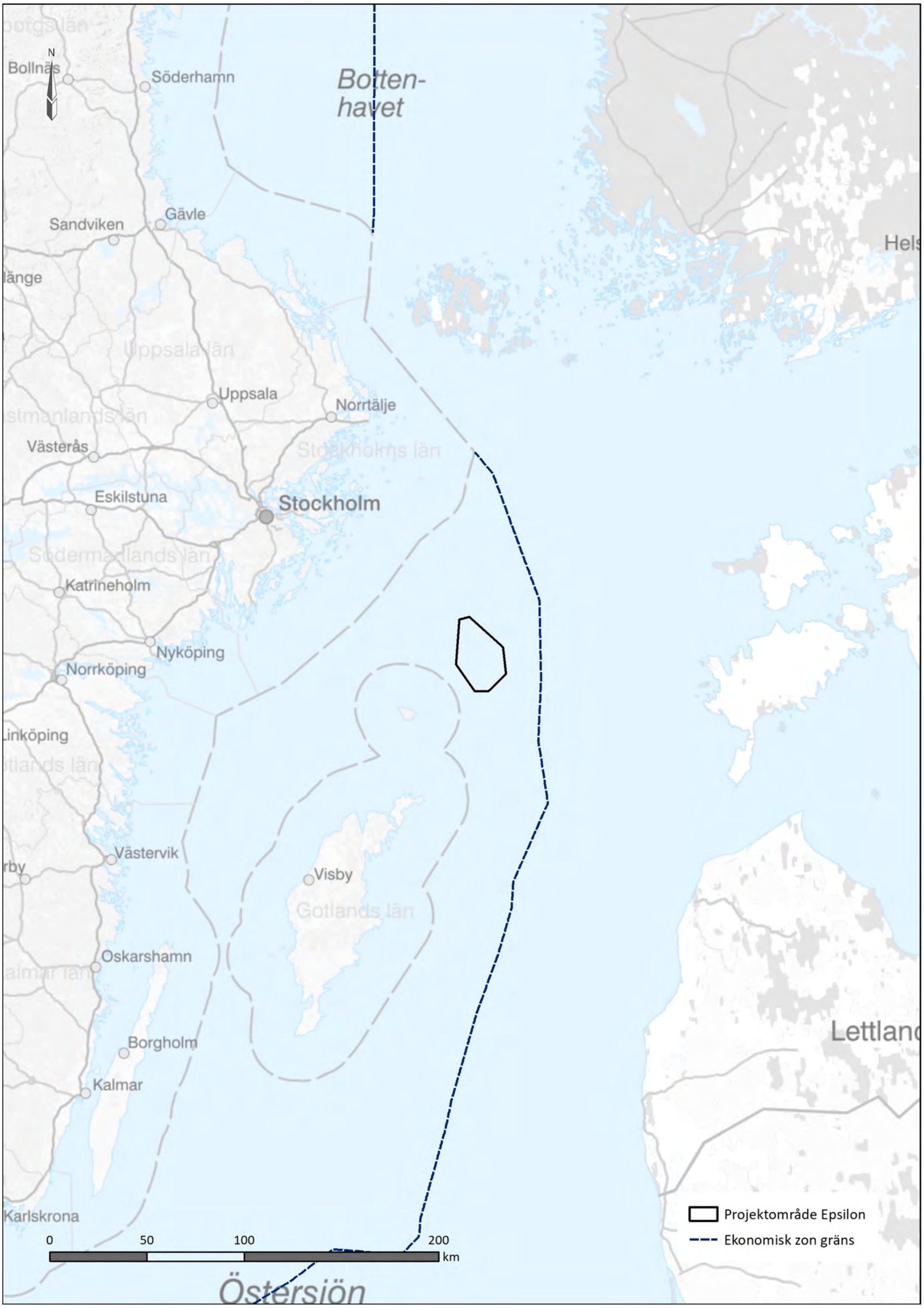
The Baltic Offshore Epsilon project area is located in Sweden's Exclusive Economic Zone, for the most part in the marine area of the North Baltic Sea and South Kvarken with a smaller part in the Central Baltic Sea. The distance to the surrounding land is long. The closest land is Gotska Sandön, 31 kilometres south-west of the project area. It is approximately 67 kilometres to Långviksskär in the Nämndöskärgården national park, 60 kilometres to Fårö and 94 kilometres to Nåttarö, see Figur 2 and Figur 3. The project area consists of open sea without islands.

The project area is 678 square kilometres. The sea depth varies between approximately 70 and 180 meters with depths of over 100 meters dominating. The shallowest areas are in the eastern parts of the project area. The average depth in the entire project area is approximately 130 meters (SGU, 2021). The seabed in the area is low in oxygen and the seabed sediment is probably dominated by postglacial sand, gravel, stone and glacial clay (SGU, 2021).

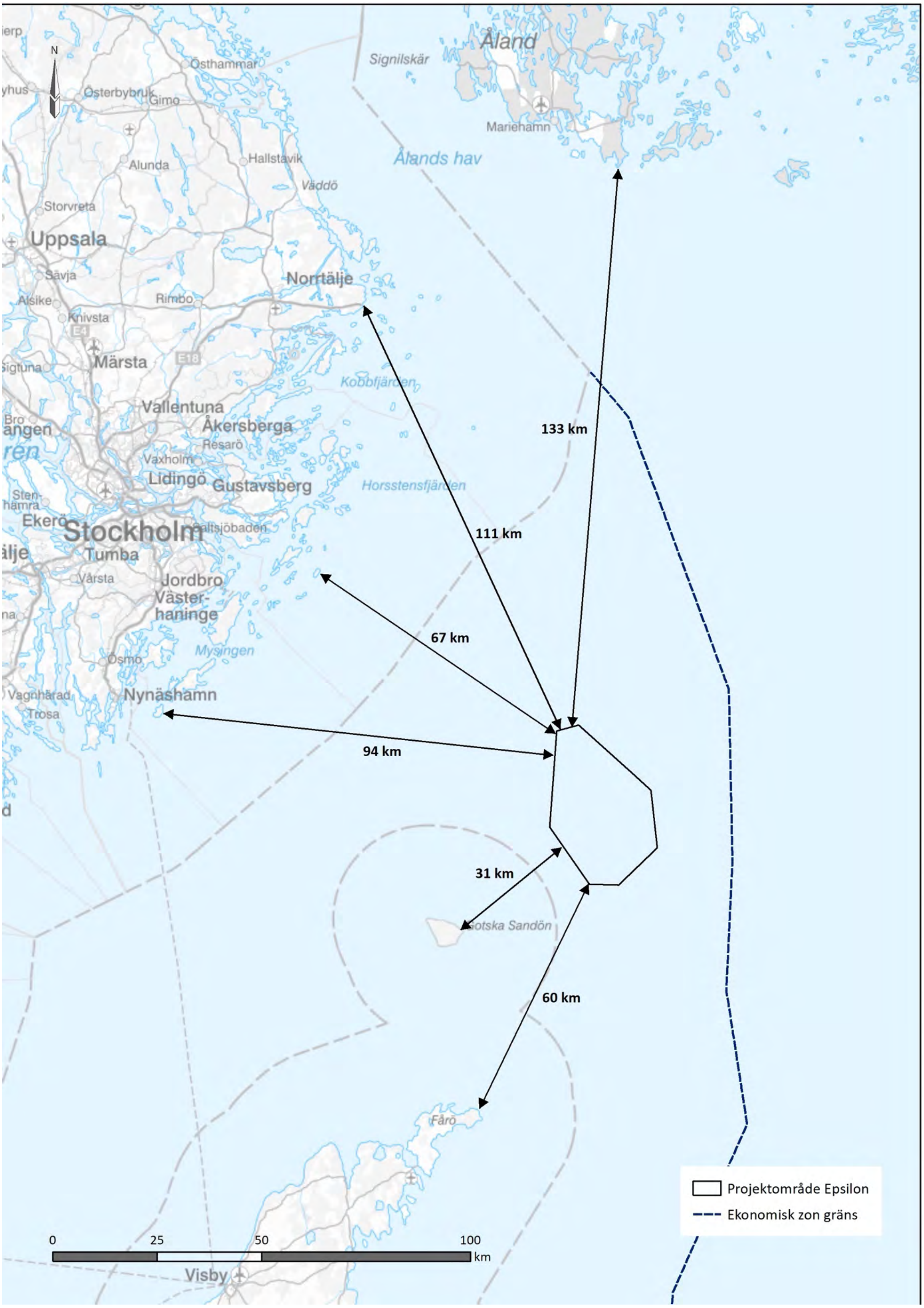
Factors underlying the delimitation of the project area are described in more detail in Section 2.1.1 *Choice of location.*

A separate application for electricity connection to the main grid has been submitted to Svenska Kraftnät, see Section 5.2 concerning electricity connection.

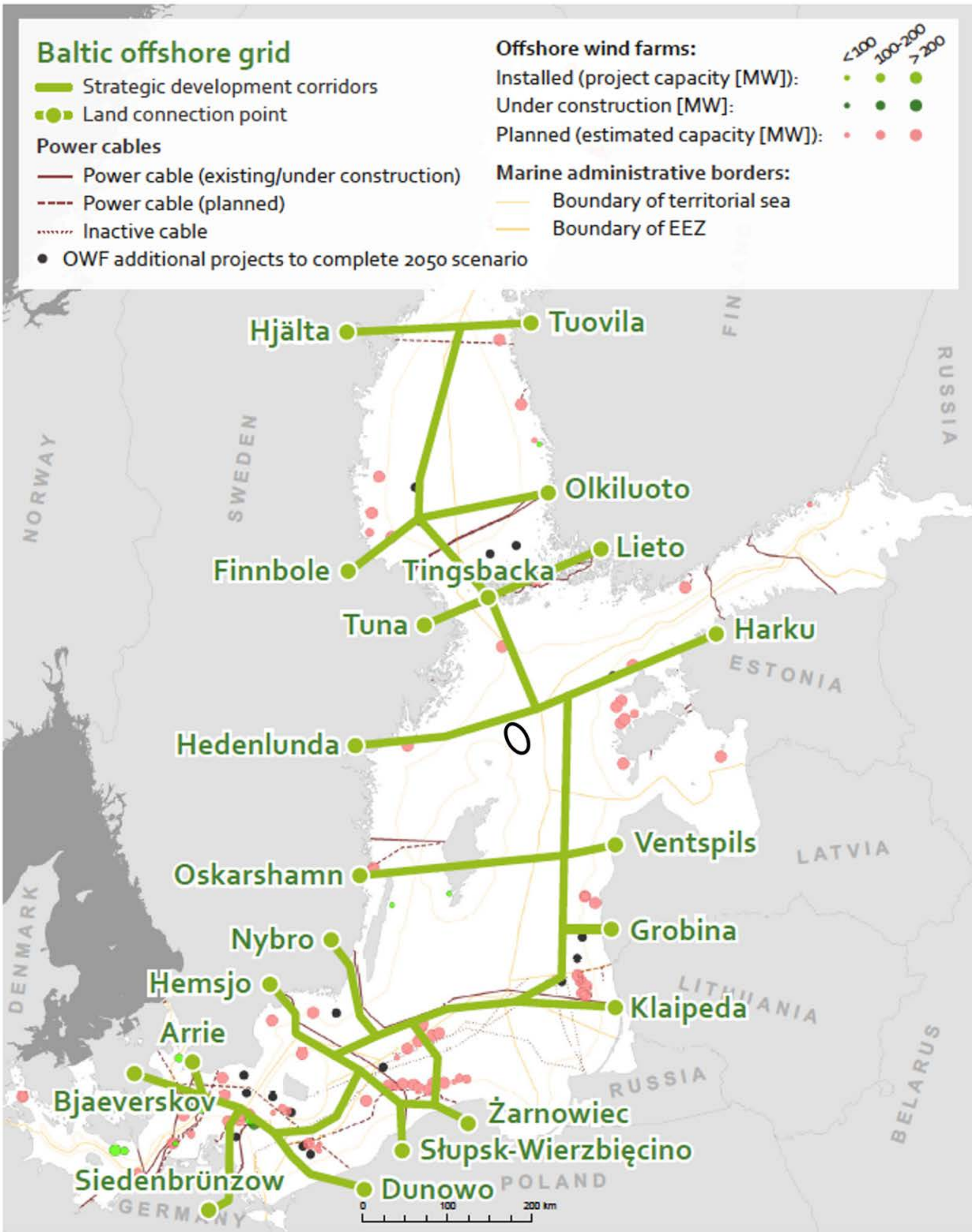
In order to strengthen the opportunities for offshore wind power in the Baltic Sea, surrounding countries have jointly started the Baltic Offshore Grid Initiative, which will push forward joint plans for electricity grids in the Baltic Sea and between the various countries on the Baltic Sea. The Baltic Offshore Epsilon project area is strategically well placed with possible future connections to several countries (Baltic InteGrid, 2019), see Figur 4.



Figur 2 Location of the project area in the Baltic Sea. The grey dashed line is Sweden's territorial border



Figur 3 Location of the project area and distance to land. The closest land is Gotska Sandön, approximately 31 kilometres south-west of the project area and Fårö 60 kilometres to the south. Solid line – project area, dashed line – Swedish EEZ.



Figur 4 The Baltic Offshore Grid (BOG 2050) concept. Source: Baltic InteGrid (n.d.), page 25. The black ring marks the approximate location of the project area in relation to the draft plan's investigation corridors and has been added to the map afterwards.

2.2.1 Design options

The work to develop the most optimal layout of the plant, i.e., the placement of wind turbines and associated infrastructure, with the least possible environmental impact is ongoing during the course of the project. Design options may, for example, include different locations of the wind turbines, different dimensions of the wind turbines or different choices of foundations. The layout presented during the consultation phase, see Section 2.4 *The extent and design of the wind farm* should therefore only be seen as an example of what a planned wind power plant might look like. However, the number of wind turbines in the final layout will not exceed 184.

A summary report of the various design options that have been investigated will be made in the forthcoming EIA.

2.3 Zero option

A zero option is a comparison option describing the situation if planned activities are not carried out. An account of the zero option will be included in the forthcoming EIA and the assessed environmental impacts resulting from the planned activities will then be assessed in relation to the zero option.

2.4 The extent and design of the wind farm

Plans for the Baltic Offshore Epsilon wind-power plant show it consists of a maximum of 184 wind turbines with a total installed power of approximately 3,000 MW and an expected annual output of approximately 12 TWh, see Tabell 3.

The wind turbines within the plant will be connected via an internal cable network which is connected to one or more offshore substations for transmission to land via one or more connection cables. See Section 2.4.5 for a more detailed description of electrical and communication systems.

There are two main techniques for anchoring foundations to offshore wind turbines; directly in the seabed (seabed-fixed foundations) or via cables (floating foundations). See Section 2.4.2 *Foundations and attachment* for a detailed description of different foundations. Both of these technologies are considered to be relevant to Baltic Offshore Epsilon. Due to the sea depth, seabed-anchored foundations may only be relevant in the eastern part of the project area where the depth is less than the rest of the project area.

The number of turbines, and thus also their locations in relation to each other, will be planned based on available technology before decisions on construction are made. Different options are presented in Tabell 4. An example layout is described in Section 2.4.1 *Wind turbines and layout.*

Tabell 3 Dimensions of the planned Baltic Offshore Epsilon wind power plant.

Number of wind turbines	Up to 184
Power per turbine	Approx. 20 MW, production approx. 80 GWh/year (example turbine)
Total height	Up to 330 meters

Tabell 4 Parameters for power, size of turbines and distance between these depending on the number of turbines used. For the example layout and in the calculation of production and power profiles, 184 turbines of 20 MW have been used (see Section 2.4.1).

Number of turbines	Power	Rotor diameter	Total power	Average distance
[#]	[MW]	[m]	[MW]	[m]
184	15	230	2760	1800
153	20	263	3060	2000
134	25	295	3350	2150

2.4.1 Wind turbines and layout

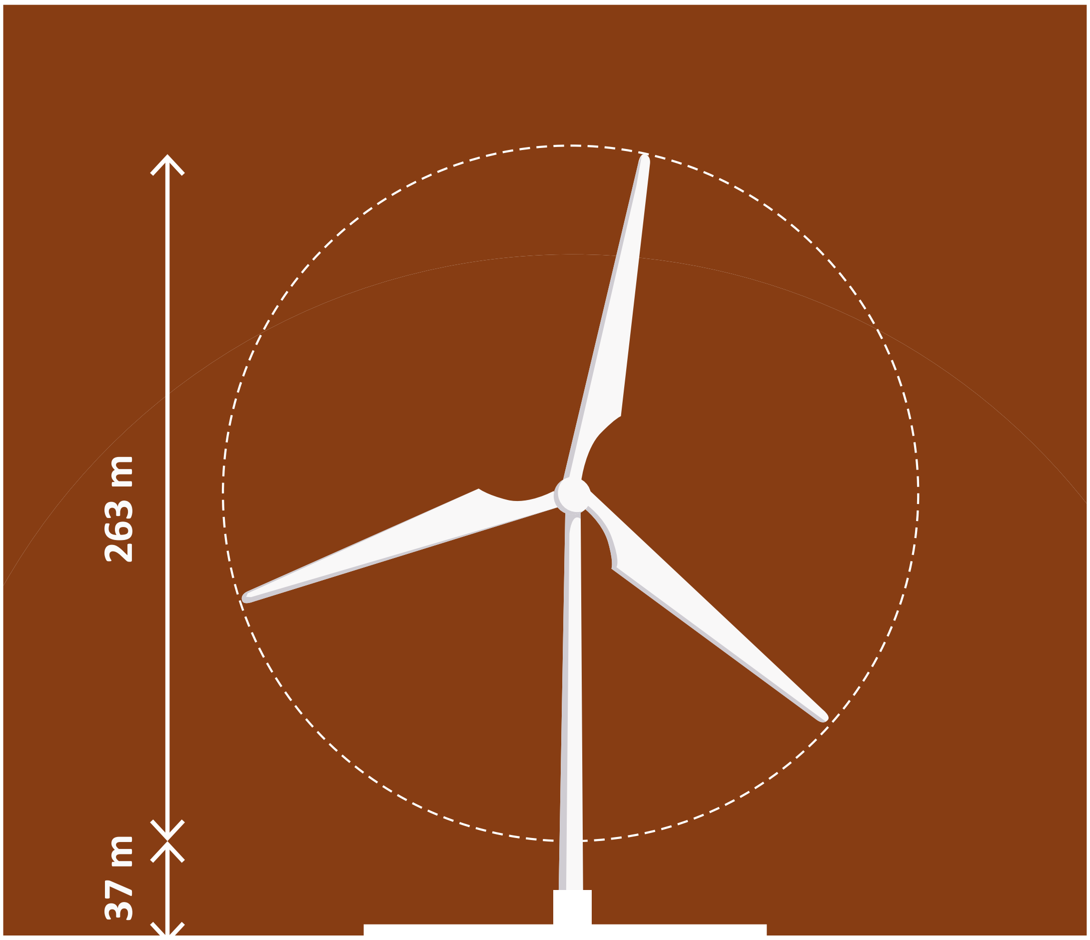
Due to the relatively long processes involved in realising offshore wind power, combined with the rapid technological development in the wind power industry, it is not possible today to describe the wind turbines that may be built in the future in any level of detail. The current schedule indicates that Baltic Offshore Epsilon is likely to be completed by approximately 2030–2032 at the earliest, see Section 5.4 *Preliminary schedule and implementation.*

Today there are wind turbines for offshore wind power with an installed power output of 15 MW and according to industry forecasts, it is likely that 20 MW turbines will be available around the year 2025. The production analysis for the project is based on an example plant with an installed power of 20 MW. This therefore implies a somewhat conservative expectation of future technology development up to 2030–2032. The example plant has a rotor diameter of 263 meters and a total height of 300 meters, see Figur 5. Note, however, that what is intended to be applied for is a maximum total height of 330 meters for the wind turbines.

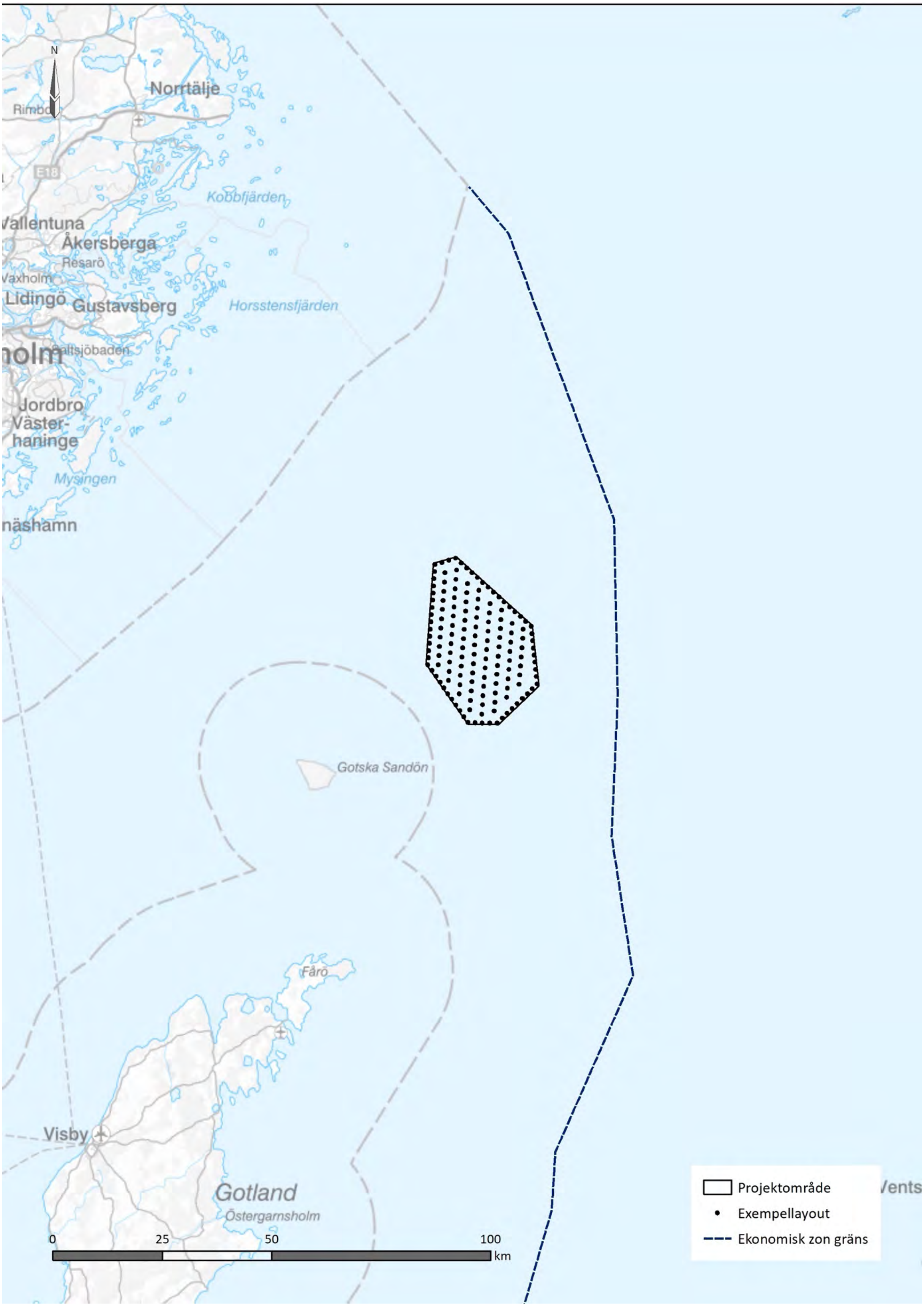
The locations of the wind turbines within the project area are governed by the local conditions, such as geotechnics, depth conditions, navigation, natural and cultural values and wind conditions. The wind turbines also need to be placed at a distance of approximately two kilometres from each other in order not to affect each other's production and to maintain good safety. An example layout is presented in Figur 6.

Downstream services

During the construction and decommissioning phase of the wind power plant, temporary disturbances may occur, including in the form of increased ship traffic and piling for anchoring foundations. For a description of how it may above impact all marine wildlife, recreation and navigation, see the respective sections in Chapter 3.



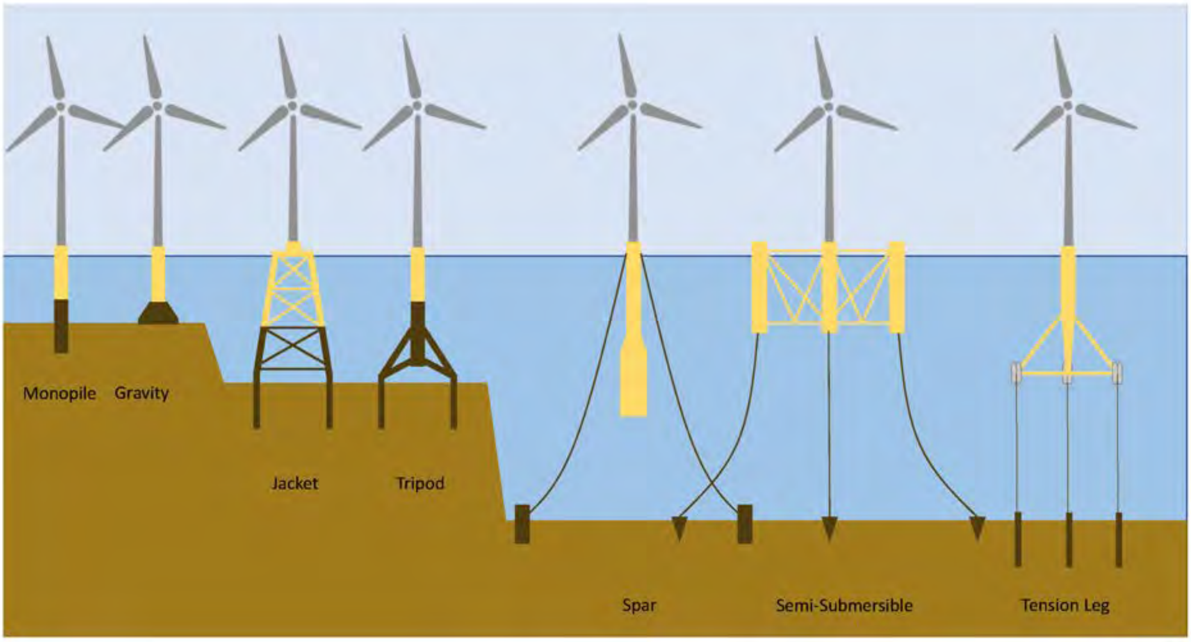
Figur 5 The size of the sample plant above the water surface in the preliminary production analysis for Baltic Offshore Epsilon



Figur 6 Example of layout for the wind power plant. Solid line – project area, dashed line – Swedish EEZ, dots – example of turbine layout.

2.4.2 Foundations and attachment

Offshore wind turbines can be placed on seabed-fixed or floating foundations, see Figur 7. The current state of the art allows seabed-fixed fixed foundations to be used to a depth of approximately 60 meters; at greater depths floating foundations are a more suitable solution. Floating foundations are a newer technology which is currently relatively expensive and, in the short term, only competitive at great water depths. However, future development and significantly larger volumes are expected to drive down the costs of floating foundations. Which anchoring method will be relevant in Baltic Offshore Epsilon will be investigated and determined upon final selection of the wind turbine model.



Figur 7 Overview of foundation types for offshore wind turbines. Source: Dornhelm et al. (2019).

2.4.3 Seabed-fixed foundations

The seabed-fixed foundations use four main techniques.

Monopile foundations

Monopile foundations consist of a steel cylinder that is driven into the seabed by piling. It is currently the most common technology for offshore wind power infrastructure. It is quick and relatively cheap to install. The technology is well suited to relatively shallow water depths, up to 30–40 meters with current technology, and seabeds that mainly consist of sand or gravel. There is ongoing research with the goal of changing the design to produce monopile solutions that work all the way down to a depth of 70 meters. A disadvantage of conventional monopile installation by means of piling is that it creates vibrations and noise that can disturb underwater organisms and animals. In sensitive areas, an alternative to monopiles can therefore be suction pipe/anchor anchoring where the pipe itself is driven down using negative pressure generated in the pipe. This option is suitable for soft seabeds.

Gravity foundations

The gravity foundation consists of a circular concrete structure filled with ballast that rests on the seabed. The tower is attached to the foundation and the wind turbine is held upright by gravity. Gravity foundations are a simple and cost-effective method that suits most foundation types. The disadvantage is that the area of use is limited to relatively shallow water depths; 30 meters is a general maximum seabed depth.

Jacket (truss) foundations

Jacket foundations consist of a truss structure anchored to the seabed. It is a stable structure that can withstand high loads and considerably greater depth than the above solutions. The foundation is also relatively insusceptible to the type of seabed, as the method of attachment to the seabed can be adapted to the conditions.

Tripod foundations

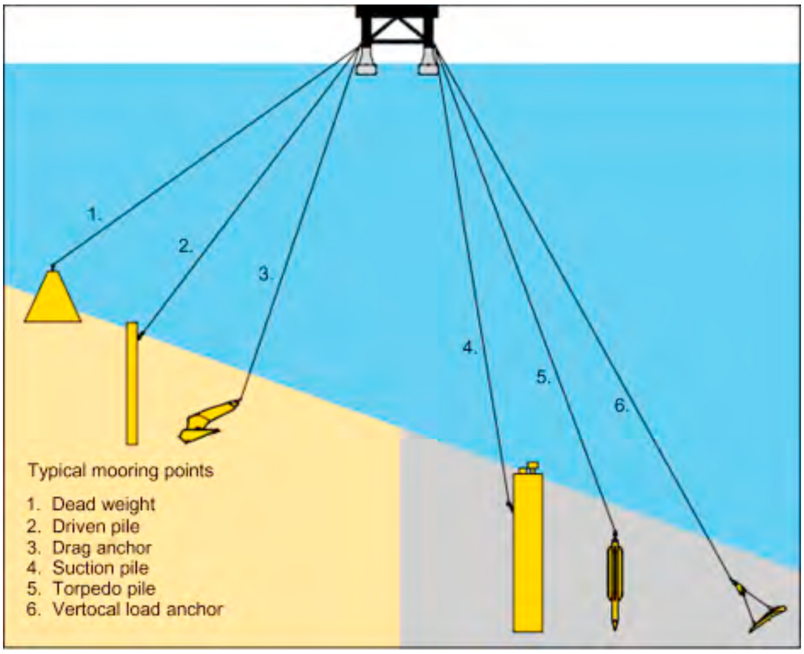
A tripod foundation consists of an upper cylindrical part that joins the tower and a lower three-legged structure that distributes the force to the bottom. The tripod technology is stable and can handle relatively large sea depths. It is also suitable for most solid types of seabed. The disadvantage is the cost and that it requires greater efforts during transport.

2.4.4 Floating foundations

There are currently three main technologies for floating foundations. However, rapid development is ongoing and it is likely that more feasible solutions will be developed before Baltic Offshore Epsilon is completed.

All floating foundations described below are based on anchoring to the seabed with ropes. The choice of attachment depends on the type of seabed that exists and can thus vary within the project area Figur 8.

Under normal production conditions, the foundation can be floating, i.e. *semi-submersible* or *spar* foundations, move horizontally with the movements of the water masses in a radius of approximately 10–25 meters from the centre. The anchorages in the seabed do not move and lashing lines never end up so slack that they reach the seabed.



Figur 8 An overview of the most common bottom attachment methods. Source: Vryhof anchors, 2010

Boom

The boom technique is based on a counterweight that is placed directly below the floating wind turbine and thus stabilises the turbine to prevent lateral movements from both aerodynamic loads and forces from waves and marine currents. The stabilising counterweight typically consists of a cylinder filled with ballast. One practical limitation is that the cylinder body is generally the same length as the wind turbine's tower, which means that very deep ports, or another solution, are required to carry out the assembly off-site.

Semi-submersible

The wind turbine is placed on a floating platform that is anchored to the bottom with slack anchor lines. The floating platform can consist of one single large floating element or many floating elements (pontoons) assembled with arms to distribute the lifting force over a larger surface thereby increasing stability.

Tension Leg

The tension leg technique is based on a floating platform that is stabilised by tensioned lines anchored to the seabed. Compared to the techniques above, which rely on slack lines to hold the turbines in place, the tension leg technique means that the platform needs more buoyancy and that the lines' attachment needs to withstand more load.

2.4.5 Electrical and communication systems

The wind turbines are connected with an internal cable network for communication and transmission of the energy produced. The voltage level in today's internal cable systems is usually 66 kV, but it is likely that higher voltage levels may also be relevant for Baltic Offshore Epsilon. Communication between the wind turbines is important for operational monitoring and load control at both turbine and plant level.

The internal cable network is connected at one or more sea-based substations, known as OSSs (Offshore Substations). The stations transform the electricity produced by the wind turbines into high voltage direct current (HVDC) in order to reduce electrical losses during transmission to land via one or more connection cables.

No dumping of waste materials is planned, however, a channel will be created in connection with the laying of the cable at the correct depth in the seabed.

Any impact on plant and animal life from internal cable networks and substations as well as the risk of current leakage into water, both during the construction phase and during operation, will be analysed and clarified in the EIA and form part of the risk and vulnerability analysis in the event of an accident or sabotage.

A separate application for electricity connection to the main grid has been submitted to Svenska Kraftnät, see Section 5.2 concerning electricity connection.

3. AREA CONDITIONS AND EXPECTED ENVIRONMENTAL IMPACTS

This chapter gives a brief account of the surrounding conditions and the expected environmental impacts that the wind power plant could have. In future work with the EIA, these environmental impacts will be investigated and reported in more detail.

3.1 Plan conditions

The oceans are largely unexplored and are important from many different aspects; they are transport routes, provide resilience against climate change, habitat for biodiversity, important for food production and recreation and more. In order to ensure that we use the seas in a long-term and sustainable way without damaging them, it is important to carefully investigate the impact of the planned activities before any possible installation.

The current project area is within Sweden's Exclusive Economic Zone and it is therefore the state that has planning responsibility for the area through maritime spatial planning and marine environment management. The distance from the project area to Finland's Exclusive Economic Zone is approximately 18 kilometres.

3.1.1 Maritime spatial plan

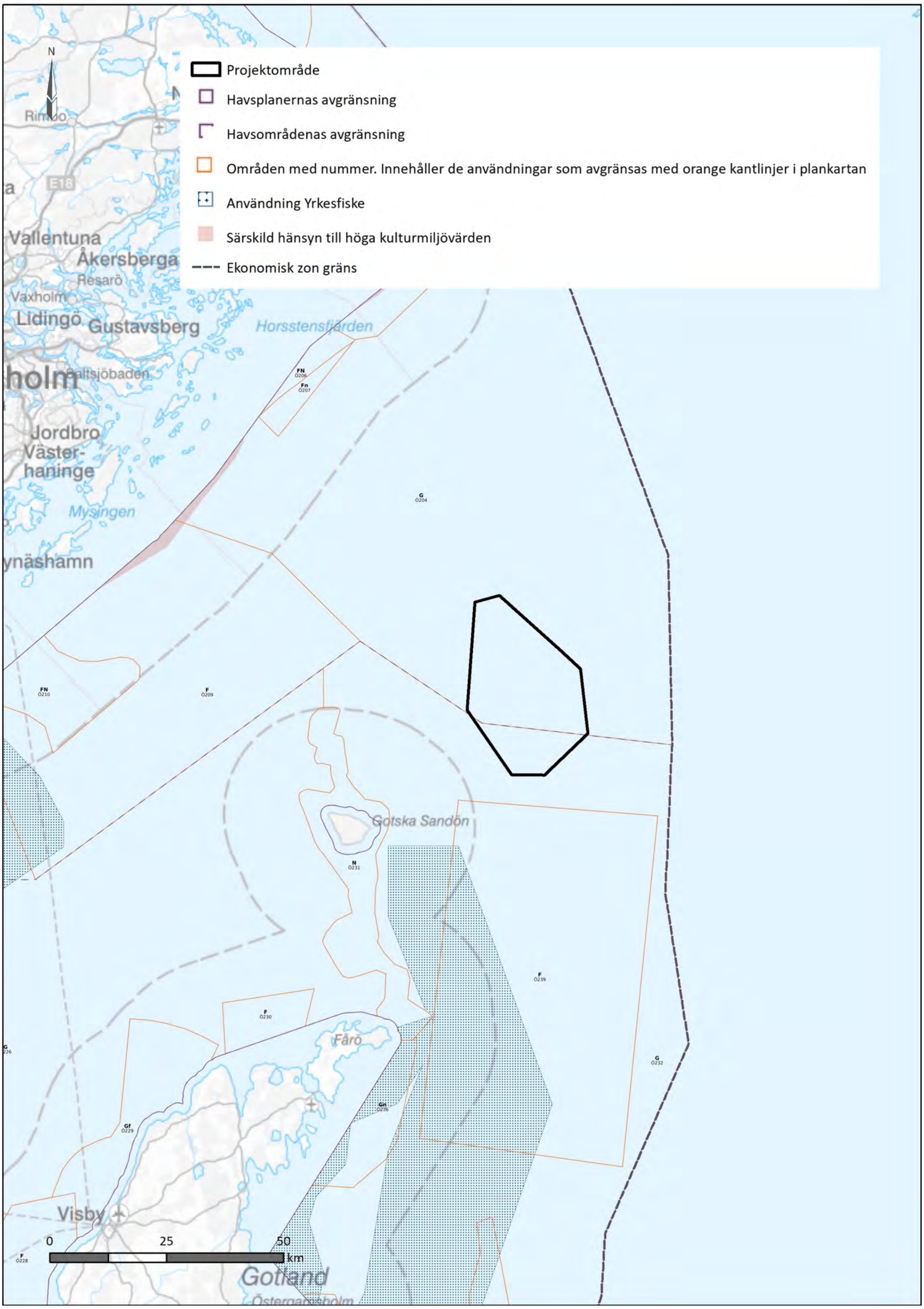
In the Swedish Agency for Marine and Water Management's maritime spatial plan (2022a), the project area is within the North Baltic Sea and South Kvarken marine area, sub-area Ö204, as well as to some extent in the Central Baltic Sea marine area, sub-area Ö232, both defined *General use*, see Figur 9 and Tabell 5. Otherwise, parts of the project area are mainly of interest in terms of navigation. Commercial fishing is also conducted in areas defined for general use.

According to the maritime spatial plan, the North Baltic Sea marine area is well suited for energy generation as the wind conditions are good, there is a suitable depth in several places and the need for electricity is large in southern Sweden (Swedish Agency for Marine and Water Management, 2022a).

Based on criteria of annual average wind, depth and area size, the location for Epsilon was identified in the planning process for the maritime spatial plans as in the public interest and of significant importance for energy generation. However, in the maritime spatial plan for the Baltic Sea decided in February 2022, no areas are specified for energy generation within either Ö204 or Ö232 (Swedish Agency for Marine and Water Management, 2022a).

Tabell 5 Excerpt from description of marine area Ö204 North Baltic Sea and South Kvarken and Central Baltic Sea Ö232. Special consideration must be given to these aspects if they arise. Defence interests must be given priority if coexistence cannot be achieved. Source: Swedish Agency for Marine and Water Management, 2022a.

Area	Use	Special consideration	Preference or special adaptation for coexistence	Justification for precedence
Ö204	General use Navigation	High cultural environmental values	Defence is given priority over energy generation.	National interest claims for total defence are given priority according to Ch. 3. Section 10 of the Swedish Environmental Code over national interest claims for wind power and public interests of significant importance for wind power. The uses are deemed not to be able to coexist.
Ö232	General use Navigation Investigation area navigation Commercial fishing			



Figur 9 Chart for part of the marine area North Baltic Sea and South Kvarken (Ö204 in the north) and Central Baltic Sea (Ö232 in the south). Source: The Swedish Agency for Marine and Water Management (2022a), maritime spatial plan. Solid line – project area, dashed line – Swedish EEZ.

3.1.2 Marine environment management

The Marine Environment Directive (Framework Directive on a Marine Strategy, 2008/56/EC) aims to maintain or achieve a good environmental status in Europe's seas by 2020 at the latest. In Sweden, the directive has been implemented through the Swedish Marine Environment Ordinance (2010:1341) which states that it is an environmental quality standard that marine environmental management must mean that a good environmental status is maintained or reached in the North Sea and the Baltic Sea. The Swedish Agency for Marine and Water Management is the authority responsible for the implementation of marine management. The administration includes, among other things, developing environmental quality standards with the indicators that must be used to assess whether the good environmental status is maintained or achieved and developing and implementing programs to monitor that the environmental quality standards are followed as well as identifying the measures that must be taken to maintain or achieve a good environmental status. Environmental quality standards and indicators are laid down in regulation HVMFS 2012:18, Appendix 3. In order to achieve good environmental status, eleven Swedish environmental quality standards for the marine environment have been established. See more in Section 3.2 *Environmental quality standards*.

3.1.3 HELCOM Baltic Sea Action Plan

HELCOM, the Baltic Marine Environment Protection Commission, is a collaboration between all the countries around the Baltic Sea that aims to protect the marine environment in the Baltic Sea from all types of pollution. In 2007, HELCOM developed an action plan, the Baltic Sea Action Plan, with measures to work towards (HELCOM, 2007). The action plan lists several threats to the Baltic Sea and identifies actions that the countries around the Baltic Sea undertake to implement. Among other things, it describes how pollution by hazardous substances must be reduced, that the unique brackish water ecosystems of the Baltic Sea must be preserved, to ensure long-term fishing and to work towards safe and environmentally friendly navigation. The plan does not directly affect wind power and the planned wind power operations do not conflict with any of the parts of HELCOM's action program if they are implemented effectively and, for example, ensure that no hazardous substances are dispersed during construction or operation.

3.2 Environmental quality standards

Environmental quality standards are regulations governing the quality of land, water, air or the environment in general. Environmental quality standards can specify pollution levels or disturbance levels that people, the environment or nature may be subjected to without danger. They can also consist of limit values or guideline values, indicate the highest or lowest incidence of organisms in surface water or groundwater or consist of the requirements that are otherwise placed on environmental quality due to Sweden's membership of the EU.

The Marine Environment Directive (Framework Directive on a Marine Strategy, 2008/56/EC) aims to maintain or achieve a good environmental status in Europe's seas by 2020 at the latest. In Sweden, the directive has been implemented through the Swedish Marine Environment Ordinance (2010:1341) which states that it is an environmental quality standard that marine environmental management must mean that a good environmental status is maintained or reached in the North Sea and the Baltic Sea.

The Swedish Agency for Marine and Water Management is the authority responsible for the implementation of marine management. The administration includes, among other things, developing environmental quality standards with the indicators that must be used to assess whether the good environmental status is maintained or achieved and developing and implementing programs to monitor that the environmental quality standards are followed as well as identifying the measures that must be taken to maintain or achieve a good environmental status.

The aspects that are relevant in terms of maintaining or achieving a good environmental status in the sea are physical and chemical conditions, habitats and biological conditions. Stress can consist of physical disturbance, such as damage to the seabed, the diffusion of nutrients, polluting substances, as well as biological disturbance, for example removal of species through fishing.

The action program that the Swedish Agency for Marine and Water Management has drawn up for marine environment management, identifies which measures are needed to ensure that the environmental quality standards for the marine environment can be followed and to reach set targets for good environmental status in the marine environment (Swedish Agency for Marine and Water Management, 2021). The measures are divided into different thematic areas. The thematic areas that are deemed to be affected by the planned wind power installation are *seabed integrity*, *underwater noise* and *biodiversity*.

Marine benthic communities are negatively impacted by both effects of eutrophication and by direct impact of the seabed through, for example, trawling. Oxygen content and currents are also important factors, see also Section 3.8.1 *Impact on marine currents and mixing.* Although the planned wind power plant affects the integrity of the seabed through direct land encroachment, the total amount of substrate increases with the activity and benthic organisms can benefit. The seabed is also protected for a long time from the impact of trawling when the wind turbines are in operation. Environmental quality standards for the integrity of the seabed mean that good environmental status is characterised such that "*The seabed area unaffected by* *human activity must have an extent that provides conditions for maintaining the structure and function of the seabeds for each habitat type*" and that "*The area of biogenic substrates must be maintained or extended".*

The action program proposes measures to reduce the spatial distribution of seabed trawling and thereby limit its impact on the integrity of the seabed.

The sounds in the oceans caused by human activity increase both in strength and frequency and may impact the animals that live there, see more in Section 3.9 *Natural environment* and 3.14 *Sound.* Impulsive noises are generated by a number of activities in the marine environment. The greatest risk of impact on marine mammals is currently believed to be linked to impulsive underwater sound arising during the construction of infrastructure, where the most common construction activity in the Swedish administrative area is the installation of offshore wind power infrastructure. Environmental quality standards for underwater noise mean that good environmental status is characterised such that *"Human activities must not cause harmful impulsive noise in the distribution areas of marine mammals during periods of time when the animals are sensitive to disturbance."*

The action program states that, overall, there are several existing measures which together are deemed to provide good conditions for limiting impulsive noise in the construction phase of offshore wind power infrastructure.

Sweden currently has no specific environmental quality standards with indicators for achieving good environmental status with regard to biodiversity (Swedish Agency for Marine and Water Management, 2021). On the other hand, all environmental quality standards for the marine environment help benefit biodiversity. Since biodiversity is covered by all species and habitats in an ecosystem, description and quantification of the impact also becomes complex. Different stressors can have cumulative effects and thus increase or decrease the stress to which a species or habitat is exposed. Eutrophication, hazardous substances, marine litter, noise, physical loss and physical disturbance of habitats, fishing including by-catches and alien species are all relevant stressors which in the future may also be amplified by the expected climate change (Swedish Agency for Marine and Water Management, 2021).

Depending on the conditions in the specific area, offshore wind turbines may have a positive impact, a negative impact or both, and provide opportunities for different animals and plants' to coexist with the turbines. Future EIA work will put forward various proposals for measures to take biodiversity into account, see more in Section 3.9.8 *Biodiversity and ecosystem services.*

3.3 Nearby wind power plants

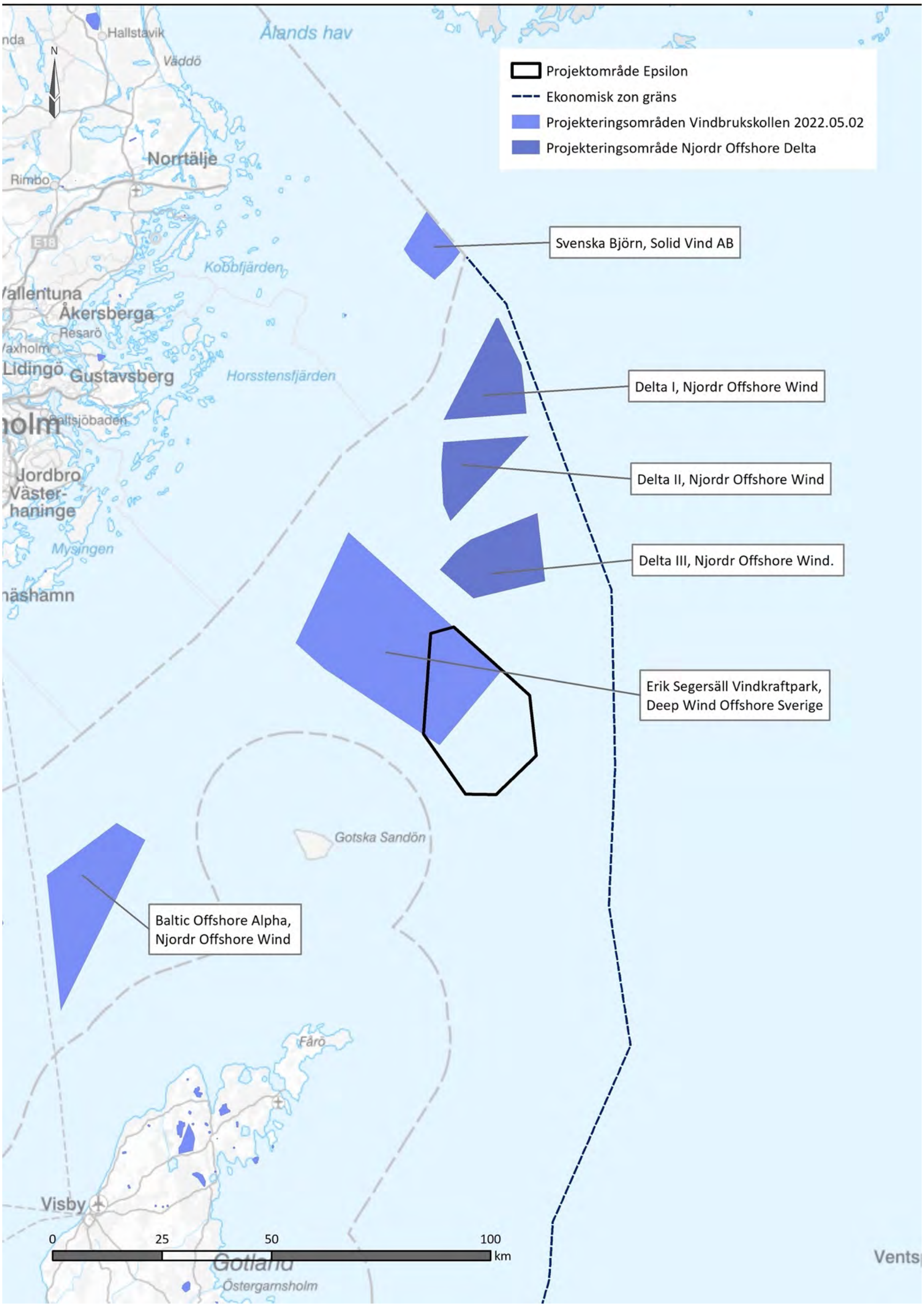
So-called cumulative effects can occur if there are wind power plants in the vicinity of the project area in question. Figur 10 and Tabell 6 examine the wind power plants that have been constructed, have been granted an alternative building permit or are planned within a 50 kilometre radius of the project area. Within this distance, a planned wind farm, Baltic Offshore Delta, is being processed approximately 10 kilometres north of the project area, which is also being designed by Njordr Offshore Wind. Another project at the planning stage, which touches on the project area for Epsilon, is Deep Wind Offshore DWO Sverige AB's Erik Segersäll Wind Farm project.

Cumulative impacts that the project may have will be described and assessed in future EIAs based on which other projects are planned or have been granted permits.

Please note that the reporting of nearby wind power plants and project areas represents a snapshot that may change over time. The information comes from Vindlov's mapping service Vindbrukskollen (2022), which is updated by the operators themselves.

Tabell 6 Compilation of wind power plants within 50 kilometres and their distance to the project area.

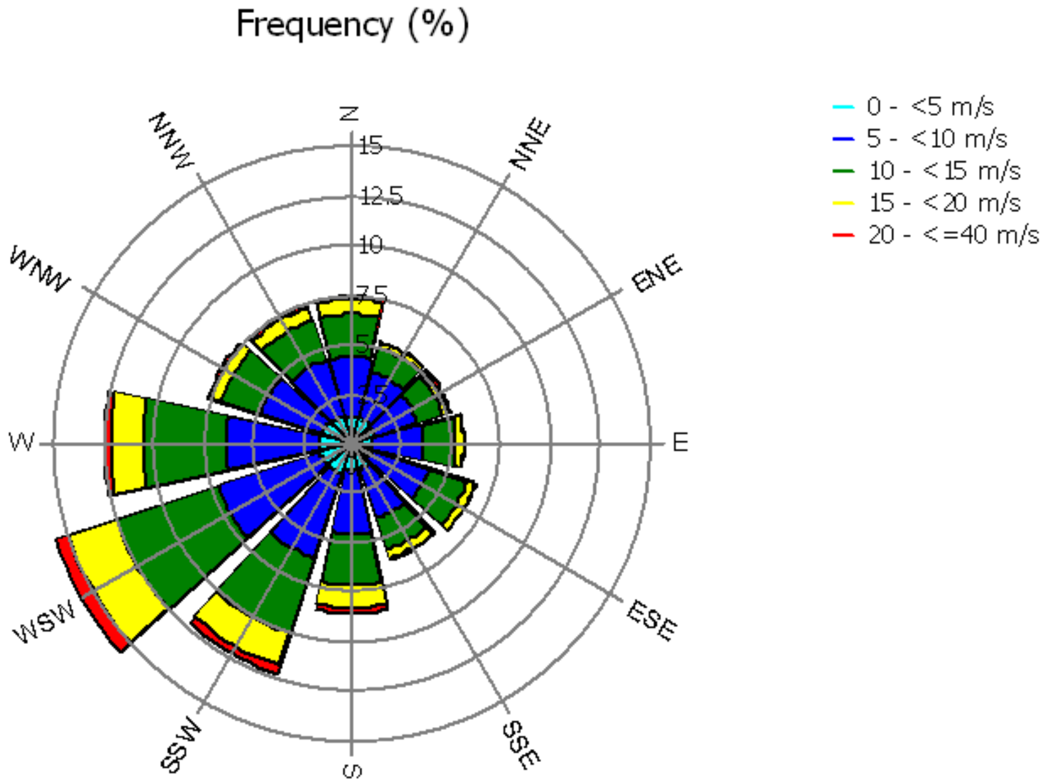
Plant	***Operator***	***Extent/total height***	***Status***	***Distance***
Baltic Offshore Delta	Njordr Offshore Wind AB	253 wind turbines/330 meters	Processed	Approx. 10 kilometres north
Erik Segersäll Wind Farm	Deep Wind Offshore DWO Sverige AB	300 wind turbines	Processed	0 kilometres/coincident



Figur 10 Map of planning areas for wind power infrastructure in the vicinity of the project area. Solid line – project area, dashed line – Swedish EEZ.

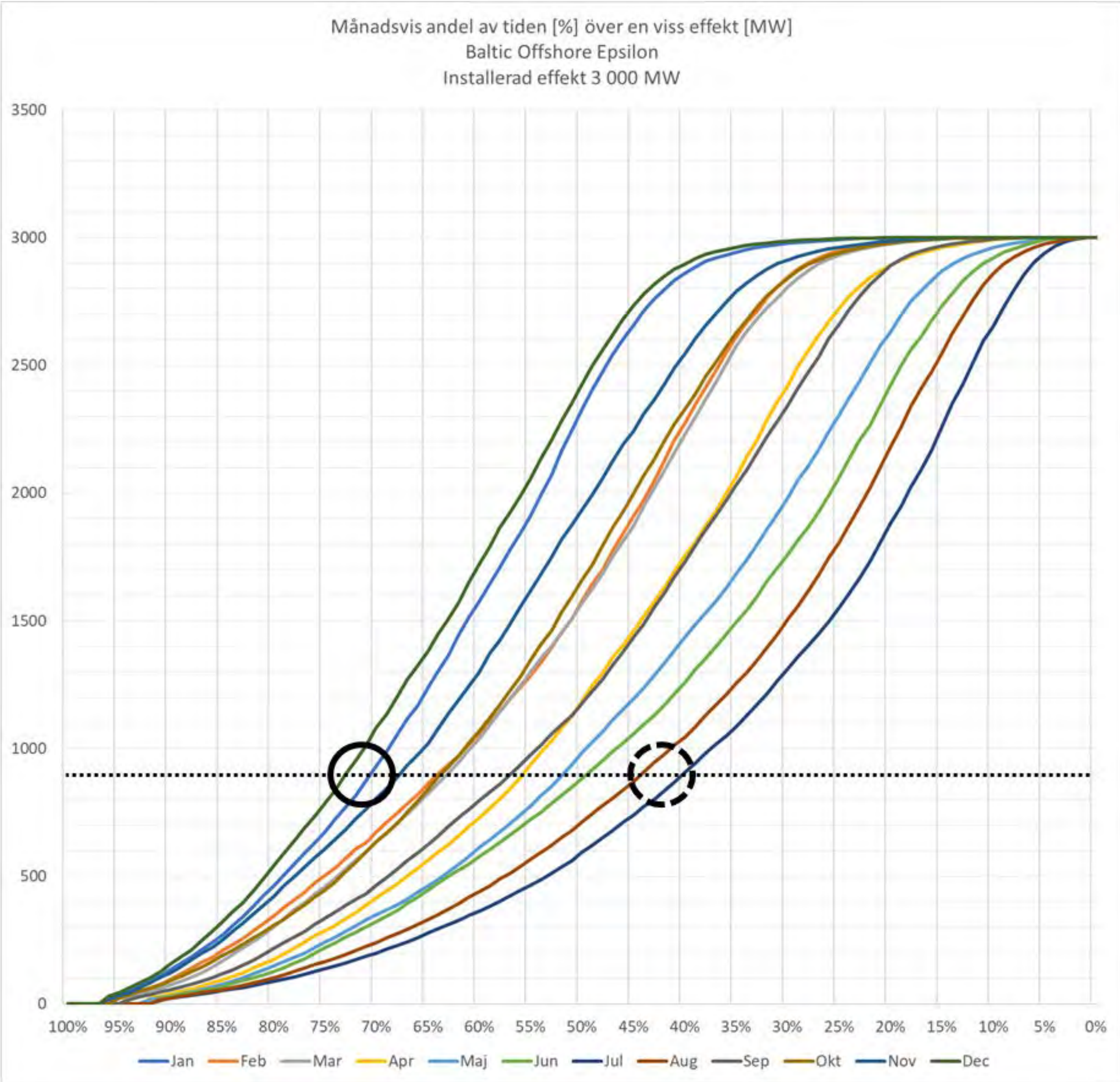
3.4 Wind resources

The wind resource in the project area is very good with an average wind speed of 9.7 m/s at a height of 160 meters. The prevailing wind direction in the area is westerly and south-westerly. These winds also have the highest average wind speed in the area and thus constitute a large part of the potential wind resource in the area. The measurement data is based on long-term corrected high-resolution simulations of the local wind conditions, see Figur 11.



Figur 11 The prevailing wind direction in the Baltic Offshore Epsilon project area is westerly and south-westerly, based on long-term corrected high-resolution simulations of the local wind conditions using the ME-WAM model (Keck and Sondell, 2020).

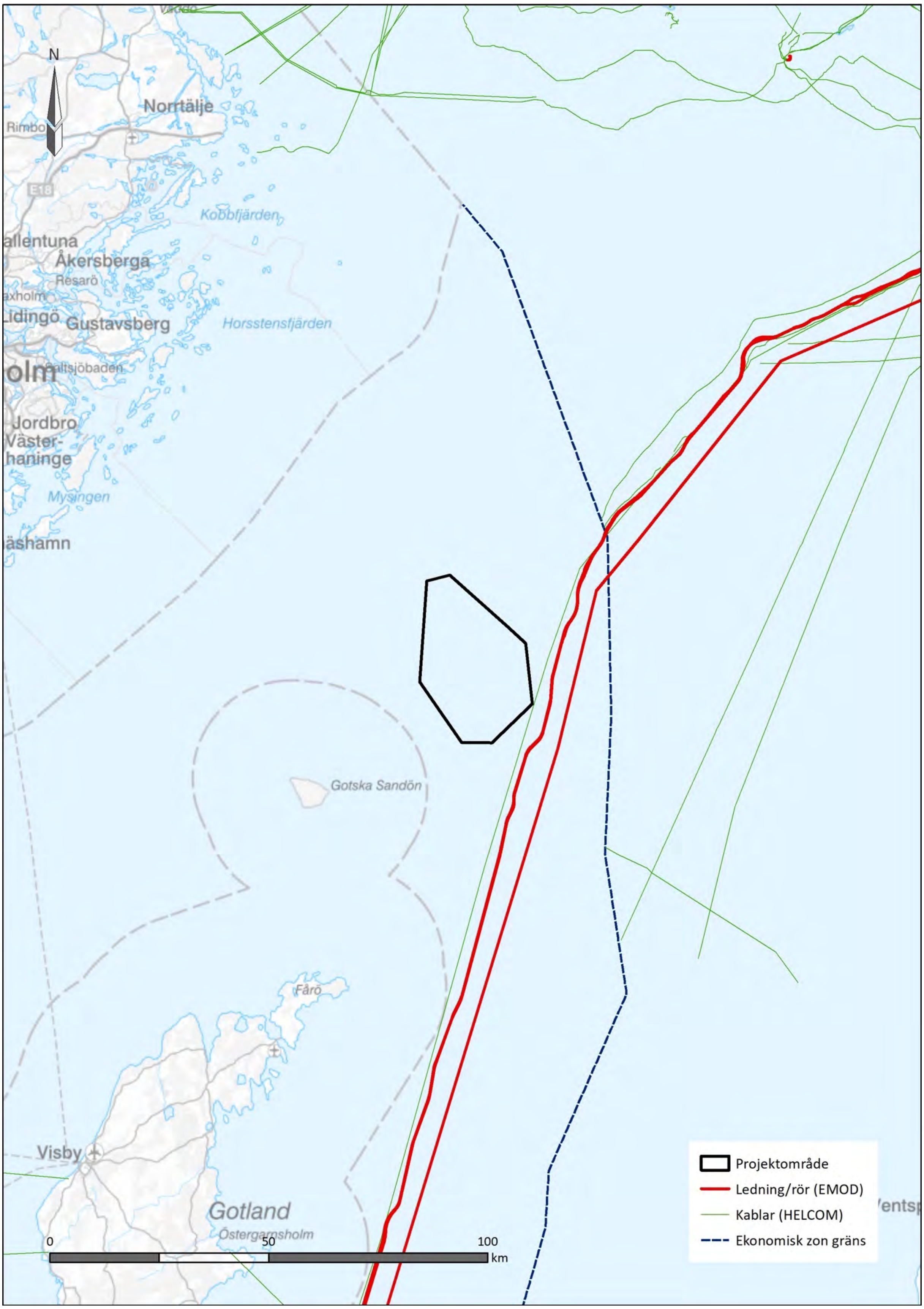
The good wind resource in the area and the fact that it is rarely calm over the sea leads to a more even production over the year, see the calculated power profile for Baltic Offshore Epsilon set out in Figur 12. The calculations show that the power output in December and January, when there is the greatest need for energy, is over 900 MW for 70-75 percent of the time (solid marker in Figur 12) while in the middle of summer it is above 900 MW only about 40–45 percent of the time (dashed marker in Figur 12). In December and January, the power output is also above 2400 MW more than 50 percent of the time. The power output can be compared with the capacity of the nuclear power reactor Oskarshamn 3, which has a maximum power output of 1450 MW.



Figur 12 Cumulative distribution of total power output from the Baltic Offshore Epsilon wind farm for different months of the year. To increase the understanding of the figure, markers have been inserted after the analysis. The dashed line shows the limit of 900 MW, the solid marker shows when the power output in December and January exceeds 900 MW, and the dashed marker shows when the power output exceeds 900 MW in summer time.

3.5 Cables and conduits

A large number of cables and conduits run in the Baltic Sea, mainly for communication and transmission of electricity in the region. Most of the conduits have an east-west route between Sweden, Finland and Estonia. According to available documentation, there are no cables or conduits in the project area, see Figur 13. The fibre cable C-lion touches the eastern part of the project area. The project area is crossed approximately five kilometres to the east by the gas pipelines Nordstream 1 and Nordstream 2 between Russia and Germany, see Figur 13. Updated information about existing and planned cables and conduits in connection with the project area will be obtained during the further planning and described in the EIA.



Figur 13 Map of known cables and conduits found near the project area (HELCOM, 2018 and EMODnet, 2017). The fibre cable C-Lion (green) and the gas pipelines Nordstream 1 and 2 (red) pass close to the project area. Solid line – project area, dashed line – Swedish EEZ, red line – pipes, green line – cables.

3.6 Areas of national interest

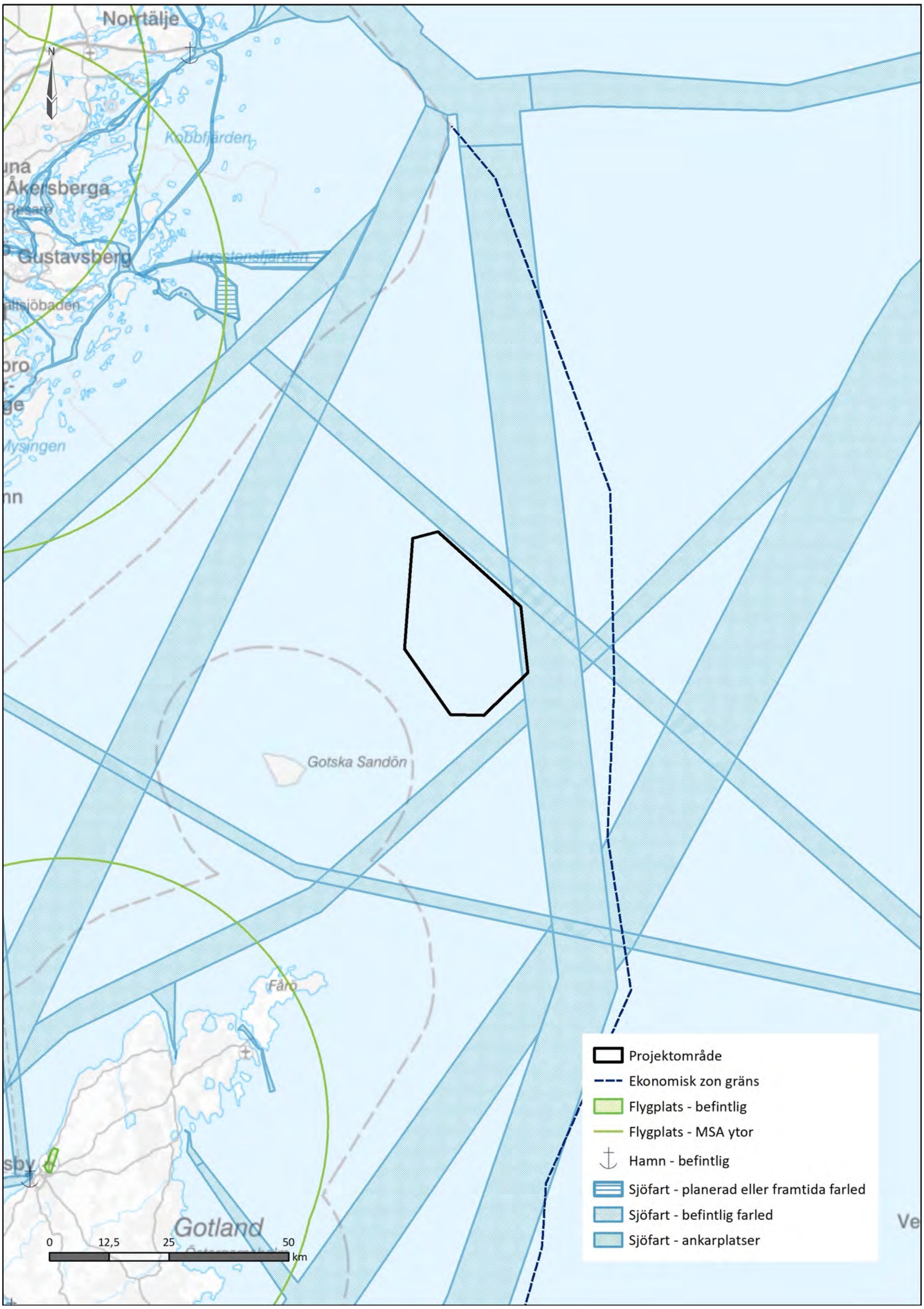
National interests are geographical areas, designated because they contain nationally important values and qualities. Areas of national interest may aim to preserve values or prioritise the area for a certain type of exploitation, but may also be designated for a certain type of use, such as commercial fishing.

A designated sea lane of national interest for navigation touches the eastern part of the project area, see Figur 14. No other designated national interests are directly impacted by the project area.

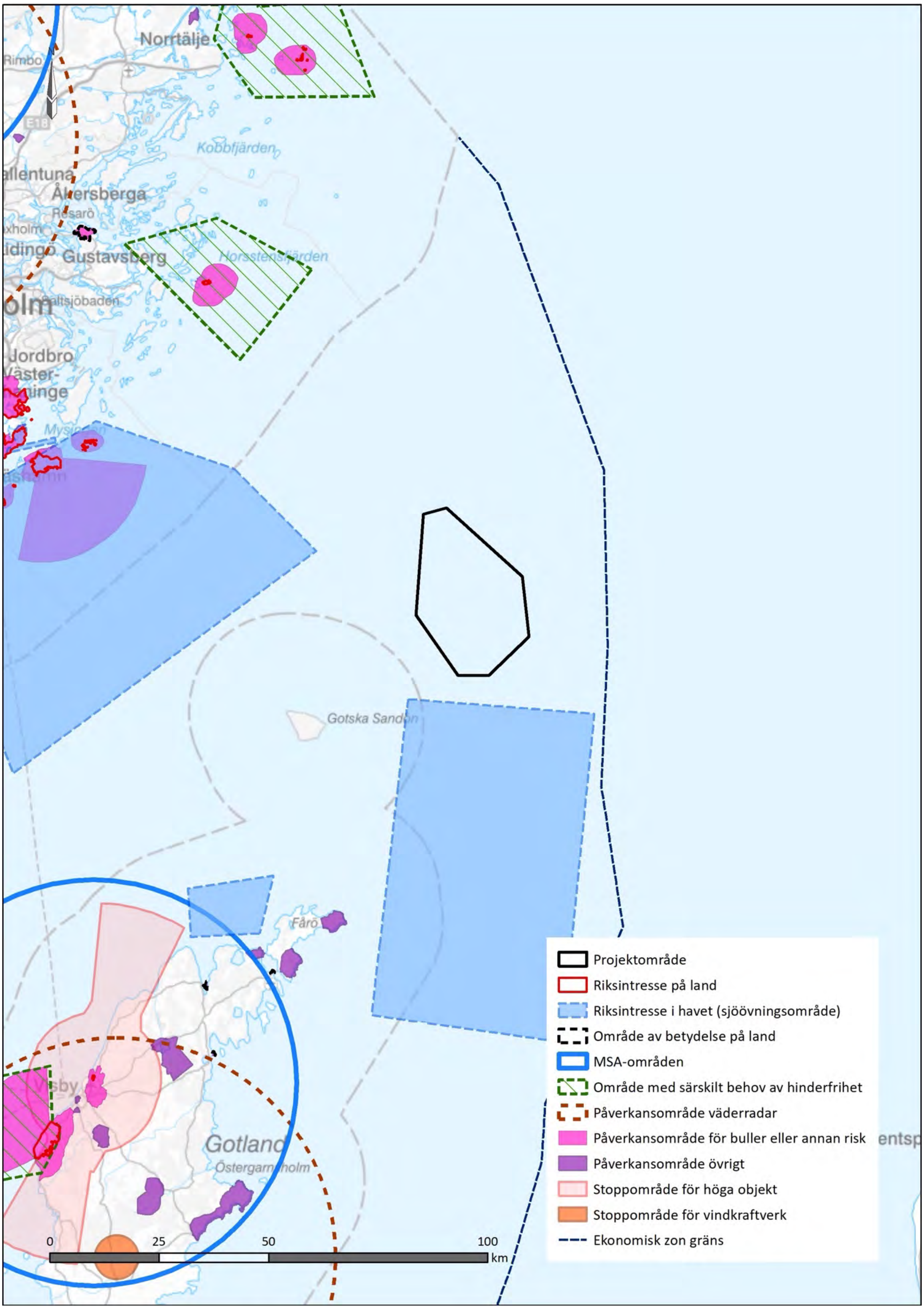
The marine area just south of the project area, east of Gotska Sandön and Fårö is designated as of national interest in the sea for naval training areas. The marine area approximately 25 kilometres to the west is also designated as of national interest in the sea for naval training areas, see Figur 15. The maritime spatial plan (Swedish Agency for Marine and Water Management, 2022a) indicates use for defence purposes along large stretches of the coastline in the North Baltic Sea and South Kvarkan marine area due to claims of national interest for total defence and impact areas.

National interest for nature conservation in the capacity of the Gotska Sandön located approximately 30 kilometres south-west of the project area and also including the Natura 2000 area *Gotska Sandön-Salvorev,* see Figur 16. Gotland and Gotska Sandön are also covered by national interest for active outdoor life, see Figur 17. Gotska Sandön is also of national interest for outdoor life and cultural environment conservation, Figur 17,

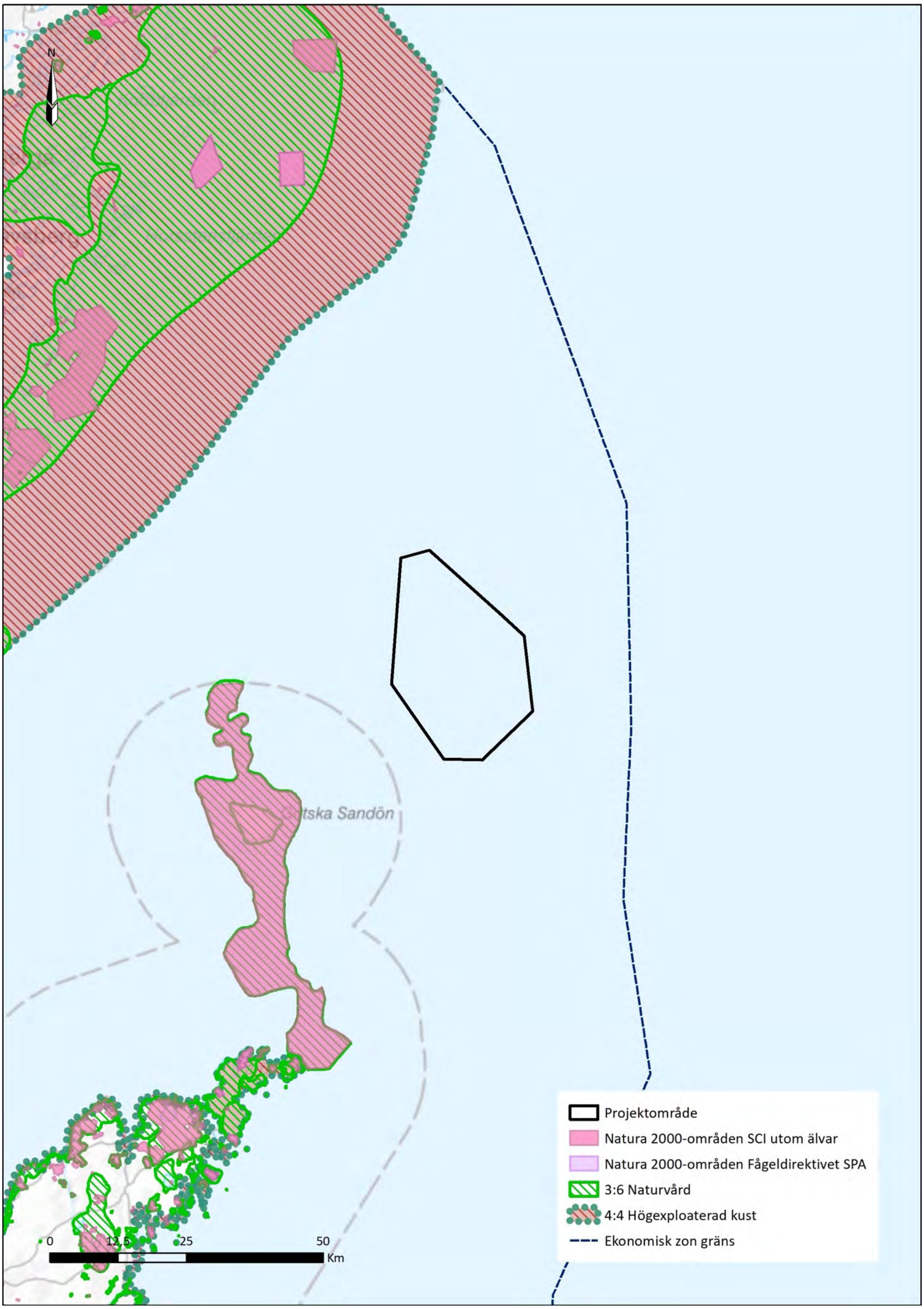
About 20 kilometres south of the project area is an area of national interest for commercial fishing, see Figur 18.



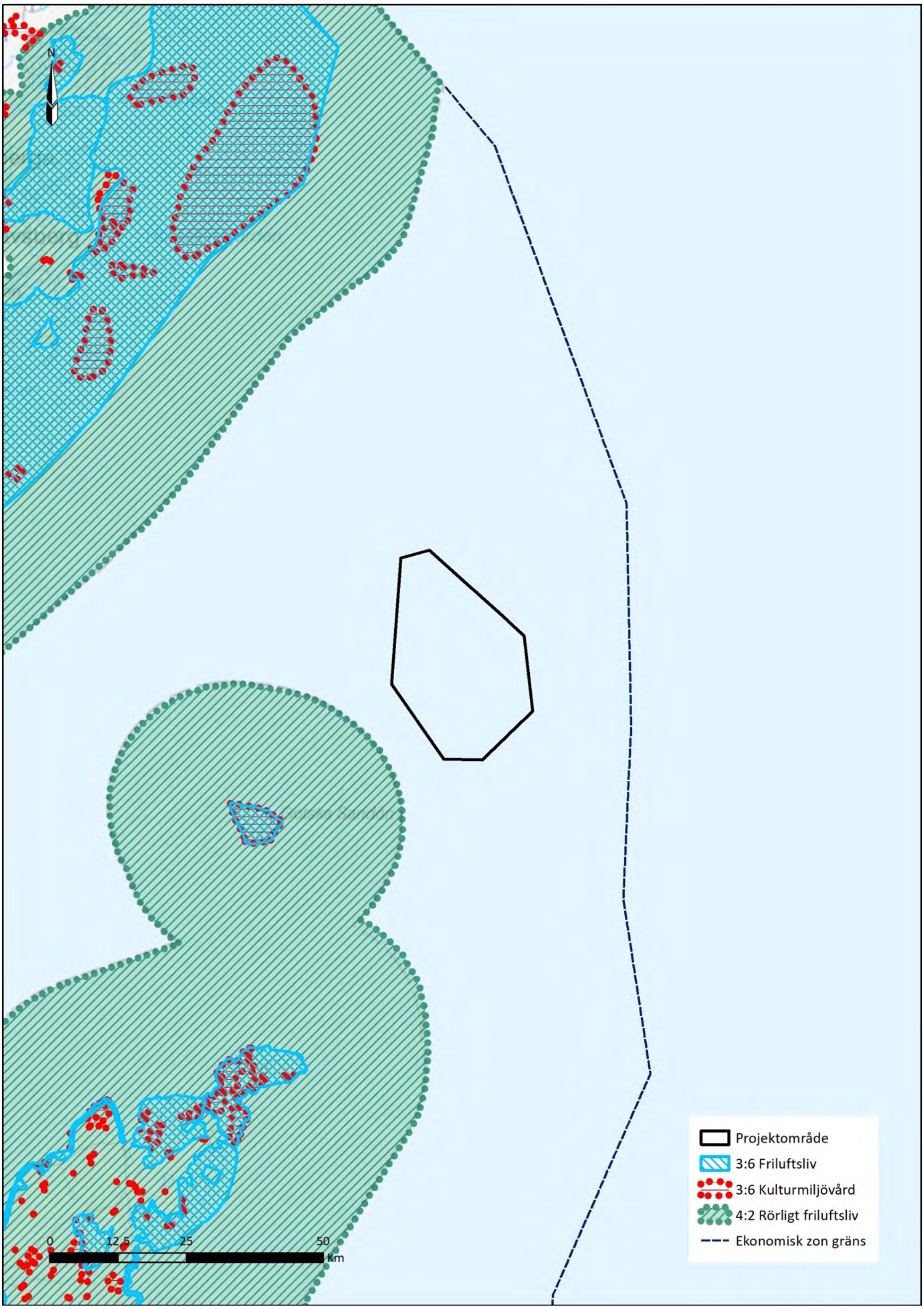
Figur 14 National interests for communications within approximately 100 kilometres of the survey area: navigation, ports and airports. An existing sea lane of national interest for navigation is touched by the eastern part of the project area. The project area is not within any MSA areas or any areas of national interest for air traffic. Solid line – project area, dashed line – Swedish EEZ.



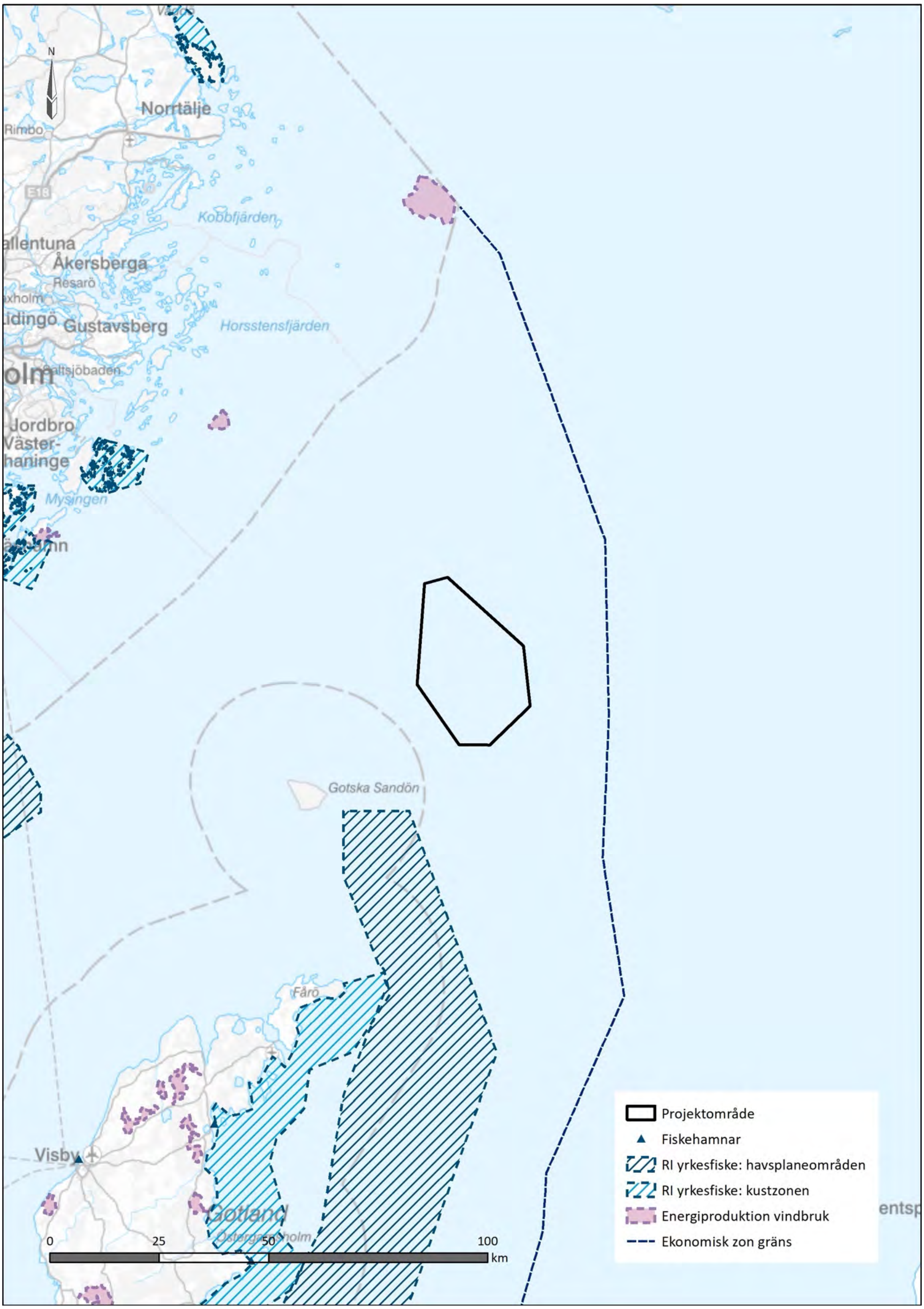
Figur 15 The national interests of the armed forces within 100 kilometres of the project area. Solid line – project area, dashed line – Swedish EEZ.



Figur 16 National interests for nature conservation and Natura 2000 areas within approximately 100 kilometres of the project area. Solid line – project area, dashed line – Swedish EEZ.



Figur 17 National interests for cultural environmental protection and outdoor life within approximately 100 kilometres of the project area. Solid line – project area, dashed line – Swedish EEZ.



Figur 18 National interest for commercial fishing and for energy production wind farms within approximately 100 kilometres of the project area. Solid line – project area, dashed line – Swedish EEZ.

3.7 Landscape picture

The landscape picture and the consequences of installing a wind power plant are subjective and based on the human experience of the landscape. In general, it can be stated that it is inevitable that a wind power plant will impact the prevailing landscape picture, but how the changes are experienced varies depending on the viewer and are related to the viewer's expectations of the landscape picture and attitude towards renewable energy.

The landscape picture refers to the nature of the landscape, i.e. the landscape's appearance and perceptual aspects. This section is therefore closely connected with other sections described in this consultation document, for example outdoor life and recreation and the cultural environment.

The project area for Baltic Offshore Epsilon is located in the open sea a long distance from islands and the surrounding mainland. The nearest land is Gotska Sandön approximately 31 kilometres south-west of the project area. It is approximately 67 kilometres to Långviksskär in the Nämndöskärgården national park, 60 kilometres to Fårö and 94 kilometres to Nåttarö.

The visual impact of Baltic Offshore Epsilon has been analysed via line-of-sight analyses and photomontage. Line-of-sight analyses show the theoretical possibility of seeing the wind turbines before they disappear below the horizon due to the curvature of the sea, Figur 19 while the photomontage aims to give a more realistic picture of the visual impact of the turbines.

There are three main aspects that determine how well the planned wind turbines will be experienced on-site.

1) **The curvature of the earth** determines how far it is theoretically possible to see the wind turbines. As an example, it is possible to see a 300 meter high wind turbine at a distance of about 60 kilometres before it disappears completely below the horizon.

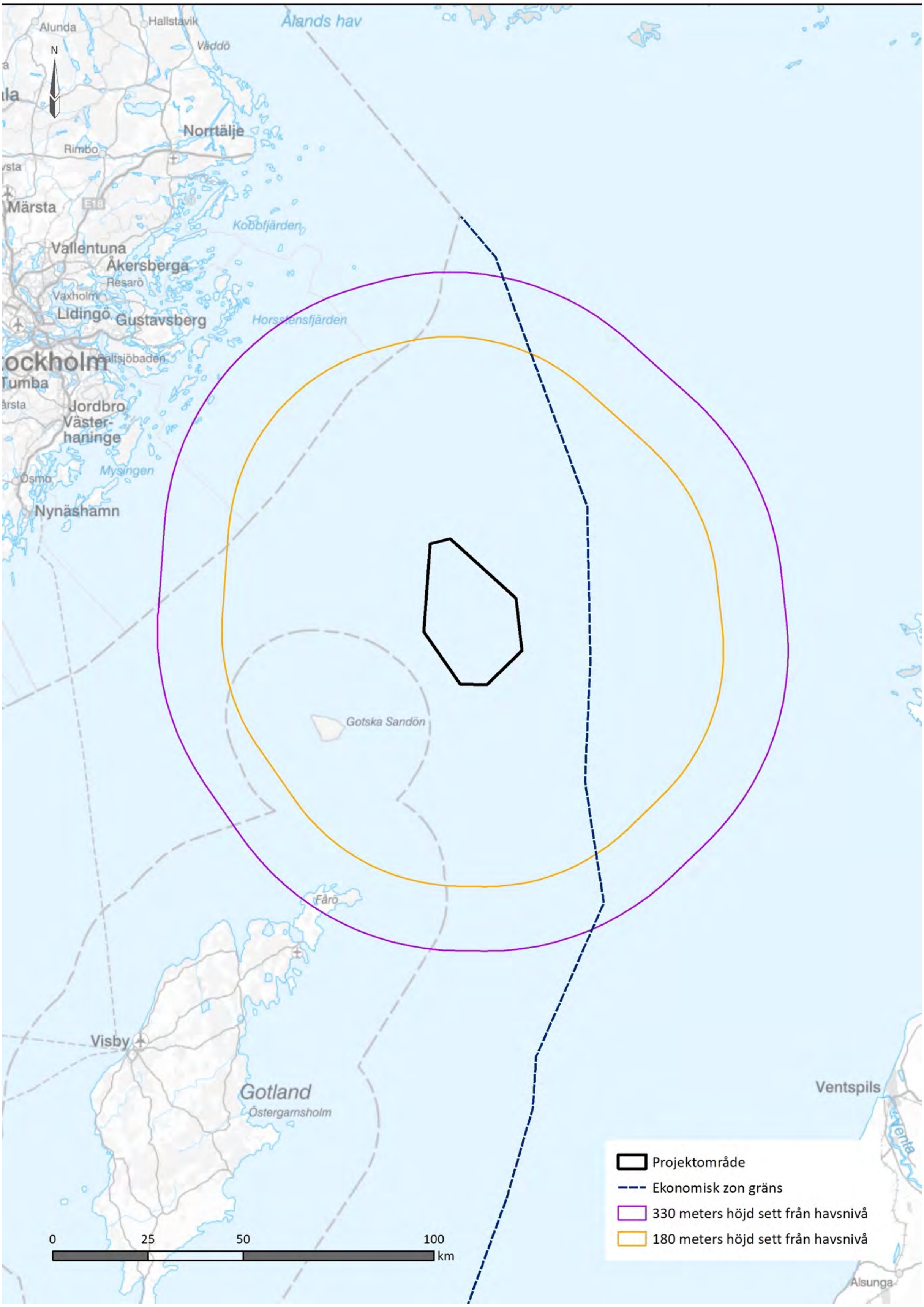
2) **The view** determines the practical possibility of seeing the wind turbines. All photomontages in this document are produced with a view that corresponds to the view at a distance of 20 kilometres on a clear day with variable cloudiness.

3) **The scale effect** is important to consider in order to get an idea of how large the turbines appear on the occasions when you can practically see them. For example, a 300 meter high wind turbine at a distance of 50 kilometres corresponds to the experience of a 15 meter flagpole at a distance of 2.5 kilometres, or a 5 millimetre long hair on a straight outstretched arm.

Figur 19 shows the theoretical possibility of seeing the wind turbines with a completely clear line of sight and taking into account the curvature of the earth. The inner line shows how far away an obstruction light placed 180 meters above sea level is visible above the horizon at sea level. The outer line shows the same information for the wind turbine's upper blade tip at 330 meters above sea level.

In Figur 20 and Figur 21 two examples are given of the visibility of the turbines from Gotska Sandön (roughly 30 kilometres from the nearest turbine) and Holmudden on western Fårö (roughly 60 kilometres from the nearest turbine). Both photomontages are made with 80 mm camera optics, which corresponds to approximately twice the magnification compared to the human eye. The images must be observed from a distance equal to seven times the height of the image to correspond to the experience on-site. in good weather, the turbines will be visible on the horizon from Gotska Sandön. From Holmudden, pretty much all the turbines are completely below the horizon and the individual tips that reach above the horizon are not possible to see due to the distance. More photomontages can be found in Appendix 5 and at www.njordroffshorewind.eu/pagaende-projekt/Epsilon.

Additional visibility analyses will be produced Within the framework of the EIA indicating from where the wind turbines will be visible. Furthermore, photomontages and obstruction animations will also be produced to illustrate how the planned wind power plant may look from some representative locations in its surroundings.



Figur 19 The lines indicate the distance for the theoretical possibility of seeing at sea level an obstruction light placed 180 meters above the horizon (orange line) and the wind turbine's upper blade tip at 330 meters above sea level (purple line). Solid line – project area, dashed line – Swedish EEZ.

Figur 20 Photomontage representing the visibility of the turbines from Gotska Sandön. The closest distance to the turbines is 31.4 kilometres. Note that the montage is based on a photo from another location.

Figur 21 Photomontage representing the visibility of the turbines from Holmudden on western Fårö. The closest distance to the turbines is 62.2 kilometers.

3.8 Oceanography and marine geology

The Baltic Sea is an inland sea with brackish water. The northern parts have a large supply of fresh water and thus a very low salinity, while in the south there is a greater exchange of seawater from the North Sea and the water therefore has a higher salinity. The sea around the project area has a salinity of around six parts per thousand. The salinity rises slightly with the depth and at a depth of 80 meters is just under ten parts per thousand, measured at Huvudskär East buoy, measurements at various depths during the period May 2001 to April 2022 (SMHI, 2022a).

The depth within the project area varies from approximately 70 meters in a few places down to a depth of 180 meters in the deepest places. In the main, the depth is around 100 meters, generally with shallower parts in the eastern parts of the project area. The seabed in the part of the sea where the project area is located probably mainly consists of postglacial fine sand and glacial clay (SGU, 2021).

Data for oxygen measurement between the years 2000-2020 within the project area, show very low oxygen levels (mean value <0.2 ml/l) near the bottom (Baltic Bio Hindcast, 2022).

Data from the Swedish Agency for Marine and Water Management (2018) show less than two milligrams of oxygen per litre in the sediment in the vicinity of the project.

Based on model data produced during the period 1993–2020, the maximum significant wave height in the project area is between 8-8.5 meters. Maximum simulated wave height is between 13.5–14.5 meters (Copernicus Marine Service, 2020). However, storms, and therefore also wave intensity, are expected to increase in number and strength in line with climate change (IPCC, 2022), see also Section 3.16 *Wear and extreme weather conditions.*

The sea-water level varies depending, among other things, on winds, air pressure and land elevation. The sea-water level varied between half a meter below to one meter above mean water level (measurement at Landsort Norra between October 2004 and September 2021, RH2000). On average, throughout the period, the sea level was 13 cm above the mean water level (SMHI, 2022a).

The results of surveys in the area will improve knowledge about depth estimation, oxygen content in seabed sediments, seabed material as well as the distribution and intensity of the types of seabed. See planned investigations in Chapter 5.

3.8.1 Impact on marine currents and mixing

The oxygenation of the seabed of the Baltic Sea is linked to the supply of oxygen-rich salt water from the North Sea. The oxygen-rich water is distributed to the east and north with the seabed currents of the Baltic Sea, see Figur 22. This dynamic is very important for the ecosystem in the brackish water environment of the Baltic Sea.

Offshore seabed-fixed wind turbines, see Figur 23, which are therefore mounted on towers attached to the seabed, has the potential to affect the mixing of the stratified water masses, which in turn may theoretically have consequences for salinity and oxygen content (see also Section 2.4.2 *Foundation and attachment*).

Studies have been carried out on the mixing induced by seabed-fixed foundations, both individual cylinders and entire wind farms, placed in the marine current in the western Baltic Sea (Rennau et al., 2012). Furthermore, the fluctuations in salinity in the Bornholm Channel have been simulated in different scenarios of wind power development in the western Baltic Sea (Rennau et al., 2012). The analysis shows that the changes in salinity at the bottom of the Bornholm Channel, as a result of wind-induced mixing in water, are very low compared to the natural variations over the year. They are at levels between 0.002 and 0.006 psu, which corresponds to about 0.1-0.3% of the salinity at the bottom of the Bornholm channel. The conclusion of the study is that the impact on the Baltic Sea ecosystem is expected to be minor.

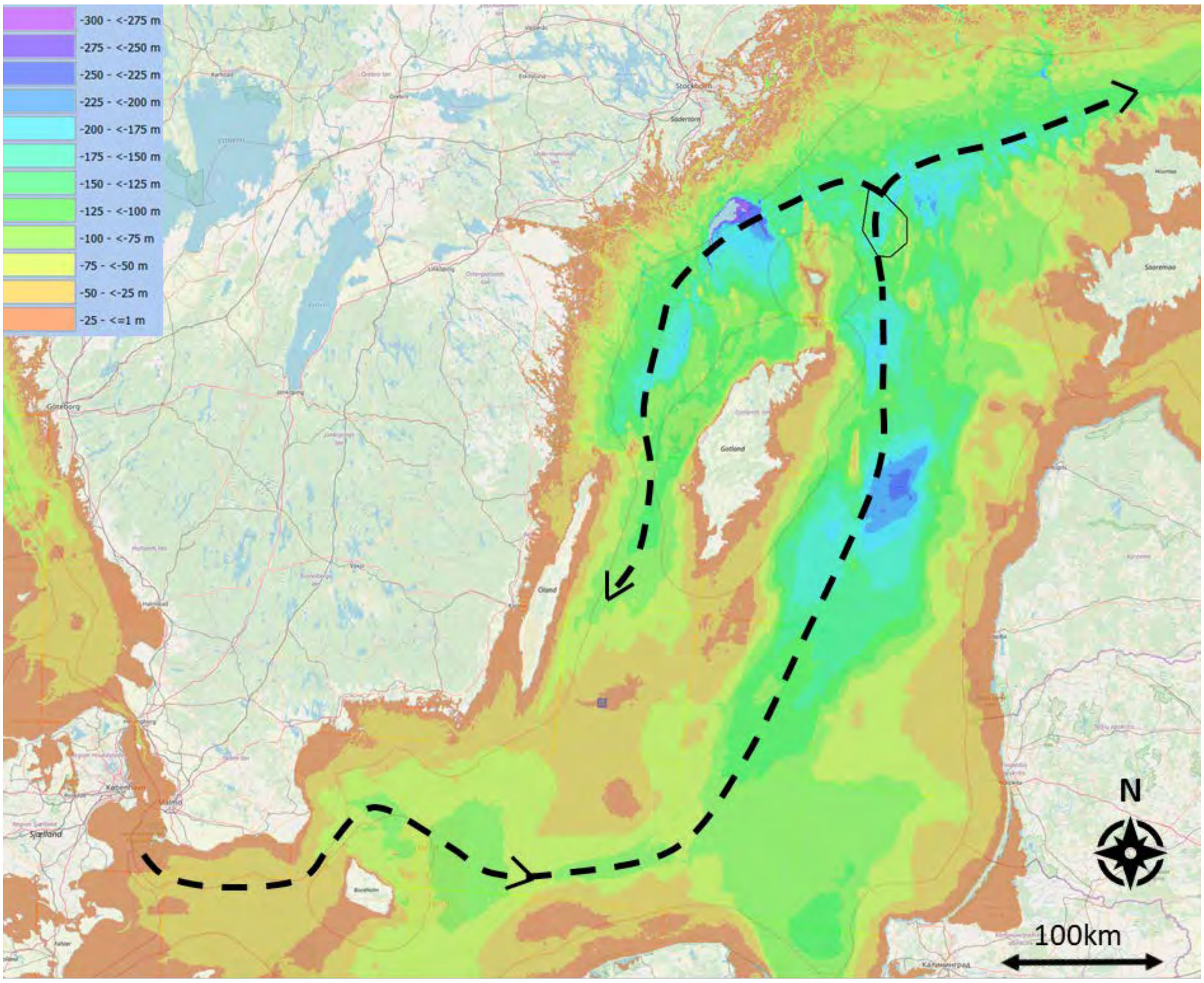
A similar study for seabed-fixed turbines in the German part of the North Sea (Carpenter et al., 2016) is in line with the study above:

- The turbulence induced by the towers may contribute to vertical mixing.
- In case of large-scale expansion, this is considered to have a detectable effect on temperature stratification in the sea. (However, note that stratification due to salinity is less sensitive).
- The potential environmental impact of mixing will be minor. The impact on the ecosystem can be both positive and negative.

Current knowledge suggests that the impacts of seabed-fixed wind turbines are expected to be very limited.

Carpenter et al. (2016) also suggests that the impact from floating wind power infrastructure is expected to be negligible in terms of mixing and impact on marine currents. This means that, in the deepest places, where the salty, oxygen-rich currents are most important, offshore wind power infrastructure will not affect the mixing locally, as seabed-fixed turbines will probably not be relevant at seabed depths below 50–80 meters.

Project Epsilon, which is located in the area where the northward seabed current runs, therefore has a low probability of risk of impacting marine currents.



Figur 22 The path of North Sea water into the Baltic Sea. The area of project Epsilon is marked with a polygon. Source: Njordr, adaptation of substrate data from SMHI and Baltic Sea Bathymetry Database, http://data.bshc.pro/about/.

Figur 23 Overview of foundation types for offshore wind turbines. Source: Illustration Joshua Bauer, NREL 49055.

3.9 Natural environment

Marine ecosystems are affected by things such as salinity, temperature, currents, winds, waves, depth conditions and seabed substrates. The planned activity can affect currents and waves locally by acting as physical obstructions to the movement of the water, as well as contributing new substrates for organisms to establish themselves on. The activity can also affect the natural environment by generating noise.

According to the current maritime spatial plan, the project area is not located within any area designated for consideration of high natural values.

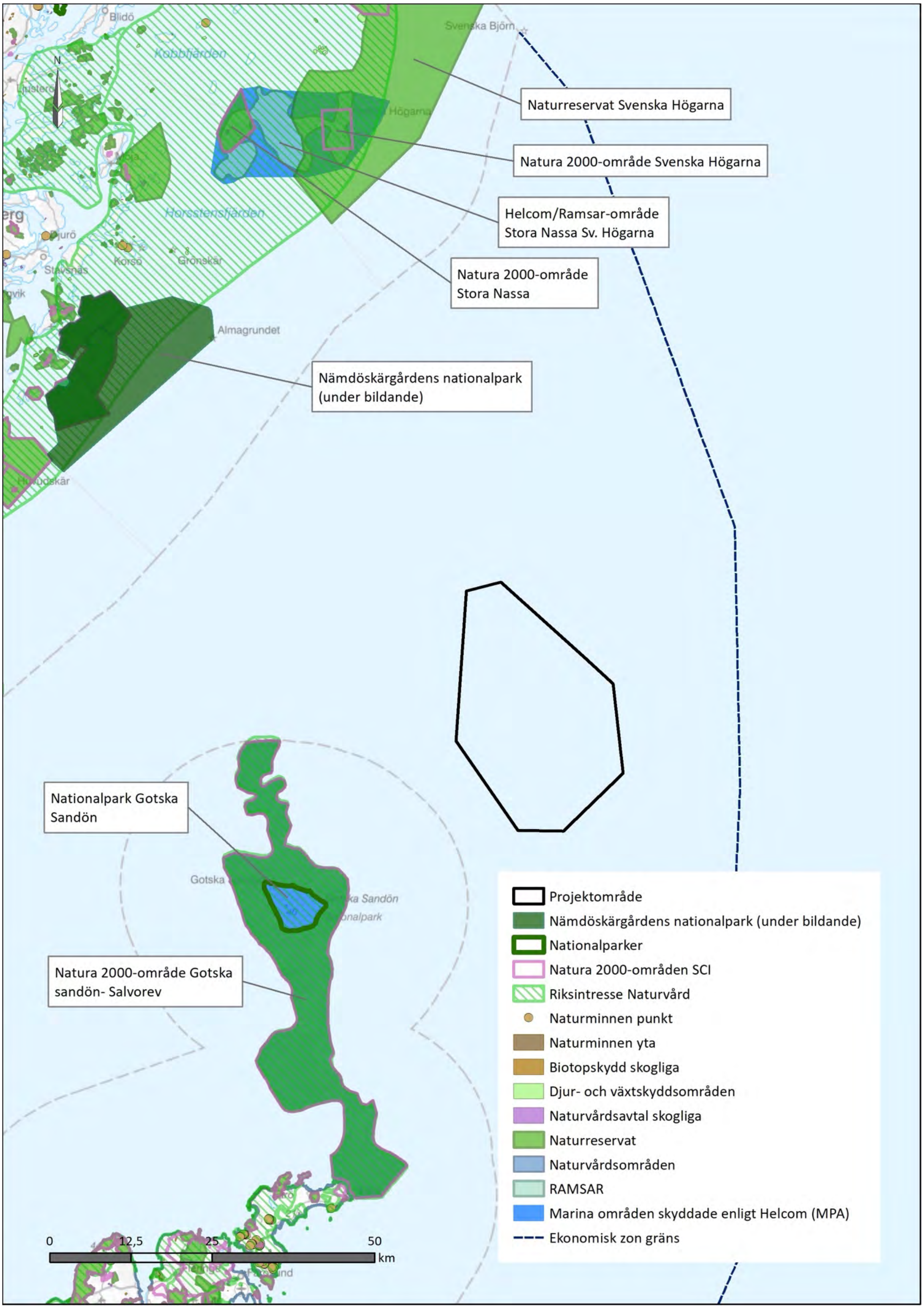
Through the Symphony planning tool, the cumulative load on the marine environment has been evaluated (Swedish Agency for Marine and Water Management, 2018). The cumulative impact is dominated by eutrophication and pollution. Lack of oxygen at the seabed is the single greatest stressor. According to the evaluation, the environmental impact out at sea is highest in the central Baltic Sea south-east of Gotland and continues to be high towards north-east Gotland. In addition to the load, a summarised large-scale picture of the sea's natural value can also be produced. Analysis suggests that high natural values are primarily linked to shallower areas, which could partly be explained by the fact that there is a lack of oxygen at several parts of the deeper seabed of the Baltic Sea. The combined natural values, according to the green map produced in the Symphony project, are likely to be relatively low within the project area. However, there are high uncertainties in the data and knowledge of the natural values in the area is low (Swedish Agency for Marine and Water Management, 2018). The natural values will be investigated further within the framework of the EIA.

Plants and animals can be affected by the installation of offshore wind power infrastructure through the impact of acoustic disturbance, by the fact that seabed habitats are affected, and flying animals can collide with the wind turbines (Vindval, 2017). In the case of flying animals, it is mainly the operational phase that can affect them negatively, for example, due to collision risk or habitat loss, see Sections 3.9.5 *Birds* and 3.9.6 *Bats.* The main negative impact on life below the surface of the sea occurs during the construction phase when the activity is greater in the area and the disturbances are more frequent. During the operational phase, however, the impacts of the wind farm can be positive for marine life, for example through artificial reef formations, see Sections 3.9.2 *Life on the seabed* and 3.9.3 *Fishes.*

3.9.1 Protected areas

No areas that are protected with respect to the natural environment are directly adjacent to the project area, see Figur 24.

About 31 kilometres south-west of the project area lies Gotska Sandön, with both the National Park and the Natura 2000 area *Gotska Sandön-Salvorev*. About 67 kilometres west of the project area is the proposed national park area Nämdöskärgården national park, which is under construction and scheduled to open in 2025. The national park area is located in a very varied and relatively unexploited part of the Stockholm archipelago and includes, among other things, the four existing nature reserves Bullerö, Långskär, Långviksskär and Biskopsö, which are also part of the EU Natura 2000 network. The investigation area for the national park also includes a larger marine area east of the aforementioned nature reserves.



Figur 24 Protected areas with respect to the natural environment adjacent to the project area. No protected areas are located directly adjacent to the intended wind farm, but Gotska Sandön national park with the Natura 2000 area Gotska Sandön-Salvorev is located approximately 31 km from the project area. Solid line – project area, dashed line – Swedish EEZ.

3.9.2 Life on the seabed

The depth within the project area varies from approximately 70 meters in a few places to a depth of 180 meters in the deepest places. The depth is mainly around 100 meters, deeper in the eastern and western parts of the project area. The shallowest areas are in the central part of the project area. The seabed in the area is low in oxygen and the seabed sediment is probably dominated by postglacial sand, gravel, stone and clay.

Measurements taken in the vicinity (StationsID BY29/LL19) of an area with a seabed depth of 174–184 meters show visibility depths of 7–18 meters (SMHI, 2022b). Large parts of the seabed of the Baltic Sea are deoxygenated, as is also the case in the area around the project area. Great depth, limited visibility and a deoxygenated seabed create poor conditions for most living organisms.

Depending on the seabed substrate, construction and excavation for a wind farm can involve heavy turbidity, which can also negatively impact animals and plants during the construction phase. However, the impact is local and only takes place during the construction phase. Even an acoustic disturbance can locally affect benthic (bottom-dwelling) organisms. It is likely that microorganisms, which are quick to re-establish themselves, are mainly found on the seabed of the project area. Once the foundations are in place, the structures can act as artificial reefs (Vindval, 2012). These can be used as substrates for benthic organisms that can then live closer to the surface.

Blue mussels are found at a depth of 30–40 metres, although densities are often highest at a depth of 10–20 meters (County Administrative Board Stockholm, 2016). The project area's shallowest depth is around 70 meters, which is why the planned activity is unlikely to have a negative impact on blue mussels, or indirectly linked to this factor on species whose diet includes blue mussels, as the depth is greater than that within the project area. However, the reef-like structures of the foundations can enable the establishment of blue mussels in the area (Swedish Agency for Marine and Water Management, 2019). With expected climate changes, the distribution of the blue mussel is expected to change. According to the Swedish Agency for Marine and Water Management, an area north of the project area has been designated as an important site for the distribution of the blue mussel (Swedish Agency for Marine and Water Management, 2019). However, the modelling of designated areas is based on distribution in 2099, which is long after the operating time of the planned wind power plant.

To some extent, the wind turbines can constitute obstructions for both commercial fishing and birds, which in turn can create protected environments for both mussels and other benthic organisms.

3.9.3 Fishes

There are approximately 80 species of fish in the Baltic Sea (Helcom, 2012). Around 95 percent of the commercial fish catch in the Baltic Sea consists of cod, herring and whitebait. However, targeted cod fishing has been banned since 2019 and is not part of the commercial fishing. The project area is not identified as either a breeding or spawning area for any of the three species.

The main impact on fish will probably be sound impact as fish perceive particle change caused by sound waves. Fish without or with very small swim bladders perceive sounds with a frequency below a few hundred Hz. Fish with swim bladders, or other air-filled cavities, can also perceive higher frequencies. Some fish can perceive frequencies up to 100 kHz (Schack et al., 2019). However, fish can often move away from occasional noises, and it is above all noise impacts in breeding habitats for threatened or weak populations that have negative consequences.

Several fish have an organ, the lateral line, which perceives weak electric currents and vibrations and is used, among other things, to find food. Many cartilaginous fish have sense organs, the ampullae of Lorenzini, that sense electrical impulses, something used to detect prey, and possibly also for navigation. Around electric cables, an electromagnetic field occurs that can affect fish's use of their senses based on electrical signals, and signals from electric cables can be mistaken for prey (Vindval, 2012). Bony fish are estimated to be affected by electric fields with a voltage of 0.5 volts per meter and also weak magnetic fields (Swedish Environmental Protection Agency, 2001). Migratory fish such as eel and salmon are particularly sensitive to electromagnetic fields and their navigational ability can be affected (Vindval, 2012).

The artificial reef structures that wind turbine foundations create can in some cases benefit fish, both by providing structures that they for them to dwell on and encouraging benthic organisms on the foundations that provide food. However, one negative effect of these reef structures can be that invasive species can potentially spread more easily from "island to island". The fact that fishing activities are closed for a period and that birds may avoid the wind farm may in the long term means that commercial species such as sturgeon, whitebait and cod may be given a sanctuary and benefit.

The presence of different fish species in the area and how these may be affected, as well as what measures are taken in such a case to reduce disturbances, will be further highlighted in the EIA.

3.9.4 Marine mammals

The marine mammals that can exists in the project area's surroundings are porpoises, harbour seals, grey seals and Baltic ringed seal. Several species that live in the Baltic Sea have adapted to the specific conditions that prevail in the brackish water sea, which means that several of the Baltic Sea stocks can be assumed to constitute unique populations and in some isolated cases are assessed as being on the red list (the risk that individual species will become extinct in Sweden) separately from the species in the rest of the country.

The porpoise is a species protected by the EU Species and Habitats Directive (Appendices 2 and 4 of the Directive). There are three genetically distinct populations in Swedish waters where the Baltic Sea population is the one that mainly resides in the Baltic Sea itself (Benke et al. 2014). The Baltic porpoise constitutes a very small isolated population and is classified as *Critically endangered* (Artdatabanken [Species Database], 2020). Coastal seas and the sea south of Öland and Gotland are considered to be important areas for porpoises, see Figur 25 (AquaBiota, 2016).

Data from the SAMBAH project, a project that investigated the living conditions of harbour porpoises in parts of the Baltic Sea, has been collected from areas between 5–80 meters deep (Sambah, 2016). In the study, the Baltic Sea population was estimated to consist of a total of approximately 500 individuals. The project area and its surroundings are not considered to be a particularly important area, although porpoises are likely to pass through occasionally.

Modelling has been carried out that shows the relative presence of grey seals in the project area's surroundings, while harbour seals and ringed seals do not occur (Swedish Agency for Marine and Water Management, 2018). The grey seal population is the most numerous of Sweden's three seal species (Sveriges vattenmiljö [Sweden's Aquatic Environment], 2021).

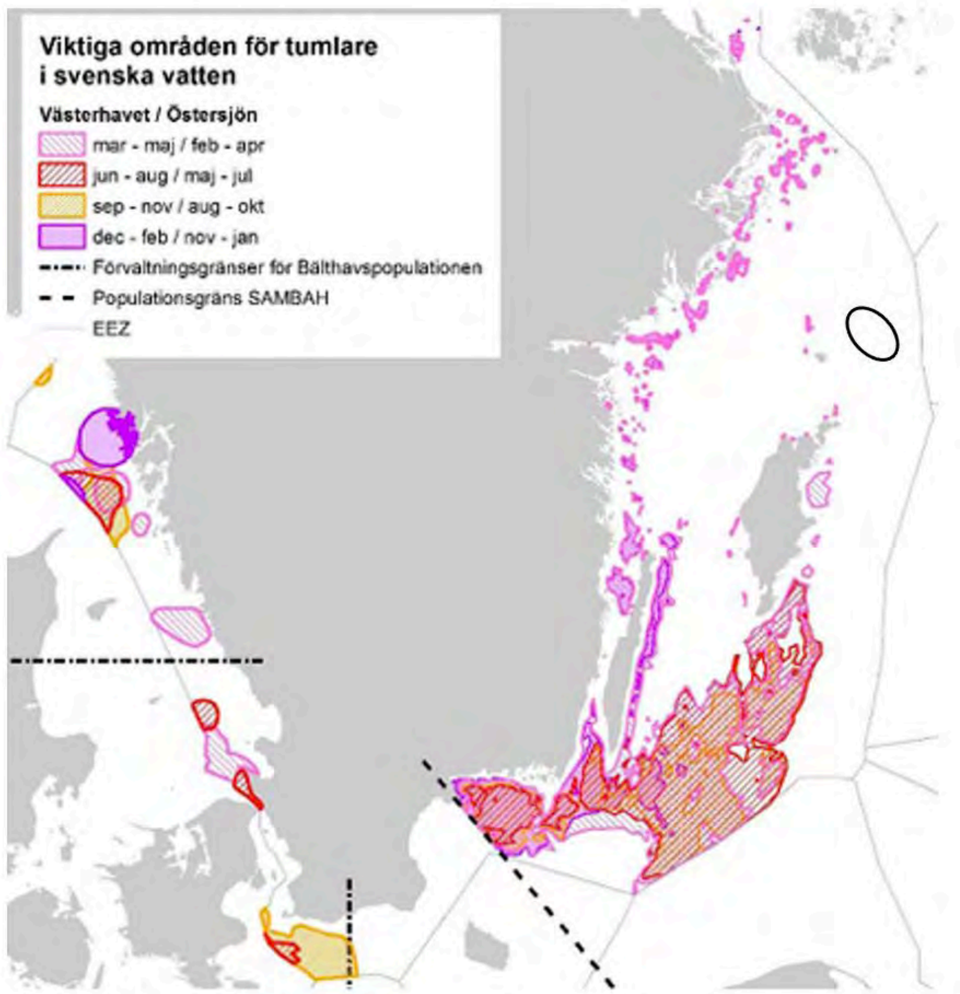
Wind power infrastructure can negatively affect marine mammals through acoustic noise that can travel long distances in the water. Depending on the distance to the sound source, the impact can cause stress, behavioural changes and flight, but also in some cases hearing loss. Porpoises are particularly sensitive to impacts during the calving and mating season (County Administrative Board of Västra Götaland, 2014). For porpoises, the mating season is estimated to be between June and August and calving in May and June (Sambah, 2016). According to studies carried out during the installation of wind power plants, seals appear to be less sensitive to underwater sounds than porpoises (Vindval, 2012). However, they can be sensitive during the calving and mating season (Vindval, 2012).

Loud underwater noise mainly arises in connection with piling during the construction phase of the wind power plant, see Sections 3.14 *Sound* and 3.17 *Construction/construction phase*. However, there are currently no set limit values for underwater noise to protect porpoises in the Baltic Sea, although such limit values are being developed. There is ongoing development and testing of sound dampening measures such as noise curtains to prevent the sound from carrying in the water. This development is being monitored prior to the completion of Baltic Offshore Epsilon.

The impact of noise during the operating phase is much less, see Section 3.14 *Sound.* A study of operating noise has been made at offshore wind power infrastructures at the three Middelgrund wind farms in Sweden, as well as at Vindeby and Bockstigen-Valar in Denmark (Tougaard et al. 2009). The study shows that for porpoises, this operating noise is only audible within a radius of approximately 20 – 70 meters from the foundations (Tougaard et al. 2009). For seals, the audibility of operating noise varied from less than 100 meters up to several kilometres and behavioural reactions could not be excluded for seals within a distance of a few hundred meters. The noise was judged not to reach any dangerous levels or disturb the communication between the individuals (Tougaard et al. 2009).

A study on an offshore wind farm in the southern North Sea, which was constructed during a period of the year when the area was largely empty of porpoises, shows that the porpoise density increased after construction compared to before (Scheidat et al. 2011). This is assumed to be due to increased food availability and reduced noise due to reduced boat traffic after the creation of the farm (Scheidat et al. 2011).

There are certain times of the year at which porpoises and seals are more sensitive than others and times of the year when they are likely to be in different parts of the sea. Disturbing events that risk stressing porpoises and seals in various ways will therefore be scheduled at times of the year when the least disturbance occurs. In addition, measures to reduce the impact in the event that any porpoises or seals are present in the area will be set out in the EIA. Within the framework of the ongoing work before the EIA, in-depth surveys will also be carried out to identify the need for measures to protect the marine mammals and their habitats from impact, see Section 5.2 *Planned investigations.*



Figur 25 Important areas for porpoises in Swedish waters per quarter and year-round. To increase understanding of the figure, the approximate location of the project area has been added to the map afterwards. Figure ref: AquaBiota 2016.

3.9.5 Birds

Several species that live in the Baltic Sea have adapted to the specific conditions that prevail in the brackish water sea. Many of the Baltic Sea stocks can therefore be assumed to constitute unique populations and in individual cases they are red-listed (the risk of individual species becoming extinct in Sweden) separately from the species in the rest of the country.

Different bird species use different marine areas in different ways. In connection with the coastline, there are often migratory routes across the sea. One known migratory route runs through the Gulf of Finland. Another known migratory route passes through the Gulf of Bothnia. The migratory route runs on a very wide front and is controlled by weather and wind. In the event of westerly winds, the route is pushed east and a larger proportion follows the eastern shore of the Baltic Sea. In the event of winds from the east, the route is instead pushed to the west and follows Sweden's east coast to a greater extent. The migratory routes, which are used by ducks, waders and geese, but also lapwings, terns, seagulls and possibly even perching birds (in special weather conditions) could be affected by the planned activity.

Certain areas at sea are used as overwintering areas, as resting areas during autumn and spring and as foraging areas.

The offshore banks in the central Baltic Sea, mainly Hoburgs Bank and Norra Midsjöbanken south of Gotland, are the areas in the Swedish Exclusive Economic Zone where an expansion of wind power could have the greatest impacts on bird populations (Vindval 2012).

The impact on birds of offshore wind power infrastructure depends on their location and how the birds use the area. Some bird species are at risk of colliding with the wind turbines and many species exhibit avoidance behaviour at wind power plants. The installation of wind power infrastructure can also mean habitat loss, but the extent of the impact depends on how the specific area is used by birds (Vindval 2012).

Based on the report of the County Administrative Board of Gotland County (2018) "*Seabirds' use of marine areas around Gotland and Öland: the importance of marine area protection* ", the shallow areas north of Gotska Sandön are known as a overwintering area for, among other things, long-tailed ducks. Other wintering seabird species that can be seen in the area around Gotska Sandön include razorbills, black guillemot, the common guillemot, the common merganser and the great cormorant. During migration periods, velvet scooter and common scooter can pass the area around Gotska Sandön (County Administrative Board of Gotland County, 2018)

The distance to the nearest nesting site, which according to the report from the County Administrative Board of Gotland County (2018) is Gotska Sandön, is approximately 31 kilometres south-west of the project area. The common eider and the lesser black-backed gull, among other birds, breed here.

In order for an area to be used for foraging by, for example, the long-tailed duck, the depth should not exceed 20–30 meters (County Administrative Board of Gotland County, 2018). Species such as the common eider and the common scooter cannot dive as deeply (County Administrative Board of Stockholm County, 2017). The seabed depth in the project area and its surroundings makes food such as mussels and crustaceans difficult to access. This means that the project area is not likely to constitute an important foraging area for these species. Species such as razorbills and the common guillemot dive for fish in the open water mass and can catch prey at significantly greater depths (County Administrative Board of Stockholm County, 2017).

The Baltic Offshore Epsilon project area is currently not considered to be core areas for any bird species. In order to get a more detailed picture of the use of the project area and its surroundings by different bird species, however, inventories are required, see Section 5.2.

Technical solutions, such as radar, with the help of which the turbine is switched off if there is a migratory route for birds, will be proposed as protective measures if deemed necessary. Inventories of birds will be carried out and form the basis for developing suitable protective measures for the forthcoming Environmental Impact Assessment.

3.9.6 Bats

Bats can move long distances, and there is, for example, a description of how the Nathusius' pipistrelle species crosses the Baltic Sea between Valsörarna in Finland and Holmögadd in Sweden (County Administrative Board of Västerbotten, 2018). Studies in southern Sweden have shown that 11 out of 18 bat species investigated flew as far as 14 kilometres out to sea to search for food (Ahlén et al., 2009). This can be compared to the fact that land (Gotska Sandön) is approximately 30 kilometres from the project area. The height the bats flew at is usually less than ten meters above sea level, which means they would fly under the rotor blades. When hunting, however, they can quickly change altitude and thus risk being exposed to a collision with the rotor blades.

Bats probably prefer to pass over seas where the passage is the shortest distance possible over open water (County Administrative Board of Västerbotten 2018). However, there are large gaps in knowledge of how bats move across the sea.

The distance between the project area and land means that it is migrating bats that must primarily be taken into account. In calmer weather, insects may accumulate near the wind turbines, which could attract bats. In order to investigate the possible movement of bats across the project area, a desk study will be carried out within the framework of the EIA, where previous observations, knowledge and probability are reviewed by a bat expert to investigate the need for possible protective measures.

3.9.7 Species protection

THE RED LIST

The Red List is an account of species' relative risk of extinction in the area that the Red List refers to, in our case Sweden. Even common species can be red-listed if their populations are in sharp decline.

The Red List is divided into six different categories, each with its commonly used abbreviation: Data Deficient (DD), Extinct in the Wild (EW), Near Threatened (NT), Vulnerable (VU), Endangered (EN) and Critically Endangered (CR) . Species in the three latter categories are identified with a common term for *endangered species*.

The Swedish Red List is produced by ArtDatabanken according to international criteria and is revised regularly. The latest Red List was published in 2020.

THE SWEDISH SPECIES PROTECTION ORDINANCE

The Swedish Species Protection Ordinance is legislation governing the protection of a number of species and all wild birds, as well as the protection of their habitats. The Swedish Species Protection Ordinance incorporates the EU's Species and Habitats Directive and the Birds Directive into Swedish legislation. The ordinance includes two lists of species: Appendix 1 and Appendix 2. In simple terms, it can be said that all the listed species are protected, which means that you may not collect, harm or kill the listed species. For the species in Appendix 1, the habitats of the species are also protected and must not be destroyed.

A total of 14 percent of all fish species present in the Baltic Sea are threatened and 22 percent are red-listed, including cod, which is assessed as vulnerable (VU) and is also listed on the IUCN Global Red List (SLU [Swedish Agricultural University], 2020a). The Baltic Sea population of porpoises is considered to be critically endangered and it is protected throughout Sweden and included in international conventions or EU directives (SLU, 2020a).

Better knowledge of marine invertebrates is required to be able to know their status for sure, there is a currently lack of knowledge which makes assessments for 172 species impossible. To remedy this, more areas need to be investigated. Currently, 14 species are judged to be critically endangered, 442 species are viable and a total of 157 species are on the scale in between (SLU, 2020b). One measure to enhance the viability of marine invertebrates is to protect areas from bottom trawling and other exploitation and to reduce emissions of both nutrients and environmental toxins.

Inventories enable knowledge to the obtained about species covered by the Swedish Species Protection Ordinance, and an investigation of the impact on species will be carried out as a basis for future environmental impact assessment. The investigation will be based partly on what is already known from knowledge sources such as Artportalen (Swedish Species Observation System), partly on findings made in connection with inventories and other supporting studies. Several red-listed species may be present in or around the project area, such as porpoise and cod.

The presence of protected species according to the Swedish Species Protection Ordinance and red-listed species, the wind farm's impact on these species and appropriate protective measures will be investigated before the forthcoming EIA.

3.9.8 Biodiversity and ecosystem services

Biodiversity is decreasing at an increasingly rapid rate worldwide and in Sweden the number of species on the red list has increased. Figures from 2020 show that the Artdatabanken has red-listed 21.8 percent (4,746 out of 21,740) of the assessed Swedish species, which is an increase from 19.8 percent red-listed species in 2015.

Biodiversity is a prerequisite for ecosystem services. Ecosystem services is a collective term describing the benefits that nature provides and which in various ways contribute to a good quality of life for people.

In 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) published a knowledge compilation on the state of biodiversity and the benefits of nature. The report describes the most important influencing factors for loss of biodiversity, which are changed land use, direct use of species, climate change, pollution and invasive species.

Climate change is listed as the third biggest threat to biodiversity. The expansion of wind energy is an important climate measure as it can quickly contribute to reducing greenhouse gas emissions, see also Section 4.1 *Climate and renewable energy.* The earlier wind energy is developed, the greater the climate benefit. In order for there to be a sustainable expansion of wind energy both on land and at sea, the negative impact on biodiversity needs to be taken into account (Bergström et al., 2022). According to the Swedish Society for Nature Conservation (2021), wind power should not be developed in protected areas or other areas with high biodiversity. At the same time, they promote wind power as the optimum way to phase out fossil fuels quickly enough and in an environmentally friendly way. The Swedish Society for Nature Conservation has shown that with the right locations, on land and at sea, wind power can be expanded to close to 130 TWh with little negative consequences for biodiversity (Naturskyddsföreningen, 2021). And by slowing climate change and reducing the amount of pollution, renewable electricity production in itself has a preventive effect on the loss of biodiversity.

In addition to the fact that wind power installations, by reducing climate change, contribute to a preventive effect on the loss of biodiversity, wind power installations can also contribute to creating variation in the marine environment. Offshore wind turbines can, depending on the conditions of the specific area, have a positive impact, a negative impact or both, and provide opportunities of different animals and plants to coexist with the turbines (Swedish Energy Agency, 2021c). Future EIA work will examine various protective measures taking biodiversity into account.

3.10 Cultural environment

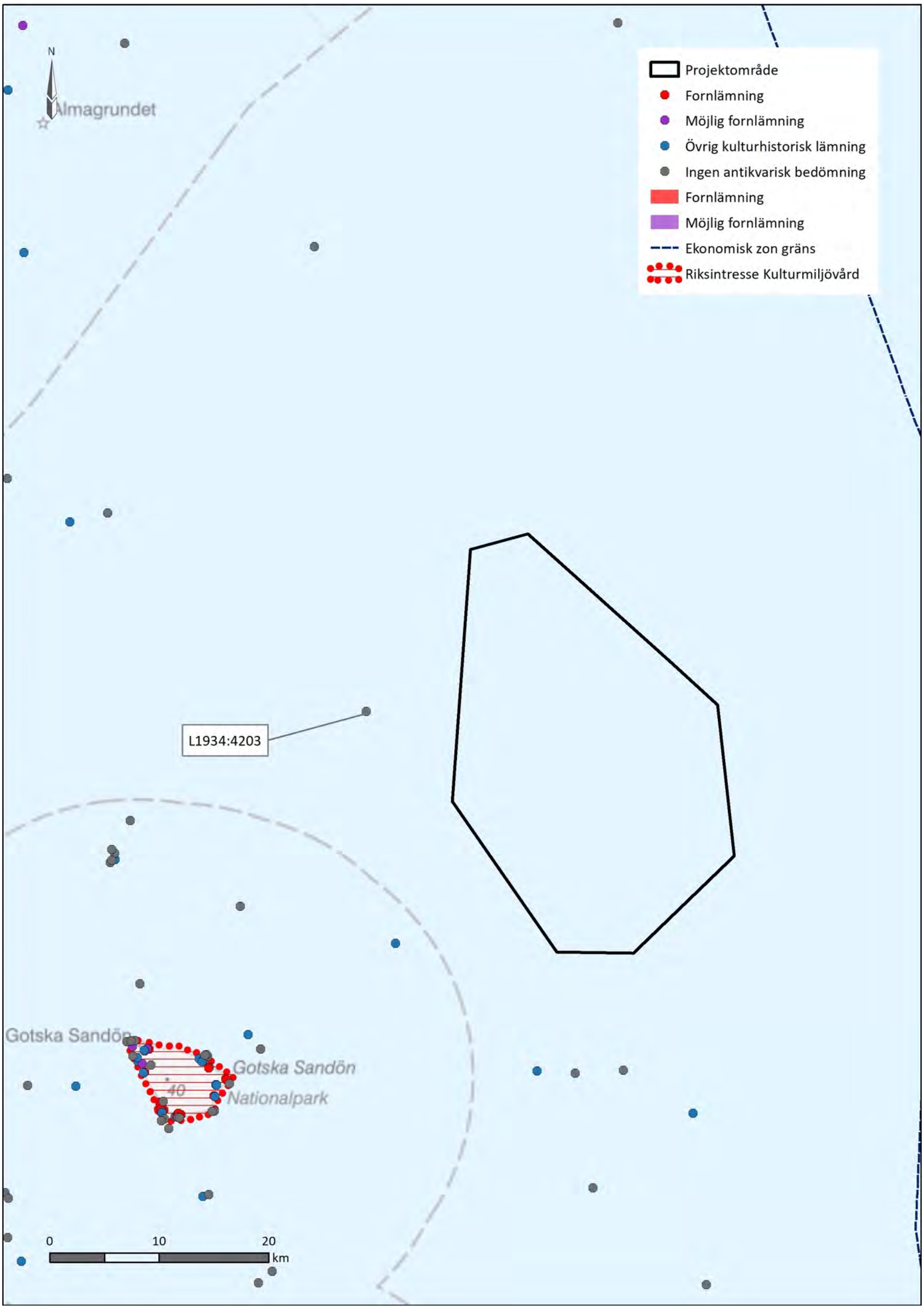
Within a radius of 10 kilometres from the project area there is a known shipwreck that has cultural and historical significance but lacks an antiquarian assessment in database of the Swedish National Heritage Board (RAÄ), Figur 26. According to the database, the remains are located approximately 10 kilometres west of the project area. Tabell 7 shows the RAÄ number for the wreck.

Gotska Sandön, approximately 30 kilometres south of the project area, is of national interest for cultural environmental protection.

Within the framework of the work for the forthcoming EIA, a marine archaeological investigation will be carried out. Any findings of wrecks made during surveys or construction will be reported to the County Administrative Board and any infrastructure installed on the seabed will be at least 100 meters away from wrecks.

Tabell 7 Excerpt from the Fornsök database of the Swedish National Heritage Board (2021), known cultural-historical wrecks within 10 kilometres of the project area.

ID	**Name**	**Value description**	**Distance from the project area**
L1934:4203	Galeas from Visby	Ship/boat wreck, unconfirmed in the field	Approx. 10 kilometres west



Figur 26 Known cultural-historical wrecks within 20 kilometres of the project area. Solid line – project area, dashed line – Swedish EEZ.

3.11 Outdoor life and recreation

The impact of a wind power plant on outdoor life and recreation can consist partly of physical encroachment and the appropriation of areas that are of great value for outdoor life and recreation, partly of a changed landscape picture, and partly also a changed experiential value from surrounding areas. No areas within or in close proximity to the project area are known areas of interest for outdoor life. The whole of Gotland, including Gotska Sandön , is of national interest for active outdoor life. The area extends a long way out from the coast and is located approximately 10 kilometres south/south-west of the project area. The coastal areas and the archipelago in Stockholm County are also of national interest for active outdoor life. The area is approximately 45 kilometres north-west of the project area, see Figur 17. Any impact on these will be investigated within the framework of the EIA.

3.12 Natural resources

There are no areas within or near the project area designated as important for natural resources. There are no areas for sand extraction in the vicinity of the project area according to the maritime spatial plan of the Swedish Agency for Marine and Water Management (Swedish Agency for Marine and Water Management, 2022a).

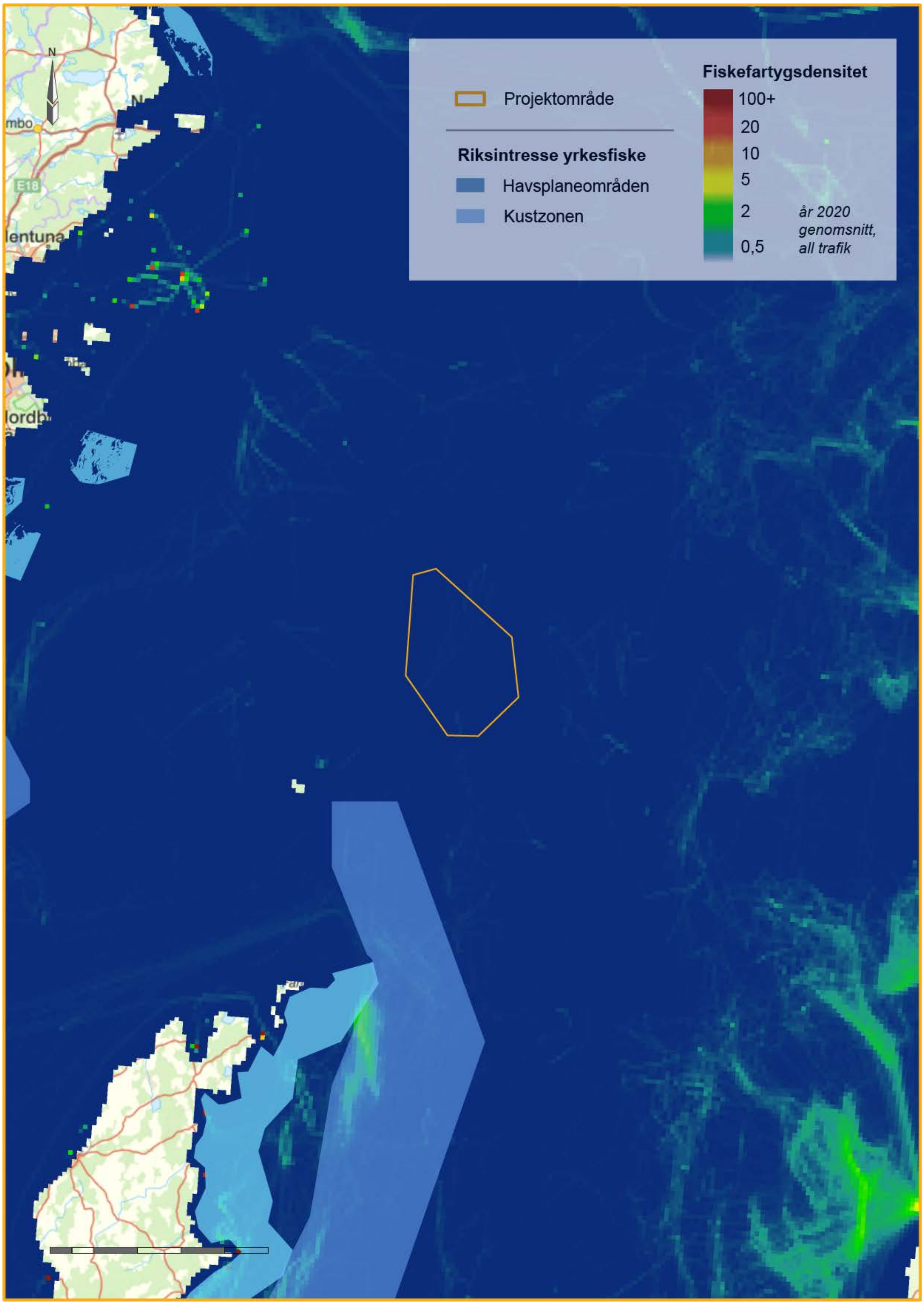
3.12.1 Commercial fishing

There is no designated area for commercial fishing within or adjacent to the project area. The nearest area of national interest for commercial fishing is approximately 20 kilometres south of the project area. The presence of fishing boats in the area is also restricted (EMODnet, 2022), Figur 27.

Commercial pelagic fishing, i.e. fishing in the open water mass, is carried out throughout the North Baltic Sea from the municipality of Värmdö and southwards and in a smaller area in South Kvarken. In the area, mainly Atlantic herring and whitebait are fished by trawling (Swedish Agency for Marine and Water Management, 2022). Analyses of catch statistics, i.e. how much fish is trawled in the area within and around the project area, will be carried out before the forthcoming EIA. Available data from EMODnet (2022) and ICES (2020) show that the fishing that takes place in the vicinity of the project area mostly involves pelagic trawling and nets that are mostly used to catch Atlantic herring and whitebait.

Catch data for the project area registered by the Swedish Agency for Marine and Water Management indicates that, in the five years before 2022, just over 103 tons of Atlantic herring and just under 105 tons of whitebait were landed at a point in the northern part of the project area in 2017 alone.

Fixed infrastructure, such as a wind power plant, can make it difficult for commercial fishing with trawling (Swedish Agency for Marine and Water Management, 2022a). The wind farm's impact on commercial fishing will be further investigated in the forthcoming EIA.

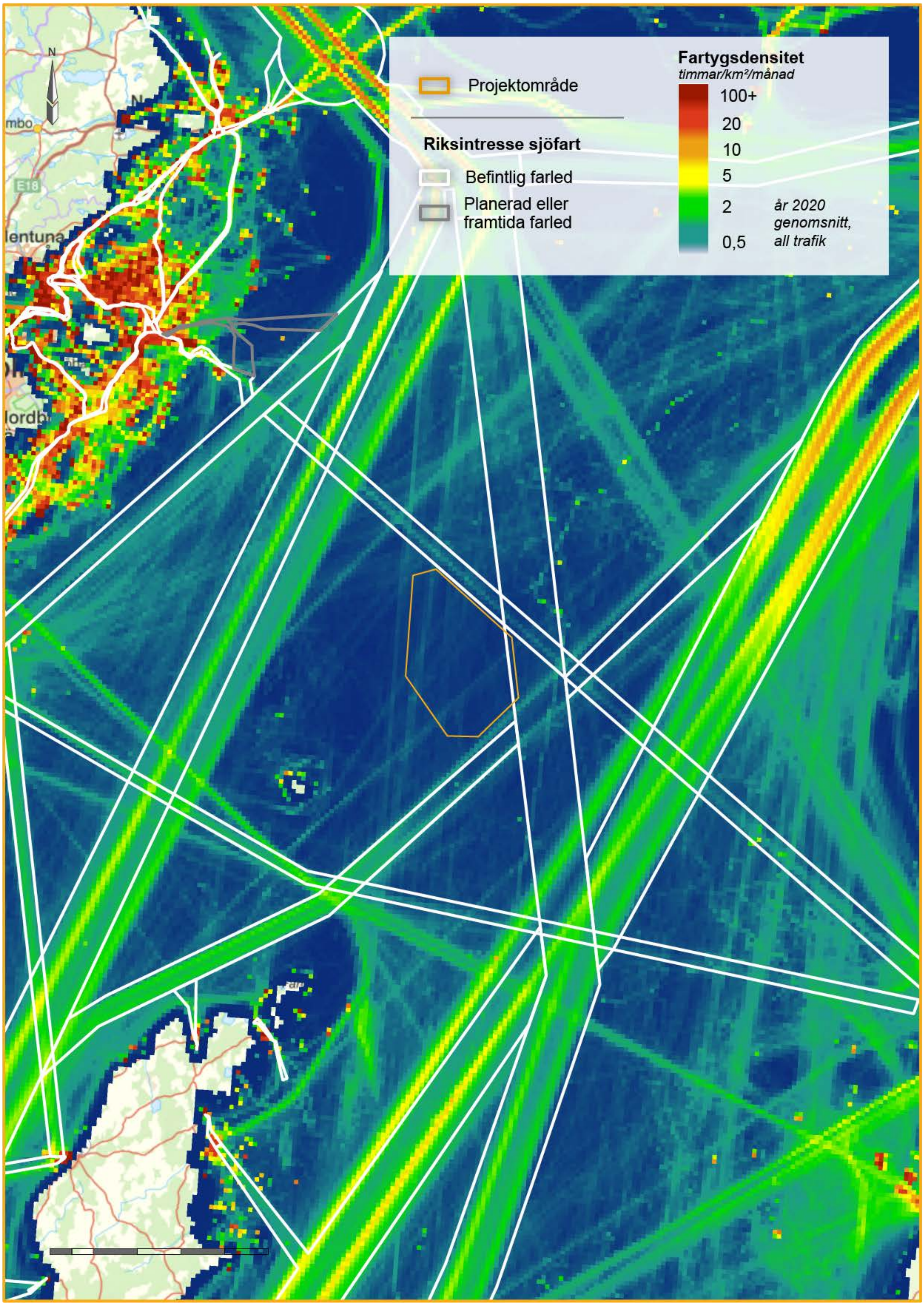


Figur 27 Commercial fishing areas of national interest and density of the presence of fishing vessels. The dark blue background is sea i the background map.

3.13 Navigation

The Baltic Sea is of great importance for international trade and is therefore also one of the busiest areas in the world (Swedish Agency for Marine and Water Management, 2022a). The bulk of the traffic consists of cargo vessels and tankers that sail between the rest of Europe and Sweden, Finland, Estonia and Russia, and to some extent north along the coast (EMODnet, 2022). Passenger ferries mainly running between Sweden, Finland and Estonia also make up a large part of the traffic.

The eastern part of the project area partially coincides longitudinally with a sea lane of national interest for navigation, see Figur 28. According to AIS data from 2020, however, the sea lane is used very sparingly and the majority of ship traffic past the project area instead goes west of the project area, partly outside designated sea lanes of national interest (EMODnet, 2021).



Figur 28 Map of areas of national interest for navigation and other types of traffic and the frequency of ship movements in the area.

3.14 Sound

The sound that modern wind turbines make is mainly an aerodynamic sound of a whistling nature that arises as a result of the passage of the rotor blades through the air. The sound is determined by the speed of the blade tip, the shape of the blade and the turbulence of the air. The wind turbines also emit a machine noise that occurs within the nacelle (engine house).

There are several calculation models available for wind turbine noise. The Swedish Environmental Protection Agency recommends either the Swedish calculation model for wind power or Nord2000. The Swedish calculation model is relatively simple, while Nord2000 is a much more advanced calculation model and requires special software.

The preliminary sound emission from Baltic Offshore Epsilon has been analysed using Nord2000 in the calculation program WindPRO. The calculation is performed to illustrate a so-called worst-case scenario with the lowest possible sound attenuation, Appendix 3.

The result from Nord2000 has also been compared with calculations using the Danish model (Danish Environmental Protection Agency, 2021) which corresponds to the Swedish Environmental Protection Agency's model, which was used in Offshore mode which also makes an extra correction for multiple reflections with the sea surface. When calculating sound emissions from offshore wind turbines, a reduced attenuation of the sound is used and in addition, a correction is included for possible reflections with the sea surface. The correction is dependent on the frequency and height of the wind turbine and the distance above the water. This calculation is also made using the calculation program WindPRO, Appendix 4.

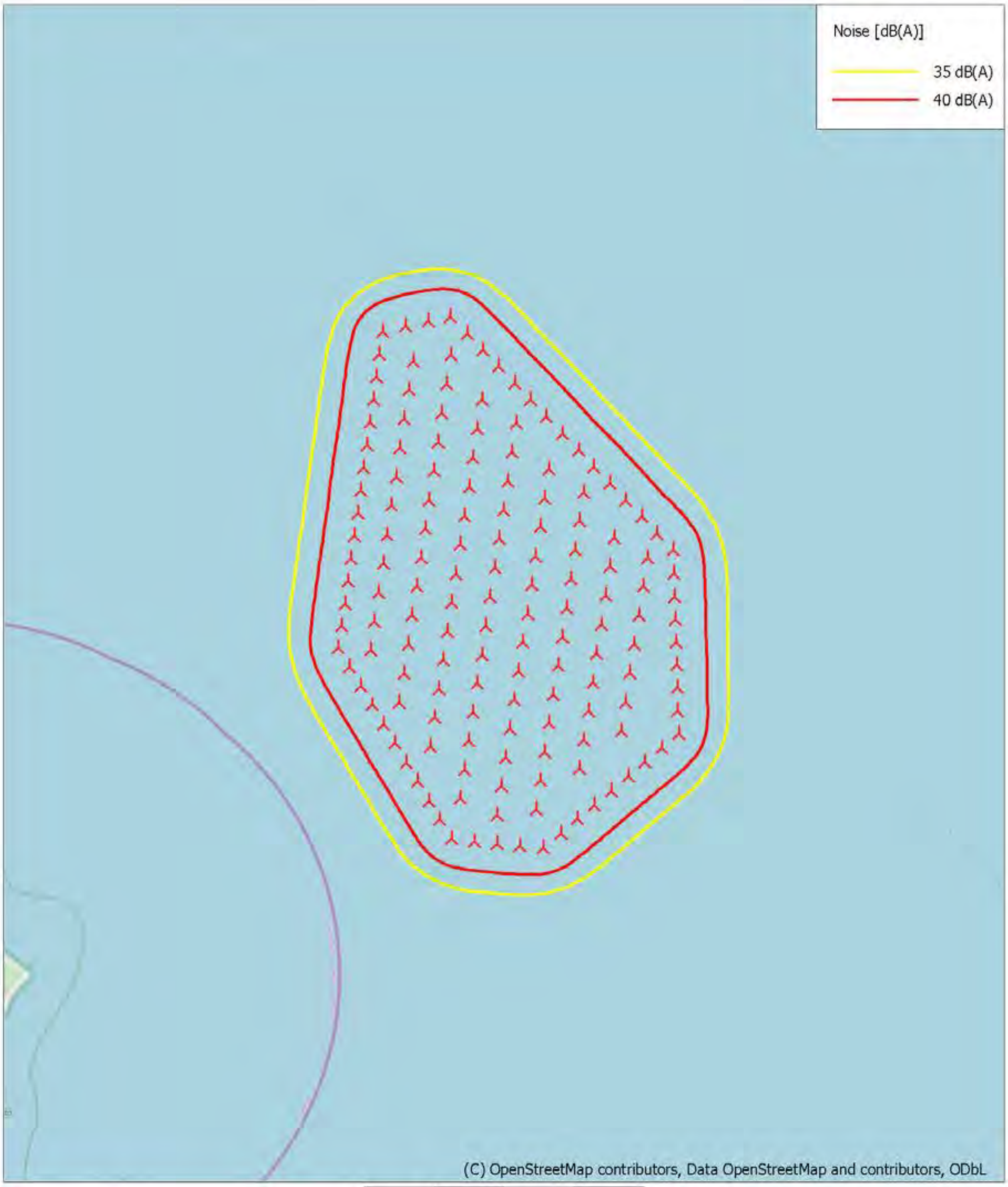
The result from the Danish calculation model shows that there is a distance of at most approximately two kilometres between the outer wind turbines and the calculated 40 dB(A) line and of about 3–4.5 kilometres to the 35 dB(A) line. Even if the result from the calculation using Nord2000 shows a shorter propagation of the sound, it means overall that only those in the vicinity of the offshore wind turbines will hear them, Figur 29.

Project:
Offshore_Epsilon

Licensed user:
Karlstad Modern Energy AB
Lantvärnsgatan 8
SE-65221 Karlstad
+46 702185064
Niklas Sondell / niklas.sondell@modernenergy.se
Calculated:
2022-05-02 09:54/3.5.552

NORD2000 - 8.0 m/s

Calculation: Nord2000



0 5 10 15 20 km

Map: EMD OpenStreetMap , Print scale 1:400 000, Map center Swedish UTM 33-SWEREF99 (SE) East: 786 084 North: 6 508 061

New WTG

windPRO 3.5.552 by EMD International A/S, Tel. +45 69 16 48 50, www.emd-international.com, windpro@emd.dk 2022-05-02 13:49 / 5 windPRO

Figur 29 The result of calculations of sound emissions for the project Baltic Offshore Epsilon performed using the calculation model Nord2000.

3.14.1 Low-frequency noise and infrasound

Low-frequency noise is sound in the frequency range 20–200 Hertz. Sound below 20 Hertz is called infrasound and is usually not audible but can affect people negatively if the sound level is high enough. The rotation of wind turbines gives rise to infrasound which is often around 1 Hertz and in that frequency range, a level of around 120 dB is required to see an impact on people (Swedish Environmental Protection Agency, 2020b).

Low-frequency noise generated by offshore wind power infrastructures above all risks affecting marine mammals and fish, but there is currently a lack of knowledge about the effects of the long-term continuous impact of low-frequency noise (Swedish Agency for Marine and Water Management, 2022).

The potential impact of low-frequency sound and infrasound arising from the project will be reported in the forthcoming EIA.

3.14.2 Underwater noise

During operation, in addition to noise from the wind turbines themselves, there is also noise from service vessels. Disturbing noise can come from, among other things, propellers and engines, but also technology that emits sonar and echolocation sounds can primarily affect porpoises (County Administrative Board of Västra Götaland, 2014).

The greatest impact in terms of noise from offshore wind power infrastructure occurs during the construction phase. Sound can come from ships and surveys but piling, especially in connection with the construction of monopile foundations, gives rise to loud sounds that can travel long distances in the water. Which sound is generated depends on the choice of foundation. Foundations with several smaller piles emit a lower sound than those consisting of one large pile and when constructing foundations that are dug or drilled into the seabed, no such noise occurs at all (Swedish Agency for Marine and Water Management, 2022a). The noise that occurs during piling risks affecting marine wildlife, especially porpoises. The impact varies depending on the distance to the sound (County Administrative Board of Västra Götaland, 2014). See also Section 3.9.4 *Marine mammals.*

In order to minimise the impact of noise, where possible, foundations can be chosen that requires less piling or no piling at all, the force and therefore the sound generated during piling can be increased gradually so that larger animals are scared off and have time to leave the area, and noise-damping devices such as cofferdams (insulating framing) can be used (The County Administrative Board of Västra Götaland, 2014). Another noise-damping device is so-called bubble curtains (Swedish Agency for Marine and Water Management, 2022a), which means that air is pumped down a pipe and flows out through valves to create a stream of bubbles up to the surface. The bubbles break up the sound waves and dampen the noise.

The potential impact of underwater noise arising from the project and protective measures to limit such noise will be examined in the forthcoming EIA.

3.15 Shadows

In sunny and clear weather, sweeping shadows are caused by the rotor blades of the wind turbines. The shadows can be perceived at a relatively large distance, depending on the surrounding topography, for a few minutes at times when the sun is low. Depending on the total height of the wind turbines and the surroundings, the shadows can be perceived at a distance of up to approximately two to three kilometres. With distance, the shadows thin out and lose their sharpness. At a great distance, the shadows are only perceived as diffuse light changes.

The project area is located in the open sea a long distance from land and it is therefore only those in the vicinity of the offshore wind turbines who can see the shadows. In the water, the deepest shadows penetrate about 18 meters down, further down than that the light does not reach the project area (SMHI, 2022b). The distance to land means that shadow effects on people are extremely limited and the environmental aspect is intended to be delineated in future EIAs.

3.16 Risk and safety

Obstruction marking

The Swedish Transport Agency's regulations and general advice on the marking of objects that may pose a danger to aviation (TSFS 2020:88) state that wind turbines higher than 150 meters in a structured grid with mutual distances greater than 1000 meters need to be equipped with high-intensity, white flashing obstruction lights on the nacelle (engine house). When the nacelle has a height of more than 150 meters above the ground or water surface, the tower of the wind turbine must also be marked with three low-intensity obstruction lights positioned at half the height of the nacelle. As the mutual distance between the wind turbines in Baltic Offshore Epsilon is planned to be two kilometres, this means that all turbines need to be equipped with white flashing obstruction lights on the nacelle and low-intensity obstruction lights at half the tower height. If the total height of the wind turbines exceeds 315 meters above the water surface, additional markings and lighting may also be required by decision of the Swedish Transport Agency.

In addition to aviation obstruction lights on the nacelle and in the middle of the tower, light markings for shipping traffic are also required based on the Swedish Transport Agency's regulations and general advice (TSFS 2017:66) on marking at sea with maritime safety devices.

Air traffic

The air space is divided into controlled and uncontrolled air. In controlled airspace there is an air traffic control that communicates with the pilot and directs the air traffic. In the uncontrolled airspace, it is the pilot who is responsible for avoiding collision, but the air traffic service can assist with information (Swedish Civil Aviation Administration, 2022). The project area is within the Swedish Flight Information Region (FIR), where Sweden is responsible for its airspace, but close to Finland's FIR. This is monitored in the event that the project area were to change.

The project area is not within any MSA areas or any areas of national interest for air traffic.

Accident risks

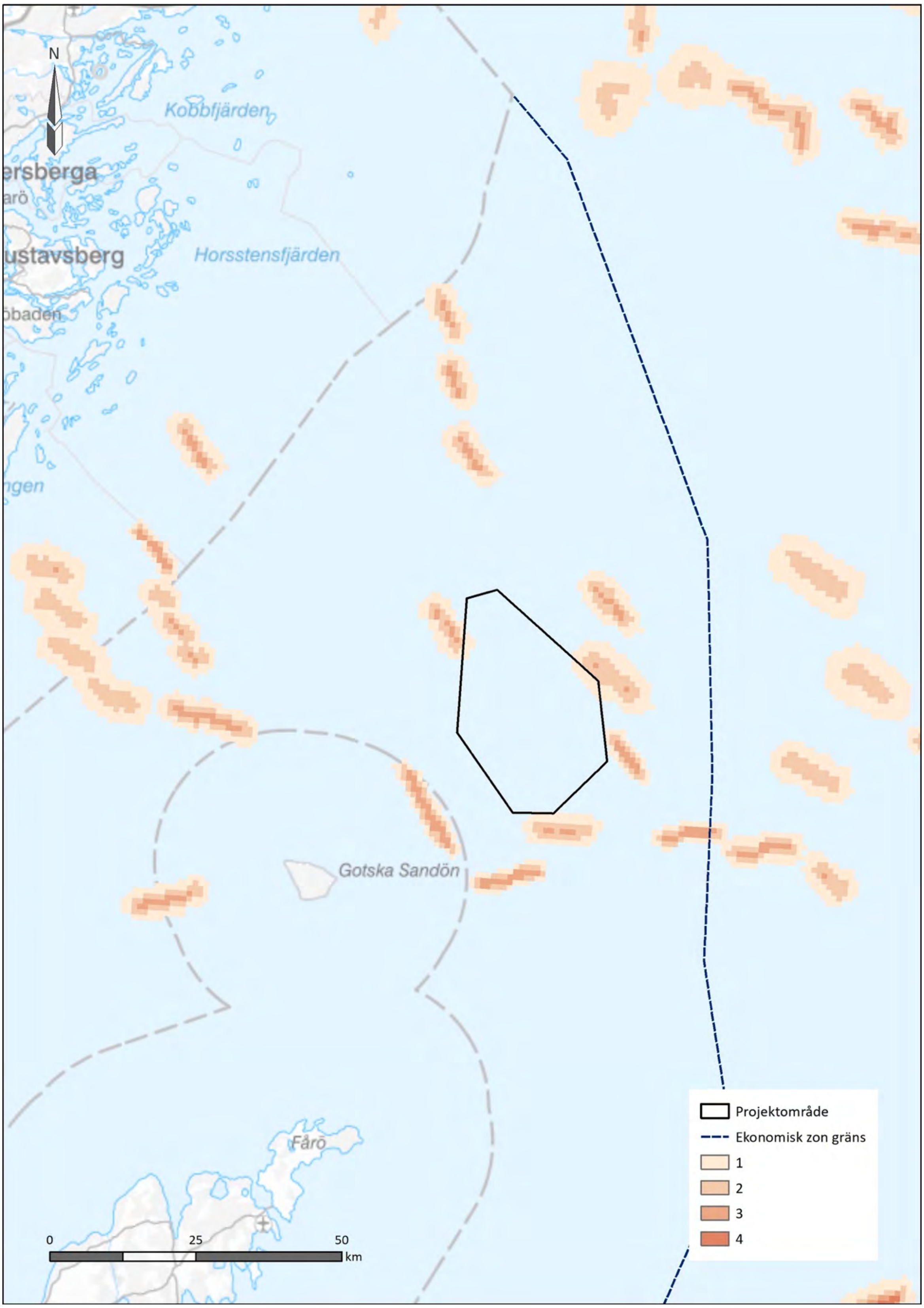
The Swedish Rescue Services Agency's report *New accident risks in a future energy system* (Swedish Rescue Services Agency 2007) states that wind turbines in themselves cannot be described as a risk, with the exception of work environment risks in connection with construction, repair and service work that includes working at a height. Accidents in connection with the operation of the wind turbines are unusual. Special precautions have been prescribed by, among others, the Swedish Work Environment Authority.

The project area is located in the Baltic Sea, which is one of the busiest seas in the world (Swedish Agency for Marine and Water Management, 2022a) and there is a risk of collisions with ships and boats. Collisions can occur if the ships/boats hit or sail into structures within the wind power plant. Due to the long distance from land, it may take a long time to obtain assistance. A risk analysis will be drawn up within the framework of the EIA which, among other things, investigates the risk of collision and what happens if the wind turbines collapse, for example if they sink or float away. The preparedness and protective measures that are taken in the event of an accident occurring during construction will also be examined.

The technology and measures that will be used to prevent oil leakage into the sea will also be described within the framework of the EIA.

Mines and dumped ammunition

In the Baltic Sea, there are areas which are a risk due to the presence of dumped ammunition and sunken mines from the Second World War (Swedish Agency for Marine and Water Management, 2022a). No areas within the project area have been identified as having a high risk of the presence of sunken mines. In close proximity to the project area there are areas with an identified risk of the presence of mines, see Figur 30. The estimate of the presence of mines is not comprehensive and there is risk even within the project area. The closest known area for dumped ammunition is south of Gotland (EMODnet, 2022). During ongoing planning of Baltic Offshore Epsilon, investigations and surveys will be carried out to identify possible ammunition and mines within and adjacent to the project area.



Figur 30 Map of areas at risk of the presence of sunken mines from the Second World War. The scale goes from low (1) to high (7) risk but only classes 1–4 are found in the area near the project (HELCOM, 2019).

Wear and extreme weather conditions

The wind turbines normally operate at wind speeds of around 4–30 meters per second. A turbulent wind affects the performance and lifespan of wind turbines. Turbulence intensity differs from site to site, but in general. conditions over seas are more favourable (about 8 percent) than over flat lowlands (13 percent) or forests (20 percent) (Petersen et al. 1998). At higher wind speeds, the stress on the ball bearings of the wind turbines is great and the wind turbines are at risk of damage. To reduce the stress, the blades of the wind turbines can be angled so that a greater proportion of wind energy is let through. In extreme winds, the rotor can also be temporarily switched off.

Wind conditions and sea conditions (current, waves), as well as the interaction between them, will both be measured and modelled in detail before final turbine selection and tower and foundation design. Extreme winds and extreme waves, as well as extreme load combinations between wind and waves, provide the basis for securing the plant for the extreme design loads. With regard to fatigue loads, this is largely determined by the turbulence of the air together with the wind distribution, but also by waves and the interaction with waves. All final design of the complete wind farm will be certified and approved.

Material from the rotor blades can erode when exposed to wind, waves, rain, snow and ice. In recent years, the question of whether wind turbines contribute to the spread of microplastics and the hormone-disrupting substance Bisphenol A has been raised. Studies from Norway show that weight loss from the blades is mainly due to paint and that the emissions from wind turbines regarding microplastics are negligible (Swedish Wind Energy Association, 2021). The rotor blades contain small amounts of the hormone-disrupting substance Bisphenol A. Even if all the Bisphenol A in the rotor blades were to end up in the sea (which is only theoretically and not practically possible), this would mean negligible levels that cannot have a negative impact on the environment or human health.

Fire

Fires can occur in wind turbine engine houses and the most common causes are lightning strikes or electrical faults. In cases where fire does occur, this happens in enclosed spaces and the risk of spreading is therefore small. The wind turbines are equipped with a monitoring system that sounds an alarm and shuts down the wind turbine if the temperature in the turbine becomes too high.

Ice formation and ice-fall

In circumstances where free water is present in the air, for example fog or low clouds, when the temperature is below zero, ice can form on the blades of the wind turbines. This leads to loss of production, changes the load on the turbines and also constitutes a risk of ice-fall. With offshore wind power infrastructures, there is also a potential problem with ice formation on towers and foundations.

Ice build-up conditions in the project area in the northern Baltic Sea are relatively favourable. Calculations carried out for conditions on land at a height of 100 meters show that, in a normal year, all nearby coastal areas have between 0-100 hours of active ice build-up, i.e. the time when new ice can form on the wind turbines (Kjeller Vindteknikk, 2012). Just over 50 kilometres out into the Baltic Sea, low temperatures are significantly less common, which means that the risk of ice formation on the rotor blades is reduced.

Based on this, the expectation is that the impact of ice on the wind turbines' output will be negligible. Furthermore, possible problems with ice-fall on the turbines will be uncommon, but not negligible. The current guidelines on ice-fall stipulate a maximum ice-fall distance of just under 600 meters for an example structure with a total height of 330 meters. The large respective distances between the wind turbines in the project area means that it will be possible to travel through the wind power plant outside that risk distance. If the need arises, safety measures, such as warning systems, can be implemented when there is a risk of ice-fall.

The frequency of ice-fall and maximum ice-fall distances will be investigated further in the forthcoming EIA.

Electromagnetic fields

Electromagnetic fields are the collective name for electric and magnetic fields. They arise, among other things, when electricity is produced, transported and consumed. The fields are everywhere in our environment, around power lines, transformers and electrical appliances. Wind turbines do not in themselves give rise to strong electromagnetic fields. However, transformers and power lines/electrical cables may do so.

All electrical cables generate electromagnetic fields that can affect marine organisms to varying degrees. The impact depends on the type of cable used, the amount of electricity transmitted and the animal affected. By taking various protective measures, such as using special cables and burying the cable in the seabed, the impact can be minimized.

Electromagnetic fields around electric cables appear to have an impact, albeit limited, above all on fish that use magnetic fields or electricity to navigate and search for food, for example eels and cartilaginous fish (Vindval, 2012).

3.17 Construction/construction phase

For an offshore wind power plant, the construction phase includes preparations for foundations, seabed anchoring and cable laying, as well as installation of foundations, wind turbines, substations and other electrical infrastructure. Construction work is expected to last at least two years and is sensitive to adverse weather conditions. Normally, construction and installation in the entire project area does not take place at the same time, but in stages. During the installation, a safety zone is established to protect assembly, personnel and third parties.

Parts of the Baltic Offshore Epsilon project area will have different technology solutions for seabed anchoring. The different technologies lead to differences in the construction work and in the installation of the wind turbines. An overview of this is given below.

As the project area is extensive, the construction period extends over a number of years, see Section 5.4. The turbines will be installed by a small number of installation vessels simultaneously. This means that a disturbance will occur locally for a relatively short time during the construction process.

Seabed-anchored wind turbines

As described in Section 2.4.2, there are two main types of seabed-fixed foundations that, with current technology, are relevant to Baltic Offshore Epsilon. Current monopile and gravity foundations are deemed not to be relevant at sea depths of 60 meters or more. The remaining options with current technology are Jacket foundations and Tripod technology. Monopile technology may become relevant if technology with deeper foundations is developed.

Jacket foundations and tripod foundations are available in various designs, but the attachment to the seabed is usually carried out with either a suction pipe/anchor (a technique based on a created negative pressure in the attachment pipe by pumping water out) or steel pipes that are piled or drilled into the seabed. The choice of technology depends on the seabed conditions at the site.

Both foundation types are assembled on land and transported to the project area by boat. On-site, the structures are lowered to the seabed with a crane and anchored using one of the above techniques. Depending on the conditions and the construction of the foundation, erosion protection can be installed either before or after the installation of the foundation. Erosion protection is used to prevent the seabed around the foundation from eroding and undermining the anchoring. The erosion barriers usually consist of a lower layer of gravel and an upper layer of stones of mixed-sizes.

The most common construction method when installing seabed-fixed offshore wind turbines is for the main components (tower, engine house and composite rotor) to be transported to the site by barge and for the turbine to then be assembled on site using a crane.

Floating wind turbines

Floating technology on the other hand, enables almost all assembly to take place on land. The foundations and wind turbines are assembled in port and then towed floating to the project area where they are connected to the prepared anchor lines attached to the seabed.

Offshore substation (OSS)

An OSS (offshore substation) is normally installed on its foundation using a crane vessel. Depending on how the OSS and its foundations are designed, they may also be floated out or installed using other lifting methods, for example using their own support legs.

Internal cable network and connection cables

The wind power plant's internal cable network and connection cables are laid from cable vessels. If protection is needed for anchors, for example, cables can be flushed, plowed or buried in the seabed, normally to a depth of approx. 1.5 metres. Flushing is usually used in softer seabeds, while plowing and burying are used in harder seabeds. The final installation depth depends on the geological conditions and the required level of protection. In cases where the geological conditions do not allow cables to be laid in the seabed, they can be protected by being covered with, for example, stone or laid in pipes. If a cable needs to cross another cable, the cables are usually protected using concrete mats or stone.

3.18 Operational phase

Both wind turbines and OSSs are remotely monitored and unmanned during normal operation. However, there is continuous maintenance of the wind power plant, which requires personnel and materials to be transported to the wind power plant by smaller service boats, ships or helicopters. An office for staff as well as for the storage for equipment and materials will be established on land near the wind farm.

For more extensive work, such as replacing larger components, an support vessel, a floating crane or similar may be used. Cables are inspected when necessary to ensure, for example, that protection for the cables at the foundations of each wind turbine is intact. In the event of damage to the cable, it is repaired by lifting the cable section in question using a cable vessel for repair, after which the cable is re-laid on the seabed. In order to protect the cables from being damaged, it is inappropriate to carry out bottom trawling and to anchor within the wind power plant and over the route of the connection cables.

3.19 Disassembly and decommissioning

The expected lifespan of an offshore wind farm is between 30 and 35 years, after which the wind power plant is decommissioned and the area restored. During decommissioning, wind turbines, any floating foundations and substations will be dismantled and transported away from the site.

In some cases, it may be beneficial to leave foundations, seabed fixings and seabed-laid cables in place to form artificial reefs (Andersson and Öhman 2010). If this, in consultation with the relevant authorities, is judged to be unsuitable for the project area, foundations and other underwater components will also be removed from the site and the site restored in accordance with the authorities' requirements at the time of decommissioning.

4. CLIMATE AND SUSTAINABLE DEVELOPMENT

The concept of sustainable development was created by the UN World Commission on Environment and Development and is defined as "a development that satisfies current needs without jeopardising the ability of future generations to satisfy their needs" (Brundtland Commission 1987). This chapter gives a brief account of the goals that form the basis of the environmental consideration that is sought to achieve sustainable development. In the forthcoming EIA, an analysis is made of how compatible the planned wind power plant is with the global goals, the environmental goals and the goals for reduced emissions and increased production of renewable energy.

4.1 Climate and renewable energy

In 2015, the countries of the world agreed on a new climate agreement, the Paris Agreement, which is a legally binding international agreement that Sweden ratified in 2016. The EU is a party to the Paris Agreement, which means that the EU submits a jointly developed climate plan that all EU member states stand behind. Sweden's long-term goal of zero net emissions of greenhouse gases into the atmosphere by 2045 at the latest and the goal of completely renewable electricity production by 2040 are linked to the Paris Agreement. The government has stated that a significant expansion of wind power is likely to be a prerequisite for Sweden to meet the goals of zero net emissions and renewable electricity production. In the national strategy for sustainable wind power expansion, a total national expansion need for wind power by the 2040s is assumed to correspond to at least 100 TWh, of which approximately 80 TWh is land-based and the rest is offshore (Swedish Energy Agency 2021b). Among other things, the strategy gives the county administrative boards the task of producing regional planning documents for wind power and proposes distributing the expansion need between the counties.

The latest reports (August 2021 and February 2022) from the UN climate panel, IPCC (Intergovernmental Panel on Climate Change) are unambiguous and based on observations of actual development, not solely on modelling (IPCC 2021; IPCC 2022). The climate situation is critical and the increase in the global average temperature is a clear effect of human emissions of greenhouse gases. We risk exceeding the 1.5 degree target, to limit the global temperature increase to 1.5 degrees, within 10–20 years. The reports emphasise that climate change is happening here and now and that the effects of climate change are also manifesting faster than expected. Recent increases in extreme weather in the form of droughts, forest fires and floods will become ever more extreme and frequent. Climate change must be dealt with as a direct threat to life on earth. Enormous emission reductions are required and must happen quickly.

Sweden is part of the common northern European electricity system in which the proportion of electricity generated using fossil fuels is still high. In our closest EU neighbouring countries, with which we are directly connected, the fossil-based electricity production amounted to just over 50 percent of total electricity production. Increased wind power production in Sweden, with increased electricity export, therefore also replaces fossil electricity production from coal and gas power in Europe, which provides an extensive climate benefit.

Today there is an imbalance within the electricity system in Sweden, with high electricity production and relatively low consumption in northern Sweden and low electricity production and high consumption in southern Sweden. There is also an increased demand for renewable electricity when the industrial and transport sectors work to change and become fossil-free, but also for new electricity-intensive industries such as data centres.

4.2 The global sustainability goals

The global sustainability goals have been drawn up by UN member states and consist of 17 goals, see Figur 31. These goals aim to meet four main targets by the year 2030 (Global Goals, 2022). The four main targets are to

- eliminate extreme poverty
- reduce inequality and injustice in the world
- promote peace and justice
- solve the climate crisis.

The 17 goals are linked to global development, everything from how marine resources should be used to how cities should be built and what consumption needs to look like in order for us to achieve sustainable development. Of the 17 targets, 9 can be linked to wind power and are set out in Tabell 8. The connection may be that wind power can help achieve the goals, but also that it is something to think about and take into account when building wind power plants so as not to counteract the goals.

Figur 31 The Sustainable Development Goals (Global goals, 2022).

Tabell 8 The global sustainability goals' connection to wind power establishment.

Goal No	Focus	Connection to wind power establishment
Goal 3	Good health and well-being	General goal involving all aspects of sustainable development for all ages. Specific to wind power, the connection is primarily to psychosocial health (involving everything from potential perceived disturbance in the living environment to feelings of hope for the future as a result of an increased amount of renewable energy), as well as a reduced risk of deaths linked to chemical emissions and other pollution of soil, water and other habitats.
Goal 6	Clean water and sanitation for all	The connection to goal 6 involves ensuring drinking water for all and protecting water-related ecosystems. When installing wind power infrastructure, it is important to take adequately ensure that the goal is not impeded.
Goal 7	Sustainable energy for all	Goal 7 aims, among other things, to increase the proportion of renewable energy in the world. Wind power plays a central role in this increase along with other types of renewable energy. The more comprehensive goal also focuses on there being access to clean energy for everyone.
Goal 9	Sustainable industry, innovation and infrastructure	Goal 9 emphasises that, among other things, road networks, mobile technology and electricity networks must be safe and stable. In order to enable a sustainable industrial sector, access to renewable energy

		is also required. Wind power establishment can be a positive contributing factor to this.
Goal 11	Sustainable cities and communities	Sustainable urban development means, among other things, a greater proportion of electrification of transport. This requires environmentally sound and sustainably produced electricity, and wind power can help with that. This goal also includes protecting natural and cultural heritage, which in some cases affects areas where wind power is established. Furthermore, the development of wind power technology contributes to enabling wind power development in more countries and cities. The need for renewable energy is great in cities globally.
Goal 12	Sustainable consumption and production	Goal 12 is about how we should use and manage the natural resources that exist with regard to the environment, social aspects and economy. Wind is a renewable resource that should be used efficiently, and locations where wind power infrastructure is constructed must also be valued based on these aspects. The goal is also about responsible handling of chemicals and waste and reducing the amount of waste. Both during the construction, operation and decommissioning of wind power, it is important that chemicals and waste are handled in a resource-efficient and responsible manner, and that as much as possible of the material used can be recycled.
Goal 13	Combat climate change	The purpose of Goal 13 is to mitigate climate change. The focus is primarily on preparing for a changing climate. This goal also includes the agreement set out in the Paris Agreement on reduced emissions of greenhouse gases and that global warming should not exceed 2 degrees.
Goal 15	Ecosystems and biodiversity	Goal 15 deals, among other things, with the sustainable use of ecosystems. The establishment of wind power must take into account the ecosystems and biodiversity that exist in the area as well as the cumulative effects of the establishment of wind power in order not to counteract the goal.
Goal 17	Implementation and global partnership	Goal 17 is a general goal of global solidarity. Driving the wind power industry forward (both in terms of technical and scientific capacity) can contribute to the development of the global market and benefit wind power globally.

4.3 The Swedish environmental goal system

Sweden's environmental goal system consists of a generation goal, 16 environmental quality goals and 17 stage goals (Swedish Environmental Goals, 2022). The environmental goal system defines how Sweden should go about achieving the ecological parts of the global sustainability goals.

The aim of the environmental goal system is to act as a guide in the work for sustainable social development and to be the benchmark for all Swedish environmental work, regardless of where and by whom it is carried out. Establishment of wind power contributes directly and indirectly to achieving the environmental quality goal *Limited climate impact*, while not preventing other environmental quality goals from being achieved. However, in order for wind power to be compatible with the environmental quality goals, consideration must be given to the location and design of the planned activities. Wind power establishment then mainly affects the targets *Limited climate impact, Non-toxic environment*, *A balanced marine environment, Flourishing coastal areas and archipelagos* and *A rich plant and animal life*. Which of the goals are affected and whether the impact is positive or negative depends on location considerations and other factors. Other goals have no clear connection to the establishment of wind power if it is carried out according to established methods.

5. ONGOING WORK

This chapter briefly describes how forthcoming environmental impact assessment work is structured, which underlying investigations are planned and which schedule the project is following.

5.1 Environmental Impact Assessment (EIA)

After completion of the consultation procedure, an EIA will be drawn up. An EIA constitutes a central document that is attached to the permit application. The purpose of the EIA is to lay the foundation for the environmental assessment of planned activities and to form a basis for decisions by the licensing authority.

An EIA must identify and describe direct and indirect environmental impacts on human health and the environment and enable an overall assessment of the consequences that arise as a result of planned activities.

Content and scope of the forthcoming EIA

It is proposed that future EIAs follow the same outline as this consultation document. However, the focus will be on clarifying and analysing in even greater detail the environmental impact of the planned activities and distinguishing the significant environmental impacts that the planned activities entail.

The EIA will also examine protective measures that have been taken during planning and which are intended to be implemented during construction, operation and decommissioning to avoid, minimise, remediate and compensate negative environmental effects. Based on the information that is available at this stage, we make the assessment that significant environmental impacts consist of impacts on:

- The natural environment - negative with regard to birds, marine mammals and bats

- The natural environment - positive for some species such as benthic organisms, fish and some seabirds linked to "artificial reef formation" and reduced disturbance from trawling and ship traffic
- Sound/noise and turbidity of water areas
- Navigation – with regard to the use of a marine area
- Climate – positive impact of renewable energy production in a region with greater needs than current production

In the ongoing EIA work, these issues will be investigated and examined in greater detail.

The results of the surveys that will be carried out at various stages of the project's implementation should help increase knowledge of the conditions in the area with regard to the majority of the relevant factors that will be analysed.

5.2 Planned investigations until granting of environmental permit

A number of inventories and investigations will be carried out within the framework of the EIA. The results will be the basis for the layout of the wind power plant in the application, as the location of the wind turbines and the internal electricity and communication network will be adapted as much as possible based on identified values to minimise negative impacts. The following inventories and investigations have been or will be carried out:

Seabed and water surveys

In order to be able to assess the environment on the seabed before the EIA, several different seabed samples will be taken in the area. The planned surveys aim to analyse infauna (benthic animals that live buried in the seabed) and epifauna (benthic animals that live on top of the seabed) as well as grain size and substance composition in the seabed substrate. This is complemented by video-based surveys using drop-down video (DDV). Sediments are taken with a grab bucket and infaunal samples are taken using cylinder samplers, for example a "Haps-corer".

In addition to this, the oxygen content at the bottom will be measured and modelling data for sea currents and salinity in the area will be developed.

Any findings, cultural environment objects, mines or other findings, will be reported to the relevant authorities.

Permits for surveys of the seabed require a separate application, see Tabell 1.

Natural and cultural values

Infaunal samples are taken to map fauna on the seabed and in the seabed. Grain size, substance composition and oxygen content in the seabed substrate can be mapped from sediment samples. This in turn can be used to assess the possibilities for life, the possible risk of dispersal of environmental toxins and later provide input for calibrating geophysical mapping.

- Fishes and invertebrates.
- Seabed surveys of seabed fauna and also of possible seabed flora.
- Marine mammals: initial desk study to clarify the importance of the area primarily in relation to porpoises and grey seals, and to investigate the need for inventories.
- Birds: inventories will be carried out during different seasons depending on the life patterns of the species concerned. Density can be inventoried be plane or by boat or with the help of GPS.
- Bats: desk study will be conducted where previous observations, knowledge and probability of possible movement across the project area will be reviewed.
- Species protection: corresponding species protection investigation.
- Marine archaeological investigation.

Visualisations, measurements and modelling

- Visibility analysis.
- Photomontage.
- Obstruction light animation.
- Sound calculations, including the propagation of low-frequency sound under the water surface.
- Cumulative effects of the project overall with other impacts from, for example, other wind power establishments and shipping.
- Analysis of possible synergistic effects, which could be affected by the establishment of wind power, with regard to changed water circulation, oxygen content and eutrophication.

Navigation

A navigation-related risk analysis will carried out based on the location of the area from a navigational standpoint. Navigation-related impact, risks and appropriate protective measures will be analysed and evaluated in detail, mainly based on the risk of interference with ship's navigation equipment, risk of sailing, the need for safety distances between the farm and nearby shipping lanes, changed maritime traffic patterns as a result of the farm, the need to change, move, establish maritime safety devices in the area, risks and measures linked to the construction and decommissioning phase, prerequisites in the event of maritime and environmental rescue and marking the farm for navigation according to the Swedish Transport Agency's regulations and general advice (TSFS 2017:66) on marking at sea with maritime safety devices. Cumulative effects in relation to other offshore wind farms (existing or planned) in the immediate area regarding the impact on navigation will also be taken into account.

Defence interests

Investigation of coexistences between the project based mainly on the national interest of the military component of Swedish total defence has been initiated in dialogue with the Swedish Armed Forces.

Electrical connection and internal cable network

An application for an electrical connection to has been submitted to Svenska Kraftnät, which is conducting an initial study on connection feasibilities. As soon as advance notification has been given about a suitable connection point, the letter of intent and technical feasibility study will begin. The electrical connection is likely to include cabling to a land-based grid station. This will be investigated in a separate process with consultation and a permit application.

Any impact on plant and animal life from internal cable networks and substations, both during the construction phase and operation, will be analysed and made clear in the EIA and form part of the risk and vulnerability analysis in the event of an accident or sabotage.

5.3 Planned surveys after granting of environmental permit

Wind measurement

The wind conditions at the site will be investigated by erecting one or more measuring masts or alternatively measuring with laser-based equipment (LIDAR) to increase the precision of the production and load calculations.

Seabed surveys

Based on the results of seabed surveys carried out before the submitted application, additional investigations will be required after the environmental permit has been granted for the final design of the foundations and attachment. The extent of these will depend on the results of the aforementioned surveys and the choice of technology for the foundation and seabed attachment of the wind turbines.

After the permit is granted, areas at planned turbine locations and corridors for internal cable networks will be examined in more detail in terms of geophysics and geotechnics. Geophysical surveys will be conducted in order to identify potential obstructions and evaluate the seabed in the layout. The surveys will take place with the help of echolocation and sonar equipment. In addition, seismic surveys will be carried out with the aim of obtaining more knowledge about what is below the surface of the seabed and getting a clearer picture of the area. Finally, it may be relevant to obtain geotechnical drill samples at current turbine positions.

At this stage, a detailed analysis of the presence of unexploded ordnance (UXO) will also be carried out to safeguard future construction work around the turbine locations. The survey is conducted using a magnetometer and will be carried out in detail before any work on the seabed is carried out. The results of the survey will be reported to the relevant authorities.

In parallel with the geophysical survey, a marine archaeological survey of potential turbine positions and cable corridors is also taking place. Marine archaeological findings will be reported to the relevant authorities and no construction activities will take place closer than 100 meters from the find.

To reduce disturbance to porpoises and other marine mammals before the seabed surveys are carried out, a PAM (Passive-Acoustic Monitoring), which listens with four hydrophones, can be installed on a work vessel. Once it is ensured that there are no porpoises or other mammals in the area, the seabed survey instruments are soft-started to keep any marine mammals at a certain distance before switching to more disturbing frequencies.

High-amplitude sound pulses used by sub-bottom profilers such as Innomar's SBP (Innomar, 2016) can affect the hearing ability of marine mammals. For a risk assessment, consideration must be given to the sound pressure level (SPL), the sound exposure level (SEL) and the volume where these measurements exceed certain limits. Due to the short sound pulses typically used and the highly directional sound pulse transmission of parametric sub-bottom profilers, the risk of impact on marine mammals is much lower than when using conventional (linear) acoustics such as boomers, sparkers, chirp systems or seismic equipment such as airguns. For Innomar's SBP, it can be concluded that the generated SPL/SEL will not exceed any known TTS limit at a horizontal distance of more than 20 meters around the emitter. Although a mammal is unlikely to be near the ship when the SBP is turned on, it will be out of the disturbed region in a very short time. For that reason, parametric sub-bottom profilers like Innomar's SBP have been chosen as the preferred method.

5.4Preliminary schedule and implementation

The timeline for realising Baltic Offshore Epsilon is estimated to be roughly 10 years.

The goal is for Njordr Offshore Wind AB to submit an application for a permit in 2024 in accordance with the Swedish Exclusive Economic Zone Act and the Swedish Continental Shelf Act for the construction and operation of a planned wind power plant.

During the years and summers of 2023–2027, the in-depth investigations listed above will be ongoing and will form the basis for the layout of the planned wind power plant. The investigations will be attached in their entirety to the prepared EIA.

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APPENDIX 1. TERMS AND DEFINITIONS

To make it easier for the reader, we have compiled specific terms and definitions that we use when we describe the planned activities and account for the project's conditions and expected environmental impacts.

Power output	The rate of energy conversion. Production capacity is measured in kilowatts (kW) and its multiple units: 1000 kW = 1 megawatt (MW) 1000 MW = 1 gigawatt (GW) 1000 GW = 1 terawatt (TW)
Energy	The product of power output and time. The energy produced is measured in kilowatt-hours (kWh) and its multiple units: 1000 kWh = 1 megawatt hour (MWh) 1000 MWh = 1 gigawatt hour (GWh) 1000 GWh = 1 terawatt hour (TWh)
Downstream service(s)	A collective name for the services that the wind turbines require: internal power lines within the wind power plant, electrical connection to land, piling and construction of foundations as well as the transport of parts to the wind turbines by ship.
Environmental impacts	According to the Swedish Environmental Code Ch. 6 Section 2 impacts affecting human health and the environment, etc. A more detailed explanation can be found in Section 1.2 *Applicable legislation*.
Environmental Impact Assessment (EIA)	A document attached to the permit application. The document must describe direct and indirect environmental impacts on human health and the environment and enable an overall assessment of the consequences that arise as a result of the planned activities.
Project area	The area that the wind power project designer has calculated that the wind-turbine construction project must be housed within.
Consultation document	A document that contains information about the planned project and, on an overall level, gives an account of the potential environmental impacts of the planned activity.
Protective measures	The measures taken to avoid, minimise, restore and compensate negative environmental impacts.
Total height	The hub height (tower height) of the wind turbine, plus the length of the rotor blade, i.e. the height of the wind turbine up to the tip of the blade when it is at its highest.

APPENDIX 2. CONSULTATION GROUP

Obstruction assessment

The stakeholders below have been sent a request with an obstruction assessment for the project.

- The Swedish Armed Forces
- Swedish Civil Aviation Administration
- The Swedish Transport Administration
- Ths Swedish Maritime Administration
- The Swedish Transport Agency
- The Swedish Civil Contingencies Agency

- Hi3G Access AB (Tre)
- The Swedish Post and Telecom Authority
- Tele2
- Telenor
- TeliaSonera AB (Telia Company)
- Teracom AB

Proposal for consultation group

The consultation group is proposed to consist of:

- BatLife Sweden
- The Swedish National Board of Housing, Building and Planning
- The Swedish Energy Markets Inspectorate
- The Swedish Energy Agency
- The Swedish Shipowners' Association
- The Swedish Armed Forces
- Gotland's Ornithological Association
- Greenpeace
- Haninge Municipality
- The producers' organisation of sea and coastal fishermen
- The Swedish Agency for Marine and Water Management
- The Marine Environment Institute
- The Swedish Board of Agriculture
- The Swedish Legal, Financial and Administrative Services Agency
- Royal Swedish Yacht Club (KSSS)
- The Swedish Coastguard

- The County Administrative Board of Gotland County
- The County Administrative Board of Stockholm County
- The Swedish Civil Contingencies Agency (MSB)
- The Swedish Museum of Natural History
- Gotland Society for Nature Conservation
- The Swedish Environmental Protection Agency
- Nynäshamn Municipality
- Gotland Region
- Stockholm Region
- The Swedish National Heritage Board
- SIKO
- Ths Swedish Maritime Administration
- The Archipelago Foundation in Stockholm County
- SLU Aqua
- SMHI
- The Swedish National Maritime and Transport Museums
- The Swedish Anglers Association
- Ports of Stockholm
- Stockholm Chamber of Commerce
- Stockholm Ornithological Association
- The Swedish Boating Union
- Svenska Kraftnät
- The Swedish Cruising Association
- The Swedish Society for Nature Conservation
- Swedish Fishermen's Producer Organisation (SFPO)
- The Geological Survey of Sweden (SGU)
- The Swedish Geotechnical Institute (SIG)
- The Swedish Ornithological Association (Birdlife Sweden)
- Swedish Pelagic Federation
- The Swedish Transport Administration
- The Swedish Confederation of Transport Enterprises
- The Swedish Transport Agency
- World Wide Fund for Nature (WWF)
- Värmdö Municipality
- World Maritime University
- Cinia OY, C-Lion1 cable
- Nordstream 1
- Nordstream 2

International

- All countries affected on the basis of the Espoo Convention (handled in conjunction with the Swedish Environmental Protection Agency)

APPENDIX 3. SOUND CALCULATION NORD2000

Separate report

APPENDIX 4. SOUND CALCULATION (DANISH MODEL)

Separate report

APPENDIX 5. PHOTOMONTAGE

Separate report