Draft Government decision on offshore wind power areas in the exclusive economic zone and the environmental report on the decision prepared in compliance with the SEA Act

SWECO

MINISTRY OF ECONOMIC AFFAIRS AND EMPLOYMENT

Draft Government decision on offshore wind power areas in the exclusive economic zone

Background

Under the Act on Offshore Wind Power in the Exclusive Economic Zone (937/2024), the Government has the right to designate an area located in Finland's exclusive economic zone for utilisation of wind energy (*offshore wind power area in the exclusive economic zone*), and decide on competitive tendering regarding the area and the conditions for exploiting the area. Finland's exclusive economic zone is an international sea area that Finland can exploit for such purposes as offshore wind power. The Government will make its decision at the presentation of the Ministry of Economic Affairs and Employment. This decision (decision on area selection) is a prerequisite for constructing offshore wind power in the exclusive economic zone. In its decision, the Government will designate one or more areas in Finland's exclusive economic zone for offshore wind power and the decision can also specify the timetable for the competitive tendering process concerning concessions to use the area(s) in question. The tendering process will be organised by the Finnish Energy Authority. The winner of the tendering process has the right to submit an application for an exploitation permit to the Government, which grants the concession for the tendered area. The concession allows the project developer to develop an offshore wind power project and to apply for the permits required for the project, the most important of them being the water permit. This decision thus precedes the actual project development stage.

The Government decision on an offshore wind power area or areas in the exclusive economic zone concerns the exploitation of wind energy. Under the decision, the area can also be exploited for processing electricity generated from wind energy into such products as hydrogen. The Government decision on area selection does not include the right to lay the cables required for an offshore wind power project. The Government grants the permit for laying the cables under the Act on Finland's Exclusive Economic Zone (1058/2004).

A strategic environmental assessment (SEA) of the Government decision must be carried out under the Act on the Assessment of the Effects of Certain Plans and Programmes on the Environment (200/2005; SEA Act). The Government decision on offshore wind power areas in the exclusive economic zone is a plan or programme referred to in the SEA Act even though strictly speaking it is a decision. Under section 8 of the SEA Act, an environmental report must be drawn up as part of other preparations *before the approval of the plan or programme*.

The environmental report is a separate part of this document (page 8 of the contents, from page 10 onwards). It describes in more detail the process referred to in the SEA Act. The Government can thus only make its decision after the assessment of the draft decision referred to in the SEA Act has been carried out. For this reason, this document describes the draft Government decision to the extent that the draft decision has been subject to the SEA process. The Government has the power to make decisions on the matter but in its capacity as the ministry presenting the matter, the Ministry of Economic Affairs and Employment has prepared a description of the contents of the draft decision.

Draft decision

The Ministry of Economic Affairs and Employment proposes that the Government makes a decision on designating four areas located in Finland's exclusive economic zone for the exploitation of wind power. The areas are shown in Figure 2. Two of the four areas are located in the Bothnian Sea (West and East) and the other two in the Bothnian Bay (South and North). Bothnian Bay South and North as well Bothnian Sea East border the Finnish territorial waters.

Bothnian Sea West is located close to the border between the exclusive economic zones of Sweden and Finland. The total size of these areas is 921 km^2. Size of the individual areas:

- **Bothnian Sea West: 211 km^2**
- **Bothnian Sea East: 202 km^2**
- **Bothnian Bay South: 284 km^2**
- **Bothnian Bay North: 224 km^2**

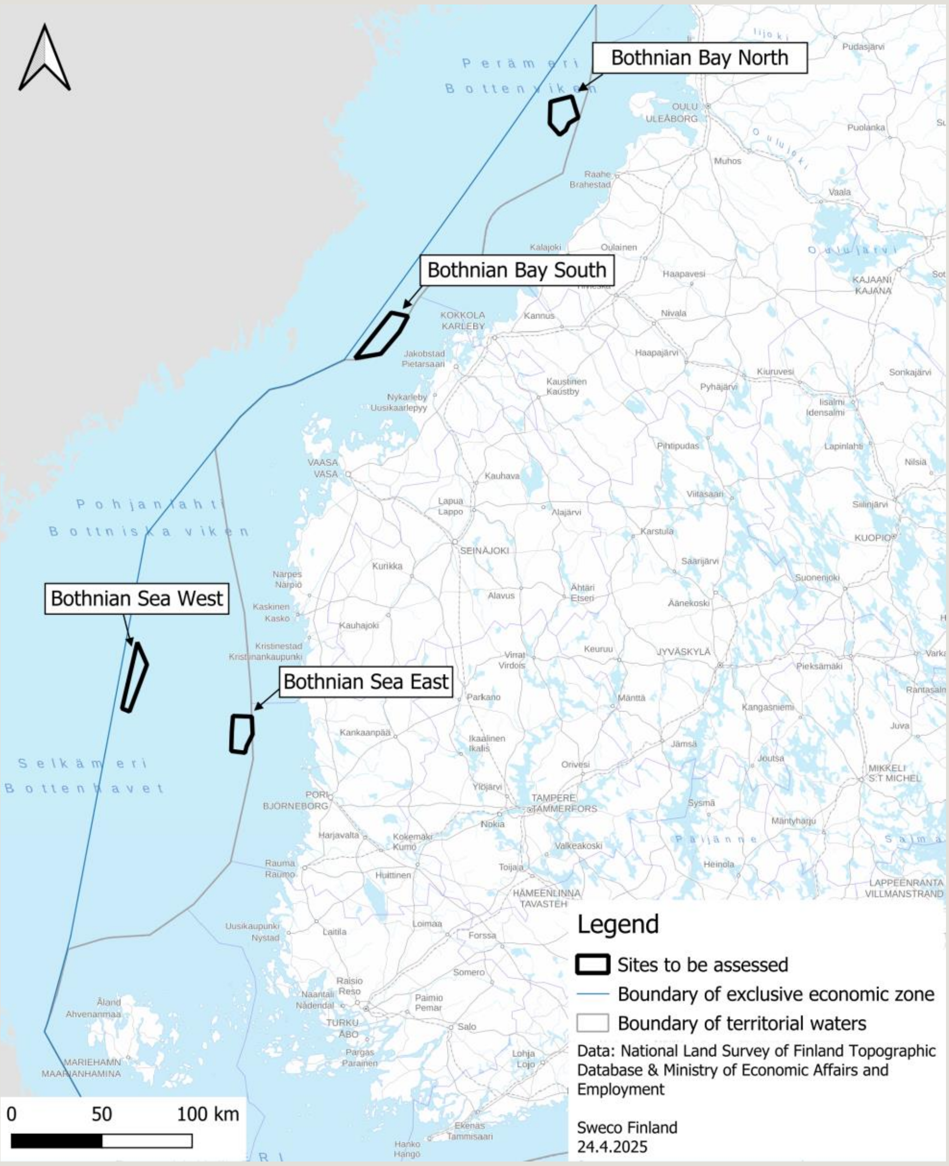

Figure 1: Locations of the proposed areas.

It is proposed that the following conditions should apply to the use of each area:

- The area may be used for the exploitation of wind energy and research aimed at it. This also includes the right to use the area for secondary electricity production (such as a hydrogen plant) if the necessary permits are granted.

- Figure 2The efficiency of the use of the area must be at least 5 MW installed offshore wind power capacity/km^2. If the size of the area to be exploited is later reduced in accordance with section 17, subsection 3 of the Act on Offshore Wind Power in the Exclusive Economic Zone, meeting of the efficiency requirement is calculated from the smaller area.
- The area may be exploited for 35 years from the date on which the wind farm has been taken into its intended use.
- If the wind power project to be built in the area is connected to the Finnish main grid, a maximum of 1.3 gigawatts can be connected to the main grid.

Grounds

The condition for the exploitation of wind energy presented in the draft decision is based on sections 1 and 2 of the Act on Offshore Wind Power in the Exclusive Economic Zone. Under the decision on area selection, the area can be used for the exploitation of wind energy and research aimed at it. Thus, the exploitation permit to be applied for the area tendered under the decision on area selection only applies to the right to exploit wind energy. If the area is to be exploited for other purposes, an application for a separate permit must be submitted to the Government in accordance with the Act on Finland's Exclusive Economic Zone. Laying of cables also requires a permit under the Act on Finland's Exclusive Economic Zone. The exploitation of wind energy also includes the exploitation of wind-based electricity as processed products.

The purpose of the efficiency requirement is to ensure that a sufficiently large offshore wind farm is built in the area, and that this large area is not reserved on a long-term basis for a project that fails to produce any significant amount of renewable electricity. The specification of the area arises from section 17, subsection 3 of the Act on Offshore Wind Power in the Exclusive Economic Zone, under which the validity of the exploitation permit can be limited so that, after a specific period, the exploitation permit only applies to the area where the offshore wind farm will be located. Thus, after a specific period, the exploitation permit could only apply to the area where the construction actually takes place. The permit holder would thus have the right to exploit the entire area for constructing an offshore wind power project if it wanted to do this and would be granted the necessary permits. For the part of the area for which the permit holder did not apply for or receive any permits, the duration of the exploitation permit would be limited. For example, the unbuilt part of the area could no longer be exploited when the wind farm is producing electricity. The aim is to ensure that the area where the offshore wind farm is not located can be used for other purposes or be put out to new tender under a Government decision.

The requirement for a 35-year exploitation period contained in the draft decision would start from the date on which the wind farm is taken into its intended use. To take into its intended use means that most of the wind turbines that the actor has planned for the area and for which it has received permits are operational. In practice, this means the start of energy production in an offshore wind farm. The purpose of this requirement is to ensure that the area can be exploited for the duration of the expected useful life of the wind turbines. The intention is not to ensure that the permit holder could continue to exploit the area by upgrading the turbines. This requirement should already be set in the decision on the area selection as it is a key condition that must be known before the area is put out to tender. The duration of the exploitation permit will be more than 35 years as the actual project development, research, application for permits and construction will take several years and will take place between the granting of the exploitation permit and the start of energy production.

The purpose of the requirement concerning the maximum capacity to be connected to the main grid is to encourage project developers to find solutions that reduce the capacity to be connected to Finland's main grid when more than 1.3 GW of offshore wind power capacity is built in the offshore wind power area. The aim is to ensure the adequacy of the connection capacity for a maximum number of projects within the desired timetable.

The Ministry of Economic Affairs and Employment proposes that the Government determines the timetable for the tendering process for at least one area and decides how the timetable for the tendering process for the other areas should be determined. At this stage, however, the draft decision will not contain any timetable for the tendering process. The tendering timetable depends on a number of factors, and the tendering timetable is not an essential requirement for the SEA process. The four proposed areas are the key part of the draft decision from the perspective of the SEA process. Furthermore, the tendering timetable does not determine when the wind farm will be built as it will be influenced by numerous other factors such as the length of time required by the project development, including the duration of the permit process and any appeals. In other words, the Government decision does not set any timetable for the project.

Other conditions concerning the exploitation of the area may also be included in the Government decision on area selection. To the extent that they are not described above, they concern requirements that are not essential to the SEA process. These terms and conditions may be related to the requirements set out in procurement regulation as the tendering for offshore wind power areas in the exclusive economic zone is carried out in accordance with the EU's directive on concession contracts (2014/23/EU). However, these conditions do not have any such environmental impacts that should be assessed in the SEA process.

The Government decision on offshore wind power areas in the exclusive economic zone does not yet mean that offshore wind farms will also be built in these areas. The decision concerns the selection of the areas. Only the actual project development carried out by the project developer, which may take several years, will show whether the project will become a reality. Offshore wind turbines and any processing activities require several permits and the granting of them is at the discretion of a number of different authorities. It is also possible that no tenders meeting the requirements will be received. In that case, putting the area out to new tender can, however, be considered.

Preparation of the draft decision

In the selection of the offshore wind power areas included in the draft decision, the Ministry of Economic Affairs and Employment has taken into account the increasing of the production of clean energy and promotion of offshore wind power envisaged in the Programme of Prime Minister Petteri Orpo's Government. The aim of the drafting process has been to designate several offshore wind power areas in the exclusive economic zone, each of which could be used as site for an offshore wind power project with a capacity of about one gigawatt. Under section 2 of the Act on Offshore Wind Power in the Exclusive Economic Zone, the overall good of society must be taken into account in the selection of offshore wind power areas in the exclusive economic zone. According to the Government proposal for the act (147/2024 vp), this means that other uses of the marine areas, especially transport and fishing as well as environmental factors, must be taken into account. The purpose of the concept of overall good of society is to ensure that offshore wind farms are built in areas where offshore wind power will bring maximum benefits to society without causing excessive harm to other uses of the sea. In connection with the drafting process, members of the coordination group for offshore wind power[1] have been consulted to determine the impacts arising from the selection of the offshore wind power areas. The members of the group include representatives of ministries, government agencies, interest organisations, the main grid company Fingrid and the Geological Survey of Finland, coordinator of maritime spatial planning cooperation, and project developers of offshore wind power.

Environmental impacts on birdlife, marine nature, underwater ecological values and the landscape have been taken into account, using existing information as a basis. However, when

[1] Ministry of Economic Affairs and Employment, "New coordination group to intensify national cooperation in promotion of offshore wind power". Published 8 October 2024. https://tem.fi/en/-/new-coordination-group-to-intensify-national-cooperation-in-promotion-of-offshore-wind-power

the areas were specified it was recognised that the environmental and nature data on the exclusive economic zone is insufficient and, in the absence of observation data, the environmental impact assessment has largely been based on modelled data.

In accordance with the rationale for section 2 of the Government proposal, the aim has been to ensure shipping to all Finnish ports all year round. In accordance with the same rationale, account has also been taken of important fishing areas in the exclusive economic zone and of the aim to secure adequate operating prerequisites for the fishing industry.

To determine suitable offshore wind power areas in the exclusive economic zone, the Ministry of Economic Affairs and Employment requested a report on potential areas from the Finnish Environment Institute. Identifying the site best suited for wind power in each area where project developers have been granted research permits for offshore wind power under the Act on Finland’s Exclusive Economic Zone was set as the objective for the report. The sites were expected to be sized between 200 km^2 and 250 km^2. The research permits applied for by project developers indicate which areas are attractive to project developers and thus they also give some indication of which areas would be of interest. In its report, the Finnish Environment Institute was expected to pay attention to existing information on natural and environmental factors, coordination of maritime activities and the technical and economic feasibility of the projects (especially the water depth in the area). In January 2025, members of the coordination group for offshore wind power and project developers for offshore wind power were given the opportunity to comment on the seven areas identified by the Finnish Environment Institute. Comments were received from the following eighteen parties: Ministry of Transport and Communications, Ministry of the Environment, Ministry of Agriculture and Forestry, Finnish Transport and Communications Agency Traficom, Finnish Transport Infrastructure Agency, regional councils, Provincial Government of Åland, Fingrid, Geological Survey of Finland, maritime spatial planning coordination group, Metsähallitus, five offshore wind power project development companies, Renewables Finland and Finnish Energy. Based on the comments, a number of changes were made to the preliminary proposals. Most of the changes were prompted by impacts on shipping and fishing and the fact that the area was considered too deep. According to the project developers’ comments, the areas were too small, and in their view, the objective should be to have offshore wind power areas of about 300 km^2. After the feedback had been received, attempts were made to increase the size of the areas but the efforts had only limited success. Water depth and shipping-related factors were the key reasons hampering the efforts to increase the size of the areas.

The Ministry of Economic Affairs and Employment will continue the preparations of the draft Government decision on area selection, and the proposal for a decision can be submitted to the Government for approval after the SEA process has been completed.

Contents of the environmental report

Summary

The environmental assessment based on the Act on the Assessment of the Effects of Certain Plans and Programmes on the Environment (200/2005; SEA Act) covers the Government decision on offshore wind power areas in the exclusive economic zone. The environmental report resulting from the assessment describes the starting point and findings of the SEA process. In the environmental report, the impacts on humans, natural environment, community structure, the use of natural resources and their cross-impacts have been assessed for each offshore wind power area. The report also presents the combined impacts of the implementation alternatives, assesses the most significant risks of the draft decision on the basis of these impacts, and presents proposals for managing the impacts.

Focus in the assessment is on identifying and assessing the key environmental impacts that may affect humans, natural environment, community structure and the use of natural resources. In the environmental report, the results are illustrated with tables and maps.

The report presents the combined effects of the implementation alternatives and assesses the most significant risks arising from the draft decision. The report also proposes measures to manage the impacts.

The report contains the national and international consultations carried out in accordance with the SEA Act. The opinions and views received from the consultations are discussed as part of the environmental report and they were taken into account in the finalisation of the report.

The purpose of the assessment is to support the Government decision and planning of offshore wind power areas and to promote sustainable implementation of wind power. The environmental assessment is used to identify the framework conditions for offshore wind power projects and for mitigating their harmful impacts. At the same time, the social licence is strengthened and basic information is provided to actors in the sector for project-specific planning.

The opinions submitted in the consultation required under the SEA Act are appended to the report as a summary (Appendix 1) and the opinions have been taken into account as necessary in the finalisation of the report.

1 Foreword of the environmental assessment

The environmental impacts of certain types of official plans and programmes must be assessed under the Act on the Assessment of the Effects of Certain Plans and Programmes on the Environment (200/2005; SEA Act). This obligation also applies to the Government decision on offshore wind power areas in the exclusive economic zone even if, strictly speaking, it is a decision rather than a plan. Before the decision is made, the environmental impacts of the draft decision must be assessed in a SEA process.

This chapter describes the legislative background, purpose and objectives of the SEA process. It also describes the course of the environmental assessment, both at general level and in this specific assessment, and how the results of the assessment will be used.

1.1 Background and purpose of the environmental assessment

Under section 3 of the SEA Act, the authority responsible for a plan or programme must ensure that the environmental impacts of the plan or programme are investigated and assessed sufficiently in the course of preparation if the implementation of the plan or programme may have significant environmental impacts.

At the time of the environmental assessment, the Government decision on offshore wind power areas in the exclusive economic zone was in draft form, and the actual decision will only be made after the environmental assessment. The content of the draft decision is described in more detail at the beginning of this material. Preparation of the draft Government decision is the responsibility of the Ministry of Economic Affairs and Employment, which has commissioned an environmental impact assessment and environmental report in accordance with the SEA Act from Sweco Finland Oy. The steering group, with members from the Ministry of Economic Affairs and Employment and the Ministry of the Environment, has played an active role in the various stages of the SEA process. More detailed information on the carrying out of the SEA process can be found in section 1.3.

This document corresponds to the environmental report specified in the SEA Act. In accordance with section 2 of the SEA Act, the environmental assessment contained in the document means the assessment of the environmental impacts of a plan or a programme referred to section 8–11 of the act and the preparation of the environmental report contained in the assessment, organisation of consultations, consideration of the findings of the environmental report and consultations in decision-making and provision on information on the decision. For reasons of clarity, the environmental assessment is, when necessary, referred to as the ‘SEA process’ to distinguish it from the project-specific environmental impact assessment (EIA).

The assessment contains:

1. Identification and assessment of the likely significant environmental impacts of offshore wind power areas in the exclusive economic zone
2. The monitoring plan referred to in section 12 of the SEA Act
3. The environmental report referred to in the SEA Act and Decree
4. National information provision and consultations referred to in the SEA Act in different stages of the work
5. Processing of the opinions and views received during the commenting round and in other consultations as part of the environmental report

The purpose of the environmental assessment is to support the Government decision and planning of offshore wind power areas in the exclusive economic zone. Its purpose is also to support sustainable implementation of offshore wind power generation by producing background material for private and public actors in the sector. The assessment will identify framework conditions relating to the environment and society within the limits of which offshore wind power projects can be carried out and which can mitigate their harmful impacts and risks. The commenting round and consultations will strengthen the social licence of offshore wind power built in the exclusive economic zone. At the same time, they provide actors in the sector with basic information and starting points for project-specific planning. The SEA process will support project actors’ ability to manage their risks by defining the framework conditions for the activities, which will also make wind power more attractive as an investment.

The purpose of the SEA process and the resulting environmental report is not to comment on the approval of offshore wind power projects or on the feasibility of individual wind turbine projects from a technical, economic or legal perspective. Its aim is to assess the draft decision itself and to produce information on the impacts of its implementation on the environment. A well-organised environmental assessment can enhance the benefits or acceptability of the plan implementation or highlight the best ways to identify and minimise harmful impacts.

1.2 Course and objectives of the SEA process

A high-quality environmental assessment produced in compliance with the SEA Act is carried out as a process linked to the different stages of planning so that the actors can identify how to mitigate significant impacts when implementing the plan.

The purpose of the assessment process concerning the Government decision on offshore wind power areas in the exclusive economic zone is to compile the relevant existing data and analyse it from the perspectives referred to in the act using the environmental impact framework, allocated to the different life cycle stages of the offshore wind power project. The findings will benefit public administration, companies and stakeholders. Publicly available information will determine the level of detail of the findings as this SEA process does not include field studies or produce entirely new data on the state of the environment.

In accordance with the SEA Act, the environmental report describes the impacts on biodiversity, biota, vegetation, water, soil, air and climate factors, population, human health, living conditions and happiness, landscape, community structure and built environment, material wealth, cultural heritage, exploitation of natural resources and the relationships between these factors.

The environmental report contains the contents required under the law as follows:

- The current state and characteristics of the environment in the area under review (broadly speaking, the Gulf of Bothnia) as well as the changes in its state and the visibility of environmental problems in the area are described in chapter 3. This also corresponds to the situation in which no offshore wind power would be built in the area (zero alternative). Key sources and information gaps are mentioned for each perspective.
- Identification and assessment of the impacts is based on impact pathways. In them, an offshore wind power project is a factor changing the environment that causes a visible change on the sites of the impact area, from which the impact will spread further to the ecosystem. This assessment framework and its assumptions and the factors specifying it are described in chapter 4.
- Each of the four potential target areas listed in the draft decision are discussed separately so that the existing information on the current state of the environment in the areas envisaged for each offshore wind power project and information gaps concerning the areas are first described in detail. The likely significant impacts that would result from the use of the area are then described in accordance with the assessment framework. The interactions between the areas (greatest possible impact) are also described. These impact assessments are described in chapter 5.
- The relationship between the draft decision and other plans and programmes is examined as part of the rest of the structure so that essential plans and programmes are described in chapter 2 and they are visible in the environmental trends described in chapter 3. Chapter 5 discusses possible combined impacts on the environment if the offshore wind power areas described in the draft decision are realised.
- The draft decision has prompted discussion among stakeholders on issues that are significant for the sector and societal situation as a whole such as security of supply, social licence and preparedness for climate change. Although these are not directly listed as requirements in the SEA Act, they have been taken into account in suitable contexts.

The SEA process has been carried out so that it meets the requirements of the SEA Act and the Government Decree on the Assessment of the Effects of Certain Plans and Programmes on the Environment (347/2005; SEA Decree) supplementing it, and it has been implemented on the basis of the latest SEA guidelines[2] and guidelines on ecological surveys and ecological impact

[2] Paldanius, J. 2025. Guide on environmental assessment under the SEA Act Publications of the Ministry of the Environment 17/2025 (in Finnish, with English abstract)

assessment.[3] Course of the environmental assessment (see Figure 1) is specified in SEA legislation and guidelines.

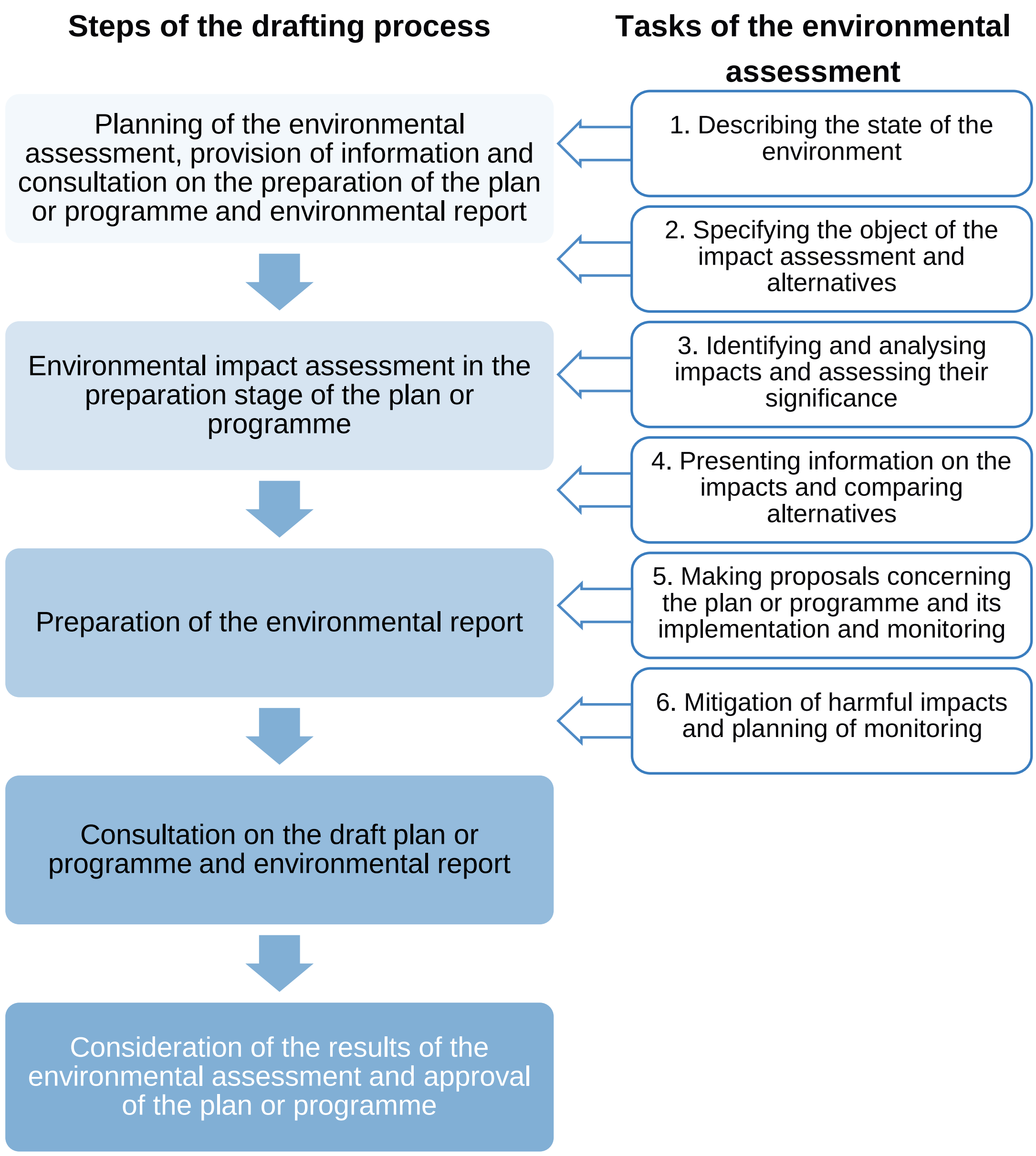

Figure 1: Course of the SEA process and the content of the different steps. Adapted from the guide on environmental assessment under the SEA Act.[4]

The latest guide for carrying out an environmental assessment under the SEA Act had not yet been published as the preparation of the environmental report started and for this reason, the SEA guide published in 2017 has also been used

[3] Mäkelä, K. & Salo, P. 2023. Ecological Surveys and Ecological Impact Assessment. A Guide for Surveyors, Customers and Authorities. Reports of the Finnish Environment Institute 43/2023 (in Finnish, with English abstract).

[4] Paldanius, J. 2025. Guide on environmental assessment under the SEA Act Publications of the Ministry of the Environment 17/2025 (in Finnish, with English abstract)

in the drafting of the report.[5] The SEA guides contain recommendations on good practices for the SEA process. The interpretations and recommendations presented in the guides are indicative and they are not legally binding. The new guide, published in 2025, covers the changes to the SEA legislation made after 2017 that affect the carrying out of environmental assessments and it includes updated practical tools, models and working methods for efficient management of the SEA process.

1.3 Carrying out the SEA assessment of the draft decision on offshore wind power areas in the exclusive economic zone

The SEA process was carried out between April and November in 2025. The assessment was commissioned by the Ministry of Economic Affairs and Employment, which is responsible for preparing the decision. The assessment was carried out by Sweco Finland Oy, whose expert team's competence covers both offshore wind power and sustainable use of seas in a broader sense, marine ecology, maritime sectors and environmental assessments. The assessment steering group had representatives from the Ministry of Economic Affairs and Employment and the Ministry of the Environment as members.

Existing and publicly available data and modellings of the characteristics of the area under review, state of its environment as well as research literature on the environmental impacts of offshore wind power were used in the environmental assessment. Descriptions of potential offshore wind power areas prepared by the Finnish Environment Institute were also used in the description of the current state of the environment and in the environmental impact assessment. An expert assessment produced by the implementation team also played a key role.

The assessment process includes two consultation rounds in Finland and internationally. In the first stage (between May and July), a consultation was held on the planning of the environmental assessment and preparation of the environmental report. In the second stage (autumn 2025), a consultation will be held on the draft Government decision and the finalised environmental report. The consultation of the second stage will be carried out in Finland in accordance with the SEA legislation and the international consultation will be carried out in accordance with the Convention on Environmental Impact Assessment in a Transboundary Context (Finnish Treaty Series 69/1997; the Espoo Convention) and the Protocol on Strategic Environmental Assessment (Finnish Treaty Series 69/2010; the SEA Protocol) based on it. The opinions submitted in the consultations required under the SEA Act will be archived and published as an appendix to the environmental report and as a summary (Appendix 1).

[5] Paldanius, J. 2017. Guide on environmental assessment under the SEA Act Environmental administration guidelines 2/2017.

2 Object of the assessment

2.1 Potential offshore wind power areas in the exclusive economic zone and the main content of the draft Government decision on them

The assessment concerns the draft Government decision on offshore wind power areas in the exclusive economic zone even though, strictly speaking, it is a decision rather than a plan. The key content of the draft decision comprises four potential offshore wind power areas and requirements concerning them. The content is described at the start of this material. The total size of the potential offshore wind power areas is 921 km^2. Size of the individual areas:

- **Bothnian Sea West: 211 km^2**
- **Bothnian Sea East: 202 km^2**
- **Bothnian Bay South: 284 km^2**
- **Bothnian Bay North: 224 km^2**

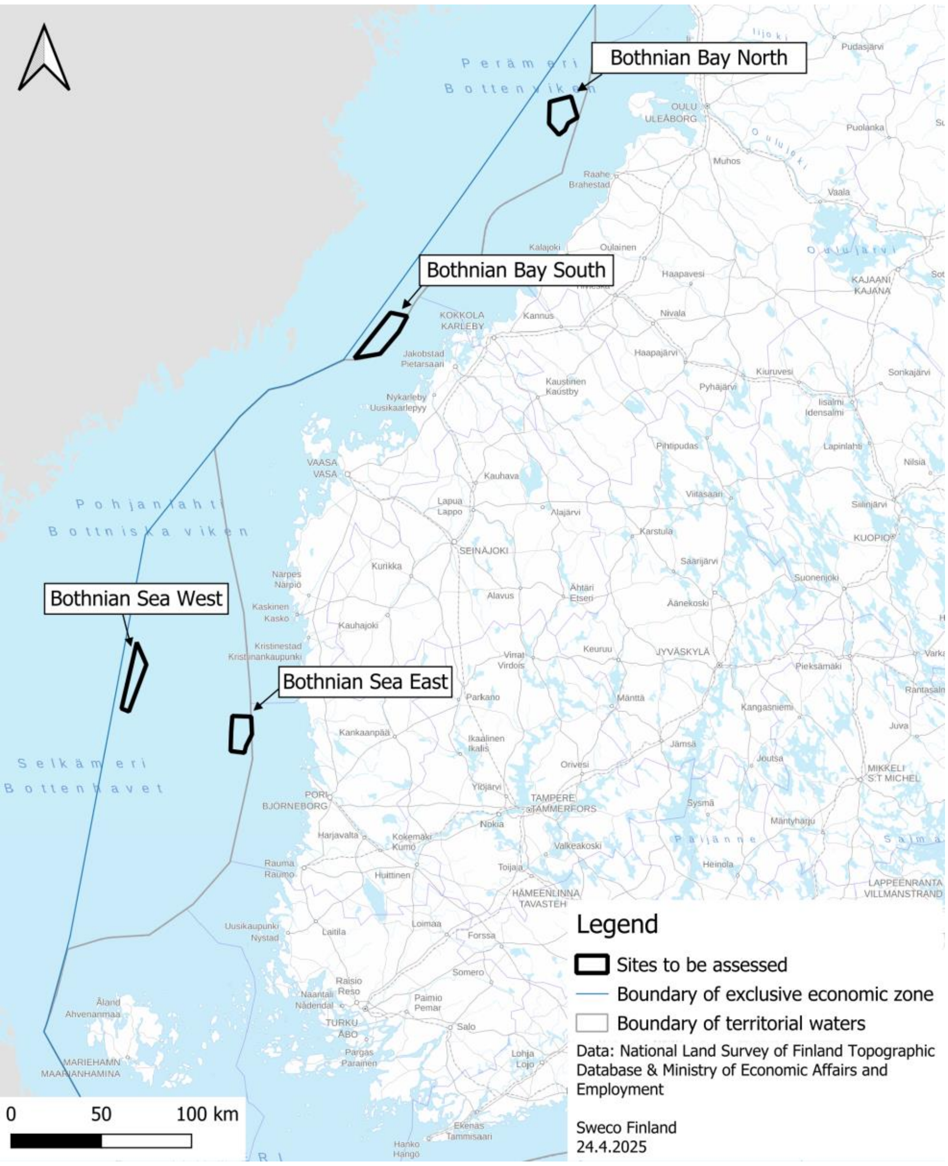

Figure 2: Location of the areas in the draft decision to be assessed.

The responsibility for drafting the decision on offshore wind power areas rests with the Ministry of Economic Affairs and Employment, which submitted the information on the draft decision essential in terms of the SEA assessment to the party carrying out the assessment on 31 March 2025.

2.2 Life cycle and general technical implementation methods of an offshore wind power project

Offshore wind power means wind power production in sea areas; wind power production in land areas is called onshore wind power. The essential feature of offshore wind power is that the sites on which electricity is produced are located far away from the majority of land-based end users.[6] In particular, this applies to wind power production sites in the exclusive economic zone far from the coast.

In this environmental assessment, offshore wind power means the complex consisting of turbine units and the infrastructure they need on the production site as well as transmission of electricity to the onshore grid. The production site infrastructure includes internal cables and an offshore substation. Power transmission to land comprises a connection cable from the offshore substation to an onshore connection point. However, the Government decision on area selection will not apply to cables, and transmission of electricity to land is not mandatory.

The SEA assessment is based on the available information and current, widely used solutions in the sector. The manufacture of offshore wind power components and the origin of raw materials are outside the scope of the SEA assessment. The assessment, comparison and selection of different technical solutions for offshore wind power are part of the project-specific planning and environmental impact assessment (EIA) process as well as the project's permit processes.

2.2.1 Project life cycle

In this environmental assessment, the life cycle of an offshore wind power project consists of four stages (see Figure 3: The stages and life cycle of an offshore wind power project from planning to decommissioning.). The emissions and waste generated during the presented life cycle fall under the scope of this assessment. As a stage, the SEA process itself is not included in the presented life cycle and comes before the preliminary studies and planning of the project.

The **preliminary study and planning stage** covers surveys and scientific studies of the area, planning of the offshore wind power project and electricity grid, and selection of technical solutions. This stage includes the EIA and permit processes.

After the studies and planning and once the EIA and permit processes have been completed, the offshore wind power project and its infrastructure can be built. **Construction** includes seabed intervention, installations at sea, cable laying, soil disposal, sea and land transport; and port operations, such as intermediate storage and pre-assembly. The construction activities will depend on the selected technology and the number of wind farms to be built.

Once the construction work has been completed, the **production and maintenance** stage of the project will begin. This is the stage with the longest duration. It includes monitoring, servicing and maintenance of the turbines and submarine cables as well as the transport of crews and spare parts needed for these activities. This stage also involves possible environmental monitoring obligations and follow-up studies.

The current service life of an offshore wind turbine is about 30 years, after which it will be decommissioned. The **decommissioning stage** includes transport and demolition work on the production site and activities associated with them in ports. This phase also comprises any environmental restoration work, recycling of materials and waste management. It is assumed in this SEA process that the structures above and below water level will be demolished at the end of the

[6]See Figure 2

project, at least to the depth required for maritime safety. The stage also includes any post-demolition environmental monitoring studies.

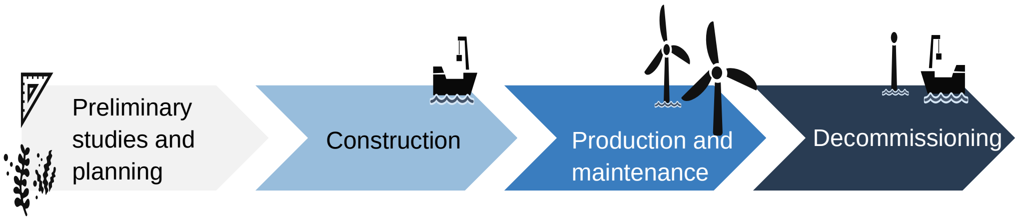

Figure 3: The stages and life cycle of an offshore wind power project from planning to decommissioning.

2.2.2 Common technical implementation methods

Structure and size of the wind turbine

The technical implementation includes deciding on the size of the wind turbine. In this context, the size refers to the total height of the turbine unit, including the tower and the rotor with its blades. In other words, the total height is measured to the tip of the rotor blade when it is pointing upwards. The axis of the wind turbine can be either horizontal or vertical; in most cases, the axis is horizontal.

The size of the wind turbine affects its power generation capacity: larger turbines produce more electricity than smaller ones. Fewer larger turbines are needed to achieve the same production capacity. The size of the wind turbine also affects its environmental impacts. For example, as larger wind turbines are higher, the landscape impact and bird collision risks they create are greater, whereas more seabed foundations are needed if a larger number of smaller turbines are constructed. The size of the wind turbines also affects their proximity to each other: larger wind turbines require more space around them than smaller ones.

In the implementation alternatives of the EIA programmes for projects planned in Finland, the turbines vary from 15 to 30 MW in capacity, and from 260 to 400 metres in total height. The draft decision covered by the environmental assessment does not specify the power or other technical details of the individual turbines. Instead, the decision specifies the maximum and minimum total power of the wind power projects suitable for the designated wind power areas.

Foundations and placement

There are various technical solutions for building wind turbines, and the essential differences in the case of offshore wind power concern the implementation of their foundations. The selection of foundation technology is influenced by the characteristics of the production site to be set up, including seabed quality and water depth. The placement of wind turbine units can be decided taking local environmental and natural conditions into account. Deciding on their placement and foundation type will be part of the mitigation measures associated with individual wind turbines.

The environmental impact assessment programmes[7] for offshore wind power projects published in Finland (EIA programmes for offshore wind power projects

[7] EIA programmes for offshore wind power projects in the exclusive economic zone: Navakka offshore wind power project. https://www.ymparisto.fi/fi/osallistu-ja-vaikuta/ymparistovaikutusten-

in the exclusive economic zone) and the compilation report prepared by the Swedish Environmental Protection Agency[8] discuss foundation solutions for offshore wind turbines. They can be roughly divided into seabed foundations and floating solutions.

Seabed foundations include piled, gravity-based and tripod foundations, the most common type of which is the piled foundation. While the different foundation solutions have their limitations regarding seabed quality and depth, what they all have in common is that the structures are anchored to the seabed.

Floating foundations, which are mainly anchored to the seabed using cables, have also been developed for wind turbines. As their name suggests, the turbines float on the surface of the sea. Wind turbines with floating foundations can be placed in deeper water areas than those with foundations on the seabed, and the depth on the site must be at least 60 metres. However, floating turbines are a relatively new technological solution, and their feasibility has its own problems. In the Gulf of Bothnia the ice creates specific difficult conditions, and in their current development phase, using floating wind turbines in challenging ice conditions presents problems.

Electricity transmission solutions and their placement

Offshore wind power essentially includes wind turbines located on the production site at sea, cables within the production site, offshore substations and any transmission cables from the production site to onshore electricity infrastructure.

Each offshore wind power project needs an offshore substation for electricity transmission purposes. Cables connect each turbine on the production site to the offshore substation. The substation consists of a switchgear that assembles cables of equal voltage from different turbines and feeds the power downstream, or a transformer substation where transformers are used to convert the generated electricity into the form in which it can be transmitted to the mainland. The required voltage depends on the selected cable technology; this determines the voltage that the transformers will produce and whether the electricity will be transmitted as DC or AC.

From the substation, the submarine cable transfers electricity along the bottom to an onshore substation. The transmission cables are laid along a prepared cable route on the seabed. On soft seabed, it is also common to immerse the cables in the seabed sediment, for example by ploughing, and to protect them in shallower sections of the transmission route using such materials as rocks or concrete where the cable meets the land.[9] The cable-laying technique to be used depends on the topography and quality of the seabed.

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arviointi/eolus-finland-oy-navakka-merituulivoimahanke-satakunnan-edusta-selkameri#contact-information (in Finnish), Wellamo offshore wind power project https://www.ymparisto.fi/fi/osallistu-ja-vaikuta/ymparistovaikutusten-arviointi/eolus-finland-oy-wellamo-merituulivoimahanke-selkameri (in Finnish), Vågskär offshore wind power project https://www.ymparisto.fi/fi/osallistu-ja-vaikuta/ymparistovaikutusten-arviointi/ilmatar-offshore-ab-vagskar-merituulivoimahanke-selkameri (in Finnish), and Bothnia offshore wind power project https://www.ymparisto.fi/fi/osallistu-ja-vaikuta/ymparistovaikutusten-arviointi/ilmatar-offshore-ab-bothnia-merituulivoimahanke-selkameri (in Finnish)

[8] Bergström, L., Öhman, M., Berkström, C., Isæus, M., Kautsky, L., Koehler, B., Nyström Sandman, A., Ohlsson, H., Ottvall, R., Schack, H. & Wahlberg, M. 2021 – Effekter av havsbaserad vindkraft på marint liv, En syntesrapport om kunskapsläget 2021. Naturvårdsverket rapport 7049

[9] Niras Consulting ltd. 2015. Subsea cable interactions with the marine environment, Expert review and recommendations report. Renewables Grid Initiative.

Each production site needs at least one transmission cable to feed the energy downstream unless it is, for example, converted into hydrogen on the production site in the future. If several cables are used for electricity transmission at sea, the area affected by seabed interventions in connection with cable laying will grow.

When cable routes are planned, the seabed quality and water depth as well as the ecological values and conservation status of the area must be taken into consideration. While ecological values should be considered in the alignment of the route, as a rule it must be as straight as possible. Due to technical challenges and environmental impacts, the aim is to avoid uneven seabed and the need for excavation. Other human activities in marine areas, including fishing and shipping, must also be taken into account in cable placement. Similarly, existing pipelines and cable routes with their safety distances must be taken into account. Wrecks to be protected and any war-time explosives must also be considered in terms of cable routes. Consequently, cable routes have certain framework conditions that determine the placement of cables: the production site, electricity recipient, reliability of supply, other users of the sea area, societal needs and environmental conditions.

2.2.3 Possible offshore hydrogen production and safety of the sites

Offshore hydrogen production

In the future, the reform of the Electricity Market Act (588/2013) may create a basis for supplying electricity directly from the production area to end users in coastal areas.

Offshore hydrogen production concepts are under development but there are still very few actual production plants and environmental impact assessments. Offshore hydrogen production is based on electrolysis, which uses renewable wind energy to separate hydrogen from sea water. This requires renewable energy, an electrolysis plant and possibly seawater desalination, storage capacity and transport or transfer capacity.

If hydrogen is produced from electricity at sea, the need for transmission cable and connection point capacity in the area will be reduced. However, hydrogen or the products processed from it must also be transferred; this requires a pipeline or the products can also be transported from the area by vessel.[10]

The production, storage and transport of flammable and explosive gases and liquids requires that risks are taken into account and that domino risks (chains of accidents) are prevented. In a chain of accidents, a hydrogen explosion could damage the wind turbine unit or cause it to collapse. There are separate safety regulations for large-scale storage, handling and transport of dangerous substances on land, including the location and land use of the production plants. The growing number of hydrogen project plans has led to a need to update the legislation.[11] The technical and economic feasibility of hydrogen production on the target sites is outside the scope of this SEA process.

[10] In the future, it may also be possible to place functions of the hydrogen value-added chain, such as processing of hydrogen into ammonia or methanol, at offshore wind power areas. In that case, the infrastructure would depend on the type of products produced in the area.

[11] Ministry of Economic Affairs and Employment: Safety Requirements for Industrial Treatment of Hydrogen and the Need for Legislative Updates. Publications of the Ministry of Economic Affairs and Employment 2024:37 (in Finnish, with English abstract)

Risk management and safety of offshore wind power

As all infrastructure important to society, offshore wind power is not immune to the risk of exceptional situations, accidents and intentional damage. These risks are identified, assessed and minimised in the placement and design of the turbines, in the permit processes and operating practices during production. The following is a list of identified potential risks facing offshore wind power.

Offshore wind power and work at sea involve safety risks for the personnel performing construction and turbine maintenance work. Offshore wind turbines reduce the number of available shipping routes and impact the accuracy of the radar image, which means that there is a risk of collisions between vessels and offshore wind turbines. Damage to turbines and falling parts or ice that has accumulated in the structures do not generally pose a significant safety risk as access to offshore wind power areas is restricted.

The turbines are typically monitored by means of remote monitoring and maintained on a proactive basis. This is because maintenance is more difficult during ice cover than during the open water season. Proactive maintenance is also used to manage the risks of damage and detachment of wings and it improves the occupational safety of the personnel performing maintenance work.

Reliability of production and security of supply have prompted a debate on whether more than one transmission cable would be needed for each offshore wind power area so that in the event of a malfunction or intentional damage, the electricity production capacity of the entire area would not be disconnected from the main grid and cause harm to the energy system.

2.3 Determining the area covered by the assessment

The four geographical production areas specified in the draft decision constitute the area reviewed in this environmental assessment. Structures located in the offshore wind power areas (turbines in the production areas and their structures and the transmission of electricity at sea) are the activities discussed in the assessment. The impacts of each of the four areas are assessed by production area and (for cable routes) at the top level.

The focus in the examination of combined impacts is on the Gulf of Bothnia, and on the activities in that sea area. At the same time, it should be noted that some of the individual impact pathways extend beyond the area examined in this document, for example to the southern parts of the Baltic Sea. The actual impact area is thus larger than the area under review. Wherever possible, the impacts outside the area covered by the assessment are identified and listed in this environmental assessment but no detailed assessment of them will be prepared.

Identification of different impacts and their extent and intensity are assessed in chapter 4.

2.4 Relationship with other plans and programmes

The relationship of a plan or programme covered by the assessment with other plans or programmes is examined as part of the SEA assessment. Table 1 contains the other plans or programmes that are closely related to the development of offshore wind power in the exclusive economic zone and the draft Government decision. These comprise the strategies and plans concerning energy and climate policy, plans concerning the use of marine areas and offshore wind power and the commitments and programmes concerning the protection of marine environment and biodiversity.

Table 1. Key plans and programmes concerning the development of offshore wind power in the exclusive economic zone and the decision on offshore wind power areas and the way in which they relate to the draft decision.

Plan or programme	Content of the offshore wind power in the exclusive economic zone	Relationship with the draft decision
Programme of Prime Minister Petteri Orpo's Government A strong and committed Finland, 20 June 2023	Entry on preparing legislation on the development of offshore wind power in the exclusive economic zone, limiting global warming, doubling the production of clean electricity, operational reliability, investments, hydrogen, clean nature and biodiversity, combating biodiversity loss Source: A strong and committed Finland:Programme of Prime Minister Petteri Orpo's Government, 20 June 2023 – Valto	**Synergy:** The draft decision is in accordance with the entry contained in the Government Programme and promotes many of the themes highlighted as objectives in the Government Programme.
Carbon neutral Finland 2035 – national climate and energy strategy (2022)	Meeting the climate commitments set by the EU for the year 2030 and the emission reduction targets specified in the Climate Change Act, increasing the share of renewable energy and phasing out Russian fossil energy, national hydrogen strategy and generating energy for the promotion of the hydrogen economy and electric fuels Source: Carbon neutral Finland 2035 – national climate and energy strategy – Valto	**Synergy:** offshore wind power in the exclusive economic zone would support the achievement of emission reduction targets, increasing of the share of renewable energy and the implementation of the national hydrogen strategy
Preparation of a new national energy and climate strategy	Not yet confirmed Climate targets, security of energy supply and delivery reliability, promotion of renewable energy sources, scenario calculations assessing energy and emission trends Source: Energy and climate strategy –	N/A

	Ministry of Economic Affairs and Employment	
Fingrid: Preliminary potential for connecting offshore wind power with Fingrid's main grid in the 2030s	Seven potential 1.3 GW connection points have been identified in mainland Finland. This would impact the potential production volumes of offshore wind farms and the location of submarine cables. The need to reinforce the main grid has been recognised. Source: Fingrid's final report refines the preliminary connection possibilities for offshore wind power – Fingrid & Final report	**Synergy:** The Fingrid plan identifies the connection potential with offshore wind power in the exclusive economic zone. At the same time, the placement of offshore wind power determines which connections can be realised.
Gasgrid: Updated route plan for the national hydrogen infrastructure	Enabling hydrogen economy, route plan based on an estimate of the location of hydrogen production and/or utilisation potential Source: Updated national hydrogen infrastructure route plan announced at Gasgrid's Future of Gases event – Gasgrid Finland	**Potentially synergic:** under the draft decision energy can also be produced for the hydrogen economy
Maritime spatial planning	Sustainable use of marine areas and strategic coordination of maritime activities, compilation of information on the state and use of marine areas, identification of potential areas for marine energy production and other activities Source: Maritime spatial planning MSP	**Synergy:** Maritime spatial planning supports the coordination of maritime activities and produces information on the use and ecological values of marine areas. One of the areas in the draft decision is outside the areas identified for energy production in the maritime spatial plan.
Government resolution on launching an auction procedure for Finland's public water areas in five offshore wind farm areas 2023 & offshore wind power development by Metsähallitus	Preliminary development of offshore wind power and competitive tendering in state-owned parts of the Finnish territorial waters, five offshore wind power projects approved by the Government, in one of which project development	**Partially contradictory, potential partial synergies:** Offshore wind power projects in the exclusive economic zone and territorial waters would probably have significant combined impacts on the environment and human activities. Projects in territorial waters must be taken into

	is under way with a partner (Korsnäs) and in two of the projects, Metsähallitus is carrying out project development work and statutory land use planning (Ebba and Edith) Sources: Metsähallitus launches auctions concerning large-scale offshore wind power projects – Government & The competitive tendering process for Ebba and Edith offshore wind projects has been concluded – Metsähallitus will continue project development and relaunch the process later | Metsähallitus	account in the selection of wind power areas in the exclusive economic zone. At the same time, project development plans could potentially benefit from each other as value-added chains are built.
Natural resource plan for marine areas 2024–2028	Strategic policies and action plan of Metsähallitus in territorial waters concerning the development of offshore wind power, protection of natural and cultural heritage, fisheries, shipping and marine extractives. Source: Natural resource plan for marine areas 2024–2028 (in Finnish)	**Partially contradictory, partial synergies:** Guides the development of wind power in territorial waters and in this way contributes to the combined impacts in the development of offshore wind power in the Gulf of Bothnia and to potential synergies as value-added chains are built. Impacts are also generated through the coordination of other activities.
National river basin management plans and marine strategies	Assessments of the state of the marine environment, monitoring of the state of the marine environment, marine environment management measures (See chapter below for more details) Source: River basin management plans and marine strategies (in Finnish)	**Contradictory, partial synergies:** development of offshore wind power in the exclusive economic zone may adversely affect the state of the marine environment. At the same time, it can also have positive impacts through climate change mitigation. The information produced by the marine strategy can be used in the assessment and mitigation of environmental impacts.
National restoration plan	Under preparation Implements the Nature Restoration Regulation of the European Union Source: Preparation of the national restoration plan – Government (in Finnish)	**Probably contradictory:** Offshore wind power areas in the exclusive economic zone would reduce the size of untouched seabed and habitats and pose risks to biodiversity

The draft decision on offshore wind power areas in the exclusive economic zone implements the Programme of Prime Minister Petteri Orpo’s Government and the national climate and energy strategy.

The draft decision contributes to the implementation of international climate policy and the achievement of the national carbon neutrality target by providing a basis for the production of zero-emission renewable energy with offshore wind power.

There is a close relationship between Fingrid's connection point plan and the draft decision assessed in this document. It is essential to develop Finland's main grid so that offshore wind farms can be connected to the grid. Extent of the need to develop the main grid depends on the number of offshore wind farms that will actually be built.

Gasgrid's hydrogen infrastructure plan is also closely linked to the increase in offshore wind power capacity. Hydrogen production needs energy and in the optimum situation, this energy is emission-free. At the same time, hydrogen or products processed from it can play an important role as a future energy reserve balancing the energy system as the proportion of renewable energy production fluctuating according to the weather increases, and there is a continuing geographical mismatch between production and energy use.

To support sustainable use of the sea, maritime spatial planning is carried out jointly by regional councils in coastal areas. In this work, maritime activities are coordinated on a strategic basis. Important research findings and information from stakeholders for the placement of offshore wind power and other activities is collected in the process. Maritime spatial planning is the only spatial planning tool in the exclusive economic zone and it supports the placement of offshore wind power in the entire Finnish marine area, taking appropriate account of other activities and the state of the environment.

The relationship between potential offshore wind power areas on the one hand and biodiversity policy and biodiversity protection on the other in such matters as the implementation of the national restoration plan is twofold. As a mitigator of climate change, a major driver of biodiversity loss, offshore wind power helps to prevent biodiversity loss. At the same time, the construction of offshore wind power changes marine habitats and affects species. These impacts are described in this environmental report. The most direct impacts are felt in marine nature, marine environment management and water resources management.

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Marine environment management is closely linked to the potential development of offshore wind power in the exclusive economic zone, which is covered by Finland's marine strategy. [12] Under the Water Management Act, a marine strategy is drawn up for Finnish territorial waters and exclusive economic zone to organise marine environment management. The strategy sets out objectives for the state of the marine areas in the exclusive economic zone and the information it produces on the state of the sea supports the sustainable development of offshore wind power and the monitoring and mitigation of environmental impacts. The marine strategy has three parts: The first part contains an assessment of the state of the marine environment, definition of the good state and the environmental objectives, the second part contains an examination of the

[12] Marine environment management in the EU is based on the Marine Strategy Framework Directive (Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy). It has been implemented in Finland by means of the Act on the Organisation of River Basin Management and the Marine Strategy (1299/2004; Water Management Act), and the decrees implementing the act (Government Decree on the Organisation of the Development and Implementation of the Marine Strategy (980/2011), Government Decree on Water Resources Management (1040/2006) and the Government Decree on Water Resources Management Regions (1303/2004)).

adequacy of the monitoring programme and, if necessary, its update, and the third part contains an examination of the programme of measures and the required update. The monitoring programme assesses the state of the sea by using various indicators (qualitative descriptors), which concern such factors as biodiversity, fish populations, eutrophication and hazardous substances.[13] In addition to Finland's national marine strategy approved by the Finnish Government, the Baltic Marine Environment Protection Commission (HELCOM) has prepared its own programme, the Baltic Sea Action Plan. The Action Plan contains 199 measures to improve the state of the Baltic Sea and it was last updated in 2021. The measures are partially in line with national water resources and marine environment management measures and most of them are jointly implemented by the Baltic Sea states.[14]

Marine areas closer to the coast are part of inner area of water resources management and marine environment management. The boundary of the water resources management region is about 20 km closer to the coast than the administrative boundary between the exclusive economic zone and territorial waters, and if the offshore wind power areas envisaged in the draft decision reviewed in this SEA process are realised, a submarine cable would be the only structure located in the water resources management regions. The European Union Water Framework Directive (WFD)[15] creates a framework and objectives for the protection of inland surface waters, transitional waters, coastal waters and groundwater in the EU. The protection of waters aims to achieve the good state of water bodies.

In Finland, the requirements set out in the Water Framework Directive are primarily implemented by means of the Water Management Act and many of the Government decrees issued on the basis of the act.[16] According to the act, the general objective of the organisation of water resources management and marine environment management is to protect, improve and restore waters and the Baltic Sea so that the state of surface waters and groundwater or the Baltic Sea does not deteriorate and is at least 'good'. Finland provides the EU with the data on both mainland Finland and Åland required under the Water Framework Directive and the Marine Strategy Framework Directive in a single report.

The fourth planning period for water resources management and the third planning period for marine environment management now in progress cover the period 2022–2027.[17]

[13] Itämeri.fi, marine strategies. https://itameri.fi/en/humans-and-the-baltic-sea/marine-management-and-environmental-protection/methods-of-environmental-protection/

[14] Ympäristö.fi, River basin management plans and marine strategies (in Finnish) https://www.ymparisto.fi/fi/luonto-vesistot-ja-meri/vedet-ja-vesistot/vesien-ja-merensuojelu/vesien-ja-merenhoidon-suunnitelmat#merenhoitosuunnitelma-ja-itameren-suojelun-toimintaohjelma

[15] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

[16] Government Decree on Water Resources Management (1040/2006), Government Decree on the Organisation of the Development and Implementation of the Marine Strategy (980/2011), Government Decree on Water Resources Management Regions (1303/2004) and the Government Decree on Substances Dangerous and Harmful to the Aquatic Environment (1022/2006).

[17] Introduction to water resources and marine environment management planning. An overview of the joint work phases of water resources and marine environment management planning and their content for the period 2022–2027 (in Finnish). Version dated 29 May 2023

2.5 Environmental objectives relevant to the plan or programme

The aim of the Marine Strategy Framework Directive is to ensure good state of the marine environment. In Finland, the directive is implemented by means of a marine strategy, which constitutes the national marine strategy required under the directive. The action plan of Finland’s marine strategy for the period 2022–2027 lists a large number of environmental objectives for marine environment management. Objectives concerning the sustainable use of marine resources and the reduction of invasive species spreading with vessel traffic are particularly important issues when offshore wind power is promoted. Of the qualitative descriptors of the good state of the marine environment, offshore wind power has negative impacts, especially on underwater noise and seabed integrity. These impacts are inevitable if the aim is to promote offshore wind power but their significance partially depends on area selection and the planning of technical solutions for the project. In area selection, measures have been taken to reduce the impacts by avoiding areas where offshore wind power construction is estimated to have significant impacts on the environment.

The Habitats Directive applies to wild species and natural habitats that have been defined as endangered in the EU. The aim of the Habitats Directive is to achieve and maintain a favourable conservation status for species and natural habitats, taking into account economic, social and cultural requirements and regional and local special characteristics. In practice, the directive is implemented by means of the Natura 2000 network of protected areas.

The objective of the Birds Directive is to maintain bird populations at a level that meets ecological, scientific and cultural requirements, taking into account economic and recreational requirements or to adapt their populations to that level. The main instrument in implementing the directive is to identify areas important to birds and establish Natura 2000 protected areas in them.

Materials related to sensitive bird areas, marine nature and underwater ecological values have been taken into account in the selection of the areas. In the selection of the areas, measures have been taken to avoid sites where offshore wind power is estimated to cause significant environmental impacts. No offshore wind power sites have been placed in Natura 2000 protected areas. Bothnian Bay North is located about three kilometres from the Merikalla protected area, which is protected on the basis of underwater sandbanks, which is a Natura 2000 natural habitat type. However, the impacts of the offshore wind power project on this Natura 2000 protected area are not expected to be significant or long-lasting.

The draft decision on offshore wind power areas in the exclusive economic zone does not apply to cables, and thus the locations of possible cable routes from the offshore wind farms to the mainland are not specified in it. The aim of the Water Framework Directive is to achieve a good ecological state for surface water and groundwater. The Water Framework Directive is not applied in the exclusive economic zone but it is taken into account in the water permit process for the cables.

3 Current state of the environment, characteristics and changes that have taken place in the Gulf of Bothnia

3.1 Describing the current state of the environment

The description of the current state of the environment is a rough description of the trends in the state of the environment and waters in the current use of the areas. The description identifies the significant ecological challenges arising from the placement of offshore wind power, challenges and opportunities concerning human health and wellbeing as well as the environmental risks affecting waters and coastal areas. The description also takes into account the investment needs arising from green transition, regional economic development and the coordination between offshore wind power development and other economic and socio-cultural use of marine areas. This provides the basis for assessing the impacts of the measures set out in the plan in the next stages of the assessment.

There is less information available on the characteristics of the environment and nature in marine areas than on similar features in land areas. Unlike in marine areas, key environmental features on land, such as natural habitats, are clearly identifiable. Environmental data accumulates because the Land Use and Building Act (132/1999) regulates the use of land areas and the collection of data as part of the land use planning process. This includes consultations with stakeholders and a public decision-making process in which citizens can also comment on such matters as the preservation of local nature or provide information on the typical natural features that they have observed. At sea, underwater nature or other features are not visible or accessible in the same manner without special equipment and professional skills.

Thus, the knowledge base of the current state of the marine areas is almost entirely founded on how extensively public actors have invested in research on the state of the seas. In practice, this means how often samples have been taken and in which areas or how often the seabed has been examined, for example, by diving or with video recordings.

Companies required to obtain an environmental permit and operating at sea also monitor the state of waters. These materials, such as the material collected for the VELMU programme,[18] are partially publicly accessible. The purpose of VELMU is to collect information on the diversity of underwater natural habitats and species, and it has been built into a unique database of ecological surveys of Finland's undersea biodiversity. However, so far the focus in VELMU has been on areas close to the coast rather than on the exclusive economic zone. Some of the depth and seabed quality data concerning territorial waters is classified in accordance with the needs of the Finnish Defence Forces. With regard to the draft decision on the exclusive economic zone, this mainly concerns potential areas for future cable connections. The needs of the Finnish Border Guard may have to be considered when information on the exclusive economic zone is published.

The impact assessment is based on a description of the marine environment in the areas covered by the plan. This description draws on existing information. Essential background information for describing the state of the environment includes information on protected areas and the reasons why they are protected, significant underwater ecological values and seabed quality. For marine areas, the focus in the ecological surveys is on areas close to the coast where projects, investments and most of the other human activities are located.

The environmental assessment does not include field research or produce new data on the environment of the marine areas or the state of nature in them. For this reason, the description of the current state is based on the summaries of each target area produced by the Finnish Environment Institute (SYKE). To produce the summaries, SYKE has used a method it has considered suitable for the work.[19]

Published information sources:

- **Sensitive bird areas:** Sensitive bird areas in the Finnish maritime area for the Baltic Sea Action Plan for the Baltic Sea Action Plan. Report of the Finnish Environment Institute 24/2025 (in Finnish, with English abstract)
- **Material on marine nature:** Forsblom, L., Virtanen, E.A., Arponen, H. *et al.* Finnish inventory data of underwater marine biodiversity. *Sci Data* Volume 11, 2024
- **Areas important to humans:** Valuable areas for ecosystem services in Finland´s marine areas, Report of the Finnish Environment Institute 6/2024 (in Finnish, with English abstract)
- **Underwater ecological values and models:**
    - Virtanen E.A., Viitasalo M., Lappalainen J., Moilanen A. Evaluation, Gap Analysis, and Potential Expansion of the Finnish Marine Protected Area Network, Frontiers in Marine Science, Volume 5, 2018
    - Virtanen, E.A., Kallio, N., Nurmi, M., Jernberg, S., Saikkonen, L., Forsb lom, L. Recreational land use contributes to the loss of marine biodiversity. *People and Nature*, Volume 6, 2024
    - Forsblom, L., S. Jernberg, H. Kuosa, K. Kostamo, C. Gustafsson, and E. Virtanen Integrating Regulating Ecosystem Services in Marine Conservation Planning. *Aquatic Conservation: Marine and Freshwater Ecosystems* Volume 35, 2025

[18]Finnish inventory programme for underwater marine diversity
[19]E.A. Virtanen et al. Balancing profitability of energy production, societal impacts and biodiversity in offshore wind farm design, Renewable and Sustainable Energy Reviews, Volume 158, 2022

3.2 State of waters and eutrophication

The state of the Baltic Sea is fundamentally threatened by diffuse pollution originating from land areas,[20] which is why, as a rule, the water quality of surface layers improves towards open sea. The decrease in nutrient content away from the coast is also reflected in the range and diversity of invertebrates.[21] The water quality in the Bothnian Sea and the Bothnian Bay is better than in the Archipelago Sea and the Gulf of Finland where larger historical nutrient concentrations causing internal loading have accumulated, and where cyanobacteria (blue-green algae blooms), multiplying in the main basin of the Baltic Sea, are carried by winds and sea currents.[22]

The state of Finnish water areas has been classified in connection with the monitoring of the state of water bodies. All offshore wind power areas assessed in this SEA process are located in the water resources management region in the open sea far away from the coast. Power transmission cables from offshore wind power areas to land would be partly located in the water resources management region. In the water resources management region, the state of waters is monitored as part of the status classification work under the Water Framework Directive. (For more information on marine environment management and water resources management, see chapter 2.4)

According to the most recent report on the state of marine environment in Finland (2024),[23] nitrogen, phosphorus, chlorophyll a and blue-green algae content as well as visibility depth in the open sea areas of the Bothnian Sea are less than good. Trends in nitrogen content and visibility depth have been positive but the trend in phosphorus content and blue-green algae concentrations has been negative. Oxygen content and the state of benthic fauna has been good but the trend for oxygen has been negative.

In the Bothnian Bay, the state of the variables has remained unchanged but blue-green algae populations have not been monitored. The trend for nitrogen has been positive and for chlorophyll a, the trend has been negative. Other variables have remained unchanged.

According to the status monitoring carried out by the Helsinki Commission (HELCOM),[24] the Bothnian Sea and the Bothnian Bay are in a poor state regarding eutrophication. According to HELCOM,[25] both areas are in a poor state regarding hazardous substances. According to HELCOM classification, neither

[20] Programme of Measures of Finland's Marine Strategy 2022–2027. Publications of the Ministry of the Environment 2021:30 (in Finnish)

[21] Rinne, H., Blanc, J-F, Salo, T., Nordström, M, Salmela, N. & Salovius-Laurén, S. 2022. Variation in *Fucus vesiculosus* associated fauna along a eutrophication gradient. Estuarine, Coastal, and Shelf Science 275, 107976

[22] Helminen, H. & Inkala, A. 2024. Modelled Water and Phosphorus Transports in the Archipelago Sea and through the Åland Sea in the Northern Baltic Sea and Their Links to Water Quality. Journal of Marine Science and Engineering 12, 1252.

[23] Piepponen, H., Laamanen-Nicolas, L., Korpinen, S., Back, M., Ekebom, J., Suomela, J., Lahtinen, T., Paavilainen, P. & Rinne, H. 2024. The state of marine environment in Finland 2024. Reports of the Finnish Environment Institute 35/2024 (in Finnish, with English abstract)

[24] HELCOM Thematic assessment of Eutrophication 2016–2021. Baltic Sea Environment Proceedings No.192

[25] HELCOM (2023): HELCOM Thematic assessment of hazardous substances, marine litter, underwater noise and non-indigenous species 2016–2021. Baltic Sea Environment Proceedings No. 190.

of the sea areas differs significantly from other parts of the Baltic Sea; however, there are differences concerning individual variables.

In overall terms, the state of the Baltic Sea is poor, in both coastal waters and in the open sea even though the trend differs depending on the variables. For example, the long-term trend in nitrogen concentrations has been downwards whereas there has been a long-term increase in phosphorus concentrations (1990–2021).[26] As a result of active protection measures, discharges of both nutrients into the Baltic Sea have decreased,[27] which gives cause for optimism concerning future status trends provided that protection measures continue. Any decisions on the construction of offshore wind power in the exclusive economic zone are unlikely to have any impact on this trend. However, climate change will further intensify the threats to the state of waters arising from human activity, which means that protection measures will also be needed in the future to ensure that the state of the Baltic Sea will improve.

3.3 Other natural resources

In the Gulf of Bothnia, fishing and the extraction of sea sand and gravel have been identified as other essential marine resources. Fishing is more important of the two.

There were 1,053 companies engaged in commercial maritime fishing in Finland in 2022. Their employees worked for 135 person-years and the companies had a turnover of EUR 34 million.[28] In addition to professional fishers, commercial fishing also includes fishing ports, fish processing plants and fish wholesalers. The Gulf of Bothnia, especially the Bothnian Sea, are important trawling areas for the Finnish trawler fleet. Bothnian Bay is less important for trawling than the Bothnian Sea (Figure 4). Baltic herring accounts for a substantial proportion of the catch: between 2010 and 2022, it accounted for 97% of the total catch[29].

[26] Piepponen, H., Laamanen-Nicolas, L., Korpinen, S., Back, M., Ekebom, J., Suomela, J., Lahtinen, T., Paavilainen, P. & Rinne, H. 2024. The state of marine environment in Finland 2024. Reports of the Finnish Environment Institute 35/2024 (in Finnish, with English abstract)

[27] HELCOM Thematic assessment of Eutrophication 2016–2021. Baltic Sea Environment Proceedings No.192

[28] Maritime spatial planning 2025: Maritime spatial planning and impacts of the maritime sectors on regional economy (in Finnish). Report 27 June 2025 (unpublished manuscript). Sitowise Oy.

[29] Lappalainen, A., Setälä, J., Helminen, J., Lehtonen, T., Niukko, J., Rantanen, P., Saarni, K. & Söderkultalahti, P. 2023. Fishing areas of the Finnish trawler fleet in the Baltic Sea between 2010 and 2020 (in Finnish). Luke, Natural Resources and Bioeconomy Studies 102/2023.

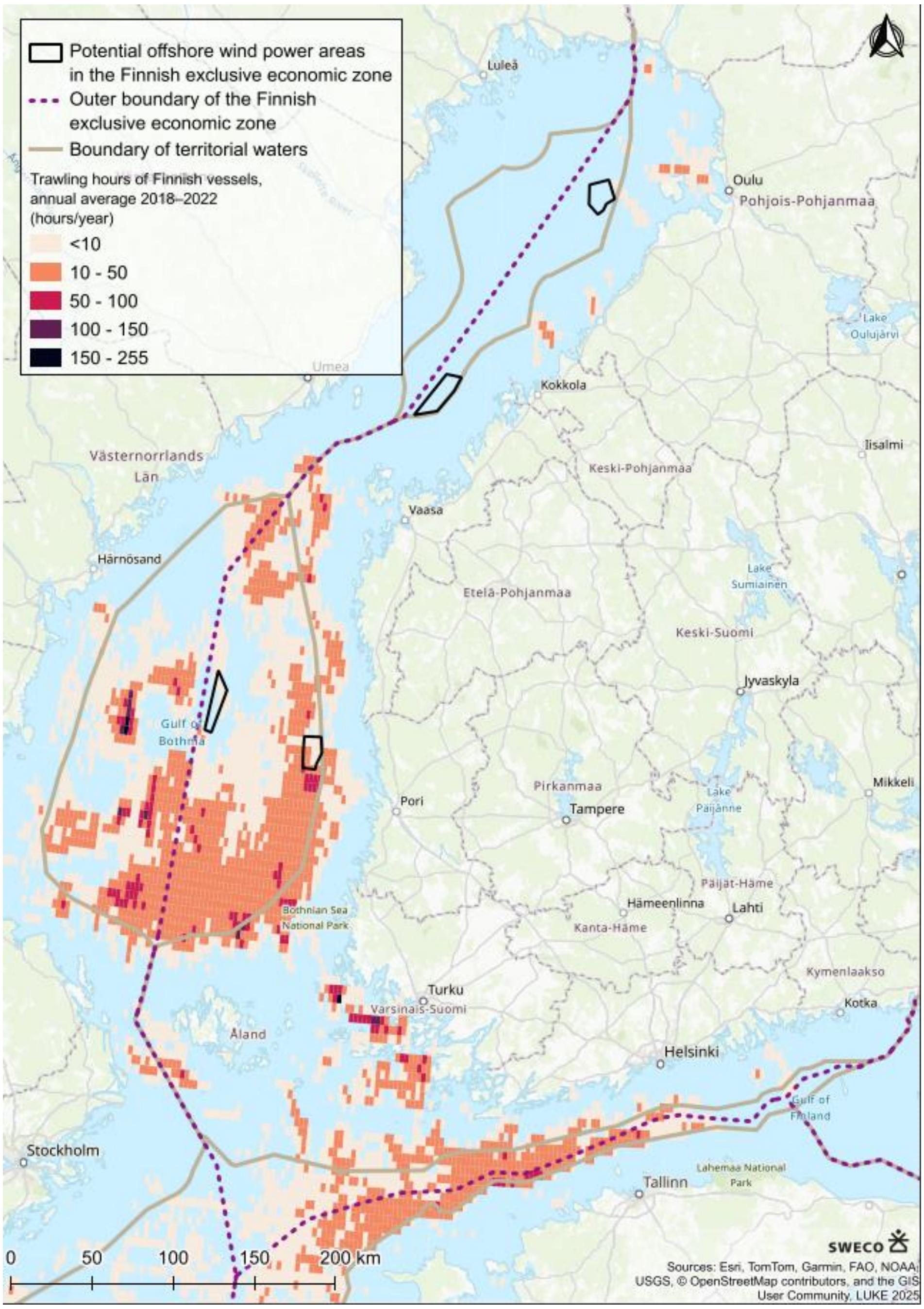

Figure 4. Annual average trawling hours of Finnish vessels in c-squares in the Gulf of Bothnia between 2018 and 2022. (Source: Natural Resources Institute Finland.[29])

However, it will be difficult to predict, which areas will be used for commercial fishing in the future as climate change will put pressure on the industry to change its practices.[30] Other pressures for change include trends in the regulation of

[30]Arki, V. & Mikkola, R.: Taking fishing into account in maritime spatial planning (in Finnish). Maritime spatial planning. https://merialuesuunnittelu.fi/wp-content/uploads/2025/01/arki-ja-mikkola-kalastuksen-huomioiminen-merialuesuunnittelussa-1-1pdf-1.pdf (referred to on 12 June 2025)

Baltic herring fishing, increase in the proportion of marine protected areas in the EU, and other activities restricting the use of marine areas for fishing in general or trawling, such as national defence needs or offshore wind power. Changes in the state of the sea will also affect fishing through the size of fish stocks.[31]

Recreational fishing is estimated to have an employment impact of about 1,021 jobs and a value-added effect of EUR 54 million. These impacts are generated through retail trade and transport as well as tourism and recreational services.[32]

There is one gravel extraction site in the Gulf of Bothnia: off Yppäri in Pyhäjoki in the Bothnian Bay. As far as it is known, similar activities have not been carried out in the exclusive economic zone.[33] The pressure to extract sea sand or gravel is expected to increase but the profitability of the operations in the exclusive economic zone may be adversely affected by long distances to the sites where these resources are used.[34]

In addition to mineral aggregate, mineral deposits and other mineral resources located in the seabed may also be exploited as extractive resources. These are currently not exploited in the Baltic Sea and the resources in the outer sea areas in particular are poorly known. However, growing demand for resources attracting interest as raw materials for the battery industry, together with emerging technologies, may provide a basis for profitable exploitation in the future. In the Swedish exclusive economic zone in the Gulf of Bothnia, a project to exploit mineral deposits has reached the permit application stage. If successful, the project will probably prompt a similar planning process in the Finnish exclusive economic zone.[35]

3.4 Biodiversity

This chapter describes the biodiversity of the Baltic Sea and the Gulf of Bothnia in general. The later chapters discussing impacts describe the biodiversity of the target areas by species and ecosystem in more detail.

In the Baltic Sea, including the Gulf of Bothnia, biodiversity and the regional variety of species are strongly dependent on salinity. The Baltic Sea is the largest brackish water basin in the world. Salinity affects the composition of the species in the area so that the proportion of marine biota decreases towards the north, while at the same time, the proportion of freshwater species increases.[36] Kvarken constitutes a clear limit for the distribution of two key marine species: bladder wrack and blue mussel are fairly rare north of the Kvarken.

Similarly, the distribution of many other aquatic species and the size of their populations are affected by salinity. For example, vendace, a freshwater species, occurs in the Bothnia Bay but not in the Bothnian Sea. The distribution of species that do not breathe in water is not directly dependent on salinity. However, the

[31] Maritime spatial planning 2025: Maritime spatial planning and impacts of the maritime sectors on regional economy (in Finnish). Report 27 June 2025 (unpublished manuscript). Sitowise Oy.

[32] Maritime spatial planning 2025: Maritime spatial planning and impacts of the maritime sectors on regional economy (in Finnish). Report 27 June 2025 (unpublished manuscript). Sitowise Oy.

[33] VELMU: sea sand and gravel extraction areas (2025) (in Finnish)

[34] Maritime spatial planning 2025: Maritime spatial planning and impacts of the maritime sectors on regional economy (in Finnish). Report 27 June 2025 (unpublished manuscript). Sitowise Oy.

[35] Maritime spatial planning 2025: Maritime spatial planning and impacts of the maritime sectors on regional economy (in Finnish). Report 27 June 2025 (unpublished manuscript). Sitowise Oy.

[36] Snoeijs-Lejonmalm, P. (2017) Patterns of biodiversity. In Snoeijs-Lejonmalm, P., Radziejewska. T. & Schubert, H. (ed.) *Biological Oceanography of the Baltic Sea* (pp. 123–192). Springer Science+Business Media Dordrecht.

distribution indirectly depends on the availability of food. For example, the distribution of common eider partially depends on the number of blue mussels, the main food of the species.

Seabed habitats

With regard to the benthic habitats, the state of the Bothnian Sea and the Bothnian Bay is good, and the most extensive healthy seabeds in the Baltic Sea can be found in the Gulf of Bothnia.[37] However, it should be noted that the classification material has been collected from a limited number of sampling points, and the results have been used to classify large areas. In other words: the status classification has been generalised to cover large areas using a small number of points. The number of sampling points decreases further away from the coast, which means that there is only a small number of points in the exclusive economic zone.

Biodiversity in the exclusive economic zone is characterised by water depth. Near the coast there are shoreline areas, sandbanks and reefs on which rich habitats are created. Such habitats are predominantly created in the photic zone, which is located at a water depth where there is enough light for photosynthesis.[38] However, most parts of the exclusive economic zone are so deep that photosynthesis is impossible. In such cases, the benthic habitats consist of heterotrophic species (species that are not primary producers, for example, photoautotrophs). On soft seabeds, the number of species and biomass are larger than on hard seabeds, except for blue mussel colonies, which can have extremely high biomass content. Blue mussels do not occur in the Bothnian Bay but the Bothnian Sea is part of their range. The Gulf of Bothnia is a suitable area for benthic habitats as oxygen concentrations in the area have been at a good level. The Bothnian Bay is poor in benthic fauna, which is due to the absence of marine species. For example, many bivalves that form large concentrations of biomass do not occur in the Bothnian Bay. Such species include Baltic clam (*Limecola balthica*), softshell clam (*Mya arenaria*) and blue mussel (*Mytilus trossulus x edulis*).

With regard to underwater habitats, there is also another significant difference between the Bothnian Bay and the Bothnian Sea: Bladderwrack and narrow wrack (*Fucus vesiculosus*[39] and *Fucus radicans*[40]) are found in the Bothnian Sea. The latter is a key species creating habitats for other species and it is not found in the Bothnian Bay. Similarly, blue mussels forming habitats in the Bothnian Sea are rare in the Bothnian Bay.[41] The habitats formed in the Bothnian Bay by photoautotrophic algae do not extend to the same depths as in the Bothnian Sea

[37] HELCOM Thematic assessment of biodiversity 2016–2021. Baltic Sea Environment Proceedings No. 191.
[38] Snoeijs-Lejonmalm, P. (2017) Patterns of biodiversity. In Snoeijs-Lejonmalm, P., Radziejewska. T. & Schubert, H. (ed.) *Biological Oceanography of the Baltic Sea* (pp. 123–192). Springer Science+Business Media Dordrecht.
[39] Laji.fi: Fucus vesiculosus https://laji.fi/en/taxon/MX.206710 Species | Finnish Biodiversity Information Facility (referred to on 12 June 2025)
[40] Laji.fi: Fucus radicans https://laji.fi/en/taxon/MX.213359 Species | Finnish Biodiversity Information Facility (referred to on 12 June 2025)
[41] Laji.fi: Mytilus trossulus https://laji.fi/en/taxon/MX.212392Blue mussel – Mytilus trossulus | Description | Finnish Biodiversity Information Facility (referred to on 12 June 2025)

due to a lack of algae species. However, the aquatic plant communities in shallow and shore areas extend to greater depths than in the Bothnian Sea.[42]

Birds

Most of the birds in sea areas primarily occur on or near the coast. Birds, or animals in general, always occur in an area for some reason, such as catching food, breeding or migration. During migration, birds may also move across sea areas but outside migration periods most of the birds occurring in sea areas belong to the following three categories:[43]

- Fish-eating seabirds that catch their food on the water surface or by diving in the water column. Catching the food does not depend on water depth. This group includes gulls, razorbills and cormorants.
- Waterbirds feeding on benthic animals that dive to the bottom after food. This group includes common eider and tufted duck.
- Plant-eating seabirds feeding in shallow areas with a depth of less than one metre. These birds are rarely found in the exclusive economic zone outside migration periods as the areas are too deep for catching food. This group includes swans and other Anatinae.

Fish-eating birds catching their food in the open sea can move throughout the sea, feeding and looking for areas to catch food. Waterbirds feeding on benthic animals can catch their food in shallower areas. For example, a common eider can dive to a depth of about 30 metres but in practice, these birds prefer shallower sites where finding food is easier.

More generally, different bird species, including land birds, can also be found in the open sea[44] outside their normal habitat during migration periods. However, there is no certainty about their flight altitudes, numbers and sensitivity to offshore wind power during migration periods in the Gulf of Bothnia. However, the flight altitude of migratory birds depends on the weather, wind conditions and time of the day.[45] For breeding and migratory birds, Finnish maritime areas can be divided into four different sensitivity categories. All coastal areas and the archipelago are particularly sensitive from the perspective of breeding birds and migratory birds, and the risk to birds arising from offshore wind power in these areas is considered very high. In practice, the only areas suitable for offshore wind power are located in the open sea where the risk is estimated to be low. Despite the low risk, a project-specific report must always be prepared so that the area-specific risks can be assessed in more detail. The importance of project-specific reports is mainly based on the absence of information on such matters as the significance of offshore migration to birds.[46]

[42]Bergström, L., Öhman, M., Berkström, C., Isæus, M., Kautsky, L., Koehler, B., Nyström Sandman, A., Ohlsson, H., Ottvall, R., Schack, H. & Wahlberg, M. 2021 – Effekter av havsbaserad vindkraft på marint liv, En syntesrapport om kunskapsläget 2021. Naturvårdsverket rapport 7049

[43]Bergström, L., Öhman, M., Berkström, C., Isæus, M., Kautsky, L., Koehler, B., Nyström Sandman, A., Ohlsson, H., Ottvall, R., Schack, H. & Wahlberg, M. 2021 – Effekter av havsbaserad vindkraft på marint liv, En syntesrapport om kunskapsläget 2021. Naturvårdsverket rapport 7049

[44]Piironen, A., Paasivaara, A. & Laaksonen, T. (2021). Birds of three worlds: moult migration to high Arctic expands a boreal-temperate flyway to a third biome. Movement Ecology 9:47.

[45]Kahlert, J., Leito, A., Laubek, B., Luigujõe, L., Kuresoo, A., Aaen, K. & Luud, A. 2012. Factors affecting the flight altitude of migrating waterbirds in Western Estonia. Ornis Fennica 89.

[46]Tikkanen, H., Below, A., Ekblad C., Lehtiniemi T., Lindén A., Mikkola-Roos M. and Pöllänen A, Reports of the Finnish Environment Institute 24 | 2025 Sensitive bird areas in the Finnish maritime area for the Baltic Sea Action Plan (in Finnish, with English abstract).

Fish

The food web in the open sea is based on phytoplanktons and benthic decomposers. The fish in the area feed on benthic animals, zooplanktons eating phytoplanktons and each other.[47] Common open sea species include Baltic herring (*Clupea harengus membras*), sprat (*Sprattus sprattus*) eelpout (*Zoarces viviparus*) and sculpins and in the Bothnian Bay, also vendace (*Coregonus albula*).

Migratory fish such as salmon (*Salmo salar*), smelt (*Osmerus eperlanus*), eel (*Anguilla anguilla*) and grayling (*Thymallus thymallus*) can also occur in the open sea during migration. Not much is known about the significance of shallow areas in the open sea as breeding grounds for Baltic herring (in the Bothnian Sea) and vendace (in the Bothnian Bay)[48]. Brown trout (*Salmon trutta*) and migratory whitefish (*Coregonus lavaretus*) may also occur in the exclusive economic zone but they usually stay closer to the coast than salmon and eel. However, the exact migratory routes of migratory fish at sea are not known. Human activities that have changed habitats have weakened the strength of migratory fish stocks, and maintaining the natural cycle of these stocks is a key means of strengthening them.

Environmental impacts on migratory fish can be transboundary, making them an important international issue. They are a good example of environmental issues extending beyond offshore wind power areas, the assessment of which is hampered by insufficient scientific knowledge of the exact migratory routes of different species and the living conditions they require. Potential environmental impacts on migratory fish may include changes in migration routes or feeding habits. The potential impacts of magnetic fields in wind power areas on the migration of salmon are not known.[48]

Concerning fish stocks, the greatest risks arise from the absence of information and extensive combined impacts, which in addition to the climate change, also involve the development of offshore wind power in Swedish sea areas.[48]

Mammals

Two species of seals occur in the Gulf of Bothnia: the grey seal (*Halichoreus grypus*) and the Baltic ringed seal (*Phoca hispida botnica*). Both species can move over wide sea areas in search of food. Grey seals breed on rocky islets. Finland and Sweden are jointly responsible for protecting the Baltic ringed seal. The Baltic ringed seal needs ice for breeding, and the population is therefore concentrated in the Bothnian Bay.[49] The estimated population in the Bothnian Bay has varied between 8,000 and 15,000 in recent years,[50] and in the past, the population has been significantly smaller in other parts of the Baltic Sea.[51]

[47] Snoeijs-Lejonmalm, P. (2017) Patterns of biodiversity. In Snoeijs-Lejonmalm, P., Radziejewska. T. & Schubert, H. (ed.) *Biological Oceanography of the Baltic Sea* (pp. 123–192). Springer Science+Business Media Dordrecht.

[48] Oral communication, Antti Lappalainen, LUKE, 1 September 2025

[49] Snoeijs-Lejonmalm, P. (2017) Patterns of biodiversity. In Snoeijs-Lejonmalm, P., Radziejewska. T. & Schubert, H. (ed.) *Biological Oceanography of the Baltic Sea* (pp. 123–192). Springer Science+Business Media Dordrecht.

[50] Natural Resources Institute Finland: Marine seal populations, population estimate, Baltic ringed seal. The estimate is based on the calculations produced by the Swedish Museum of Natural History https://luonnonvaratieto.luke.fi/numerotieto/raportit?panel=merihyljekannat&lang=en . Referred to on 1 August 2025.

[51] Halkka, A. & Tolvanen, P. (ed.) (2017), WWF Finland: The Baltic Ringed Seal – An Arctic Seal in European Waters.

Nowadays, the species also breeds in the Archipelago Sea, Gulf of Riga and the Gulf of Finland but as it depends on ice, climate change is expected to lead to a more rapid growth of the northern populations.[52]

Harbour porpoise (*Phocoena phocoena*) also occurs in the Baltic Sea but the Gulf of Bothnia is outside its breeding area or main range.[53] However, harbour porpoises have been sighted in the southern Gulf of Bothnia.[54]

Bats are not known to occur regularly in the open sea but it has been observed that they can migrate across the Kvarken between Finland and Sweden.[55] However, there is no detailed information on the offshore migration of bats in the Bothnian Sea or the Bothnian Bay. However, based on the results of a pilot study carried out in the Archipelago Sea, Åland and the Hanko area, bats are more common in the outermost archipelago and in the periphery of the open sea than previously thought. For example, Nathusius' pipistrelle (*Pipistrellus nathusii*), which is classified as vulnerable, was sighted at all monitoring points. The outermost of these sites were Bengtskär and Utö in the Archipelago Sea and Signilsskär and Märket in the outer archipelago west of Åland.[56] It is possible that offshore wind power can also attract bats, in which case there is a high risk of collision with turbines. However, no studies are available on the subject, and the collision mortality of bats on the mainland is not monitored either[57]

3.5 Human population and community structure

Finland has 34 municipalities with shoreline on the Gulf of Bothnia.[58] More than 700,000 people live in the Finnish coastal municipalities on the Gulf of Bothnia.[59] There are also free-time residential buildings in the area and they are estimated to bring more than 200,000 additional residents to the municipalities on a seasonal basis.[60] On the Gulf of Bothnian coast, there are numerous free-time residential buildings in the archipelago and in the immediate vicinity of the shore.[61]

[52] Halkka, A. & Tolvanen, P. (ed.) (2017), WWF Finland: The Baltic Ringed Seal – An Arctic Seal in European Waters.
[53] HELCOM: Map and data services https://maps.helcom.fi/website/mapservice/index.html (referred to on 12 June 2025)
[54] SYKE 2022: Species presentation, harbour porpoise (in Finnish). https://www.ymparisto.fi/sites/default/files/documents/Py%C3%B6ri%C3%A4inen.pdf (referred to on 12 June 2025)
[55] Schneider, M. & Fritzén, N. 2022. Flador och deras insektproduktion – betydelsen för lokala och migrerande fladdermöss i Kvarken. Delrapport inom Interreg Botnia Atlantica projekt Kvarken Flada.
[56] Vasko, V. and Loisa, O., 2025, Outer archipelago as migration route for bats (unpublished; in Finnish)
[57] Oral communication, Eeva-Maria Tidenberg (University of Helsinki) and Olli Loisa (Turku University of Applied Sciences) 5 September 2025
[58] Statistics Finland
[59] Statistics Finland population data 2024.
[60] An estimate based on Statistics Finland's data on free-time residential buildings and estimates of residents.
[61] Maritime spatial planning 2025: Maritime spatial planning and impacts of the maritime sectors on regional economy (in Finnish). Report 27 June 2025 (unpublished). Sitowise Oy.

On the Gulf of Bothnian coast, there are merchant shipping fairways and ports that are important for securing Finland's prosperity and security of supply.[62] There are no separate fairways in the open sea as the entire marine area is used by shipping. Merchant shipping is responsible for most of Finnish imports and exports (95.7%).[63] In 2023, Gulf of Bothnian ports accounted for 20% of port calls of international traffic in Finland. Tornio, Kemi, Oulu, Raahe, Rahja, Kokkola, Pietarsaari, Vaasa, Kaskinen, Pori, Rauma and Uusikaupunki are the Finnish ports on the Gulf of Bothnian coast. They mostly handle international traffic but also domestic traffic.[64] The port of Vaasa is also an important passenger port.[65]

In the Bothnian Bay, fairways may extend into the exclusive economic zone but they typically end in territorial waters closer to the coast. To some extent, traffic outside the fairways is concentrated on regionally important uniform traffic areas, which are taken into account in maritime spatial planning. However, especially in wintertime, the safest and easiest route is selected, depending on the ice conditions. During the ice-free season, traffic is heavy, not only in the vicinity of ports but also in the narrow Kvarken where the fairways criss-cross in a small area and where there is also passenger traffic.[66]

Fairway markings are the only above-water infrastructure in the exclusive economic zone.

Telecommunication and electrical cables run on the seabed. One of the submarine telecommunication cables between Finland and Sweden runs across Kvarken and a second one via the Åland Islands.[67] The double submarine cable connecting the Finnish and Swedish power grids runs across the Baltic Sea in the Bothnian Sea,[68] and a letter of intent on a new cable has been signed.[69]

Fishing is carried out in the exclusive economic zone (described in more detail under natural resources).

3.6 Cultural environments

In the Gulf of Bothnia, cultural heritage consists of underwater cultural heritage and the tangible and intangible cultural heritage of the coastal areas and the archipelago. The oldest parts of the cultural environment consist of

[62]For example, Maritime spatial planning 2025: Maritime spatial planning and impacts of the maritime sectors on regional economy (in Finnish). Report 27 June 2025 (unpublished). Sitowise Oy.

[63]Finnish Customs, Statistics: International trade transports in 2023. https://tilastot.tulli.fi/-/ulkomaankaupan-kuljetukset-vuonna-2023 (in Finnish) Referred to on 3 June 2025.

[64]Ministry of the Environment 2024, maritime spatial planning: Situational overview of offshore wind power. Report. Sitowise Oy (in Finnish, with English abstract) https://merialuesuunnittelu.fi/wp-content/uploads/2025/05/merituulivoiman-tilanne-ja-kokonaiskuva.pdf Referred to on 4 June 2023.

[65]Traficom's statistics, Traffic at ports https://tieto.traficom.fi/en/statistics/traffic-ports Referred to on 4 June 2023

[66]Ministry of the Environment 2024, maritime spatial planning: Situational overview of offshore wind power. Report. Sitowise Oy (in Finnish, with English abstract) https://merialuesuunnittelu.fi/wp-content/uploads/2025/05/merituulivoiman-tilanne-ja-kokonaiskuva.pdf Referred to on 4 June 2023.

[67]TeleGeograph: Submarine Cable Map. https://www.submarinecablemap.com/ Referred to on 11 June 2025.

[68]Fingrid: Website: Part of the Nordic power system. https://www.fingrid.fi/en/grid/development/part-of-the-nordic-power-system/ Referred to on 12 June 2025

[69]Fingrid 2025: Fingrid and Svenska kraftnät initiate planning for Fenno-Skan 3 submarine cable between Finland and Sweden https://www.fingrid.fi/en/news/news/2025/fingrid-and-svenska-kraftnat-initiate-planning-for-fenno-skan-3-submarine-cable-between-finland-and-sweden/ Referred to on 12 June 2025.

archaeological heritage and ancient relics, and more recent traces of human activity and practising of culture in the area.

The situational description of Finland's maritime cultural heritage based on geographic data was compiled in 2019 as background material for the use of maritime spatial planning in mainland Finland. It describes maritime and underwater cultural heritage, its themes and sites as well as regional specialities and characteristics.[70] In a survey conducted for the background study of the maritime spatial planning process, respondents living, working and spending time in the coastal areas and the archipelago highlighted living or holidaying on the coast or in the archipelago and enjoying the seascape (viewing and listening) as the most important social and cultural aspects concerning the use of coastal and marine areas.[71] An open horizon is important for both culture and tourism.[72]

In the exclusive economic zone, the landscape consists of open sea. Offshore wind power areas may be visible to the coast depending on the height of the turbines. For example, in clear weather, the turbines with a height of between 260 and 400 metres discussed in this assessment may, in theory, be visible up to 50–70 kilometres away if the impact of such factors as air humidity on visibility is not taken into account. However, from such a distance they would appear as quite small on the horizon. Moreover, the wind turbine lights may be visible from a considerable distance when reflected through clouds. Impacts on the landscape are discussed in the assessment as one aspect.

Several nationally significant landscape areas, such as Hailuoto and the Kvarken archipelago landscape, are located on the coast and islands of the Gulf of Bothnia. The Kvarken archipelago is a natural heritage site formed and changing as a result of land uplift, which, together with the High Coast of Sweden (Höga Kusten), forms a UNESCO world heritage site. The Kvarken archipelago also has the status of a national landscape and two nationally significant landscape areas are located in the area: Kvarken archipelago landscapes and the cultural landscape of the Björköby archipelago. The Bothnian Bay South offshore wind power area would be located near Kvarken. The island of Hailuoto, located in the northern part of the Bothnian Bay, is an important cultural heritage site and a national landscape. Bothnian Bay North offshore wind power area would be located closest to Hailuoto.

The Gulf of Bothnian coast and the islands close to it are also known for built cultural environment sites, such as lighthouses and pilot islands, fishing huts and village landscapes as well as ancient relics such as stone heaps, monuments and beacons. Typically, the exclusive economic zone is far away from the sites of the built cultural environment but the Bothnian Sea East near the coast would also be located near ancient relics such as ancient settlements on islands and underwater wrecks.

Intangible cultural heritage can also be found on the coast of the Gulf of Bothnia. The traditional rapids fishing culture along the Torne River is recognised as intangible cultural heritage by Finland and Sweden, and it is performed along the

[70] Finnish Heritage Agency, Cultural Environment Services department: Situational description of Finland's maritime cultural environment, 2019 (in Finnish)

[71] Ministry of the Environment 2024, maritime spatial planning: Situational overview of offshore wind power. Report. Sitowise Oy (in Finnish, with English abstract) https://merialuesuunnittelu.fi/wp-content/uploads/2025/05/merituulivoiman-tilanne-ja-kokonaiskuva.pdf Referred to on 4 June 2023.

[72] Unhindered view and horizon were recognised as important in the stakeholder workshops of the interaction forums for offshore wind power project organised as part of the maritime spatial planning process.

Torne River on the border between the two countries.[73] Finland and Sweden are proposing that this dipnet fishing method should be added to the UNESCO register of intangible cultural heritage.[74] Fishing depends on the strength of migratory fish stocks, especially salmon and whitefish.

Underwater cultural heritage is represented by wrecks and their parts as well as other traces of human activity such as underwater maritime and defence structures, and submerged residential and burial sites. They are located close to the coast and no wrecks or other underwater cultural heritage are known to exist in the potential offshore wind power areas in the exclusive economic zone.[75] With regard to underwater cultural heritage, there are also inadequacies in the archaeological knowledge base, and thus there is no certainty of the existence or absence of important sites in the exclusive economic zone.

3.7 Climate change

Climate change has already left its mark on the Gulf of Bothnia and it will be the key change shaping the environment and nature in the coming decades. Finnish Environment Institute, Natural Resources Institute Finland and the Finnish Meteorological Institute centrally compile and maintain climate change information in the Climate Guide,[76] which describes the progress, adaptation to and preparedness for climate change, especially in Finnish conditions. The guide also contains the climate change information on the Baltic Sea and assessments of its impacts on maritime activities and marine nature, including references to research reports.

To sum up the very extensive and multidimensional change, it can be concluded that the rise in Baltic Sea water temperature will change weather conditions, aquatic environment, water quality and ice conditions. It will also have a direct and indirect impact on the occurrence of habitats and composition of species, increasing the occurrence of invasive species.

Increasing rainfall in the sea will reduce the salinity of brackish water, and increased precipitation on land will further increase leaching and, as a result, nutrient loading from land areas. This will boost eutrophication despite measures to reduce nutrient runoff. The rise in sea level will increase coastal erosion and thus also leaching. The number of storm days and winds in the marine area have

[73] Finnish Heritage Agency: Living Heritage. National Inventory of Living Heritage. https://www.aineetonkulttuuriperinto.fi/en/sopimus-suomessa/kansallinen-luettelo Referred to on 3 June 2025; and Finnish Heritage Agency: Living Heritage. Traditional dipnet fishing culture along Torne River, description in the wikilist of living heritage. https://wiki.aineetonkulttuuriperinto.fi/wiki/Tornionjoen_perinteinen_koskikalastuskulttuuri (in Finnish). Referred to on 3 June 2025.

[74] Ministry of Education and Culture 31 March 2025: Torne River dipnet fishing proposed for inscription on the list of UNESCO intangible cultural heritage. https://okm.fi/-/tornionjoen-lippokalastuskulttuuri-ehdolle-unescon-aineettoman-kulttuuriperinnon-luetteloon?languageId=en_US Referred to on 3 June 2025.

[75] The following materials have been accessed through the geodata portal of the National Land Survey of Finland: Finnish Environment Institute: Nationally significant landscape areas; Finnish Heritage Agency: Nationally significant built cultural environments, Other cultural heritage sites and their boundaries, World Heritage sites, Ancient relics and their boundaries and sub-sites of ancient relics; wrecks in National Land Survey’s topographic database. Information was retrieved in June 2025.

[76] Climate change information through a single address, https://www.climateguide.fi/frontpage/, information checked 5 September 2025

already increased. Ice cover in the Baltic Sea has also decreased, even though annual variations may still result in thick ice cover.

The changes are reflected in the food web and biodiversity. Climate change will further accelerate the deterioration of the state of waters caused by human activity. Climate change also acts as a driver of biodiversity loss as the habitats of existing species change as a result of changing conditions.

Offshore energy projects and other human activities located at sea will also have to prepare for more extreme weather phenomena and strong annual variations in weather conditions. These will involve such matters as ice conditions, accessibility of structures and maintenance work in poor weather or during accidents.

4 Carrying out the impact assessment

4.1 Basic premises and conduct of the impact assessment

This chapter discusses the environmental impacts of offshore wind power and the submarine cables it requires as well as their assessment at a general level in accordance with the SEA process. In practice, the impacts of an offshore wind farm and a cable route depend on the precise locations of the turbines, and they are assessed as part of the project EIA and permit procedures.

As the SEA assessment covers the draft decision on the areas to be designated for offshore wind power, a future offshore wind power project will be discussed in the SEA process as the activity with potential environment impacts. Therefore, the impact mechanisms affecting the environment are similar to the environmental impacts of the activities carried out as part of the offshore wind power project during its life cycle.

In accordance with the SEA Act, the aim is to identify and assess **likely significant impacts on the environment**. In the case of the draft decision discussed in this document, it has meant the following process:

- Collecting the information available on the current state of the marine environment described in the draft decision
- Identifying the changes typically resulting from the implementation of the offshore wind power project and the infrastructure it requires at different stages of its life cycle in the area where it is located
- Listing all possible environmental impact pathways resulting from changes in offshore wind power from the perspective of the SEA Act
- Adapting the impact pathways for each marine area: how could the environment change in that particular area
- Identifying likely significant impacts; significance may be due to factors such as the permanence or extent of the impact, high sensitivity of the target or significant data gap
- Assessing the likely significant identified impacts and possible interactions between areas or in relation to other plans for the areas
- Identifying opportunities to mitigate negative impacts

Project impact assessment examines the permanence (temporal duration and reversibility), and intensity and direction (negative/positive) of the changes resulting from by the activities.[77] According to the guidelines[78] issued by the Finnish Environment Institute and the Ministry of the Environment, the following are some of the impacts of human activities on the environment:

- negative or positive
- direct or indirect (secondary)
- accumulating, cumulative
- permanent or temporary
- reversible or irreversible
- impacts manifesting over the short, medium and/or long term
- combined impacts.

When the significance of impacts on nature is assessed, the sensitivity of the object is essential. In the case of the marine environment, certain species are more sensitive to change than others, and the small scale or rarity of certain habitats may make them more difficult to replace. The impacts on key marine species have indirect impacts on other biota and the functioning of the ecosystem. At the same time, the occurrence of a certain natural resource, such as a commercially important fish species, can make the area important for livelihoods. The sensitivity of the objects is based on, for example:

- object's ability to withstand negative changes (resistance or tolerance)
- object's ability to recover from changes (resilience)
- object's importance for the environment (key species)
- object's importance economically or for society at large

In addition to the impacts on nature, changes in the environment also affect humans: in connection with projects, we talk about societal or social impacts. Under section 2, paragraph 2 of the SEA Act, the environmental impacts to be addressed in the SEA process include impacts on human health, living conditions and wellbeing as well as community structure, built environment, landscape, cityscape and cultural heritage. Below these impacts have been combined with environmental change factors, taking into account, in particular, aspects relevant to the marine environment:

- Health: Exposure to noise, harmful substances, deterioration of water quality, etc.
- Living conditions: Changes in transport and maritime livelihoods
- Wellbeing: Changes in environmental factors such as noise, air quality, and recreational opportunities in nature
- Built environment: Changes in infrastructure
- Landscape and cultural heritage: Changes in the marine landscape, maritime traffic, maritime livelihoods and recreation

It should be noted that societal/social impacts also include other aspects, which affect such matters as security of society or the feasibility and acceptability of projects and plans. Such aspects include impacts on security of supply,

[77] Mäkelä, K. & Salo, P. 2023. Ecological Surveys and Ecological Impact Assessment. A Guide for Surveyors, Customers and Authorities, 2nd revised edition. Reports of the Finnish Environment Institute 43/2023 (in Finnish, with English abstract)

[78] Mäkelä, K. & Salo, P. 2023. Ecological Surveys and Ecological Impact Assessment. A Guide for Surveyors, Customers and Authorities, 2nd revised edition. Reports of the Finnish Environment Institute 43/2023 (in Finnish, with English abstract)

comprehensive security, preparedness for crisis situations, regional economy, self-sufficiency, trade balance or employment.

If the potential of the offshore wind power projects is fully realised in the areas designated in the draft decision, the capacity of the envisaged wind farms would account for a significant proportion of domestic renewable energy. In that case, the resulting cluster of wind turbines would probably be an essential factor for comprehensive security, and regions and companies using energy.

From the acceptance perspective, we are talking about a social licence that is broader than the human impacts covered by the SEA Act. It involves approval granted by the local community and society at large for a certain development, for example, in the context of green transition. This is a multidimensional and dynamic phenomenon, which means that it will change over time. A social licence consists of three interacting dimensions: socio-political acceptance, market acceptance and acceptance granted by the local community.[79]

This environmental report has been prepared to meet the requirements of the SEA legislation, under which it is not necessary to discuss the assessment of the environmental impacts of the draft decision from the perspective of comprehensive security, preparedness and social acceptance. However, interfaces to these topics have been included in the human impact assessment and recommendations due to their societal significance.

This SEA assessment discusses other plans, including offshore wind power projects in the territorial waters. In offshore wind power projects, the assessment of combined impacts also plays an important role. This is because of the large size of the projects and the large number of offshore wind power projects planned in the Gulf of Bothnia.

4.1.1 Identifying the impacts

The impact consists of three elements:

1) source (factor)
2) impact route
3) impact target.

In addition to a physical or chemical factor or change, such as discharges to water, noise, seabed intervention or increasing traffic, the original source of the environmental impacts also usually includes the energy produced. The sources of impact differ at different stages of the offshore wind power project.

The impact will result in changes on the site such as the reduction in greenhouse gas emissions, shrinking of the area available for other activities, fragmentation or formation of habitats or routes for species, changes in landscape, decrease or increase in jobs or mitigation or acceleration of climate change.

[79] Sources: Pamela Lesser (2024) Scales of Trust. An Exploration of the Social Licence to Operate of Mining at the Societal Level. Acta electronica Universitatis Lapponiensis 396. ISBN 978-952-337-464-5, ISSN 1796-6310; Lind, A., Määttä, H., Berninger, K., Carus Andersen, L. K., Aasen, M., Leiren, M. D., … Have, S. (2025). Social acceptance as a prerequisite for the green transition. https://doi.org/10.6027/temanord2025-507; Lehtonen, M., Kojo, M., Kari, M., Jartti, T., & Litmanen, T. (2021). Trust, mistrust and distrust as blind spots of Social Licence to Operate: illustration via three forerunner countries in nuclear waste management. Journal of Risk Research, 25(5), 577–593. https://doi.org/10.1080/13669877.2021.1957987

The impacts of these factors can arrive through a variety of different routes (for example, via air and/or water, and, in identifying of human impacts, also via financial flows), and the factors can also impact more than one object (such as groups of organisms, humans, natural resources, and jobs).

4.1.2 Assessment of significance

The significance of the impact depends on a number of different variables related to the size of the original factor and the sensitivity of the object of the impact, (its ability to withstand harmful changes are recover from them). For the assessment of significance, both the magnitude and duration of the essential impact and the sensitivity of the object are assessed. Consideration should also be given to the uncertainties arising from the impacts that affect the valuation of the different implementation scenarios and the assessment of the acceptability of the plan during the final stages of the assessment.

When the magnitude of the impact is determined, the intensity (low-medium-high), extent (local, regional, national, transboundary) and duration (temporary or permanent, continuous or intermittent) of the impact are taken into account. The impact can be positive or negative.

When the significance of the impacts is determined, criteria available in public studies are used to assess the different impacts. The assessment also draws on the views collected from stakeholders in consultations and in the maritime spatial planning process. The aim is to deepen the understanding of the significance of the impacts for humans and the environment.

The assessment of the significance of the impact on the species is based on the ecological function of each species, which refers to the characteristics and role of the species in the food chain. In the absence of species-specific data, significance has been assessed by species group. Species groups are connected by similar habitats and living habits, which means that they are affected by change pressures on the environment in the same way. For example, when birds are studied,[80] diving birds, Anatinae and fish-eating birds are species groups from the perspective of catching food while migratory and breeding birds are species groups when the sensitivity to collision and disturbance arising from offshore wind power is examined. Key species (species that are key to a particular ecosystem) as well as particularly important species that need special attention due to their endangered status or poor conservation status can be identified within groups of species.

A likely significant ecological effect is an impact in which the impact of offshore wind power on the environment affects a large group of species present in the area or weakens the living conditions of a key species that is abundant in the area. When this is used as an assessment tool, it means that dozens of different theoretically possible impact pathways targeted by species group and area must first be opened. This process will highlight likely significant impact pathways.

When the results are interpreted, this means that when a certain group of species is affected by a likely significant impact, all species in the group of species occurring in the area are affected. Correspondingly, harm to a key species affects its entire ecosystem. For example, shrinkage of the bladder wrack area

[80]Sensitive bird areas in the Finnish maritime area for the Baltic Sea Action Plan. Report of the Finnish Environment Institute 24/2025 (in Finnish, with English abstract).

undermines the living conditions of the associated species. A significant impact on a species of particular interest may mean that the favourable conservation status of that species is weakened. For example, the number of breeding sites of the Baltic ringed seal may decrease as deteriorating ice conditions push them further northwards in the Bothnian Bay. Mitigation measures can be taken and impacts can be monitored through species groups or key species.

4.2 Alternatives for implementing the draft decision

Each individual offshore wind power area included in the draft decision has been selected for independent review in the assessment of the environmental impacts carried out as part of the SEA process. The combined impacts arising from the implementation of all areas or, alternatively, two areas are also examined.

Considering these alternatives is not an expression of support for the feasibility, likelihood or timetable of any of the projects. In the finalised Government decision, one area, all four areas or any combination of them can reach the tendering process. Areas may also be put out to tender in several batches at different times. Theoretically, this will result in 16 potential alternatives and the zero alternative (Table 2).

Table 2. Theoretically possible combinations of areas and alternatives selected for review. The cell marked with x and the green colour mean that the offshore wind power area in the column is included the alternative described in the row and examined in the environmental assessment. The cell marked with t and the grey colour mean that the offshore wind power area in the column is included in the combination of areas described in the row.

	Bothnian Sea West	Bothnian Sea East	Bothnian Bay South	Bothnian Bay North
VE0	No areas			
VE2	x	x	x	x
Combinations of three areas	t	t	t	
		t	t	t
	t		t	t
	t	t		t
	t	t	t	
VE1	x			x
Other combinations of two areas	t	t		
	t		t	
		t	t	
		t		t
			t	t
Area-specific examination	x			
		x		
			x	
				x

Under section 4, paragraph 2 of the SEA Decree, the environmental report must to the extent necessary describe the current state of the environment and its likely evolution if the plan or programme will not be implemented. This constitutes the zero alternative (VE0), in which case the areas would not be put out to tender or no investments would be made. The investments may also remain unrealised even if areas located in the exclusive economic zone are selected and competitive tendering is organised. This is because the decision on the selection of areas does not necessarily mean that any of the projects will be carried out. However, this environmental assessment is based on the assumption that when an offshore wind power area is selected, an offshore wind power project will also be implemented in the area.

The partial implementation scenario (VE1) consists of two of the four areas to be assessed (Bothnian Bay North and Bothnian Sea West; see Figure 5). The areas selected for the implementation scenario differ from each other significantly in two ways: they are geographically far apart in north-south direction and at different distances from the coast.

The maximum impact scenario, in which all areas will be implemented (VE2), covers all possible harmful impacts in maximum scale – both in terms of volumes and land use. VE2 describes a situation in which offshore wind power projects will be implemented in all four areas. The combined size of the areas is 921 km^2. It is also assumed that emerging technological solutions (the possibility of producing hydrogen at sea in one of the proposed areas) are included in the maximum impact scenario. Under the draft decision, wind power in the areas can also be used for hydrogen production. It does not designate any particular area for hydrogen production and does not propose any specific framework, which means that the solution is only treated as a possible option for the future.

All alternatives are shown on the map (Figure 5) and they are described in more detail in chapter 5.

The placement of offshore wind power and cable routes is also likely to involve issues related to preparedness and comprehensive security. These are not among the environmental impacts referred to in the SEA Act but are likely to affect the future feasibility of potential projects and thus also their environmental impacts. In its opinion, Fingrid has determined which of its potential connections will serve as the most likely connection points for each of the four offshore wind power areas. However, the location of the connection points is fairly imprecise. For this reason, the implementation scenarios do not determine any specific locations for the cable routes but their impacts are assessed at the upper level, with a broad focus on the zone between each planning area and the mainland.

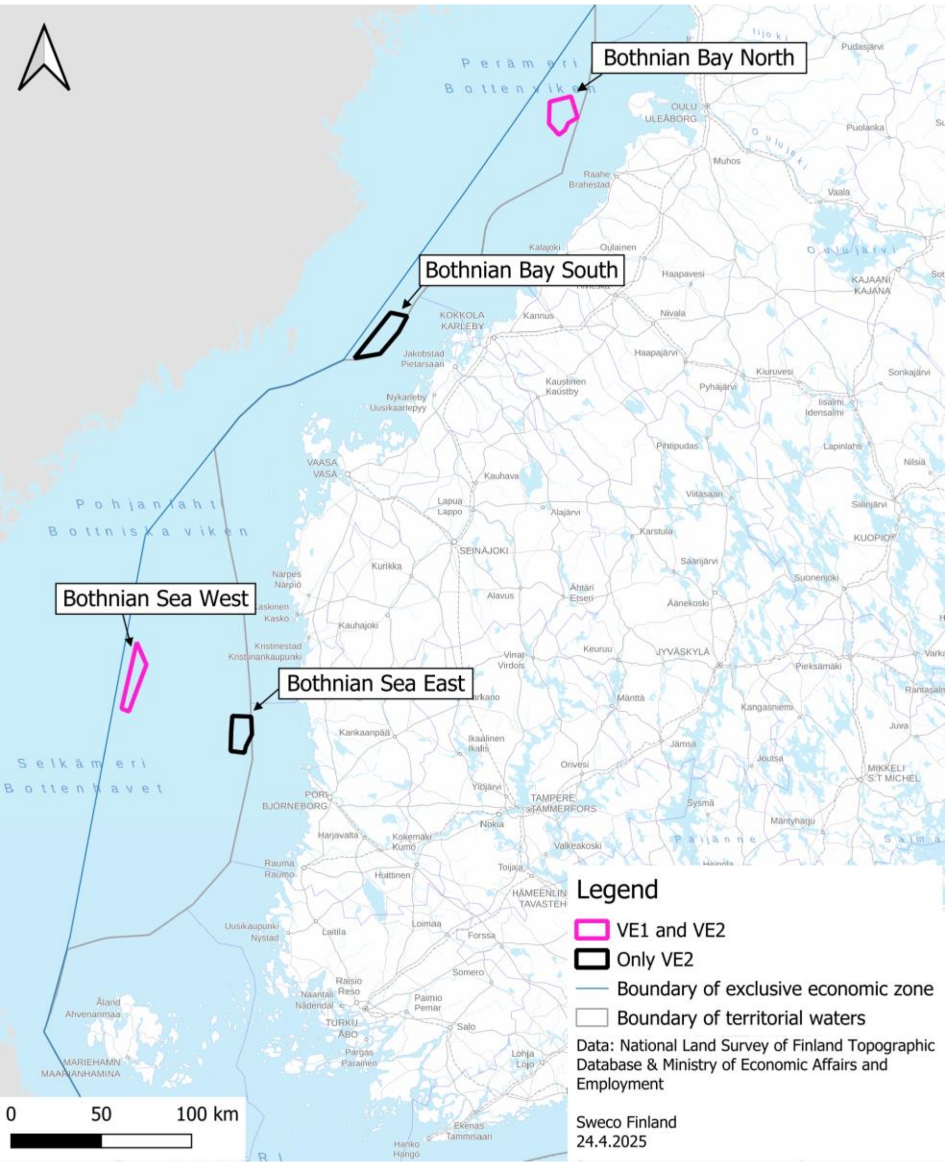

Figure 5. Areas to be assessed in the different implementation scenarios. The partial implementation scenario (VE1) covers two of the four sites: Bothnian Bay North and Bothnian Sea West. The maximum impact scenario covers all four areas.

4.3 Identified impact pathways of offshore wind power

4.3.1 Impact mechanisms and impact pathways

The environmental impact can only be assessed if there is sufficient information available on the current state of the environment, source of the impact, impact mechanism, the object, and sensitivity of the object. The SEA process is an ex-ante assessment based on existing environmental data in which the environmental impacts are catalogued and assessed in general terms. The more detailed impacts of each offshore wind power project will be investigated later, which means field studies of the target environment, impact modelling and more detailed identification of management methods.

The impacts and impact pathways of offshore wind power vary depending on the placement of the production area, cable connections and the project's life cycle stage (see chapter 2.2). Among other things, the placement of the production area determines which objects affected by the impacts are situated in the wind power impact area: the ecological values of the site and its location in relation to these values and other plans will enhance or mitigate the significance of the impact pathways.

The impact pathways of an offshore wind power project also vary during its life cycle:[81] in the construction stage the pathways are different from those in the operational or decommissioning stages. The intensity of the impacts also varies during the project life cycle: for example, the noise impacts are greater in the construction stage but of shorter duration than during the operational stage.

As described in section 4.1, the impacts on humans are either caused by changes in the environment (impacts of structures on other use of the marine areas and recreation) or by intangible impacts on the recreational value of the environment (such as noise or changes in landscape). Impact mitigation is discussed in chapter 6. The impacts of each implementation scenario are described in more detail in chapter 5.

4.3.2 Preliminary studies and planning

The impact pathways of the preliminary study and planning stage in the area under review arise from surveys and studies carried out on the production site and along cable routes (Figure 6). The EIA process for wind power projects and the water permit process typically proceed alongside the planning stage. They define the potential environmental impacts of the projects in more detail and set limits on impacts and obligations for monitoring the state of the environment and impacts on the environment.

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[81] EIA programmes for offshore wind power projects in the exclusive economic zone: Navakka offshore wind power project. https://www.ymparisto.fi/fi/osallistu-ja-vaikuta/ymparistovaikutusten-arviointi/eolus-finland-oy-navakka-merituulivoimahanke-satakunnan-edusta-selkameri#contact-information (in Finnish), Wellamo offshore wind power project https://www.ymparisto.fi/fi/osallistu-ja-vaikuta/ymparistovaikutusten-arviointi/eolus-finland-oy-wellamo-merituulivoimahanke-selkameri (in Finnish), Vågskär offshore wind power project https://www.ymparisto.fi/fi/osallistu-ja-vaikuta/ymparistovaikutusten-arviointi/ilmatar-offshore-ab-vagskar-merituulivoimahanke-selkameri (in Finnish), and Bothnia offshore wind power project https://www.ymparisto.fi/fi/osallistu-ja-vaikuta/ymparistovaikutusten-arviointi/ilmatar-offshore-ab-bothnia-merituulivoimahanke-selkameri (in Finnish)

Some of the environmental reports required for the planning and permit process can be prepared as office work on the basis of existing data. However, offshore wind power projects require field studies, ecological surveys and sampling on the project site to determine and mitigate environmental impacts and to support technical planning for wind power.

Field studies mean more vessel traffic in the area under review as it is sounded, its environment is surveyed, and the characteristics of the seabed are examined. Seabed surveys also interfere with the seabed as samples are collected and drilling required for foundation design takes place. Samples are also collected from the seabed to determine concentrations of harmful substances in the sediment (incl. heavy metals), making it possible to select disposal sites for the construction stage based on the quality of disposed sediment.

The decisions made during the field study stage will indirectly affect all other stages of the project life cycle. Concerning human impacts, the focus is on the starting points for planning (such as planning solutions contributing to noise reduction) and the final location of different structures, which determines the restrictions on the use of marine areas (recreation, cultural heritage and landscape impact) and maritime livelihoods (fishing and shipping). The techno-economic analyses used as the starting point for planning determine the technology and technical solutions to be used, which in turn determine the activities during the project life cycle and the amount of the renewable energy to be produced.

The amount of renewable energy available in the area will continue to influence the implementation and dimensioning of land-based activities consuming the energy, which will later be reflected in business, employment and regional economy. Offshore wind power has an impact on numerous other plans and programmes, which are described in chapter 2.4. The implementation of these projects will have direct and indirect environmental impacts, for example, through carbon capture, hydrogen production and their value-added chains.

Comprehensive security of society and the security measures required by critical energy infrastructure (safety zones, access restrictions and supervision) will probably also have to be considered during the planning stage.

While this stage will only generate minor impacts, decisions made during it will affect the environmental impacts of all other life cycle stages.

Key impact pathways identified for the stage:

- Disturbance caused by maritime traffic and surveys
    - Organisms move away or suffer from stress.
        - Birds, fish, marine mammals, invertebrates in underwater habitats
- Interference with the seabed when samples are collected and studies carried out
    - Highly localised destruction of benthic fauna and seabed habitat

Figure 6. Life cycle of offshore wind power projects: identified significant impact pathways in the preliminary studies and planning stage.

4.3.3 Construction

Impacts during the construction stage are relatively short-lived but intense (Figure 7). Building of foundations and cable laying require significant amount of vessel traffic and seabed intervention. The construction stage produces the first permanent environmental changes of the project. During this stage, decisions on the precise targeting of impacts will also be made as the plans are implemented in the marine areas. In practical work, it may, for example, be realised that planned foundation structures and their exact location must be changed. All changes are made in compliance with the permit conditions granted for the construction and, if necessary, by seeking changes to the permits.

The seabed on the production site is prepared for building the foundations; the extent of this intervention depends on the seabed quality and the selected foundation technique. To construct the foundations, sediment may be removed by dredging, in which case the dredged sediment will be transported to disposal sites identified in the preliminary studies. Cable laying involves immersing the cable in soft sediments whereas on hard seabeds, the cables may have to protected separately. On hard sediments, blasting may also be needed when the foundations are built, and the same applies to cable laying if the seabed is uneven.

Depending on the selected solution, foundation construction involves piling, anchoring and casting as well as transport of foundation elements. Foundations that require piling or blasting cause loud noise of short duration. During and after the construction of foundations, noise and movement caused by construction and vessel traffic will create disturbance. Increased maritime traffic during the construction stage combined with localised temporary loss of benthic fauna at the site of the foundations may expose the offshore wind power area to the spread of invasive species. However, there is no sufficient research evidence on this.[82]

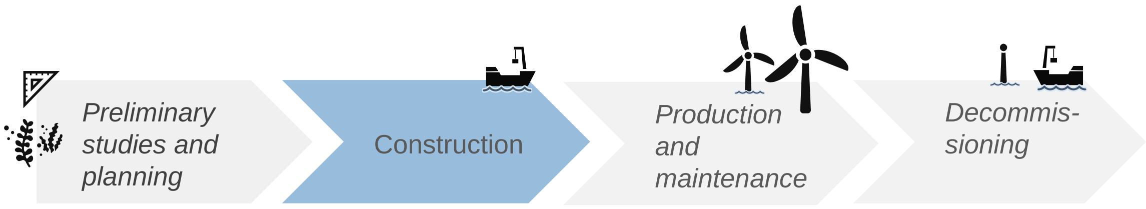
The environmental impacts during the construction stage consequently stem from physical interventions in the seabed and disturbance caused by other construction work. Seabed intervention also causes the sediment to mix with the water column, which may result in the dissolution of contaminants in the sediment into the water and the release of nutrients into the water column for a short time. Benthic habitats at the foundations are destroyed. With regard to disposal and cable laying, the impacts on the seabed during the construction stage are temporary provided that the disposal sites and cable routes are carefully selected based on preliminary studies.

The greatest sources of impact during the construction stage are thus the construction of foundations and cable laying, in connection of which the seabed is disturbed.

Possible human impacts include exposure to noise from construction when the noise can be heard at great distance at sea. Seabed intervention releases harmful substances into the sea and will thus lead to a temporary deterioration in water quality. Offshore areas are not directly used for coastal recreational activities (swimming, etc.), and thus the assumption is that humans are not directly exposed to significant concentrations of harmful substances. During the construction, the areas will be taken over for offshore wind power, which will restrict recreational boating in the area and thus also prevent potential human exposure to changes in seawater quality or turbidity. Indirect impacts on recreational fishing, for example, a situation where fish stocks are driven away, are also possible but they are likely to be minor, especially during the construction stage. Changing landscape and the fact that the offshore wind turbines and the safety zone can no longer be used for recreational purposes constitute the most significant impacts on humans. These impacts will last until the end of the turbine life cycle.

[82] Bergström, L., Öhman, M., Berkström, C., Isæus, M., Kautsky, L., Koehler, B., Nyström Sandman, A., Ohlsson, H., Ottvall, R., Schack, H. & Wahlberg, M. 2021 – Effekter av havsbaserad vindkraft på marint liv, En syntesrapport om kunskapsläget 2021. Naturvårdsverket rapport 7049

Cable laying is the only part of the work involving seabed intervention in areas near the coast. As a result, people can notice water turbidity in the immediate vicinity of the cable routes during the construction stage.



The impacts of this stage are intense but of short duration.

Key impact pathways identified for the stage:

- Disturbance caused by maritime traffic, construction of wind turbines and cable laying:
  - Organisms are driven away or suffer from stress.
    - Birds, bats, fish, marine mammals, invertebrates in underwater habitats
  - Hearing damage caused by construction noise
    - Birds, fish, marine mammals
  - Potential spread of invasive species

- Seabed intervention during construction of foundations and cable laying
  - Localised destruction of benthic habitat
  - Mixing of sediment nutrients with the water column
    - Deterioration of water quality
  - Dissolution of sediment contaminants in the water column
    - Deterioration of water quality, accumulation of harmful substances in biota

Figure 7. Life cycle of offshore wind power projects: identified significant impact pathways in the construction stage.

Fishing restrictions and the transfer of turbines, cables and safety zones for the use of offshore wind power production have significant impacts on human activities and may adversely affect maritime livelihoods and, for example, the fishing-based culture. The impact is first felt during the construction stage and it will continue until the end of the turbine life cycle.

4.3.4 Production and maintenance

Compared to the construction stage, the impacts during the production and maintenance stage are spread over a longer period but they are less intense (Figure 8). The noise impact is an example of the difference in the duration and intensity of the impacts between the construction stage and the production stage: blasting noise during the construction is short and intense, while the vibrations and humming of an operating wind turbine are less severe but longer-lasting. The wind turbines are serviced as part of production and maintenance. It may also be necessary to repair turbines and cables, in which case spare parts are transported to the site requiring maintenance. In the event of a cable failure, the cable must be lifted from the seabed and repaired on a surface vessel.

Maritime traffic and repairs disturb the fauna in the area, and seabed sediment interventions may be necessary in connection with the repairs, causing temporary disturbance to the benthic habitats and mixing sediment with the water column.

In the production stage, wind turbines generate constant noise, especially below the water level. The noise affects different organisms in different ways. In the case of fish, for example, the impact depends on the species: some species are driven away by the noise and vibration generated by the wind turbines, while other species thrive in the vicinity of the foundations of offshore wind turbines. It should be noted that waves also cause continuous natural underwater noise.

While there is no vessel traffic in the offshore wind power production area under normal conditions, in an emergency ships may navigate between the wind turbines, unless this is specifically forbidden. As a rule, trawling cannot be carried out in offshore wind power production areas, and bottom trawling cannot be carried out in places where cable routes are located. In practice, fish and benthic animals are protected from trawling in the production area.[85] With the discontinuation of bottom trawling,[83] there may be less mixing of sediment with the water column in the production area.

Hard underwater structures of wind turbines and structures protecting the cables may also create new habitats for hard seabed species; this is called the artificial reef effect.[84,85] The strength of the reef effect depends on such factors as the complexity and size of the structures.[85]

Wind turbine structures also affect currents and sea state, which in turn may have an impact on biota. Currents have a direct impact on microalgae, which in turn affect other organisms both directly and indirectly as part of the food web. The turbines also have an impact on the wind conditions in the area below the wind.

As all permanent and mobile offshore structures, offshore wind turbines are exposed to wear and erosion. Detachable parts, their pieces or microscopic surface erosion cause the gradual release of materials into the sea. This applies to all materials used in the construction of the structures (concrete, steel, carbon fibre, plastics or paints and protective agents used in their surface treatment). The selection of structures and materials is guided by standards, which are also developed with environmental considerations in mind. At the same time, during the long life cycle of wind turbines, new research on and awareness of less well-known and guided environmental issues are likely to emerge. This includes microplastics caused by the erosion of materials considered as plastics.[86]

[83] It is not entirely clear how extensively bottom trawling or near-bottom trawling (which potentially mixes bottom sediments) are carried out in the Gulf of Bothnia or how bottom trawling is defined as a method of exploiting natural resources in the area.

[84] Bergström, L., Öhman, M., Berkström, C., Isæus, M., Kautsky, L., Koehler, B., Nyström Sandman, A., Ohlsson, H., Ottvall, R., Schack, H. & Wahlberg, M. 2021 – Effekter av havsbaserad vindkraft på marint liv, En syntesrapport om kunskapsläget 2021. Naturvårdsverket rapport 7049

[85] Vehanen, T., Hario, M., Kunnasranta, M. & Auvinen H. Review on the effects of offshore wind power facilities on fish, sea mammals and sea birds. 2010. Riista- ja kalatalous – Selvityksiä 17/2010 (in Finnish, with English abstract).

[86] A study carried out in the Netherlands estimates that offshore wind turbines account for less than one thousandth of human-created offshore structures, which in addition to offshore infrastructure also include ships and the erosion of their plastic surfaces and surface treatments. Caboni M.,

While the operational cables do not generate any noise, an electromagnetic field is created around them, which may affect magnetosensitive fish species, including migrating eels, and benthic fauna close to the cable. Studies show that migration of eels is not prevented but it may be slowed down.[87] The sediment covering the cables weakens the electromagnetic field and its extent in the water column. While the service life of the cable is about 40 years, the risk of malfunctions and repairs increases after about 10 years of use. In other words, seabed intervention after the construction stage is a special case.[88] The impact of the installation depends on the habitats and organisms occurring on the installation site and seabed characteristics.

For the whole duration of the production period of the wind turbines, human activities are significantly impacted by offshore wind turbines and the safety zones designated for them becoming inaccessible for other use (such as fishing and shipping), changes in landscape, and the change in the regional economic structure caused by the production of renewable energy.

The energy available from offshore wind power can significantly change the economic structure of coastal areas during the life cycle of the offshore wind project. The drivers of change for the economic structure include restrictions on the use of the marine areas in question (transfer of the turbines and cables and areas required for their safety to the use of offshore wind power) and opportunities for the growth of industries and investments generated by renewable energy production. Depending on the location of the areas, restricting fishing and shipping may adversely affect maritime livelihoods and the fishing-based culture. At the same time, the beneficiaries include actors using electricity, such as industry and hydrogen projects, which are expected to need new renewable energy so that they can be realised. According to the regional road maps for hydrogen projects,[89] such as BotH$_2$nia Hydrogen Valley, the eight hydrogen projects in the area between Pori and Oulu and their value-added chains may create 10,000 jobs and investments totalling EUR 9,746 million between 2025 and 2030. This would be a significant change in the local community and economic structure, which would impact the vitality, competence needs, educational structures, movement of labour, demographic trends and service needs of the region in many ways.

Growth based on green transition is welcomed by communities as it is in line with municipal and regional strategies. However, rapid structural change also poses challenges to the regions.

Areas designated for the use of wind power in distant offshore areas in the exclusive economic zone are rarely important in terms of recreation and leisure activities. However, changes in the landscape, visual flicker caused by the movement of the blades, and noise and vibration generated by wind turbine rotors can probably also be noticed outside the areas. At a later stage, as part of the environmental impact assessment of each offshore wind power project, these

Estimating microplastic emissions from offshore wind turbine blades in the Dutch North Sea, Wind Energ. Sci. 10/2025

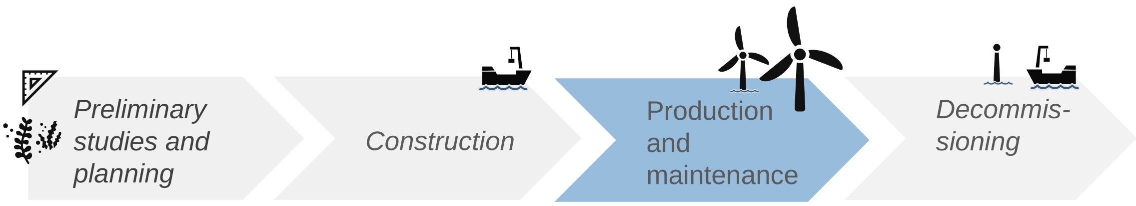
[87] Niras Consulting ltd. 2015. Subsea cable interactions with the marine environment, Expert review and recommendations report. Renewables Grid Initiative.

[88] Niras Consulting ltd. 2015. Subsea cable interactions with the marine environment, Expert review and recommendations report. Renewables Grid Initiative.

[89] For example, Hydrogen economy roadmap for Satakunta 2035, BotH$_2$nia Hydrogen Valley 2030 (in Finnish)

impact areas will be modelled more accurately and ways to minimise harmful impacts will be determined.

Maintenance-related operations will result in sporadic vessel traffic in the area. Repairs required by cable damage and malfunctions may cause momentary seabed intervention. This action is of local nature and it is unlikely to cause deterioration in water quality or human exposure.



While the impacts of this stage are long-lasting, they are weaker than the impacts arising from the construction work.

Key impact pathways identified for the stage:

- Operation and maintenance of wind turbines:
  - Wind turbine flicker and noise
    - Disturb birds, bats and fish; the impact is species-specific
  - Bird collisions with blades
  - New hard seabed habitat
  - Disturbance caused by maintenance
    - Organisms are driven away or suffer from stress
    - Intensity and objects depend on the measure

- Electromagnetic field created by cables
  - Slowing down of fish migrations
  - Magnetosensitive benthic animals are driven away or decline

- Impacts of turbine structures on other human activities
  - Prevention of fishing
    - Protection zone for fish
  - Barrier to maritime traffic
    - Reduction of noise generated by maritime traffic
  - Interference caused by wind turbine structures impacts radar use

Figure 8. Life cycle of an offshore wind power project: identified significant impact pathways in the production and maintenance stage.

4.3.5 Decommissioning

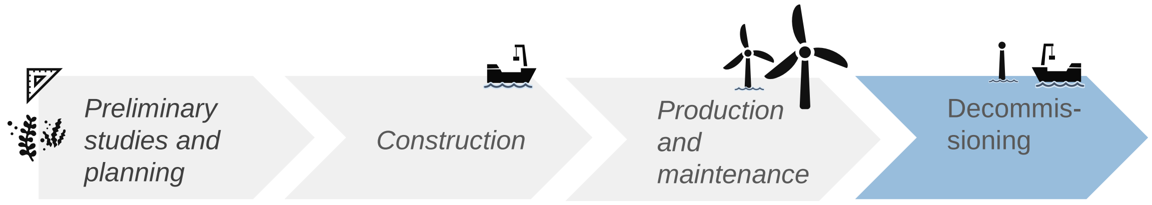
When the wind turbine ceases to operate, its structures will be demolished so that the production site can be used for other purposes and ecological values on the site can recover (Figure 9). At minimum, the wind turbine structures above sea level are demolished, and underwater structures are removed sufficiently to make the area available for maritime traffic. Concrete obligations to demolish offshore wind turbines in Finland's exclusive economic zone have not yet been laid down in legislation, and no case-law on this matter exists in Finland.

Decommissioning causes disturbance to biota through demolition operations and increased maritime traffic. Depending on the scale of the demolition work, for example, if the wind turbine foundations are removed, the activities result in seabed intervention comparable to the construction stage. Dredging and soil disposal are probably not necessary at this stage. If during the decommissioning stage, structures are demolished to the depth allowing maritime traffic, the remaining structures will continue to impact trawling of pelagic species.

The demolition of the foundations may have greater impacts on the environment than leaving them on the seabed, as long as it is ensured that no harmful substances dissolve into water from the structures. These solutions are later specified in the environmental impact assessment or in the terms of the water permit, taking into account legislative changes and technological advances during the turbine service life.

The demolition itself is not known to have any environmental health impacts on humans. After the offshore wind turbines have reached the end of their service lives, it must be decided whether the marine areas in question will remain designated for energy production. When solutions to these issues are sought, there will probably be more emphasis on climate change adaptation measures at societal level.

In addition to demolition, this life cycle stage also includes any restoration measures aimed at promoting the recovery of ecological values in the wind power impact area as well as monitoring of the state of the environment. If the areas are released for other uses, there may be even better opportunities for fishing or other maritime food production. Alternatively, warming caused by climate change may already be more clearly visible in the nature of the Baltic Sea than at present, which means that the manner in which marine resources are exploited, and the needs of recreation and leisure activities may differ from what can be anticipated in 2025.



The impacts of this stage are similar to the impacts of the construction stage but weaker.

Key impact pathways identified for the stage:

- If the structures are removed completely
  - The hard seabed habitat created during the operational stage around the foundations and cable protection structures will be destroyed and the species will be lost.
  - The noise generated by demolition work causes disturbance to biota, especially underwater.
  - When a cable is removed, sediment is mixed in the water column; nutrients and contaminants in the sediment are dissolved in water.
  - The environment recovers close to its original state

- If the structures are removed to a depth that allows maritime traffic
  - Disturbance caused by demolition work drives away animals, especially birds and fish.
  - The hard seabed habitat created around the foundations and cable protection structures is preserved.
  - The environment does not recover to its original state.
  - Bottom trawling will not be possible in the production area.

- After demolition, the disturbance caused by the noise and flicker of the wind turbines and the bird collision risk are eliminated.

- Electromagnetic fields generated by cables disappear.

Figure 9. Life cycle of offshore wind power projects: identified significant impact pathways in the decommissioning stage.

4.3.6 Identified significant impact pathways

In terms of impacts, the most significant life cycle stages are the construction stage and the production and maintenance stage.

The following have been identified as the most significant impact pathways during the construction stage:

- In the construction of foundations and cable-laying, the work is partially carried out on the seabed, which has an impact on seabed habitats. In the parts of the seabed targeted by the work, recovery of the habitat depends on whether the foundations or cables are removed at the end of their life cycle. The impact of the construction on the seabed has been identified as potentially significant because although the impact of the construction is highly local in nature, the organisms that do not migrate independently will be destroyed by seabed intervention. After the end of the human activities during the construction stage, the seabed habitat changed by the construction equipment may be restored or a new habitat may be created on the site.

- Mixing of sediment and sedimentation can cause eutrophication and dissolution of contaminants into the water column. Eutrophication increases microalgae blooms in the marine area and, together with sediment particles, it reduces the ability of light to penetrate water, which affects the depth spread of algae and aquatic plants and the amount of epiphytes. The impact depends on the characteristics of the area. Sedimentation can cover organisms that cannot escape or move, causing them to die. Spawn laid by fish during the spawning season are particularly vulnerable.
- Loud noise generated by construction can cause hearing damage in fish and marine mammals and drive away animals from the construction areas. Increased maritime traffic, together with the noise arising from the construction, may interfere with the breeding of animals or their food supply.

The following have been identified as the most significant impact pathways during the production and maintenance stage:

- Underwater noise can drive away fish and marine mammals and interfere with their communication. The noise is mostly steady and continuous. However, there is not enough species-specific research on the impacts of underwater noise, and there is no data on such matters as its impact on different groups of species or the life stages of different species.[90]
- Offshore wind power projects may change the ice conditions at their locations, which may have an impact on the use of the marine area and the habitats of different animal species. In the near future, ice conditions will also be affected by the added combined impact of climate change and maritime traffic. The combined impacts can have significant effects on Baltic ringed seal, which only uses ice floes for breeding. As the ice conditions deteriorate, the breeding area of the species will move further north into the Bothnian Bay and its range will shrink considerably.[119]
- The electromagnetic fields of the cables, together with the underwater noise, may slow down or prevent fish migration or disturb reproduction near spawning grounds. There is no precise information on migratory routes, even though it is estimated that the spawning migration of salmon runs roughly along the coast. Variation in migratory routes may result from such factors as changes in water temperature.[48] However, fish have also been found to spawn in areas where maritime traffic generates significant amounts of noise and thus the impact may not be strong but may accumulate with other projects.
- Fish stocks in the production area may benefit from the fact that trawling cannot be carried out in the area, which protects fish stocks from fishing pressure. However, at the same time, there is no detailed information on the species-specific impacts of offshore wind power, in which case, shift in the distribution of certain species may also impact trawling and fish

[90] Mooney, T.A., M.H. Andersson, and J. Stanley. 2020. Acoustic impacts of offshore wind energy on fishery resources: An evolving source and varied effects across a wind farm's lifetime. Oceanography 33(4): 82–95, https://doi.org/10.5670/oceanog.2020.408.

stocks. The chances of fishers to practise their livelihood are also reduced as the area available to them decreases.

- The impact on birds is species-specific. The turbines drive away some of the bird species (such as red-throated diver, long-tailed duck and common scoter) from the production area and may also prevent them from using the area for feeding and breeding. Some of the birds may also collide with the turbine blades. The risk of a collision varies by species and depends on the flight speed of the species and the extent to which they avoid turbines.

5 The likely significant impacts of the draft decision

5.1 Environmental characteristics of the offshore wind power areas examined in this report.

To support the selection of areas suitable for offshore wind power examined in the environmental assessment, the Ministry of Economic Affairs and Employment has commissioned a report on the identification of areas suitable for offshore wind power from the Finnish Environment Institute. The report is based on existing material on marine nature and human activities. Data contained in the material has been used as background information for the modelling carried out to identify the areas.

According to the information supplied by the Finnish Environment Institute on 19 May, areas that are potentially suitable for offshore wind power were identified on the basis of extensive existing data on marine nature and human activities that could conflict with the placement of offshore wind power. As there is no comprehensive material available on the nature in the exclusive economic zone, the work was largely based on modelled material.[91] The identification of suitable areas was based on previous work on the placement of offshore wind power,[92] in which the best areas for offshore wind power from the perspective of the economy, society at large and nature were identified by means of spatial prioritisation. The aim was to identify areas where harmful impacts can be avoided but where energy can still be produced on a profitable basis.

The same principle was applied in this work but it was based on updated data on such matters as bird areas sensitive to offshore wind power, migratory routes, fishing and ecosystem services. The data was updated in the 2023 project

[91]Virtanen, E.A., Viitasalo, M., Lappalainen, J. and Moilanen, A., 2018. Evaluation, gap analysis, and potential expansion of the Finnish marine protected area network. Frontiers in Marine Science, 5, p. 402.

Virtanen, E.A., Kallio, N., Nurmi, M., Jernberg, S., Saikkonen, L. and Forsblom, L., 2024. Recreational land use contributes to the loss of marine biodiversity. People and Nature, 6(5), pp. 1758–1773.

Forsblom et al. manuscript

[92]Virtanen, E.A., Lappalainen, J., Nurmi, M., Viitasalo, M., Tikanmäki, M., Heinonen, J., Atlaskin, E., Kallasvuo, M., Tikkanen, H. and Moilanen, A., 2022. Balancing profitability of energy production, societal impacts and biodiversity in offshore wind farm design. Renewable and Sustainable Energy Reviews, 158, p. 112087.

‘Merituulivoimalle soveltuvat alueet Suomen merialueilla’ (Areas suitable for offshore wind power in Finnish marine areas).

Sufficient size of offshore wind farms (about 200 km^2), suitable depth (max. 60 m) and a minimum distance of two nautical miles from the boundary of the exclusive economic zone were used as additional area placement criteria. The areas were also selected so that the current monitoring of the state of the sea would not be endangered and this was done by setting a distance of at least two kilometres to the existing maritime monitoring stations. In the selection of the areas, the main aim was to consider areas for which research permits have already been granted. This was done to ensure that the areas are of interest to energy production.

The Finnish Environment Institute has used the spatial prioritisation tool Zonation for the identification and analysis of suitable areas.[93] It has been extensively used in support of nature protection and land use planning. The tool combines geographic data by means of spatial prioritisation on the occurrence of species, habitats and ecosystem services, threats facing nature, connections, costs of nature protection and the needs of alternative use of land and marine areas.

The analyses can be used to identify areas featuring important and less important nature as well as areas in which the harmful impacts on humans and other use of land and marine areas can be minimised.

In later chapters, each of the offshore wind power areas to be examined is described separately based on the background material provided by the Finnish Environment Institute. In other respects, the current state of the areas is described at a more general level, and in the absence of observation data, the current state of the area is described on the basis of the known general characteristics of the sea. Thus, figures on individual areas inevitably have repetition to the extent that the areas have similar characteristics.

Information on the state of the environment in the areas and the specific environmental impacts associated with specific species as well as the information needs of the SEA process have been supplemented and validated by interviewing the following persons:

- Birds: Kim Jaatinen and Markku Mikkola-Roos (Finnish Environment Institute), 25 August 2025
- Baltic ringed seal: Penina Blankett (Ministry of the Environment) and Mervi Kunnasranta (LUKE), 22 August 2025
- Fish: Antti Lappalainen (LUKE) 1 September 2025
- Fish: Mikko Malin, Finnish Fishermen’s Association, 2 September 2025
- Marine environment management and protection of marine nature, seabed: Ari Laine (Metsähallitus), 2 September 2025
- Bats: Eeva-Maria Tidenberg (University of Helsinki) and Olli Loisa (Turku University of Applied Sciences), 5 September 2025
- Lasse Tallskog (Ministry of the Environment), interviewed as SEA process expert, Wednesday 27 August 2025

For many aspects of the areas, information based on local field studies (such as sampling or video recordings) is lacking and the descriptions and conclusions

[93] Moilanen, A., Lehtinen, P., Kohonen, I., Jalkanen, J., Virtanen, E.A., & Kujala, H. (2022). Novel methods for spatial prioritization with applications in conservation, land use planning and ecological impact avoidance. Methods in Ecology and Evolution, 13, 1062–1072. https://doi.org/10.1111/2041-210X.13819

derived from them are based on general principles on the ecology of the Baltic Sea. The possible existence of different habitats is based on modelling, which assesses the likelihood of different geological and ecological features. Concerning the ecological values of the areas, the descriptions are thus based on the environmental characteristics of each area and the description of the species and habitats likely to occur in such areas. The range of species and, for example, data or data gaps on migration routes also affect the assessment of the current status of the area.

In practice, this means that the result of a modelling of a reef or sand seabed indicates an increased probability of such geological areas. At the same time, it is known that the important macrophyte habitats characterising the Baltic Sea (such as wrack areas or sand-based sea grass meadows) occur only up to a certain water depth, that species occurring deep in the soft seabed are different from those found in the hard seabed, and that the species found in the Gulf of Bothnia are to some extent different from those occurring in the Bothnian Sea. The occurrence of plants, molluscs and insects typical of each identified ecosystem also has an impact on the significance of each area as a habitat for birds or fish.

The Table 3 below contains a summary of the typical characteristics facilitating the examination of area-specific assessments and allowing comparisons between areas.

Table 3. Characteristics and ecological values of the offshore wind power areas and their importance to species groups.

Area:	Bothnian Sea West	Bothnian Sea East	Bothnian Bay South	Bothnian Bay North
Seabed quality	Mostly soft, some hard areas	Mixed sediment, mostly soft areas	Mostly soft, some hard areas (reefs)	Mostly soft, some hard areas
Occurrence of reefs	None observed	None observed	Likely	Likely
Occurrence of sandbanks	None observed	Likely	None observed	Likely
Water depth	Max depth 60 m, too deep for macrophytes and diving birds obtaining their food from the bottom	Max depth 60 m, too deep for macrophytes and diving birds obtaining their food from the bottom	Max depth 30 m, too deep for macrophytes, reefs are possible spawning grounds and feeding areas for diving birds	Depth 10–30 m, possible local macrophyte areas, spawning grounds and feeding areas
Significance of the area for birds (risk category)[94]	Importance for migratory birds (such as black-throated diver, red-throated diver, certain waders) not exactly known No increased risk	Importance for migratory birds (such as black-throated diver, red-throated diver, certain waders) not exactly known Slightly increased risk (category 3)	Important to migratory birds (such as black-throated diver, red-throated diver, and other seabirds) but data gaps exist Increased risk (category 2)	Important to migratory birds (such as black-throated diver, red-throated diver, and other seabirds) but data gaps exist Increased risk (category 2)
Importance of the area for fish	Not known	Not known	Not well known. Possibly important to	Not well known. Possibly important to

[94]Sensitive bird areas in the Finnish maritime area for the Baltic Sea Action Plan Report of the Finnish Environment Institute 24/2025 (in Finnish, with English abstract).

Area:	Bothnian Sea West	Bothnian Sea East	Bothnian Bay South	Bothnian Bay North
			migratory fish (salmon)	migratory fish (salmon)
Importance of the area for bats	Not known but there are indications of offshore migration elsewhere in the outer archipelago (for example, Nathusius' pipistrelle)	Not known but there are indications of offshore migration elsewhere in the outer archipelago (for example, Nathusius' pipistrelle)	Not known but there are indications of offshore migration elsewhere in the outer archipelago (for example, Nathusius' pipistrelle)	Not known but there are indications of offshore migration elsewhere in the outer archipelago (for example, Nathusius' pipistrelle) Not known
Importance of the area for seals	Not well known	Not well known	Important to Baltic ringed seal	Important to Baltic ringed seal
Underwater ecological values (spatial prioritisation)	No observations of important ecological values	No observations of important ecological values	Possible underwater ecological values	Possible underwater ecological values

The maps below show the location of each area in relation to other offshore wind power areas, main grid connection points and geographic data on the key ecological values and protected sites.

The map shows other geographic areas near potential offshore wind power areas in the Finnish exclusive economic zone where wind farms might be built. The situation and status of offshore wind power projects envisaged or planned in these areas vary and depend on the processes of the countries concerned. Therefore, the realisation of energy projects (construction of an offshore wind farm and the start of production) is not yet certain.

The map shows offshore wind power projects planned in the Swedish exclusive economic zone, Finnish territorial waters and the Åland marine area.[95] The projects in the Swedish exclusive economic zone include both projects in which permit processes are under way or a prior consultation is in progress. Some of the projects in the Finnish territorial waters have reached the pre-planning stage, some have been identified and some are in the permit process stage. The map also shows the potential areas for offshore wind power identified in the maritime spatial plan for Åland. The situation corresponds to the sources checked in September 2025.

[95]Swedish projects in the exclusive economic zone, Vindbrukskollen, https://vbk.lansstyrelsen.se/?appid=d62d1589ccda4b15a4ed2d19d0afdf7b, projects in the Finnish territorial waters, Renewables Finland https://suomenuusiutuvat.fi/tuulivoima/hankkeet-ja-voimalat-suomessa/kartta/ and projects in Åland, Havsplanen, https://aland.maps.arcgis.com/apps/webappviewer/index.html?id=3fe10bf5d03c409ead0aa103f01301b3

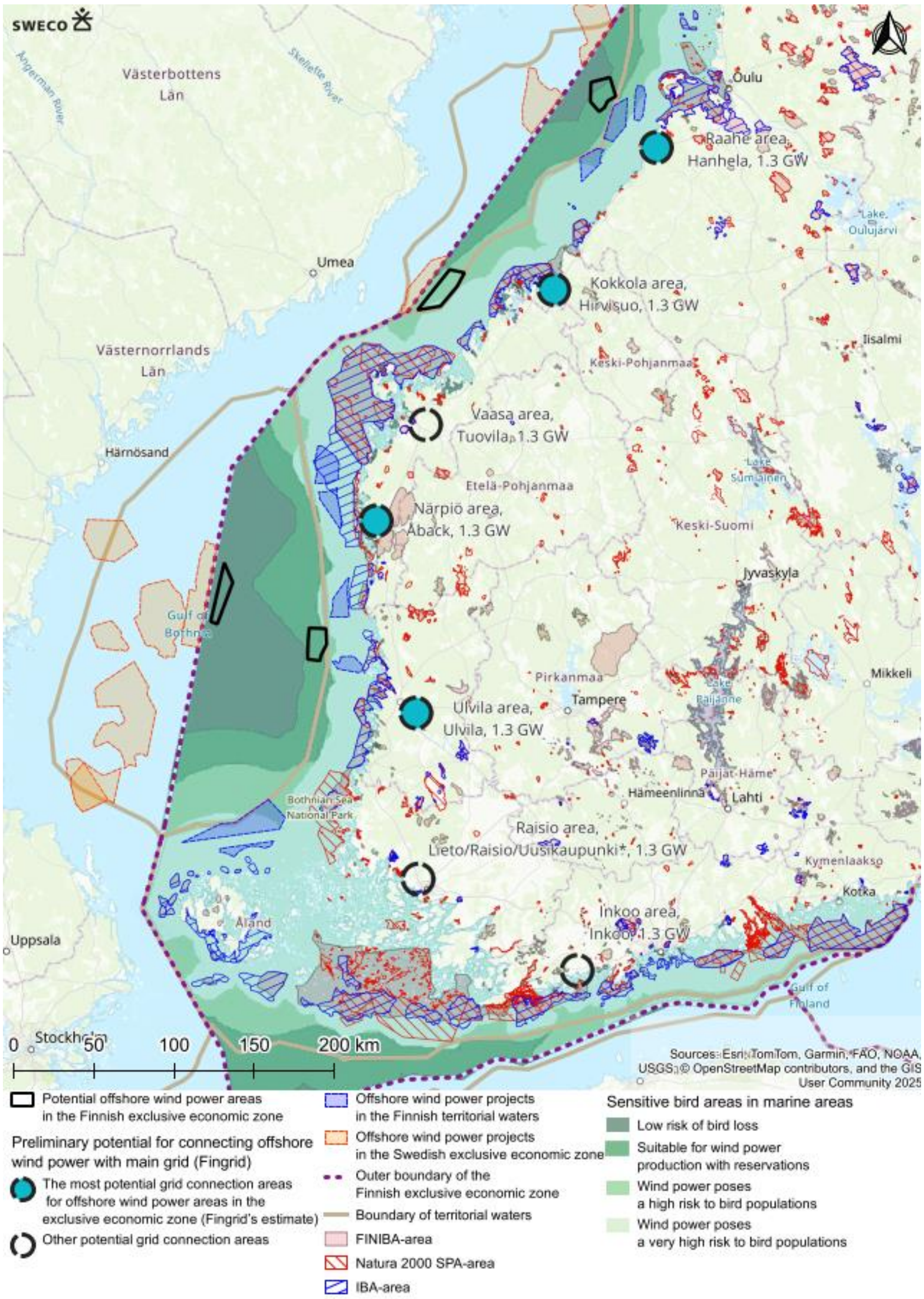


Figure 10. Areas to be assessed, other offshore wind power development projects, important and sensitive bird areas and protection of birds.

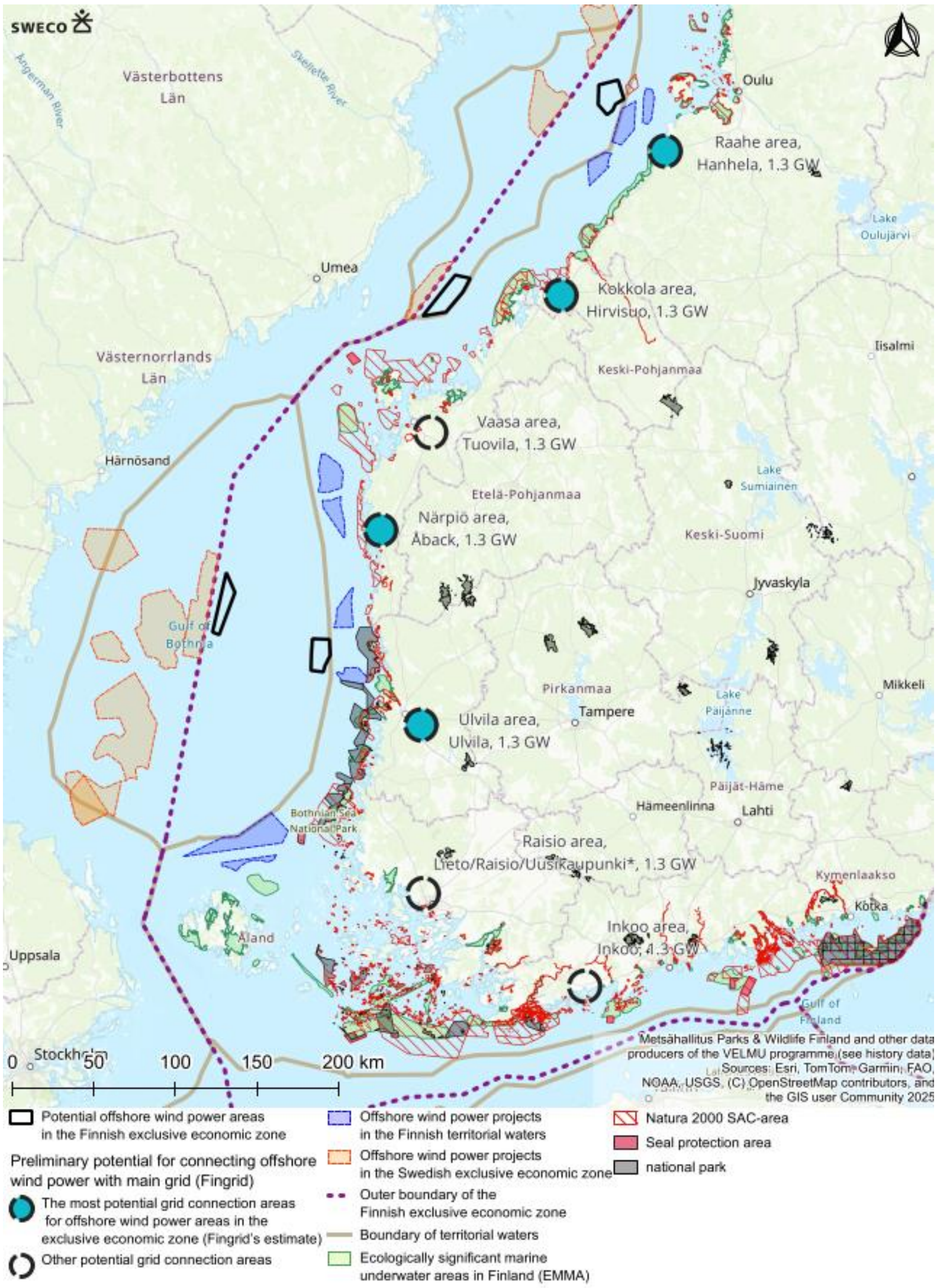


Figure 11. Areas to be assessed, other offshore wind power development projects, underwater ecological values, nature reserves and protection of seals in the Baltic Sea.

The following area-specific chapters provide information on the habitats and species in each area and the estimate of significant environmental impacts based on them.

5.2 Impacts in the area: Bothnian Sea West

5.2.1 State of the environment in the area designated for offshore wind power

There is no site-specific research-based ecological survey and sampling data on the fauna and characteristics of the area. This means that the estimate of the current fauna of the area is based on existing general information on the characteristics of the area (such as depth and seabed quality), range of the Baltic Sea biota and the ecology of the Baltic Sea, on the basis of which assumptions have been made about the current state of the area.

Description of the environment in the area produced by the Finnish Environment Institute, 19 May 2025

“Bothnian Sea West (211 km^2), which is potentially suitable for offshore wind power, is the outermost area envisaged for the purpose and it is located near the boundary of the exclusive economic zone. Most of the area has a depth of less than 60 m.[1] Based on fishing hours, trawling is carried out in small scale in the northern parts of the area.[2] Based on marine habitat models, sandbanks or reefs are not known to occur in the area,[3] but no direct observation data is available. The area is not known to be sensitive for seabirds concerning the establishment of offshore wind farms.[4] No data is available on migratory routes of birds migrating across the Gulf of Bothnia to Sweden. Based on the spatial prioritisation analysis of marine nature, the area is not known to have significant underwater ecological values,[5, 6, 7] However, no marine nature observation data is available for the area (Velmu).”

Sources used in the description:

[1]Kulha, N., Ruha, L., Väkevä, S., Koponen, S., Viitasalo, M. and Virtanen, E.A., 2024. Satellite bathymetry estimation in the optically complex northern Baltic Sea. *Estuarine, Coastal and Shelf Science*, *298*, p. 108634.

[2]Lappalainen, A., Setälä, J., Helminen, J., Lehtonen, T., Niukko, J., Rantanen, P., Saarni, K. and Söderkultalahti, P., 2023. Fishing areas of the Finnish trawler fleet in the Baltic Sea between 2010 and 2022 (in Finnish).

[3]Rinne, H. and Kaskela, A., 2018. Modelling of underwater Natura habitats in Finnish marine areas. Geologal Survey of Finland. http://urn.fi/URN:NBN:fi-fe2020100883047 (in Finnish)

[4]Tikkanen et al. manuscript

[5]Virtanen, E.A., Viitasalo, M., Lappalainen, J. and Moilanen, A., 2018. Evaluation, gap analysis, and potential expansion of the Finnish marine protected area network. *Frontiers in Marine Science*, *5*, p. 402.

[6]Virtanen, E.A., Lappalainen, J., Nurmi, M., Viitasalo, M., Tikanmäki, M., Heinonen, J., Atlaskin, E., Kallasvuo, M., Tikkanen, H. and Moilanen, A., 2022. Balancing profitability of energy production, societal impacts and biodiversity in offshore wind farm design. Renewable and Sustainable Energy Reviews, 158, p. 112087.

[7]Virtanen et al. manuscript

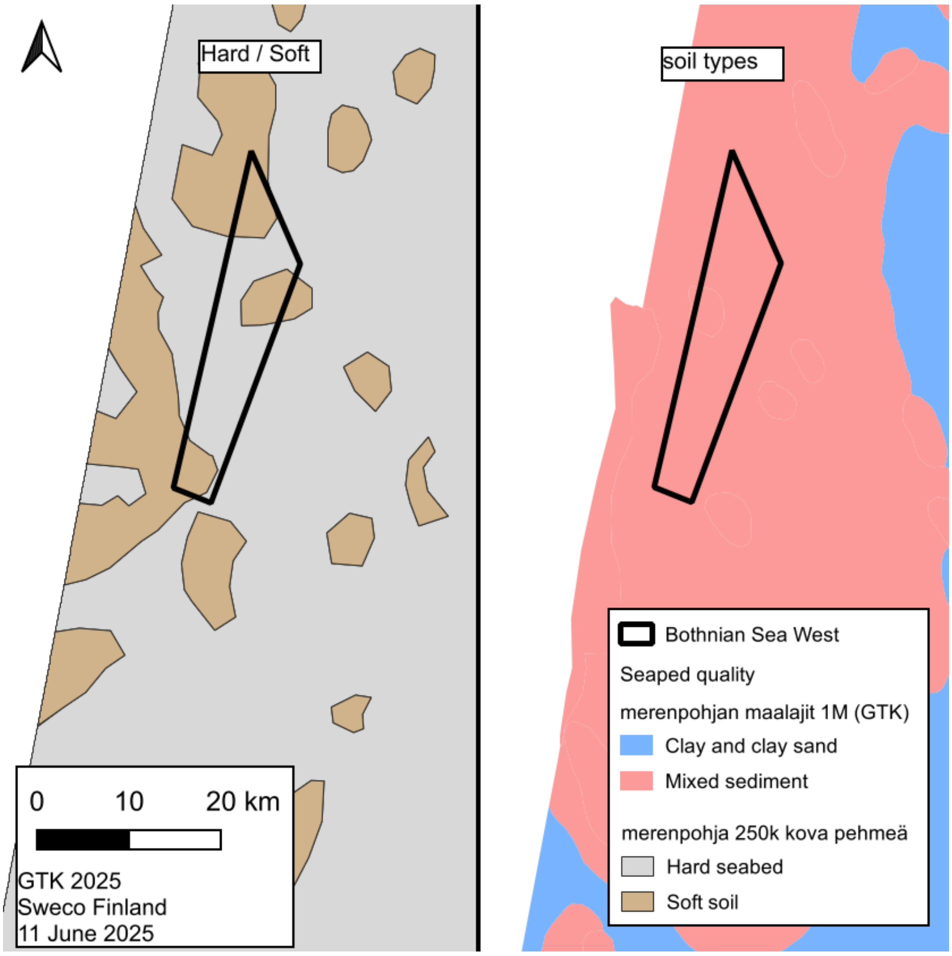


Figure 12: Seabed quality of Bothnian Sea West.

5.2.2 Significant environmental impacts of offshore wind power in Bothnian Sea West

As a rule, the most significant environmental impacts are caused by the introduction and construction of structures required for energy production and energy transmission in the marine area in question. In other words, the impacts depend on the habitats and species that occur in the area in question or which species use the area for passage or for catching food. Conclusions can be drawn on the basis of area-specific data and on the basis of general knowledge of the Baltic Sea ecology in different types of seabed and depths.

Based on the data collected from the area by the Geological Survey of Finland, the seabed of Bothnian Sea West is mixed sediment. The seabed is mainly soft but there are also hard seabed areas. The soil type is mixed sediment (see Figure 12). The data collected by the Geological Survey of Finland from the area is not particularly detailed and the seabed quality of the area may actually vary when examined in more detail.

There are no reef habitats or sandbanks in the area. Moreover, the area is too deep for macrophyte habitats (such as wracks or water milfoils).

Based on this information, most of the seabed habitats in the area are likely to consist of invertebrates typical of soft deep seabed, such as *Monoporeia affinis*, Baltic clam and *Oligochaeta*. Habitats dominated by *Monoporeia affinis* (Monoporeia and Pontoporeia habitats) are critically endangered and important for marine food chains. Not much is known about the importance of offshore shallow areas as breeding grounds for Baltic herring.[48] The benthic fauna is relatively homogeneous and thus sensitive to changes but at the same time, it is fairly easy to forecast using geological data even though the observations must be verified with more detailed samples.[101]

Construction

Seabed intervention during the construction of foundations has a significant impact on seabed habitats in the area. During the construction, the seabed is disturbed, which destroys the habitat at the site of the foundations. Full recovery of the habitat depends on whether the foundations are removed at the end of the turbine life cycle. If the foundations will remain in place, the impact can be permanent and negative. This impact has been identified as potentially significant and it mostly affects the site where the foundations are located.

Seabed intervention during foundation construction impacts the sessile (immobile) benthic fauna of the area. Benthic fauna recovers quickly but its habitat at the site of the foundations is permanently destroyed. Full recovery depends on whether the foundations are removed at the end of the turbine life cycle. The impact on benthic animals may be permanent and negative and it has been identified as potentially significant.

The noise generated during construction can have a significant impact on marine mammals. It can damage the hearing of marine mammals, especially if work is carried out without noise mitigation measures. This impact has been identified as potentially significant and it affects the project area.

The seabed intervention work carried out during cable laying affects seabed habitats. It may destroy habitats on the cable route but the impact is limited to the sections where habitats exist and where seabed intervention work is required. Thus, it does not take place on the entire cable route.[96] The impact on the destroyed seabed is permanent. The significance of the impact is uncertain and depends on the cable route and the site where the cable comes ashore. Towards the coast, starting at a depth of about 15 metres, the number of significant and endangered species increases, which also increases the risk of significant impacts.

Laying of the cable during construction may disturb significant coastal bird life sites especially where the cable comes ashore.[97]

Production and maintenance

The combined impact of wind turbines and other projects may constitute a barrier to sensitive fish species. This may interfere with the migration or feeding of fish stocks. Not enough is known of the significance of the impact on migratory fish in the exclusive economic zone. Similarly, electromagnetism of submarine cables may affect fish migration routes and cause physiological harm to species such as salmon. However, there are few species-specific studies of this.[48] As far as trawling of Baltic herring is concerned, the offshore wind power areas in the Bothnian Sea are highly problematic, as the areas where trawling can be carried

[96]A submarine electric cable is usually buried in the seabed in a soft seabed area, or a casing or other protective structure may be built for the cable in a hard seabed area.
[97]Oral communication Kim Jaatinen and Markku Mikkola-Roos (Finnish Environment Institute), 25 August 2025

out are already in use as fishing grounds and relocating the fishing activities would be challenging.[98]

Wind turbines may, alone or in combination with other projects, constitute a barrier to some bird species and disturb them. This may slow down bird migration, for example, due to the long avoidance distances, and in this way increase the energy consumption of certain species (such as divers). Resting species may also be affected at resting sites. A limited amount of satellite monitoring has been carried out in the area, indicating that waders, for example, migrate across the open sea. There is not enough information on the significance of the impacts on migratory birds in the exclusive economic zone, and thus a comprehensive impact assessment cannot be produced.

The visibility of wind turbines in the landscape reduces the amount of open landscape and may have a negative impact on humans. Wind turbines in Bothnian Sea West may be visible on the horizon in the Bothnian Sea National Park where landscape values have been identified as important recreational values.[99] This effect lasts until the end of the turbine life cycle. However, the wind turbine would not be visible from the coast.

The energy produced by offshore wind power during its operations and maintenance provides opportunities for the growth of and investments in renewable energy. This impact has been identified as potentially significant and it extends outside the project area.

Decommissioning

Demolition of the foundations causes the hard seabed habitat to disappear from the work area. Any new habitat and the species unique to it will disappear with the foundations. The demolition may cause sediment mixing and sedimentation, which affects fish spawning grounds. Habitats may be buried under sedimentation but sea currents carry sediments to natural deposits. The effect is reversible and negative but potentially significant. The noise generated by the demolition work, especially blasting, may damage the hearing of marine mammals. This impact is permanent and negative and affects the animals in the area concerned at the time of the work.

It is not yet possible to determine which species will be affected, as the demolition timetable is not known. The life cycle of an offshore wind farm is about 30 years but some of the structures may be demolished before that. It is also possible that operations in the area will continue or it is decided that some of the structures will be preserved for other uses.

5.3 Impacts in the area: Bothnian Sea East

5.3.1 State of the environment in the area designated for offshore wind power

There is no site-specific research-based ecological survey and sampling data on the fauna and characteristics of the area. This means that the estimate of the current fauna of the area is based on existing general information on the

[98]Oral communication Mikko Malin, Finnish Fishermen’s Association, 2 September 2025

[99]Metsähallitus 2022: Management plan for the Bothnian Sea National Park and Natura 2000 areas. Nature protection publications of Metsähallitus. Series C 181 (in Finnish).

characteristics of the area (such as depth and seabed quality), range of the Baltic Sea biota and the ecology of the Baltic Sea, on the basis of which assumptions have been made about the current state of the area.

Description of the environment in the area produced by the Finnish Environment Institute, 19 May 2025

“Bothnian Sea East (202 km^2), which is potentially suitable for offshore wind power, is located off Merikarvia. In terms of depth (less than 60 m), the central and northern parts of the area are mostly suitable for offshore wind power.[1] Based on fishing hours, there is extensive trawling activity in the southern parts of the area.[2] Based on marine habitat models, sandbanks occur in the area,[3] but no comprehensive observation data is available. The area is also designated as geologically significant (Geological Survey of Finland 2024) but building offshore wind power does not necessarily endanger its geological values.[4] The risk for seabirds in the area is at slightly elevated level (risk category 3) if offshore wind farms are built in the area.[5] No data is available on migratory routes of birds migrating across the Gulf of Bothnia to Sweden. Based on the spatial prioritisation analysis of marine nature, the area is not known to have significant underwater ecological values,[6, 7, 8] However, no marine nature observation data is available for the area (Velmu).”

Sources used in the description:

[1]Kulha, N., Ruha, L., Väkevä, S., Koponen, S., Viitasalo, M. and Virtanen, E.A., 2024. Satellite bathymetry estimation in the optically complex northern Baltic Sea. *Estuarine, Coastal and Shelf Science*, *298*, p. 108634.

[2]Lappalainen, A., Setälä, J., Helminen, J., Lehtonen, T., Niukko, J., Rantanen, P., Saarni, K. and Söderkultalahti, P., 2023. Fishing areas of the Finnish trawler fleet in the Baltic Sea between 2010 and 2022 (in Finnish).

[3]Rinne, H. and Kaskela, A., 2018. Modelling of underwater Natura habitats in the Finnish marine area. Geologal Survey of Finland. http://urn.fi/URN:NBN:fi-fe2020100883047 (in Finnish)

[4]Hämäläinen 2024 personal comments.

[5]Tikkanen et al. manuscript

[6]Virtanen, E.A., Viitasalo, M., Lappalainen, J. and Moilanen, A., 2018. Evaluation, gap analysis, and potential expansion of the Finnish marine protected area network. *Frontiers in Marine Science*, *5*, p. 402.

[7]Virtanen, E.A., Lappalainen, J., Nurmi, M., Viitasalo, M., Tikanmäki, M., Heinonen, J., Atlaskin, E., Kallasvuo, M., Tikkanen, H. and Moilanen, A., 2022. Balancing profitability of energy production, societal impacts and biodiversity in offshore wind farm design. Renewable and Sustainable Energy Reviews, 158, p. 112087.

[8] Virtanen et al. manuscript

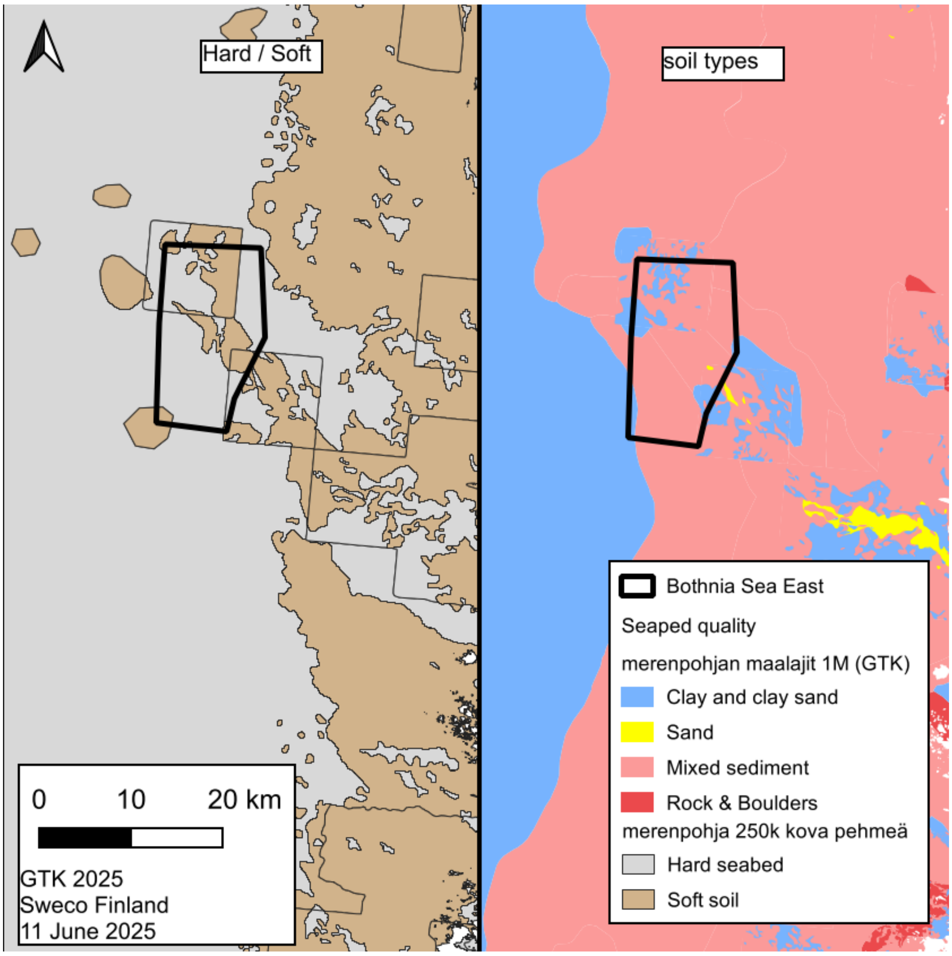


Figure 13: Seabed quality of Bothnian Sea East.

5.3.2 Significant environmental impacts of offshore wind power in Bothnian Sea East

As a rule, the most significant environmental impacts are caused by the introduction and construction of structures required for energy production and energy transmission in the marine area in question. In other words, the impacts depend on the habitats and species that occur in the area in question or which species use the area for passage or for catching food.

Conclusions can be drawn on the basis of area-specific data and on the basis of general knowledge of the Baltic Sea ecology in different types of seabed and depths.

Based on the rough geographic data on the area collected by the Geological Survey of Finland, the seabed is mostly soft but a formation of hard seabed extends across the area in southeast-northwest direction. The soil consists of mixed sediment, clay and clay sand and, to a small extent, sand (see Figure 13). The data collected by the Geological Survey of Finland from the area is not particularly detailed and the seabed quality of the area may actually vary when examined in more detail.

Sandbanks have been identified in the area but no reefs have been detected. Moreover, the area is too deep for macrophyte habitats (such as wracks or water milfoils).

Based on this information, most of the seabed habitats in the area are likely to consist of invertebrates typical of soft deep seabed, such as *Monoporeia affinis*, Baltic clam and *Oligochaeta*. The hard seabeds are poorer in species than the soft seabeds and provide a habitat for such species as bay barnacle and blue mussel. The number of hard seabed species and the size of their populations are likely to be small, as no reef habitats have been identified in the area. Not much is known about the importance of offshore shallow areas as breeding grounds for Baltic herring.[48] The benthic fauna is relatively homogeneous and thus sensitive to changes but at the same time, it is fairly easy to forecast using geological data even though the observations must be verified with more detailed samples.

Construction

Seabed intervention during the construction of foundations has a significant impact on seabed habitats in the area. During the construction, the seabed is disturbed, which will destroy the habitat at the site of the foundations. Full recovery of the habitat depends on whether the foundations are removed at the end of the turbine life cycle. If the foundations will remain in place, the impact can be permanent and negative. This impact has been identified as potentially significant and it mostly affects the site where the foundations are located.

Seabed intervention during foundation construction impacts the sessile (immobile) benthic fauna in the area. Benthic fauna recovers quickly but its habitat at the site of the foundations is permanently destroyed. Full recovery of the habitat depends on whether the foundations are removed at the end of the turbine life cycle. The impact may be permanent and negative and it has been identified as potentially significant.

The noise generated during construction can have a significant impact on marine mammals. It can damage the hearing of marine mammals, especially if the work is carried out without noise mitigation measures. This impact has been identified as potentially significant and it affects the project area.

The seabed intervention work carried out during cable laying affects seabed habitats. It may destroy habitats on the cable route but the impact is limited to the sections where habitats exist and where seabed intervention work is required. Thus, it does not take place on the entire cable route. The impact on the destroyed seabed is permanent but low in intensity. The significance of the impact is uncertain and depends on the cable route and the site where the cable comes ashore.

The noise generated by construction can disturb feeding birds. The disturbance is limited to a small part of the marine area. The effect is reversible and negative, with low intensity. However, the significance of the impact may increase in combination with other offshore wind power projects if other offshore wind turbines are built in the vicinity at the same time and more than one area is affected by the noise.

Cable laying during construction may disturb important coastal bird life sites especially where the cable comes ashore.[97]

Production and maintenance

The combined impact of wind turbines and other projects may constitute a barrier to sensitive fish species. This may interfere with the migration or feeding of fish stocks. Not enough is known of the significance of the impact on migratory fish in the exclusive economic zone. Similarly, electromagnetism of submarine cables may affect fish migration routes and cause physiological harm to species such as salmon.[48] As far as trawling of Baltic herring is concerned, the offshore wind power areas in the Bothnian Sea are highly problematic, as the areas where trawling can be carried out are already used as fishing grounds and relocating the fishing activities would be challenging.[98]

Wind turbines may, alone or in combination with other projects, constitute a barrier to sensitive bird species and disturb them. This may slow down bird migration, for example, due to the long avoidance distances, and in this way increase the energy consumption of certain species (such as divers). Resting species may also be affected at resting sites. A limited amount of satellite monitoring has been carried out in the area, indicating that waders also migrate across the open sea. There is not enough information on the significance of the impacts on migratory birds in the exclusive economic zone, and thus a comprehensive impact assessment cannot be produced.

The visibility of wind turbines in the landscape reduces the amount of open landscape and may have a negative impact on humans. Wind turbines in Bothnian Sea East impact the landscape in the Bothnian Sea National Park where landscape values have been identified as important recreational values.[100] They may also be visible on the horizon from the coast. The impact on the landscape will last until the end of the turbine life cycle and can be considered as significant for the national park.

The energy produced by offshore wind power during its operations and maintenance provides opportunities for the growth of and investments in renewable energy. This impact has been identified as potentially significant and it extends outside the project area.

Decommissioning

Demolition of the foundations causes the hard seabed habitat to disappear from the work area. Any new habitat and the species unique to it will disappear with the foundations. The demolition may cause sediment mixing and sedimentation, which affects fish spawning grounds. Habitats may be buried under sedimentation but sea currents carry sediments to natural deposits. The effect is reversible and negative but potentially significant. The noise generated by the demolition work, especially blasting, may damage the hearing of marine mammals. This impact is permanent and negative and affects the animals in the area concerned at the time of the work.

It is not yet possible to determine which species will be affected, as the demolition timetable is not known. The life cycle of an offshore wind farm is about 30 years but some of the structures may be demolished before that. It is also possible that operations in the area will continue or it is decided that some of the structures will be preserved for other uses.

[100]Metsähallitus 2022: Management plan for the Bothnian Sea National Park and Natura 2000 areas. Nature protection publications of Metsähallitus. Series C 181 (in Finnish).

5.4 Impacts in the area: Bothnian Bay North

5.4.1 State of the environment in the area designated for offshore wind power

There is no site-specific research-based ecological survey and sampling data on the fauna and characteristics of the area. This means that the estimate of the current fauna of the area is based on existing general information on the characteristics of the area (such as depth and seabed quality), range of the Baltic Sea biota and the ecology of the Baltic Sea, on the basis of which assumptions have been made about the current state of the area.

Description of the environment in the area produced by the Finnish Environment Institute, 19 May 2025

"According to the depth model, Bothnian Bay North (224 km^2), which is potentially suitable for offshore wind power, is a shallow marine area (depth mostly between 10 and 20 metres).[1] Based on fishing hours, there is little trawling activity in the area.[2] Based on marine habitat models, there are a few sandbanks and reefs in the area,[3] but no direct observation data is available. Concerning the sensitivity of the seabirds,[4] offshore wind power built in the northern part would cause less harm to seabirds than wind farms in the southern part. No data is available on migratory routes of birds migrating across the Gulf of Bothnia to Sweden. The Merikalla protected area is located about 3 km away, to the east of the area. It is protected as a Natura 2000 habitat type underwater sandbanks (1110). Based on the spatial prioritisation analysis of marine nature produced with the modelling data of about 200 underwater species,[5, 6, 7] there may be underwater ecological values in the area[5, 8, 9] However, no marine observation data is available for the area (Velmu)."

Sources used in the description:

[1]Kulha, N., Ruha, L., Väkevä, S., Koponen, S., Viitasalo, M. and Virtanen, E.A., 2024. Satellite bathymetry estimation in the optically complex northern Baltic Sea. *Estuarine, Coastal and Shelf Science*, *298*, p. 108634.

[2]Lappalainen, A., Setälä, J., Helminen, J., Lehtonen, T., Niukko, J., Rantanen, P., Saarni, K. and Söderkultalahti, P., 2023. Fishing areas of the Finnish trawler fleet in the Baltic Sea between 2010 and 2022 (in Finnish).

[3]Rinne, H. and Kaskela, A., 2018. Modelling of underwater Natura habitats in Finnish marine areas. Geologal Survey of Finland. http://urn.fi/URN:NBN:fi-fe2020100883047 (in Finnish)

[4]Tikkanen et al. manuscript

[5]Virtanen, E.A., Viitasalo, M., Lappalainen, J. and Moilanen, A., 2018. Evaluation, gap analysis, and potential expansion of the Finnish marine protected area network. *Frontiers in Marine Science*, *5*, p. 402.

[6]Virtanen, E.A., Kallio, N., Nurmi, M., Jernberg, S., Saikkonen, L. and Forsblom, L., 2024. Recreational land use contributes to the loss of marine biodiversity. People and Nature, 6(5), pp. 1758–1773.

[7]Forsblom et al. manuscript

[8]Virtanen, E.A., Lappalainen, J., Nurmi, M., Viitasalo, M., Tikanmäki, M., Heinonen, J., Atlaskin, E., Kallasvuo, M., Tikkanen, H. and Moilanen, A., 2022. Balancing profitability of energy production, societal impacts and biodiversity in offshore wind farm design. Renewable and Sustainable Energy Reviews, 158, p. 112087.

[9]Virtanen et al. manuscript

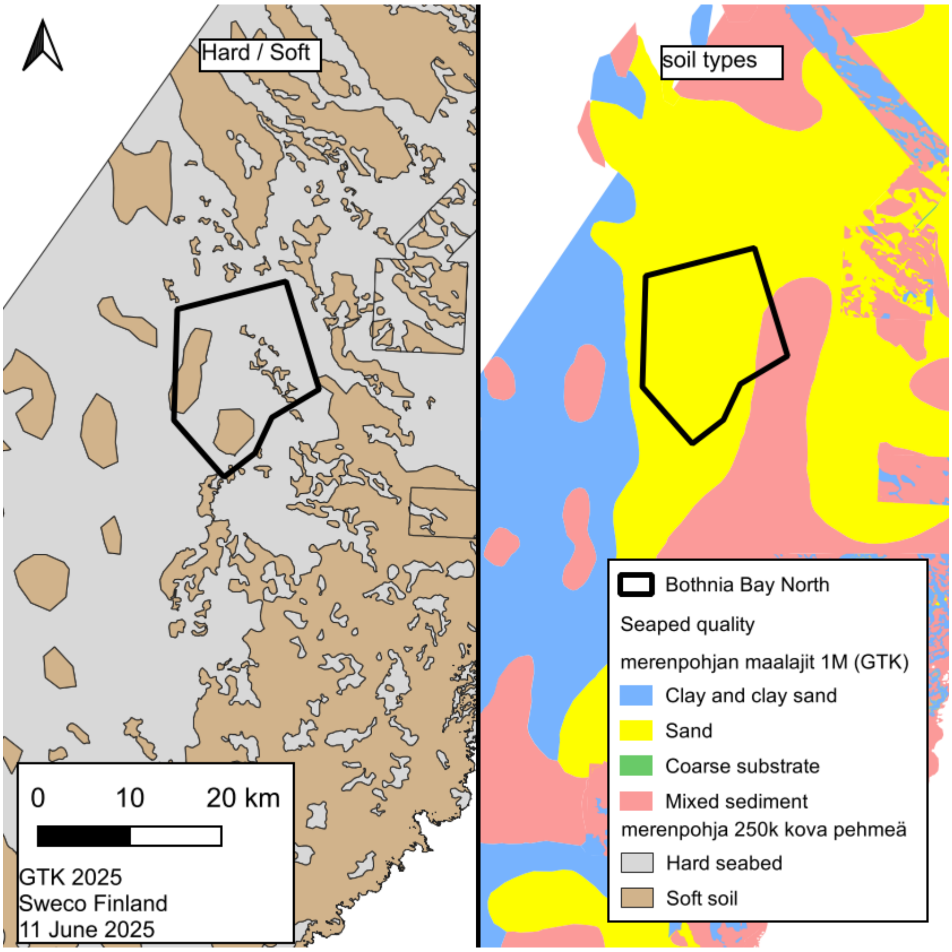


Figure 14: Seabed quality of Bothnian Bay North.

5.4.2 Significant environmental impacts of offshore wind power in Bothnian Bay North

As a rule, the most significant environmental impacts are caused by the introduction and construction of structures required for energy production and energy transmission in the marine area in question. In other words, the impacts depend on the habitats and species that occur in the area in question or which species use the area for passage or for catching food.

Conclusions can be drawn on the basis of area-specific data and on the basis of general knowledge of the Baltic Sea ecology in different types of seabed and depths.

Based on the available data, the seabed of the area is mostly soft but there are also hard seabed formations in the area. The soil is mostly sand and, to a small extent, sand and mixed sediments in the eastern part of the area (see Figure 14). The data collected by the Geological Survey of Finland from the area is not particularly detailed and the seabed quality of the area may actually vary when examined in more detail.

There are both sandbanks and reefs in the central parts of the area. The area is sufficiently shallow (10–20 m) for macrophyte habitats in Bothnian Bay conditions. Macrophytes are photoautotrophic multicellular aquatic organisms, such as algae and plants, and they include bladder wrack (algae) and water milfoils (aquatic plants).

Based on this data, most of the seabed habitats in the area are likely to consist of soft seabed invertebrates and possibly macrophyte habitats. As the area is shallow, diving birds are able to catch food there. Reefs and shallow sand seabeds and sandbanks can also act as feeding and spawning grounds for such fish species as vendace, and their role is currently unknown.[48]

Construction

Seabed intervention during the construction of foundations has a significant impact on seabed habitats in the area. During the construction, the seabed is disturbed, which will destroy the habitat at the site of the foundations. Full recovery of the habitat depends on whether the foundations are removed at the end of the turbine life cycle. If the foundations will remain in place, the impact can be permanent and negative. This impact has been identified as potentially significant and it mostly affects the site where the foundations are located.

Seabed intervention during foundation construction impacts the sessile (immobile) benthic fauna in the area. Benthic fauna recovers quickly but its habitat at the site of the foundations is permanently destroyed. Full recovery depends on whether the foundations are removed at the end of the turbine life cycle. The impact on benthic animals may be permanent and negative and it has been identified as potentially significant.

The noise generated during construction can have a significant impact on marine mammals. It can damage the hearing of marine mammals, especially if the work is carried out without noise mitigation measures. This impact has been identified as potentially significant and it affects the project area.

The seabed intervention work carried out during cable laying affects seabed habitats. It may destroy habitats on the cable route but the impact is limited to the sections where habitats exist and where seabed intervention work is required. Thus, it does not take place on the entire cable route. The impact is permanent but of low intensity. The significance of the impact is uncertain and depends on the cable route and the site where the cable comes ashore.

Blasting during construction may affect spawning areas by burying them under sediment. Sediment mixing and sedimentation during the construction of foundations also affects fish spawning grounds but sea currents also carry sediment accumulated by construction from the construction area to natural deposits. Thus, the impact of the resulting sedimentation is short-term and limited but it may be negative. The significance of the impact is not known because there is insufficient information on the characteristics of the area. The impact is limited to the project area.

Cable laying during construction may disturb important coastal bird life sites especially where the cable comes ashore.[97]

Production and maintenance

The combined impact of wind turbines and other projects may constitute a barrier to sensitive fish species. This may interfere with the migration or feeding of fish stocks. Not enough is known of the significance of the impact on migratory fish in the exclusive economic zone. Similarly, the electromagnetism of submarine cables may affect fish migration routes and cause physiological harm to species such as salmon.[48] The role of shallow areas as breeding grounds for vendace is unknown and thus, impacts cannot be ruled out.[48]

Wind turbines may, alone or in combination with other projects, constitute a barrier effect or a collision risk to sensitive bird species and disturb them. This may slow down bird migration, for example, due to the long avoidance distances, and in this way increase the energy consumption of certain species (such as divers). Resting species may also be affected at resting sites. There is not enough information on the significance of the impacts on migratory birds in the exclusive economic zone, and thus a comprehensive impact assessment cannot be produced.

The combined impacts on Baltic ringed seal are significant: winter navigation and the new areas required by it due to offshore wind turbines as well as climate change will reduce the species' habitats as the ice cover shrinks. The impact of the climate change on the ice situation is already driving the Baltic ringed seal towards more northern parts of the Bothnian Bay, which means that the species rarely occurs outside these areas. The species is unable to adapt to an ice-free environment. Moreover, the species is not known to have hot spots, such as important molting places, and little is known about the role of open sea for catching food.

The visibility of wind turbines in the landscape has a negative impact on humans. The amount of open landscape is reduced if the offshore turbines can be seen from the coast. This effect will last until the end of the turbine life cycle and it is considered as significant.

The energy produced by offshore wind power during its operations and maintenance provides opportunities for the growth of renewable energy and investments. This impact has been identified as potentially significant and it extends outside the project area.

The disturbance caused by traffic may affect birds feeding in the area. The intensity of the disturbance depends on whether it arises in areas where birds usually catch food. The impact will be permanent and negative and it will be felt outside the project area.

Decommissioning

Demolition of the foundations causes the hard seabed habitat to disappear from the work area. Any new habitat and the species unique to it will disappear with the foundations. The demolition work may cause sediment mixing and sedimentation, which affects fish spawning grounds. Habitats may be buried under sedimentation but sea currents carry sediments to natural deposits. The effect is reversible and negative but potentially significant. The noise generated by the demolition work, especially blasting, may damage the hearing of marine mammals. This impact is permanent and negative for animals in the affected area at the time of the work.

It is not yet possible to determine which species will be affected, as the demolition timetable is not known. The life cycle of an offshore wind farm is about 30 years but some of the structures may be demolished before that. It is also possible that operations in the area will continue or it is decided that some of the structures will be preserved for other uses.

5.5 Impacts in the area: Bothnian Bay South

5.5.1 State of the environment in the area designated for offshore wind power

There is no site-specific research-based ecological survey and sampling data on the fauna and characteristics of the area. This means that the estimate of the current fauna of the area is based on existing general information on the characteristics of the area (such as depth and seabed quality), range of the Baltic Sea biota and the ecology of the Baltic Sea, on the basis of which assumptions have been made about the current state of the area. Sediments in the Kvarken area may contain radioactive Cs 137 deposits[101].

Description of the environment in the area produced by the Finnish Environment Institute, 19 May 2025

"Bothnian Bay South* (284 km^2), which is potentially suitable for offshore wind power, is the largest of the areas tentatively considered for the purpose. A large part of the area has a depth of less than 30 m.[1] Based on Finnish fishing hours, there is no trawling activity in the area.[2] Based on marine habitat models, a small number of reefs are found in the area.[3] Concerning the sensitivity of the seabirds,[4] the area is at risk level 2 (increased risk) if wind power were built in the area. No data is available on migratory routes of birds migrating across the Gulf of Bothnia to Sweden. There are no nature reserves in the area or in the vicinity of the area but according to the spatial prioritisation of marine nature, the area may have underwater ecological values.[5, 7, 8] However, no marine observation data is available for the area (Velmu)."

Sources used in the description:

[1]Kulha, N., Ruha, L., Väkevä, S., Koponen, S., Viitasalo, M. and Virtanen, E.A., 2024. Satellite bathymetry estimation in the optically complex northern Baltic Sea. *Estuarine, Coastal and Shelf Science*, *298*, p. 108634.

[2]Lappalainen, A., Setälä, J., Helminen, J., Lehtonen, T., Niukko, J., Rantanen, P., Saarni, K. and Söderkultalahti, P., 2023. Fishing areas of the Finnish trawler fleet in the Baltic Sea between 2010 and 2022 (in Finnish).

[3]Rinne, H. and Kaskela, A., 2018. Modelling of underwater Natura habitats in Finnish marine areas. Geologal Survey of Finland. http://urn.fi/URN:NBN:fi-fe2020100883047 (in Finnish)

[4]Tikkanen et al. manuscript

[5]Virtanen, E.A., Viitasalo, M., Lappalainen, J. and Moilanen, A., 2018. Evaluation, gap analysis, and potential expansion of the Finnish marine protected area network. *Frontiers in Marine Science*, *5*, p. 402.

[6]Virtanen, E.A., Lappalainen, J., Nurmi, M., Viitasalo, M., Tikanmäki, M., Heinonen, J., Atlaskin, E., Kallasvuo, M., Tikkanen, H. and Moilanen, A., 2022. Balancing profitability of energy production, societal impacts and biodiversity in offshore wind farm design. Renewable and Sustainable Energy Reviews, 158, p. 112087.

[7]Virtanen et al. manuscript

[101]Oral communication: Ari Laine, Metsähallitus, 2 September 2025

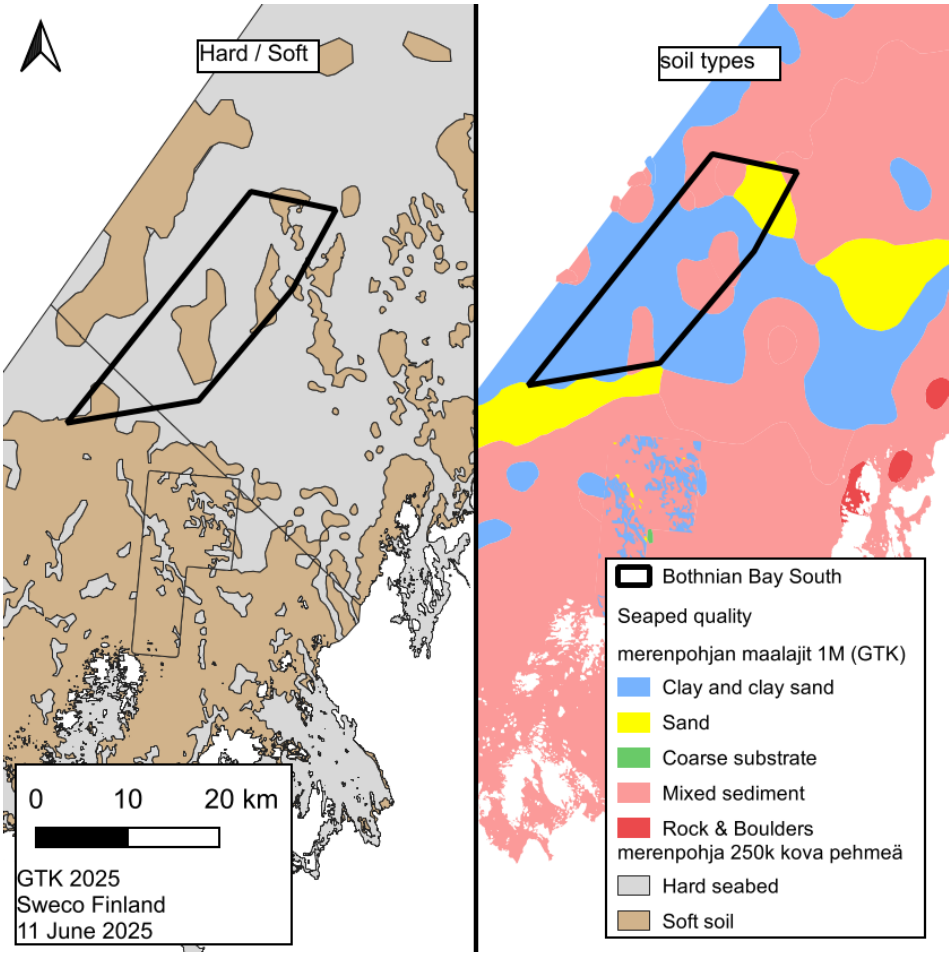


Figure 15: Seabed quality of Bothnian Bay South.

5.5.2 Significant environmental impacts of offshore wind power in Bothnian Bay South

As a rule, the most significant environmental impacts are caused by the introduction and construction of structures required for energy production and energy transmission in the marine area in question. In other words, the impacts depend on the habitats and species that occur in the area in question or which species use the area for passage or for catching food.

Conclusions can be drawn on the basis of area-specific data and on the basis of general knowledge of the Baltic Sea ecology in different types of seabed and depths.

Based on the available data, the seabed in Bothnian Bay South is mostly soft but there are also hard seabed formations in the area. The soil mostly consists of clay and clay sand and, to a small extent, sand and mixed sediment (see Figure 15). The data collected by the Geological Survey of Finland from the area is not particularly detailed and the seabed quality of the area may actually vary when examined in more detail.

Reefs occur in the northern parts of the area but no sandbanks have been found in the area. The area is too deep for macrophyte habitats (such as wracks or water milfoils).

Based on this information, most of the seabed habitats in the area are likely to consist of invertebrates typical of soft deep seabed, such as *Monoporeia affinis*, Baltic clam and *Oligochaeta*. The benthic fauna is relatively homogeneous and thus sensitive to changes but at the same time, it is fairly easy to predict using geological data even though the observations must be verified with more detailed samples.[101] The hard seabed is poorer in species and provides a habitat for such species as bay barnacle and blue mussel. Hard seabed species may occur in significant numbers on reefs; reefs may also act as feeding and spawning grounds for such fish species as vendace. The role of these areas is currently unknown.[48]

As the area is mostly less than 30 metres deep, it is likely that some diving birds can use it as feeding grounds. Diving birds are birds that feed by diving under the water (they include such species as common eider). Impacts occurring in these areas during the breeding season may affect fish-eating birds (such as gulls, terns and Caspian tern), which can make long flights in search of food from the coastal breeding islands.[97]

Construction

Seabed intervention during the construction of foundations has a significant impact on seabed habitats in the area. During the construction, the seabed is disturbed, which will destroy the habitat at the site of the foundations. Full recovery of the habitat depends on whether the foundations are removed at the end of the turbine life cycle. If the foundations will remain in place, the impact can be permanent and negative. This impact has been identified as potentially significant and it mostly affects the site where the foundations are located.

Seabed intervention during foundation construction impacts the sessile (immobile) benthic fauna in the area. Benthic fauna recovers quickly but its habitat at the site of the foundations is permanently destroyed. Full recovery depends on whether the foundations are removed at the end of the turbine life cycle. The impact on benthic animals may be permanent and negative and it has been identified as potentially significant.

The seabed intervention work carried out during cable laying affects seabed habitats. It may destroy habitats on the cable route but the impact is limited to the sections where habitats exist and where seabed intervention work is required. Thus, it does not take place on the entire cable route. The impact is permanent but of low intensity. The significance of the impact is uncertain and depends on the cable route and the site where the cable comes ashore.

The noise generated during construction can have a significant impact on marine mammals. It can damage the hearing of marine mammals, especially if the work is carried out without noise mitigation measures. This impact has been identified as potentially significant and it affects the project area.

Blasting during construction may affect spawning grounds by burying them under sediment. This impact is short-term and limited but it may be negative. The significance of the impact is not known because there is insufficient information on the characteristics of the area. The impact is limited to the project area.

Cable laying during construction may disturb important coastal bird life sites especially where the cable comes ashore.[97]

Production and maintenance

The combined impact of wind turbines and other projects may constitute a barrier to sensitive fish species. This may interfere with the migration or feeding of fish stocks. Not enough is known of the significance of the impact on migratory fish in the exclusive economic zone. Similarly, the electromagnetism of submarine cables may affect fish migration routes and cause physiological harm to species such as salmon.[48]

Wind turbines may, alone or in combination with other projects, constitute a barrier or a collision risk to sensitive bird species and disturb them. This may slow down the migration of birds, for example, due to the long avoidance distance, and in this way increase the energy consumption of certain species (such as divers). Resting species may also be affected at resting sites. There is not enough information on the significance of the impacts on migratory birds in the exclusive economic zone, and thus a comprehensive impact assessment cannot be produced.

The combined impacts on Baltic ringed seal are significant: winter navigation and the new areas required by it due to offshore wind turbines as well as climate change will reduce the species' habitats as the ice cover shrinks. The impact of the climate change on the ice situation is already driving the Baltic ringed seal towards more northern parts of the Bothnian Bay, which means that the species rarely occurs outside these areas. The species is unable to adapt to an ice-free environment. Moreover, the hot spots of the species, such as the most important molting sites, are not known and little is known about the importance of open sea as feeding grounds.[98]

The visibility of wind turbines in the landscape has a negative impact on humans. The amount of open landscape will decrease, which will have an impact especially on the cultural environments north of Kvarken (including landscape areas of national importance). The impact on the landscape will last until the end of the turbine life cycle and can be considered as significant.

The energy produced by offshore wind power during its operations and maintenance provides opportunities for the growth of renewable energy and investments. This impact has been identified as potentially significant and it extends outside the project area.

The disturbance caused by traffic may affect birds feeding in the area. The intensity of the disturbance depends on whether it arises in areas where birds usually catch food. During the operations, the impact will be continuous and negative and it will be felt outside the project area.

Decommissioning

Demolition of the foundations causes the hard seabed habitat to disappear from the work area. Any new habitat and the species unique to it will disappear with the foundations. The demolition may cause sediment mixing and sedimentation, which affects fish spawning grounds. Habitats may be buried under sedimentation but sea currents carry sediments to natural deposits. The effect is reversible and negative but potentially significant. The noise generated by the demolition work, especially blasting, may damage the hearing of marine mammals. This impact is permanent and negative and affects the animals in the area concerned at the time of the work.

It is not yet possible to determine which species will be affected, as the demolition timetable is not known. The life cycle of an offshore wind farm is about 30 years but some of the structures may be demolished before that. It is also possible that operations in the area will continue or it is decided that some of the structures will be preserved for other uses. With the demolition of the structures, the impact on landscape may also disappear but the structures may also become part of cultural heritage.

5.6 Impacts VE0: No areas

5.6.1 Description of implementation

In the zero alternative, no offshore wind power areas would be implemented in the exclusive economic zone. In that case, the natural and cultural environments and living conditions and livelihoods of local residents in the Gulf of Bothnian area will develop without the impact of the offshore wind power projects envisaged in the exclusive economic zone. In practice, the zero alternative means that the future described in chapter 3 will become reality.

Preliminary study stage

No environmental studies will be carried out in the areas covered by the draft decision as part of the preliminary study stage, which means that the minor disturbance to nature they would cause will not arise. Similarly, the environmental data normally collected during the preliminary study stage will not be obtained and will not be made available to scientific or other planning purposes.

If there is a need to collect environmental data on the areas, the collection will not be financed by companies but as part of public projects or studies conducted by universities.

Construction

No wind turbines, associated cables or marine power stations will be built, which means that there will not be any seabed intervention or disturbance of marine nature arising from the construction. Land use in the exclusive economic zone will continue as before and nature in the area will remain unchanged.

Production and maintenance

No environmental impacts caused by the operations and maintenance of wind power will arise and the marine landscape will remain unchanged.

As the offshore wind turbines will not be built, they will not produce any renewable energy either. The positive impacts on climate change arising from the use of wind power as an energy source replacing fossil fuels will not be achieved. At the same time, the energy produced in the exclusive economic zone will not support the development of the Finnish industries envisaged as part of green transition such as hydrogen production and the production of processed hydrogen products.

Decommissioning

There will not be any structures that need to be demolished and, consequently, no impacts will arise from the decommissioning.

5.6.2 Assessment of transboundary impacts and combined impacts in implementation scenario VE0

Transboundary impacts are indirect and consist of the absence of the energy generated during the production and maintenance stage.

The Nordic and Baltic main grids are interconnected and form a common electricity market. Thus, the production of electricity in one country also affects its availability and prices in other parts of the market. The fact that no energy would be produced would probably limit the potential of the hydrogen industry and infrastructure.

As no offshore wind power would be built in the exclusive economic zone in the Gulf of Bothnia under this alternative, the environment would remain in its current state (as described in chapter 3) and would be affected by the currently identified development trends (including climate change) and environmental problems. The fact that under this alternative, there would not be any research on the marine nature and species in the areas during the planning of offshore wind power and submarine cables can also be considered a transboundary impact.

The smaller scale of green transition projects or energy-intensive industrial projects, or the failure to implement them in Finland, may give a boost to new or larger projects elsewhere in the world where more renewable energy is available (see Figure 16).

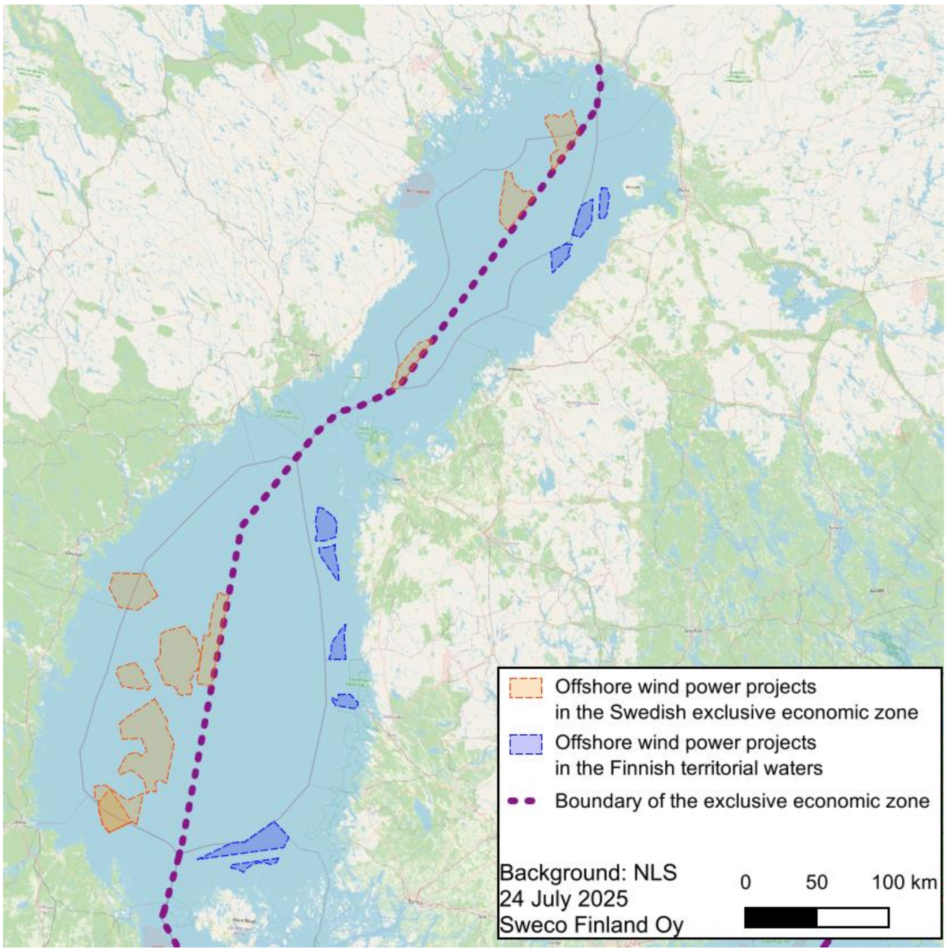


Figure 16: There will probably be offshore wind power areas in the Gulf of Bothnia even if the VE0 alternative is adopted.[102]

5.7 Impacts VE1: Example of project implementation in two areas

5.7.1 Description of implementation

VE1 describes a theoretical situation in which offshore wind power projects are implemented in two of the four designated areas: Bothnian Bay North and Bothnian Sea West. The areas are far apart, about 365 km from each other. They cover a total of 435 km^2. As areas, they are very different, mainly because of their

[102] The projects are specified in chapter 5.1. Swedish projects in the exclusive economic zone, Vindbrukskollen, https://vbk.lansstyrelsen.se/?appid=d62d1589ccda4b15a4ed2d19d0afdf7b, projects in the Finnish territorial waters, Renewables Finland https://suomenuusiutuvat.fi/tuulivoima/hankkeet-ja-voimalat-suomessa/kartta/ and projects in Åland, Havsplanen, https://aland.maps.arcgis.com/apps/webappviewer/index.html?id=3fe10bf5d03c409ead0aa103f01301b3

different distances from the coast and the differences in species between the Bothnian Sea and the Bothnian Bay.

Preliminary study stage

No significant impacts were identified in the impact pathways of the stage due to the low intensity and extent and short duration of the impact. Information on offshore habitats and species as well as on other characteristics of the areas is collected at this stage. In this implementation scenario, nature data would be collected in two Finnish marine areas that are as different as possible from each other: In the northern parts of the Bothnian Bay and in the central parts of the Bothnian Sea. This would provide comparable information on marine nature in the Gulf of Bothnia. Nature data collected during the preliminary studies will probably be available for research and other plans after the offshore wind power project has been implemented.

Construction

In this implementation scenario, the impacts of the construction stage mainly concern the building of foundations, noise and changes in habitats. Building of the foundations and seabed intervention will destroy habitats locally and affect sessile (immobile) benthic animals. The foundations account for up to an estimated 0.1% of the production area.[103] This means that the construction of the foundations in implementation scenario VE1 may destroy benthic habitats covering an area of 0.43 km^2. In Bothnian Sea West, the foundations may create a new hard seabed habitat, resulting in a maximum of 0.21 km^2 of new habitat. However, there is no certainty of the extent of the new habitat that would be created in the process. New habitats are unlikely to be created in Bothnian Bay North as the species in the area do not favour deep hard seabed habitats. However, the actual size of the new habitats depends on the selected foundation type, the final number of foundations and the size of the turbines.

Building of the foundations and seabed intervention during cable laying are of significance when they lead to the mixing of sediment nutrients with the water column and deterioration of the water quality. As Bothnian Sea North is close to the Merikalla Natura 2000 area (SAC, FI1100207), sedimentation and change in water quality may have an impact on the Natura site but the impact is not likely to be significant or long-lasting.

Noise during construction may disturb feeding birds but the disturbance is limited to a small part of the marine area and the impact is reversible and of low intensity. Blasting can damage the hearing of marine mammals if no mitigation measures are taken.

Production and maintenance

The production and maintenance stage will have extensive impacts on the environment and human lives. The impacts are long-term in nature and thus easily cumulative. The wind turbines may cause changes in the living conditions of migratory fish and migratory birds as in combination with other projects the turbines may interfere with the migration or feeding of these species.

[103] EIA programme for offshore wind power projects in the exclusive economic zone: Navakka offshore wind power project. https://www.ymparisto.fi/fi/osallistu-ja-vaikuta/ymparistovaikutusten-arviointi/eolus-finland-oy-navakka-merituulivoimahanke-satakunnan-edusta-selkameri#contact-information (in Finnish)

The electromagnetic fields of wind turbines and cables may slow down the migration of species (especially fish species) sensitive to magnetism and this effect may accumulate through several cables. This may become a major factor when combined with the impacts of other offshore wind power projects and cables. The restrictions on the use of the project area may also restrict maritime traffic but individual areas of the exclusive economic zone alone do not constitute significant obstacles. The areas of implementation scenario VE1 are located far apart and thus the areas alone do not constitute major obstacles or result in restrictions on use. The impact may become significant in combination with offshore wind power projects and submarine cables planned in the areas outside the exclusive economic zone. The likelihood of a significant impact is increased by the fact that there is insufficient information on the cumulative impact on migratory fish for impact assessment and therefore uncertainty increases the significance of the impact.

Landscape impacts generated during the production and maintenance stage are permanent and negative as the visibility of wind power in the landscape may reduce the amount of open landscape in the Bothnian Sea National Park and on the Bothnian Bay coast. The decline in fishing in the wind power area protects fish stocks, which is likely to have a positive impact on offshore fish stocks.

With the new energy produced by the wind turbines, the opportunities provided by the renewable energy for the growth of industries and investments are likely to be significant. This may be gradually reflected in business, employment and the regional economy. Offshore wind turbines also support Finland's efforts to meet its climate targets and green transition in energy production, which in turn will boost industrial development, hydrogen production and value-added chains.

To sum up the situation, the impacts of the production and maintenance stage are diverse and long-lasting and they are spread over a longer period than the impacts of the construction stage. However, they are of lower intensity. The impacts will affect biodiversity, ecosystems, human living conditions and the economy.

Decommissioning

The impacts of the decommissioning stage are similar to the impacts arising from the construction stage but weaker. The demolition of the foundations may have greater impacts on nature than if they are left in place as long as it is ensured that no harmful substances dissolve in water from the foundation structures. These solutions are specified in the environmental impact assessment and in the terms of the water permit, taking into account legislative changes and technological advances during the service life of the turbines.

Demolition of the foundations may destroy hard seabed habitats and the species unique to them. Demolition will also disturb biota, especially underwater biota, and when the cable is removed, sediment is mixed with the water column, which may weaken water quality and dissolve sediment nutrients and contaminants in water. Nature may return to near-original state but the habitat located at the site of the foundations has been destroyed.

If the structures are removed to the depth allowing maritime traffic, the hard seabed habitat will be preserved but the disturbance caused by demolition will drive away biota, especially birds and fish, and nature will not return to its original state. After the decommissioning stage, the noise and flicker generated by the turbines, the risk of colliding birds and the electromagnetic fields caused by the cables will disappear.

5.7.2 Assessment of transboundary and combined impacts in implementation scenario VE1

The most significant potential impacts in VE1 arise from cumulative combined impacts with other human activities in marine areas. The most significant cumulative combined impact arises with offshore wind turbines on the Swedish side and in the Finnish territorial waters. The impact pathways of the offshore wind power projects are similar and thus, they are also easily cumulative. A single offshore wind turbine or cable route may have little impact on migratory fish, migratory birds or feeding birds but if there are several offshore wind power projects in progress in the marine area, the combined impact may be significant. There is little research on the routes of migratory fish and the behaviour of migratory birds and bats in the open sea, which means there is no certainty of the significance or intensity of the impact.

Offshore wind power areas also limit the use of the areas in question for other human activities such as shipping and fishing. In such cases, these activities would continue in other areas to the extent possible. Relocation of fishing activities is limited by the movements of fish stocks and, in the case of maritime traffic, there is a risk of fairway congestion, especially when the marine areas are covered by ice. Fishing is particularly important in the Bothnian Sea and winter navigation in the Bothnian Bay. As the activities are relocated, the size of the marine area free of human activities will also shrink. In this case, the combined impacts are also transboundary impacts in relation to the offshore wind power projects planned in Sweden.

The impacts on migratory species are also transboundary, and the impacts on these species also affect nature in other countries.

In implementation scenario VE1, the areas form clusters with offshore wind power projects planned in the Swedish exclusive economic zone and the Finnish territorial waters (see map).

- Bothnian Bay North is located between the Swedish projects and the projects in the Finnish territorial waters. If all these projects were implemented, there would be five offshore wind power clusters in the Bothnian Bay close to each other. As a whole, the projects could cause cumulatively significant impacts on migratory fish, Baltic ringed seal, feeding birds and migratory birds if offshore wind turbines prevent migration or feeding or isolate populations of the same species from each other.
- East of Bothnian Sea West, there is an open marine area for other human activities and nature, which means that the area does not form a barrier or a major bottleneck on the Finnish side of the Bothnian Sea.
- At the time when this assessment is being carried out, several offshore wind power projects are envisaged in the Swedish exclusive economic zone. The map shows all planned areas, although their timetable and extent remain uncertain. Should they be implemented, they and Bothnian Sea West would form a large cluster of offshore wind turbines with cumulative impacts. At the same time, the amount of unspoilt nature in the area would decrease. However, the implementation of the projects in all areas so that an offshore wind farm would be built in them is highly uncertain.

- Bothnian Sea West is a small area compared to the areas in which wind farms are envisaged in Sweden. As there is still no information on the implementation of the projects in the areas, it is impossible to say how many restrictions would eventually be imposed on trawling or how the impacts on fish stocks would affect the fishing industry. Impacts cannot be ruled out but they are difficult to predict because their significance depends on the extent and focus of the combined effects.
- Considering the Swedish projects, implementation scenario VE1 as a whole would not have any significant impact on the amount of unobstructed horizon on the Swedish side.

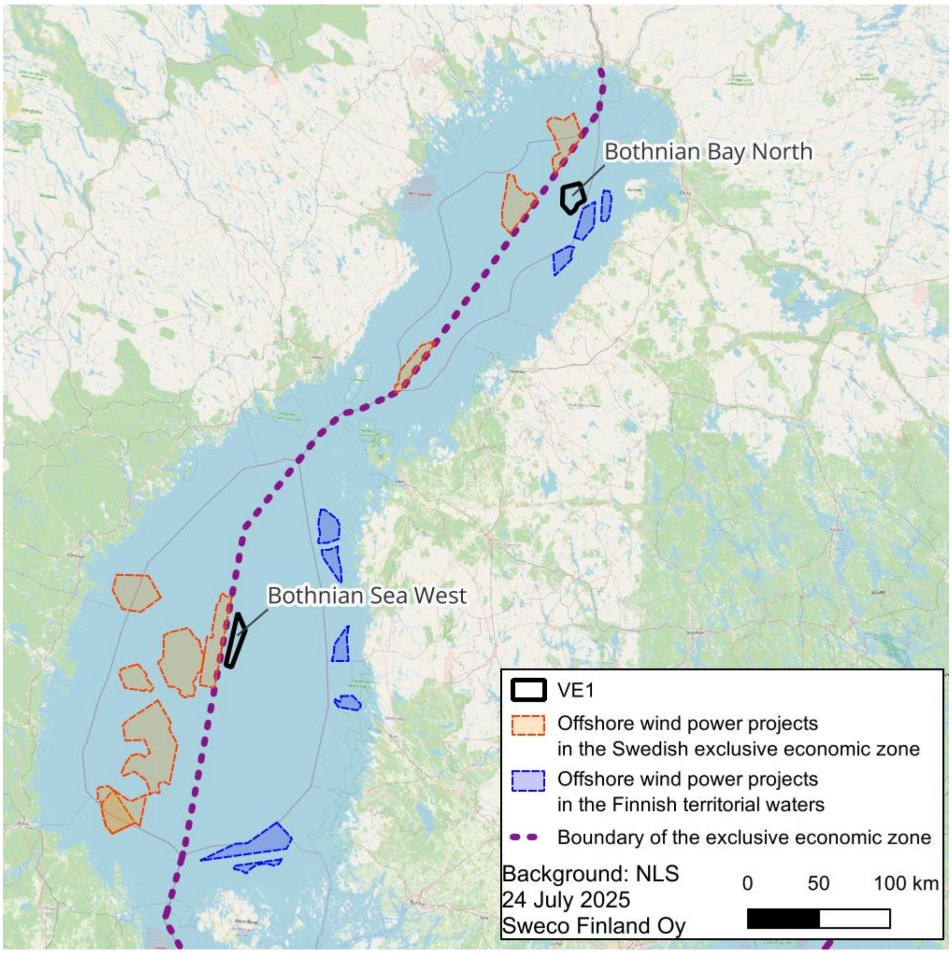


Figure 17: Offshore wind power areas planned in the Gulf of Bothnia[104] and VE1 areas.

Summary of combined impacts in production and maintenance stage

- Visibility of wind power in landscape, impact on humans

[104]The projects are specified in chapter 5.1. Swedish projects in the exclusive economic zone, Vindbrukskollen, https://vbk.lansstyrelsen.se/?appid=d62d1589ccda4b15a4ed2d19d0afdf7b, projects in the Finnish territorial waters, Renewables Finland https://suomenuusiutuvat.fi/tuulivoima/hankkeet-ja-voimalat-suomessa/kartta/ and projects in Åland, Havsplanen, https://aland.maps.arcgis.com/apps/webappviewer/index.html?id=3fe10bf5d03c409ead0aa103f01301b3

- The amount of open landscape will decrease, especially in the Bothnian Sea National Park. The impact lasts for the whole duration of the life cycle of the offshore wind power project and it is negative. The impact is significant when combined with other offshore wind power projects.

- The disturbance caused by traffic, impact on birds feeding in the area
  - The magnitude of the harmful impacts of traffic on birds depends on whether traffic will increase in important feeding grounds. The traffic will continue for the whole duration of the life cycle of the offshore wind power project and the impact is negative. It will become more significant when combined with other offshore wind power projects.
- Electromagnetic fields of the cables, impacts on migratory fish
  - Electric cables may slow down or stop the migration of species sensitive to magnetism. The impact may accumulate through multiple cables. Potentially, the impact is significantly negative. It will become more significant when combined with other offshore wind power projects.
- Barrier effect of turbines on birds
  - In combination with other projects, they may constitute an obstacle to sensitive bird species and interfere with migration or feeding. The impact is rapid because an obstacle affecting the flight path arises as soon as the wind turbine has been made operational and it is extremely negative.
- Wind turbines as an obstacle, impact on migratory fish
  - In combination with other projects, they may constitute an obstacle to sensitive fish species and interfere with migration or feeding. The effect is rapid and negative and of high intensity.
- Restriction on the use of the project area, impact on maritime traffic
  - Offshore wind power projects and cables restrict maritime traffic but individual areas do not constitute major obstacles. If realised, the impact is direct and negative, and its intensity can be considered high due to the absolute nature of the restriction. It will become more significant when combined with other offshore wind power projects.
- Restriction on the use of the project area, impact on fishing
  - Trawling can no longer be carried out in the offshore wind power area. The impact is rapid and negative and of high intensity. It will become more significant when combined with other offshore wind power projects.

5.8 Impacts VE2: Implementing projects in all areas

5.8.1 Description of implementation

VE2 describes a situation in which offshore wind power projects are implemented in all four areas. The combined size of the areas is 921 km^2.

Under the draft decision, wind energy produced in the areas can also be used for processing such as hydrogen production. However, hydrogen production is not required in the draft decision and no production volumes or technology are specified in the document. It is assumed in this environmental report that the production of hydrogen by electrolysis will be studied and possibly carried out in some of the areas. However, its processing into methanol or ammonia is not foreseen at this stage. Instead, the hydrogen would be transported by pipeline or possibly by vessel.

Only a limited amount of information and source literature is available on offshore hydrogen production.[105] Based on the current concepts, the production would take place using structures resembling offshore rigs that are anchored to the bottom. Hydrogen itself is not dangerous to the environment but due to its explosive properties it may increase the risk of environmentally harmful accidents. If there are no plans to transport the hydrogen by vessel, pipelines for hydrogen must be designed to replace electricity transmission cables in an area. If it is decided that the hydrogen will be transported by vessel, a loading solution must be devised for the area. The reliability and safety of all solutions in the ice conditions of the Gulf of Bothnia must be studied.

Preliminary study stage

No significant impacts were identified in the impact pathways of the stage due to the low intensity and extent and short duration of the impact. Information on offshore habitats and species as well as on other characteristics of the areas is collected at this stage. In implementation scenario VE2, nature data would be collected in different parts of the open marine area of the Gulf of Bothnia, and this material would provide a comprehensive description of the nature of the area and its variation. Nature data collected during the preliminary studies will probably be available for scientific research and other plans after the offshore wind power project has been implemented.

Offshore hydrogen production requires separate studies on hydrogen safety and possibly also pilot projects during the preliminary studies. It also requires more studies than wind power projects on such matters as the suitability of the seabed for the pipelines.

Construction

The impacts of the construction stage mainly concern the building of foundations, noise and changes in habitats caused by seabed intervention. Building of the foundations and seabed intervention will destroy habitats locally and thus they will also affect sessile (immobile) benthic animals. Benthic fauna recovers quickly but the habitat at the site of the foundations is permanently destroyed. The foundations account for up to an estimated 0.1% of the production area.[106] This means that the construction of the foundations in implementation scenario VE2 will destroy benthic habitats covering an area of 0.92 km^2. In Bothnian Sea West, the foundations may create a new hard seabed habitat, resulting in a maximum of 0.41 km^2 in new habitat. However, there is no certainty of the size of the new habitat that would be created. New habitats are unlikely to be created in the areas envisaged in the Bothnian Bay as the species in the area do not favour hard seabed habitats located in deep areas. However, the actual size of the new

[105] Ramakrishnan S. et al., Offshore green hydrogen production from wind energy: Critical review and perspective, Renewable and Sustainable Energy Reviews, 2024
[106] EIA programme for offshore wind power projects in the exclusive economic zone: Navakka

habitat depends on the selected foundation type, the number of foundations and the size of the turbines.

Blasting can damage the hearing of marine mammals, and without mitigation measures, the effect can be significant.

Building of the foundations and seabed intervention during cable laying are of significance when they lead to the mixing of sediment nutrients with the water column and deterioration of the water quality. As Bothnian Sea North is located close to the Merikalla Natura 2000 area (SAC, FI1100207), sedimentation and changes in water quality may have an impact on the Natura site but the impact is not likely to be significant or long-lasting.

If it is decided to build hydrogen production capacity in an area or areas, the construction process is more extensive, as the production plant requires separate foundation structures. Hydrogen pipes are heavier than power transmission cables and require greater safety distances and more seabed intervention.

Production and maintenance

The production and maintenance stage will have extensive impacts on the environment and human lives. The wind turbines may cause changes in the living conditions of migratory fish and migratory birds as in combination with other projects they may interfere with the migration or feeding of these species. There is insufficient information on the significance of the impact on migratory fish in the exclusive economic zone but the impact is estimated to be rapid, negative and of high intensity. Decrease in fishing in the area may have a positive impact on fish stocks as trawling cannot be carried out in offshore wind power areas.

The landscape impacts last for the whole duration of the production and maintenance stage, and they are particularly noticeable in the Bothnian Sea National Park, the cultural environments north of Kvarken, such as nationally important landscape areas, and possibly more extensively along the coastline of the Bothnian Sea and the Bothnian Bay. The visibility of wind turbines reduces the amount of open landscape.

With the new energy produced by the turbines, renewable energy will generate major opportunities for the growth of industries and investments. This may be gradually reflected in business, employment and the regional economy. Offshore wind turbines also support Finland's efforts to meet its climate targets and green transition in energy production, which in turn will boost industrial development, hydrogen production and value-added chains.

The electromagnetic fields of wind turbines and cables may slow down the migration of species sensitive to magnetism and this effect may accumulate through several cables. A single cable or wind power project does not constitute a major barrier but the impact may be significant when combined with other offshore wind power projects and cables. The likelihood of a significant impact is increased by the fact that there is insufficient information on the cumulative impact on migratory fish for impact assessment and therefore the uncertainty increases the significance of the impact.

If the energy produced with offshore wind power in an area were only utilised for hydrogen production in the same marine area, there would be no need for a cable connection to the mainland. Instead, an electrolysis plant, loading infrastructure or a hydrogen pipeline connection would be required. This would eliminate the electromagnetic hazards arising from the cables but the hydrogen pipeline and structures would require more seabed surface area than the cable and restrict human activities in the form of safe distances.

Restrictions on other use of the project area, such as shipping and trawling, affect other activities but individual areas do not constitute significant obstacles to maritime traffic. The areas of implementation scenario VE2 are located far apart and thus, even when combined, the areas of the exclusive economic zone would not constitute major obstacles or lead to major restrictions on use.

To sum up the situation, the impacts of the production and maintenance stage are diverse and long-lasting and they are spread over a longer period than the impacts of the construction stage. However, they are of lower intensity. The impacts will affect biodiversity, ecosystems, human living conditions and the economy.

Decommissioning

During decommissioning, the impacts of the offshore wind power projects of VE2 are similar to those of the construction stage but weaker. Demolition of the foundations may have significant impacts on nature, and if the structures are left on the seabed, harmful substances may dissolve from the structures in water.

When the foundations are demolished, the hard-seabed habitat that may have developed on them will be destroyed and the species will disappear. Noise arising from the demolition of foundations, any electrolysis plant and other hydrogen production infrastructure cause disturbance to biota, especially under water. When the cable or hydrogen pipeline is removed, sediment is mixed with the water column, which may weaken water quality and dissolve nutrients and contaminants in water. This process may bury fish spawning grounds under sedimentation, although sea currents also transport sediment to natural deposits. Nature may return to near-original state but the habitat located at the site of the foundations has been destroyed.

If the structures are removed to the depth allowing shipping, the hard seabed habitat will be preserved but the disturbance caused by demolition will drive away biota, especially birds and fish, and nature will not return to its original state. After the demolition stage, the risk of bird collisions, any obstacle impact of the turbines and the electromagnetic fields generated by the cables will disappear.

5.8.2 Assessment of transboundary and combined impacts in implementation scenario VE2

The most significant potential impacts of this implementation scenario arise from cumulative combined impacts with other human activities in marine areas. The most significant cumulative combined impact arises with offshore wind power projects on the Swedish side and in the Finnish territorial waters. The impact pathways of the offshore wind power projects are similar and thus, they are also easily cumulative. Individual offshore wind power projects have little impact on migratory fish, migratory birds and feeding birds but if there are several offshore wind power projects in the marine area, the combined impact may be significant. There is little research on the routes of migratory fish and the behaviour of migratory birds in the open sea, and thus there is no certainty of the significance or intensity of the impact.

In implementation scenario VE2, the areas form clusters with offshore wind power projects planned in the Swedish exclusive economic zone and the Finnish territorial waters (see Figure 18).

- Bothnian Bay North is located between projects on the Swedish side and projects in the Finnish territorial waters. If all the projects were implemented, there would be six offshore wind power clusters in the Bothnian Bay close to each other. Overall, the projects may cause cumulatively significant impacts on migratory fish, feeding birds, migratory birds and Baltic ringed seal through obstacles.
- Sweden is planning an offshore wind farm in the vicinity of Bothnian Bay South. However, the projects are far away from other planned projects and there is empty space around them, which the fauna can probably use to bypass the areas.
- East of Bothnian Sea West, there is an open marine area for other human activities and nature, which means that the area does not constitute an obstacle or a major bottleneck on the Finnish side of the Bothnian Sea.
- At the time when this assessment is being carried out, several offshore wind power projects are envisaged in the Swedish exclusive economic zone. The map shows all planned areas, although their timetable and extent remain uncertain. Should they be implemented, they and Bothnian Sea West would form a large cluster of offshore wind turbines with cumulative impacts. At the same time, the amount of unspoilt nature in the area would decrease. However, it remains highly uncertain whether each of these areas will have an offshore wind farm in the future.[107]
- Bothnian Sea East is located close to the projects planned in the Finnish territorial waters, and they extend from Pori to south of Vaasa. As a whole, they and Bothnian Sea East form a near-continuous offshore wind power cluster. If all the projects were realised, there would be no unobstructed horizon in this area.
- Taking into account the Swedish projects, VE2 as a whole does not have any significant impact on the unobstructed horizon on the Swedish side.

[107]'Project' refers to the planned offshore wind power areas known at the time of the assessment. There is no certainty that all these areas will be built or they may not necessarily be built during the life cycle of the assessed areas. Swedish projects in the exclusive economic zone, Vindbrukskollen, https://vbk.lansstyrelsen.se/?appid=d62d1589ccda4b15a4ed2d19d0afdf7b, projects in the Finnish territorial waters, Renewables Finland https://suomenuusiutuvat.fi/tuulivoima/hankkeet-ja-voimalat-suomessa/kartta/ and projects in Åland, Havsplanen, https://aland.maps.arcgis.com/apps/webappviewer/index.html?id=3fe10bf5d03c409ead0aa103f01301b3

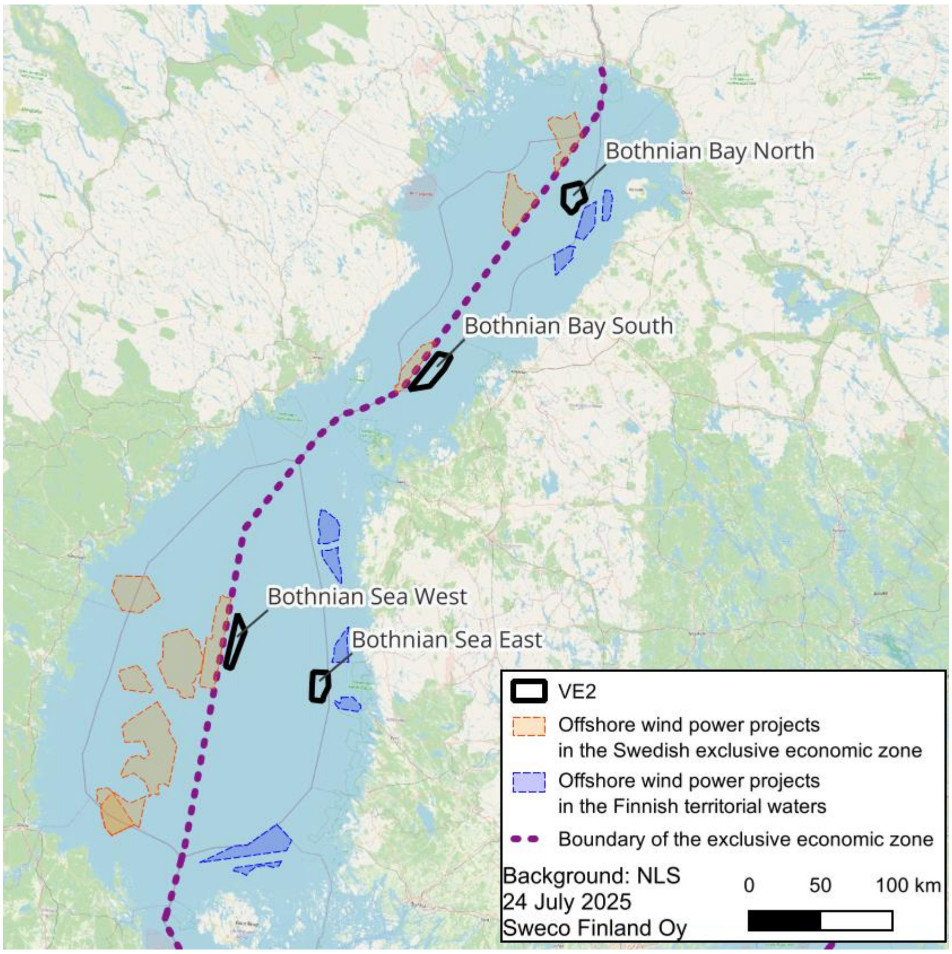


Figure 18. VE2 areas are located close to other planned wind farms.[108]

Offshore wind power areas also limit the use of the marine area for other human activities such as shipping and fishing. In such cases, the activities in question would continue in other areas to the extent possible. In that case, the amount of marine areas completely free of human activity will be reduced.

Summary of combined impacts in production and maintenance stage

- Visibility of wind power in landscape, impact on humans
    - The amount of open landscape will decrease, especially in the Bothnian Sea National Park and in cultural environments. During the production and maintenance stage, the impact is permanent and negative and of high intensity. It will become more significant when combined with other offshore wind power projects.
- The disturbance caused by traffic, impact on birds feeding in the area

[108]The projects are specified in chapter 5.1. Swedish projects, Vindbrukskollen, https://vbk.lansstyrelsen.se/?appid=d62d1589ccda4b15a4ed2d19d0afdf7b, projects in the Finnish territorial waters, Renewables Finland https://suomenuusiutuvat.fi/tuulivoima/hankkeet-ja-voimalat-suomessa/kartta/ and projects in Åland, Havsplanen, https://aland.maps.arcgis.com/apps/webappviewer/index.html?id=3fe10bf5d03c409ead0aa103f01301b3

- The magnitude of the harmful impacts of traffic on birds depends on whether traffic will increase in important feeding grounds. The traffic will continue for the whole duration of the life cycle of the offshore wind power project and the impact is negative. It will become more significant when combined with other offshore wind power projects.

- Electromagnetic fields of the cables, impacts on migratory fish
  - Cables can slow down the migration of species sensitive to magnetism. The impact may accumulate through multiple cables. The impact is open (uncertain) due to data gaps. It will become more significant when combined with other offshore wind power projects.
- Obstacle impact of turbines on birds
  - In combination with other projects, they may constitute an obstacle to sensitive bird species and interfere with migration or feeding. The impact is rapid because an obstacle affecting the flight path arises as soon as the wind turbine has been made operational and it is extremely negative.
- Wind turbines as an obstacle, impact on migratory fish
  - In combination with other projects, they may constitute a barrier to sensitive fish species and interfere with migration or feeding.
- Restriction on the use of the project area, impact on maritime traffic
  - Offshore wind power projects and cables restrict shipping but individual areas do not constitute major obstacles. The impact is rapid and negative and of high intensity. It will become more significant when combined with other offshore wind power projects.
- Restriction on the use of the project area, impact on fishing
  - Trawling can no longer be carried out in the offshore wind power area. The impact is rapid and negative and of high intensity. It will become more significant when combined with other offshore wind power projects. The impacts on trawling are highlighted in the Bothnian Sea, where there is more fishing than in the Bothnian Bay.

5.9 Comparing implementation scenarios

Under section 3 of the SEA Act, the environmental impacts of a plan or a programme must be investigated and assessed when the implementation of the plan or programme may have significant environmental impacts.

As there are currently no wind turbines in any of the offshore wind power areas in the exclusive economic zone under assessment, the assessment is based on assumptions of what would happen if offshore wind turbines were built in the area. It should also be noted that other offshore wind power areas are also planned in the Bothnian Sea and the Bothnian Bay.

Potential impacts have been identified through impact pathways as described above, starting at each life cycle stage of offshore wind power. Area-specific significance is assessed according to the characteristics of each area. If there is no specific target of impact in the area, or if the prevalence is considered low, the impact on the area is not considered significant. For example, this means that if macrophyte habitats are not believed to occur in the area, using the area for offshore wind power will not have any significant impacts on species and food chains dependent on macrophytes.

The table below compares the issues arising from the overall impacts of implementation in relation to the zero alternative (Table 3). For reasons of visual clarity, individual areas are not shown in the same table. Instead, they are discussed in their own chapters.

Table 3. Summary of the implementation stages and possible impacts of different scenarios

Scenario	VE0: No offshore wind power in the exclusive economic zone	VE1: Partial implementation scenario	VE2: Maximum impact scenario
Description	No offshore wind power in the exclusive economic zone.	Offshore wind power[109] in areas such as Bothnian Bay North and Bothnian Sea West, with a total area of 435 km^2.	Offshore wind power in all four areas, total area 921 km^2. *Please note: Hydrogen can be produced in any of the areas but it is examined here in connection with the maximum impacts.*
Area designated for the purpose	No areas to be built in the exclusive economic zone. The same amount of renewable energy production capacity can be built somewhere else.	A total of 0.43 km^2 of destroyed habitats at the site of foundations, possibly 0.21 km^2 of new hard seabed habitats. Space is also required for laying of cables from each wind power area to the shore.	A total of 0.92 km^2 of destroyed habitats at the site of foundations, possibly 0.41 km^2 of new hard seabed habitats. Space is also required for laying of cables from each area; alternatively, a hydrogen pipeline or transport infrastructure must be built.[110]
Preliminary study stage for wind power	No preliminary studies. Nature information on the areas is not produced as part of the projects.	Field surveys will be carried out to collect nature data from target areas and cable routes.	Field surveys will be carried out to collect nature data from target areas and cable routes. The risks and implementation methods of hydrogen production are assessed.
Wind power construction stage	No impacts during the construction stage.	Construction of foundations, seabed intervention and noise. Nature in the areas is affected by permanent local impacts and reversible impacts lasting until the end of the construction.	Construction of foundations, seabed intervention and noise. Nature in all areas is affected by permanent local impacts and reversible impacts lasting until the end of the construction.
Wind power production and maintenance stage	No impacts on the environment or changes in the landscape. No renewable energy production or land-based projects and emission reductions made possible by them.	Long-term impacts on biodiversity, humans and the economy. Permanent impacts on nature and the use of the marine area in two areas and cable routes. Landscape changes in the surroundings of two areas, one of which is located far from the coast.	Long-term impacts on biodiversity, humans and the economy. Permanent impacts on nature and the use of the marine areas in all four areas and cable routes. Extensive restrictions on fishing and other use of the marine areas in the areas and around them. Green transition and emission savings in many areas made possible by renewable energy.

[109]Use in accordance with the draft decision also includes the option of processing the electricity produced in the wind farms. As hydrogen production is not limited to any specific area but is considered an option for all areas, it is only considered as part of the maximum impact scenario and not as part of the partial implementation scenario.

[110]Filling of tankers, structures required for securing and safety of vessels and storage systems between loadings. Technical solutions for the production and transport of hydrogen in offshore conditions are still under development, which means that the assumption is based on the structures required for natural gas.

Scenario	VE0: No offshore wind power in the exclusive economic zone	VE1: Partial implementation scenario	VE2: Maximum impact scenario
		Green transition and emission savings made possible by renewable energy.	Development of offshore hydrogen production
Wind power decommissioning	No impacts during decommissioning.	Impacts similar to those experienced during construction but weaker. Affect habitats and species.	Impacts similar to those experienced during construction; nature and habitats facing the most significant impacts.
Summary of impacts, highlighting likely significant impacts **Area-specific impacts and data gaps are discussed in more detail in the previous chapter**			
Transboundary impact	Indirect impacts arising from the absence of energy production in the Nordic electricity market	Combined impacts with other offshore wind turbines that might be built in Sweden and Finland constitute a potential cumulative obstacle to migration and migration routes. Poor knowledge of migration routes increases the likelihood of the risk and, as a result, will probably make it significant. More detailed studies may eliminate the risk.	The implementation of projects in several areas increases the accumulation of impacts with other offshore wind power areas in Kvarken and Bothnian Bay. It is likely that a significant part of the migration routes in the area may be affected by the planned offshore wind power areas. Data gaps on species-specific distribution and migration routes significantly increase the risk and make it more difficult to target mitigation measures. A large number of offshore wind power areas will change the Gulf of Bothnian landscape.
Marine nature	No environmental change. Absence of renewable energy makes it difficult to combat climate change.	Reefs or sandbanks may occur in the shallow areas of the Bothnian Bay. More precise placement of the wind turbines can impact the need for seabed intervention. No significant underwater ecological values have been identified within the planned wind power areas.	Although no significant underwater ecological values have been identified within the planned wind power areas, designating large areas for offshore wind power areas and their cables creates a risk of cumulative impacts on species that use the northern parts of the Finnish exclusive economic zone for obtaining food and for breeding. More precise placement of the turbines and cables can impact the consequences of seabed intervention. Use of electricity at sea, for example, for the production of hydrogen, is seen as a possible alternative to cables.
Mammals	No environmental change. Absence of renewable energy makes it difficult to combat climate change.	Harm caused to Baltic ringed seal populations	Probably a major impact on Baltic ringed seal due to the reduction in habitats and breeding grounds
Birds	No environmental change. Absence of renewable energy	Harm to migratory birds occurring in or passing through the wind power areas to be built (such as black-throated diver and red-	If all wind power areas will be built, there will probably be extensive cumulative impacts and significant barrier effects in the Gulf of Bothnia for migratory birds (such

Scenario	VE0: No offshore wind power in the exclusive economic zone	VE1: Partial implementation scenario	VE2: Maximum impact scenario
	makes it difficult to combat climate change.	throated diver) and birds feeding in the area (such as gulls). The risk to bird life has increased, especially in the Bothnian Bay.	as black-throated diver and red-throated diver) and birds feeding in the areas (such as gulls).
Fish	No environmental change. Absence of renewable energy makes it difficult to combat climate change.	Possible barrier or disturbance effect on migratory fish in the wind power areas to be built	Commercially significant fish stocks (such as Baltic herring and salmon) may be affected by the electromagnetic disturbance generated by the growing cable networks required for several areas. Currently unknown spawning grounds (Baltic herring and vendace) may also be affected. The impact on fish stocks will spread to seals and fishing birds.
Impact on industries and investments	No specific positive effects.	Renewable energy supports industries and investments in areas that benefit from the energy produced by the wind farms to be built or in areas where, for example, hydrogen or other materials will be processed. The targeting of the impacts depends on the wind power areas to be built. If the electricity is produced for the main grid, there may also be beneficiaries outside coastal areas. Building and operating offshore wind turbines in northern areas require innovation and development work that can also be processed for export.	Significant support for industries, investments and green transition projects in coastal zones. According to regional hydrogen strategies and other plans, there may be potential for thousands of jobs. Turbine areas need bases and maintenance services ashore as well as planning of rescue and safety measures. Commercial fishing may be adversely affected by negative changes impacting Baltic herring and salmon. The transformation of the industrial structure will bring about societal transformation, affecting areas such as competence needs, mobility of labour, the creation of new companies and local culture. The regions characterised by maritime and fishing culture will become more technological- and knowledge-intensive.
Change in landscape	No impacts on landscape.	Impacts on open landscape in the wind power areas to be built during the life cycle of the turbines, depending on the construction of wind power and, in particular, the height of the permitted structures.	Impacts on open landscape in wind power areas to be built during the life cycle of turbines. The height of the structures planned and built in the areas and what the permits allow are the key factors concerning the landscape impacts. Using only tall structures will significantly reduce the amount of open landscape.

Implementation scenario VE0 differs significantly from VE1 and VE2 in terms of the amount of offshore wind power to be built and the resulting impacts. In VE0, no offshore wind power projects will be implemented in the exclusive economic zone, which means that the environment will not be affected and no new foundations or other structures will be built. However, as a result, renewable energy will not be produced in the Finnish exclusive economic zone, which means that the area will not be used to combat climate change and that offshore wind power in the exclusive economic zone will not support the development of green transition industries in Finland. This means that fossil energy will not be replaced or that green transition activities or offshore wind power project development will be located somewhere else.

Implementation scenarios VE1 and VE2 generate similar environmental impacts of offshore wind power. The impact pathways of the two implementation scenarios are identical and both of them cover areas in the Bothnian Bay and the Bothnian Sea. In practice, the difference between VE1 and VE2 concerns the size of the areas designated for them and the combined effect with other offshore wind power projects planned in the Swedish exclusive economic zone and Finnish territorial waters.

In VE1, two offshore wind power projects would be implemented. This will lead to local environmental impacts such as noise and changes in habitats. Building of foundations will destroy habitats but the impacts are limited and mostly of short duration. Restrictions on the use of the area resulting from wind power cables and turbines will also affect shipping and fishing. In VE2, projects will be implemented in all four areas, which will also generate more extensive impacts. Noise impacts have not been modelled, and thus, it is not yet known, for example, whether there are combined impacts between areas affecting the same target areas. However, the number of quiet areas will decrease as more wind farms are built.

The more substantial differences between VE1 and VE2 concern the combined impacts with other projects and transboundary impacts. Combined impacts can lead to significant cumulative impacts due to the barrier effect affecting migratory fish, feeding birds and migratory birds. However, due to the lack of data on migratory fish and birds occurring in the open sea, there is no certainty about the intensity of the impact.

5.10 Energy production, climate change mitigation and green transition

Finland currently has only one offshore wind power area producing offshore wind power and it is located at Tahkoluoto in Pori. The area is situated in the Finnish territorial waters between 0.5 and 3.0 km from the shoreline.

The main grid company Fingrid is preparing for the doubling of electricity consumption and production by 2035.[111] Wind power production in general is estimated to more than double from the current level by 2030 (the estimate includes only a small amount of offshore wind power).[112] A draft decision on offshore wind power areas in the exclusive economic zone would allow a maximum production capacity of 5.2 GW connected to the main grid. If the grid-connected production capacity supplied by offshore wind power areas is compared with the Windy Seas scenario of Fingrid's electricity system vision, in partial implementation scenario (VE1) or maximum impact scenario (VE2), the share of offshore wind power in the exclusive economic zone would account for

[111]Fingrid: Prospects for future electricity production and consumption Q3/2024
[112]Fingrid: Prospects for future electricity production and consumption Q3/2024

about 14% (VE1) or 28% (VE2) of the estimated electricity consumption in 2035 if the wind farms are operational at that time.[113]

However, offshore wind power will only be built if there is demand for the energy it produces. It could be used in hydrogen production and processed hydrogen, data centres and other energy-intensive industries. Similarly, offshore wind power and other energy produced from renewable sources also act as an enabler for the use of other green transition technologies and solutions and related investments. However, with regard to the hydrogen economy, it is unclear how high the demand for energy should be so that offshore wind power projects can become profitable. As a new technology with high production costs, offshore wind power is likely to become profitable and will probably become more common when additional onshore wind power can no longer be built. However, technological advances may also reduce production costs.

If offshore wind power will replace energy from fossil sources or reduces the need to increase energy produced from fossil sources, it will have an impact on climate change mitigation and on reducing Finland's greenhouse gas emissions. Offshore wind power production in the exclusive economic zone would help to mitigate climate change but more will be needed to address the problem. Reducing greenhouse gas emissions or limiting the increase in emissions have a climate-related global impact on the environment and the effects are also felt by people in other parts of the globe.

Climate change mitigation also helps to prevent biodiversity loss and it has positive impacts on the state of the Baltic Sea. The increase in precipitation resulting from climate change is expected to increase leaching and nutrient loading from land areas to the Baltic Sea, which may be reduced by the introduction of renewable energy and emission reductions.

5.11 Synthesis of the findings of the impact assessment

The assessment of the potential impacts of offshore wind power areas in the exclusive economic zone is based on the combination of existing data. What will happen if offshore wind turbines are built in one or more of the four areas proposed in the draft decision? For example, how does the construction of the foundations of offshore wind turbines affect the fish stocks in the area, and what are the consequences of this for fish stocks, fishing and the cultural heritage built around fishing? Is any of these impacts likely to be significant, for example, by permanently changing or damaging the environment?

To find answers to this question, information has been compiled on the implementation of offshore wind power projects based on the latest technology (chapter 2) and on the state of the Gulf of Bothnian environment and changes in it (chapter 3). Potential impact pathways have been constructed by combining this information (chapter 4), and the pathways have been examined for each area and as combined effects (chapter 5). There are dozens of potential impact pathways, which means that the report describes the following likely significant impacts on each area and the potential combined impacts of the construction of more than one wind power area. Mitigation and monitoring of these impacts is discussed in the following chapters.

[113]Fingrid: Prospects for future electricity production and consumption Q3/2024

The following observations are presented as synthesis of the assessment:

- With the exception of Bothnian Sea West, the areas have already been identified as energy production areas in the maritime spatial plan. To a large extent, maritime spatial planning examines the issues from the same perspectives as SEA, and drafting of the plan is an interactive process in which organisations and local residents have also been consulted.
- According to current information, no significant ecological values that would be destroyed as a result of offshore wind power have been identified in any of the areas in large scale. In Bothnian Bay (Bothnian Bay South and Bothnian Bay North), there is an increased risk to bird life and a higher likelihood of underwater ecological values due to lower water levels and the resulting reefs and sandbanks.
- It seems that the most significant likely impacts on nature arise for reasons unconnected with the construction of individual areas. The crucial thing is how large-scale offshore wind power planned in the Gulf of Bothnia (especially the Bothnian Bay) will affect the ecosystems and species in the area together and over time.
- A significant risk to species is likely to arise from the accumulation of impacts through many projects, over time and through several different impact pathways. For example, migratory fish, migratory birds or bats may move in the vicinity of several different wind turbines and cable routes, and thus a significant proportion of the routes of individual species may be affected by wind power projects in the future. A similar issue of cumulative impacts concerns commercially important fish stocks such as Baltic herring and salmon, which are also relevant to cultural heritage and livelihoods in the region.
- There is not enough information to rule out risks. As the project progresses, individual project actors will only produce information on their own areas, and no public information has been produced on the exclusive economic zone in the same way as on the coastal areas.
- The impacts of climate change and other environmental problems on the marine environment as well as the success of any water protection measures will be seen during the life cycle covering the 30-year production period of the projects. Research methods and data sets are also becoming better. At the same time, offshore wind power and hydrogen production technologies are advancing and the methods for monitoring their impacts are becoming more effective.
- It is difficult to anticipate the effects of all change factors in the impacts of the draft decision. Dynamic models and cooperation between public and private sectors will probably be needed to monitor and manage the impacts.
- Based on the first consultation, project actors considering investments are of the view that the areas are too small and partly too deep, which means that there are challenges concerning the construction and implementation of the projects. Moreover, there is also uncertainty regarding the production timetable.
- It is envisaged that offshore wind power projects will play a major role in meeting national climate targets and the need for renewable energy. Many of the planned onshore green transition projects (such as coastal hydrogen projects) are based on offshore wind power. It has not been possible to produce parallel scenarios in the assessment on what other

means and impacts could be used to produce similar amounts of renewable energy.

6 Measures to mitigate harmful impacts

In accordance with section 4, paragraph 7 of the SEA Decree, the environmental report of the assessment process also describes measures to mitigate identified impacts, and this environmental report lists proposals for measures to mitigate the impacts of the offshore wind power envisaged in the draft decision.

It should be noted that the environmental impact assessment included in the SEA process is more general and strategic in nature than the environmental impact assessment (EIA) of individual projects. The SEA process is carried out in compliance with the SEA Act and Decree while the EIA process is carried out in accordance with the Act on the Environmental Impact Assessment Procedure and the decree supplementing it.[114]

In both the SEA and the EIA processes, different implementation scenarios are examined, and stakeholders are involved to support the plans or projects examined in the assessment and decision-making on them. In this way, the EIA process for each offshore wind power project reduces the negative environmental impacts.

6.1 Mitigation hierarchy

Mitigation hierarchy[115] (see Figure 19) is commonly used in the selection of mitigation measures. It has also been used in Finnish case law[116] and international contexts.[117] Mitigation hierarchy is a principle demonstrating the significance of the measure for the preservation of biodiversity. Accordingly, priority should always be given to the measure that generates the best possible ecological impacts and that has the maximum impact on preserving the vitality of habitats and species and on minimising social impacts. If the aim is to reverse a negative trend, the measures should aim for more than merely eliminating the harm.

The first level of the mitigation hierarchy is avoidance: the mitigation measure helps to prevent the impact. The second level is reduction: the measure reduces the intensity, extent and/or duration of the impact. The third level is restoration

[114]The Act on the Environmental Impact Assessment Procedure (252/2017; EIA Act) and the Government Decree on the Environmental Impact Assessment Procedure (277/2017; EIA Decree).
[115]Sitra: https://www.sitra.fi/en/dictionary/mitigation-hierarchy/ (referred to on 24 April 2025)
[116]KHO: 2024:11
[117]SBTN: https://sciencebasedtargetsnetwork.org/companies/take-action/act/ (referred to on 24 April 2025)

and regeneration, in which measures are taken to enhance the impacts that have already been created. At the last level of the hierarchy, the impacts are compensated for in another area in similar ecological conditions. The move to the next level of the mitigation hierarchy only takes place if the measures specified at the previous level cannot be carried out or the mitigation impact of the measures is not comprehensive enough.

AVOID	REDUCE	RESTORE AND REGENERATE	COMPENSATE
The priority in all projects and activities should be to avoid harmful impacts on nature, for example, by avoiding areas of natural value and the use of harmful materials and methods.	If the impacts cannot be avoided, they should be reduced by minimising the use of raw materials and land by, for example, improving the efficiency of operations, using side streams and the circular economy and enabling the selection of sustainable methods.	Measures should be taken to mitigate the impacts that cannot be avoided or reduced by means of restoration and regeneration. These include enhancing the diversity of areas already in use.	Impacts that cannot be avoided, reduced or restored in the target area can be compensated for by applying the compensation methods specified in the Finnish Nature Conservation Act and other voluntary compensation methods. Compensation methods and the steering instruments and standards for them are still inadequate but they

Figure 19: Description of the different levels of the mitigation hierarchy and the order in which the measures should be taken (from left to right).

6.2 Proposals for mitigation measures

Mitigation measures are listed in connection with this assessment process. With regard to mitigation measures, the proposals are largely in line with the monitoring and managing of the impacts described in chapter 8 and partially concern the same issues. The duality presented in chapter 8 in mitigating the impacts of the draft decision and the projects envisaged in it is also reflected in the mitigation measures.

Due to the long life cycle of the decision, responses to data gaps are the key measures concerning the draft decision. It is also important to specify the mitigation measures when more information becomes available on the environmental conditions in the exclusive economic zone and the environmental impacts of offshore wind power in the Baltic Sea. In project-specific mitigation measures, the consideration takes place in the EIA process and the water permit procedure, which defines the permit conditions and requirements for monitoring the impacts.

For example, with regard to essential missing environmental information, it is ultimately not relevant whether acquisition of the information is considered as managing or mitigating the impacts, as long as a significant data gap has been identified.

Proposals for mitigating likely significant harmful impacts in the selection of areas

- Offshore wind power should not be placed on extremely important bird migration routes
- In practice, leaving the Bothnian Bay (especially its northern parts) wind power-free is the only mitigation measure concerning Baltic ringed seal as this is the most important area where the species occurs. As the climate changes, leading to weaker ice conditions, the only breeding grounds of the species will be located in the northern parts of the Bothnian Bay.[119]
- For fish and birds, the selection of areas should be carried out in cooperation with Sweden so that the necessary environmental information can be made available and significant combined impacts mitigated. [49]
- Research should focus on particularly important species, such as Baltic herring, so that the areas that are particular important to the species can be identified and the sensitivity of the species to offshore wind power can be determined.

Proposals for mitigating likely significant harmful impacts in the implementation of projects

- The impact of the electromagnetic radiation emitted by submarine cables on fish (especially salmon) should be studied so that the impacts and combined impacts of offshore wind power on salmon migration and other fish could be assessed in more detail[48] [98] [88]
- Selecting the technical implementation method best suited to the conditions in the project area: for example, foundation type and turbine size.
- The impacts arising from construction work can be avoided and reduced by timing the work so that disturbance to breeding of birds and fish spawning can be minimised.
- In connection with loud construction work such as piling and blasting, birds, fish and marine mammals in the vicinity can be driven away with suitable sounds. Noise originating from construction work can also be dampened by means of a bubble curtain.
- The disposal sites must be carefully selected according to sediment quality.
- For both bats and birds, there are radar systems that identify the species approaching a wind turbine and stop the turbine to prevent collision. These systems are effective in reducing the risk of animals colliding with wind turbines.

- Supporting the formation of a new reef ecosystem in the turbine foundations through restoration and regeneration will produce habitats.
- Moving of soil and structures to the project areas as well as the ballast waters and hulls of ships are possible vectors (carriers of alien species). In connection with construction and transport work, the requirements approved by HELCOM in 2017 (Outcome of HOD 51-2016 Annex 6) must be taken into account to prevent the spread of alien species, for example, by ensuring the correct neutralisation of ballast waters.

7 Carrying out the assessment and reliability of the results

High-quality environmental assessment criteria[118] are used to assess the reliability of the SEA process, and according to them

1. Reasoned and sufficiently detailed data on all significant environmental impacts of the plan, key decisions concerning the plan and alternatives concerning the decisions will be produced.
2. Proposals concerning reasoned and relevant proposals to organise monitoring and mitigate harmful impacts will be produced.
3. A comprehensive and illustrative environmental report highlighting key conclusions will be drawn up.
4. Public participation and cooperation between the authorities are used to reach key parties, and their views will be collected comprehensively.
5. Results of impact assessment, public participation and cooperation between the authorities will be taken into account when key decisions on the plan are made.

Chapter 4 describes the logic of identifying and assessing impacts, which has been used to identify likely significant impacts on the environment.

The Ministry of Economic Affairs and Employment, which is responsible for preparing the draft decision, and the Ministry of the Environment have participated actively in the preparation of the work at regular meetings of the environmental assessment steering group and by supplying comments on the assessment. The work of the steering group has been documented in the meeting memoranda.

The expert group that prepared the report has interviewed experts designated by the steering group and examined identified impacts that are likely to be significant.

Two consultation rounds are held and the first of them resulted in more than 40 opinions from Finnish stakeholders. The assessment and its contents were specified and supplemented on the basis of the consultation. The aim has been to make the structure and contents of the report systematic and illustrative.

[118] Paldanius, J. 2025. Guide on environmental assessment under the SEA Act Publications of the Ministry of the Environment 17/2025 (in Finnish, with English abstract)

7.1 Data gaps and uncertainty factors

The exclusive economic zone is located far away from the coast and the marine areas where most of the research, ecological surveys and species observations are made. This is partially due to the fact that the number of different habitats on the coast and on the mainland is larger than in deep marine areas, which naturally also means more species. At the same time, however, the lack of mapping and studies in the exclusive economic zone creates a data gap on the nature of the area. The routes and abundance of migratory fish in the open sea, the routes and flight altitudes of migratory birds and bats, the importance of bird migration at night and the importance of the open sea for the feeding of fish-eating birds and mammals are key examples of this. With regard to birds, there is a particular need for research data supplied by transmitter birds (for example, through satellite monitoring) and radars so that more detailed information on the migration routes and flight altitudes of the species migrating across the open areas of the Bothnian Sea can be obtained. Project-specific bird surveys must be accurately proportioned to the potential and size of the area so that the required monitoring volume for both migration monitoring and breeding bird monitoring are met.[97] The role of the open marine areas as feeding grounds for the Baltic ringed seal is also unknown. Further studies are needed, especially on the hot spots of the Baltic ringed seal and its resting sites during the molting season. As the Baltic ringed seal is completely dependent on ice cover, the impact of the future ice situation on the breeding and resting sites of the species should be modelled so that the combined impact of offshore wind power, climate change and maritime traffic can be assessed in more detail.[119] It is also not known whether offshore wind turbines and other infrastructure can attract bats to a collision distance.

With regard to fish stocks, the data gaps concern the extent and significance of the combined effects and the role of shallow areas in the open sea as breeding grounds and the potential impact of the magnetic fields created by cables on salmon migration. Studies have shown that the effect of electromagnetic radiation on fish is species-specific.[120] Trawling of Baltic herring is associated with a data gap on the future situation, which is caused by the development of offshore wind power, ageing of the trawler fleet and shrinking quotas.[48] Moreover, little is known about the sensitivity of Baltic herring to offshore wind power, which may affect the supply of the species if there are factors significantly impacting it.[98] The impact of the rotor movement on surface water temperature (and stratification) and the impact of the movement on species are also unknown. The migratory routes of such fish species as salmon are not well known and they may vary depending on the water temperature[48].[98] [101]

According to the ecological survey guide of the Finnish Environment Institute,[121] value of the object and its susceptibility to changes are the two sensitivity factors of the object. The higher the object is valued, the higher the sensitivity of the

[119]Oral communication, Penina Blankett (Ministry of the Environment) and Mervi Kunnasranta (LUKE), 22 August 2025

[120]Peng Xu, Bole Wang, Zhenghao Wang, Renkang Jin, Manzoor Ahmad, Yueyong Shang, Menghong Hu, Fangping Chen, Muhammad Faisal Khalil, Wei Huang, Youji Wang, Effects of electromagnetic radiation from offshore wind power on the physiology and behavior of two marine fishes, Marine Pollution Bulletin, Volume 213,2025

[121]Mäkelä, K. & Salo, P. 2023. Ecological Surveys and Ecological Impact Assessment. A Guide for Surveyors, Customers and Authorities. Reports of the Finnish Environment Institute 43/2023 (in Finnish, with English abstract).

object. However, the current status of ecological values in the areas examined in this environmental assessment is poorly known as no observation data is available. In other words, lack of direct ecological survey data constitutes an essential data gap regarding implementation scenarios of the environmental assessment. Such data could specify the extent and importance of the actual ecological values of the areas in relation to the assumptions based on the general nature data of this environmental assessment. The deficiencies must be corrected by means of studies and project-specific reports to the extent that the relevant publications or geographic data cannot meet the requirements.

There are currently no reliable quantitative assessment methods for combined impacts and cumulative effects. The assessments are based on available nature data and an expert assessment and analysis based on scientific data derived from them. It should be added that data gaps and uncertainties are present in all situations. When research has helped to fill a data gap, new data gaps typically appear or ecological conditions have changed.

7.2 Applying the precautionary principle

The precautionary principle is one of the general principles of environmental law and it is also mentioned in EU law (Article 191 of the Treaty on the Functioning of the European Union). The principle is closely linked to other internationally accepted environmental protection principles, which is reflected, for example, in section 20 of the Environmental Protection Act (527/2014) in which it is defined as the principle of caution and care. In this context, it is an essential factor because we have to manage with incomplete assessment data and because, in a broader sense, the principle describes a situation where the absence of data itself is an environmental risk. In the case of likely significant environmental impacts under the SEA Act, the precautionary principle specifically concerns the issue of likelihood. If no information or adequate assessment based of general ecological principles is available, likelihood cannot be ruled out.

Under this legal provision, the principle means that activities that pose a risk of environmental pollution must be carried out with the care and caution required by the type of the activities so that environmental pollution can be prevented and that the likelihood of the risk of pollution caused by the activities, accident risk and the chances of preventing accidents and limiting their impacts are taken into account. The precautionary principle thus means that factors arising from uncertainty must be taken into account in decision-making.[122] In practice, this means that activities should not be carried out if there is scientific uncertainty of their impacts that are considered sufficiently harmful. Identified data gaps are one reason why the precautionary principle has been used in this environmental assessment.

With regard to maritime spatial planning, reference can also be made to HELCOM’s principles of ecosystem-based maritime spatial planning. According to them, the precautionary principle should primarily be applied in areas where

[122] Ministry of the Environment 12 May 2023, Thoughts about the precautionary principle, prerequisites for granting permits and reintroduction of the permit review procedure (in Finnish).
https://ym.fi/documents/1410903/163016068/Ajatuksia+varovaisuusperiaatteesta,+lupien+my%C3%B6nt%C3%A4misen+edellytyksist%C3%A4+ja+lupien+tarkistusmenettelyn+palauttamisesta.pdf/52671251-1593-0501-16ab-6d2c63b913a0/Ajatuksia+varovaisuusperiaatteesta,+lupien+my%C3%B6nt%C3%A4misen+edellytyksist%C3%A4+ja+lupien+tarkistusmenettelyn+palauttamisesta.pdf?t=1685105958113

the long-term combined effects arising from human pressures cannot be reliably assessed, and in areas on which there is not yet sufficient information available but which are likely to contain important marine nature. In Finland, the use of marine areas is examined in the maritime spatial planning process in accordance with the principle.[123]

In most cases, the SEA process is primarily about compiling, processing and using existing information rather than producing completely new information.[124] This environmental assessment has utilised existing and publicly available data and modellings of the characteristics and environmental state of the area under review as well as research literature on the environmental impacts of offshore wind power. No field studies or completely new data of any significance have been produced, which is why data gaps have been taken into account as described in section 7.1. The precautionary principle has been used in impact assessment when data gaps have been identified.

Although this assessment does not contain any new detailed information on the marine areas under review, the risk of data gaps is managed by requiring that a separate environmental assessment of the offshore wind power projects to be built in the areas referred to in the plan is carried out as part of the EIA assessment process and permit procedures. However, project area-specific procedures are unlikely to produce comprehensive information on combined impacts and cumulative effects. If the data gaps and uncertainties concerning harmful environmental impacts are considered excessive, they may complicate the permit procedure.

[123] Kirsi Kostamo et al. Applying ecosystem approach in the preparation of maritime spatial plans. Maritime spatial planning 2020 (in Finnish)

[124] Guide on environmental assessment under the SEA Act, Publications of the Ministry of the Environment 17/2025 (in Finnish, with English abstract)

8 Proposals for monitoring and managing the impacts

[Lukuun lisätään nostoja kuulemiskierrokselta]

The plan or programme reviewed in the SEA process can be modified based on the environmental report and the results of the consultations. In this case, the environmental assessment will be taken into account when the Government prepares its decision on the offshore wind power area/areas in the exclusive economic zone.

Comparisons between the results of the different implementation scenarios discussed in the assessment give an idea of the likely significant impacts that a draft decision can have on the environment if realised and how these impacts can be minimised, managed and monitored in advance and after the start of the operations. Ultimately, the results of the impact monitoring should genuinely shape activities in the areas in terms of the development and steering of the projects located in them. In offshore wind power, this may mean, for example, inputs in operational permit conditions, technological development or, in particular, the development of research methods so that the cumulative impacts on less-known marine nature can be modelled and possibly minimised. In the future, actors may also face compensation claims concerning environmental damage and there should be procedures for monitoring them.

The recommendations can concern combined impacts, specific areas and all areas. On the one hand, they can be divided into themes, such as general response to significant data gaps concerning the marine environment and nature in the exclusive economic zone and subsequent monitoring of changes in the state of the environment based on this data, and on the other hand, monitoring and managing the impacts of projects and monitoring the impacts of mitigation measures. Figure 20 contains a summary of the levels of impact monitoring.

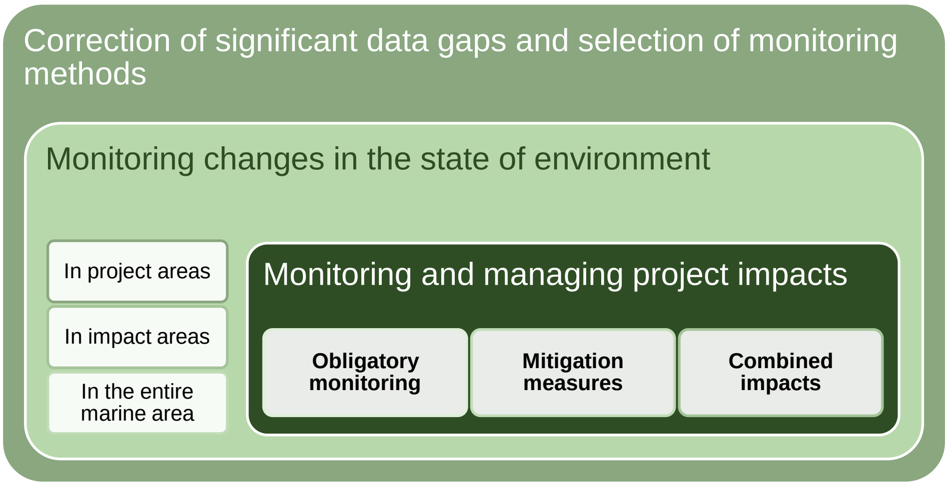


Figure 20. Summary of the needs to monitor the state of the environment in the exclusive economic zone and the impacts of offshore wind power at different levels.

In particular, the general recommendation is to monitor identified significant harmful and positive impacts and impacts involving uncertainties. The last-mentioned also highlight the need for possible basic research to provide sufficient information on the current state of the environment so that changes can be monitored.

In order to ensure an effective and high-quality process, the state of the marine areas and the information systems and other data acquisition methods used to collect monitoring data must be defined, and parties assuming responsibility for several decades of monitoring must be designated for them. The Ministry of Economic Affairs and Employment, which is responsible for the draft decision, is not responsible for monitoring the environmental state of the exclusive economic zone or the impacts of the activities located in the areas. Instead, monitoring and managing harmful impacts in accordance with the recommendations requires co-operation between several responsible parties. At a later stage, each project actor may, if it so wishes, use the perspectives provided by the public report and opinions to improve its own environmental impact assessment process and to mitigate the negative impacts.

The proposals for monitoring and managing the impacts are therefore divided into three parts. The first concerns the content of the draft decision and the second the impacts arising from the implementation of the decision (impacts during the life cycle of offshore wind power projects in the areas covered by the decision). The third part is a list of other aspects related to offshore wind power in the exclusive economic zone that are not directly within the scope of the SEA Act but that should be shared with stakeholders.

8.1 The proposals for monitoring the impacts of the draft decision

[Lukuun lisätään nostoja kuulemiskierrokselta]

At the presentation of the Ministry of Economic Affairs and Employment, the Government may make a decision designating one or more areas in the Finnish exclusive economic zone for the exploitation of offshore wind power and for the use of offshore hydrogen production.

The draft decision examined in the assessment consists of the four proposed areas but it does not yet state how many of them will be put out to tender and whether the tendering will be carried out as a combined process or for one area at a time. The decision can include opinions on the tendering timetable, and the tendering process itself will be organised by the Energy Authority. The draft decision sets the criteria for the efficiency of the use of the area, the duration of the concession and the maximum capacity of the main grid connection point.

Taking into account the national targets for boosting clean energy production and producing the energy required by green transition projects, the plan to increase offshore wind power in the exclusive economic zone is justified. Environmental aspects, impacts on humans and other use of the seas as well as technical and economic perspectives have been considered in the selection of the areas. No considerations in favour of rejecting the entire draft decision emerged during the assessment.

The starting point for the recommendations is therefore that offshore wind power will be built in the exclusive economic zone. However, data gaps have already emerged in the selection of the areas and they are likely to concern significant environmental impacts.

The environmental and human impacts of the implementation of the decision can only be monitored if these data gaps are corrected. They concern the main proposals on the impacts of the draft decision itself.

Proposals to address significant data gaps concerning the marine environment and nature and to monitor the impacts:

- A report and monitoring model for changes in ice accumulation in the Bothnian Bay and its impact on winter navigation, taking into account the impacts of continuous climate change
- More information on the impacts on the occurrence and migration of birds, especially on little-known night migration.[125] The flight altitudes and directions of migratory birds in the open marine areas of the Gulf of Bothnia and the Bothnian Sea can be determined, for example, by means of a bird radar and transmitter birds
- Additional information on offshore migration of bats
- Additional information on the cumulative impacts of offshore wind power areas, wind turbines and cables in the Baltic Sea on migratory fish species[126]
- Mapping *Monoporeia affinis* and determining its endangered status in the open sea areas of the Gulf of Bothnia
- Determining the significance of shallow areas in the open sea as breeding grounds for fish (such as Baltic herring and vendace)
- Determining the most important resting sites of the Baltic ringed seal (including molting sites) and the role of the open sea (as a food source)
- Modelling of combined impacts (climate change, maritime traffic, offshore wind turbines in Swedish territorial waters) for different groups of

[125] BirdLife Finland: Migration paths and feeding grounds of birds in areas near offshore wind turbines, 2023 (in Finnish)

[126] The information on the Baltic Sea migratory routes is currently based on marks and codes returned via the Transboundary River Commission (a system in which fishermen collect and return identification marks or codes of the fish they catch). However, there is no comprehensive data and research on the location of the migratory routes and changes in them. The research requires international cooperation.

organisms and livelihoods (such as Baltic ringed seal, fish, birds, benthic fauna, fishing)

- Modelling of impacts by species group: Impact of the placement of wind turbines and cables on different groups of organisms now and in the future
- Using the ULMO project (outer sea mapping programme) to produce a knowledge base similar to that contained in VELMU to enable systematic monitoring of the state of the seas, identification of ecological values and impact assessment

8.2 Proposals concerning the monitoring of project impacts

[Lukuun lisätään nostoja kuulemiskierrokselta]

The SEA Act and the guidelines issued by the environmental administration set out the general principles for monitoring and managing impacts during the implementation of programmes and plans. These are also linked to previously defined mitigation measures.

When applied to the Government decision, the impacts during its implementation will arise in the manner described earlier. This is because the decision allows the placing of offshore wind power projects, possible future hydrogen production and the infrastructure required by them in the area specified in the decision.

Environmental impact assessments and permits for offshore wind power projects contain requirements for monitoring the state of the environment and environmental impacts. These include the obligatory monitoring by companies and supervision by the permit authorities. Joint monitoring is a tool in which actors with impact on the same water body plan and carry out joint research on the state of water bodies and impacts on them.

Not much environmental data on the exclusive economic zone is available, and for this reason the recommendation is to collect existing environmental data from both public and private sources and to create incentives for creating and maintaining shared datasets. This cooperation can be launched already during the tendering process and continued later based on the permit obligations. By engaging in cooperation, actors can introduce new and innovative research and monitoring technologies and fund research projects. The uncertainty caused by combined impacts in the assessment of cumulative environmental impacts also requires that projects use more advanced methods to monitor operations so that significant changes affecting different groups of organisms can be identified in time. This is particularly important when large-scale assessments are carried out.

During project life cycles, provision should be made for limiting the number of future projects and/or wind turbines using the results of long-term species monitoring in the turbine areas and their surroundings so that any irreversible changes at population level can be avoided. If monitoring reveals that the risk posed by additional projects and other combined impacts to a certain group of organisms is too high, this observation may also guide future decisions such as the selection of construction solutions or the more precise placement of wind turbines in the area.

The recommendation to share information as openly as possible improves social acceptance and facilitates such matters as permit change processes.

Proposals for monitoring and managing project impacts:

- Consideration of probable significant impacts in individual areas in Natura needs assessment
- With regard to migratory birds, the placement of wind turbines must be determined by the main migration routes in such a way that the turbine area does not block the migration route or force the most sensitive species to circumvent the areas from such a distance that it would unreasonably increase the energy consumption of the species.
- The impact on migratory birds can be mitigated by leaving migration corridors of between two and three kilometres in accordance with the main migration directions in the wind turbine area so that the most daring species can fly between turbines and avoid the greatest risk of collision with them.[97]
- Especially the legislation on the national park must be taken into account when cables are laid and ecological surveys must be conducted for more detailed cable-laying areas
- Monitoring during operations can focus on bird and fish populations if, for example, the accumulated research data highlights specific risks to certain areas or groups of organisms and based on these, decisions are made on additional construction or modifications of the built environment
- The impacts of offshore wind turbines on changes in wind conditions must be assessed as part of the placement of wind turbine units in the area
- Preparation of joint monitoring programmes and joint observation activities between projects located in the same marine areas and possibly also combining other maritime activities in neighbouring areas
- Creating real-time or frequently updated datasets and interfaces to report on monitoring and observation activities
- Project-specific assessment of compensatory measures to minimise disturbance to maritime radars, GNSS signals, VHF radio communications and AIS systems
- Planning the flight corridors required by the Finnish Border Guard for surveillance, search and rescue flights, monitoring their use and risk assessment
- Mapping potential synergies between offshore wind power projects, cooperation in mitigating impacts and minimum distances between offshore wind turbines
- Planning the compensation of ecological values should already be a requirement during project planning stage. Monitoring of the recovery and restoration of nature after decommissioning should also be included in the monitoring.

8.3 Other proposals highlighted in the assessment process

[Lukuun lisätään nostoja kuulemiskierrokselta]

The environmental assessment does not cover all societal impacts, and this report does not therefore extensively consider aspects such as comprehensive security, preparedness, security of supply or social acceptance and social licence. Moreover, the SEA process concerning the draft decision on offshore wind power areas in the exclusive economic zone does not replace the EIA process for individual projects.

However, the assessment and especially the consultations have highlighted several impact perspectives and information needs that are important for the use of marine areas and the construction and approval of offshore wind power. They are discussed in a summary added to this chapter of the environmental report.

Statutory assessments and permits and the consultations required by them are not enough to ensure the implementation of the projects envisaged in the draft decision and the approval of stakeholders. Research literature[127] describes processes in which, for example, the change resulting from a green transition project in the community can be managed and trust can be achieved by building a dynamic process of interaction (figure below). This environmental assessment and the opinions appended to it provide background information and potential tools for monitoring and mitigating societally undesirable impacts.

At the conclusion of the SEA process, it is essential to continue interaction with the target communities in the period when the actual business operators for the offshore wind power areas have not yet been selected in competitive tendering. Once the operators have been selected, the focus of the dialogue shifts to companies, and the approval granted by local communities is part of the self-regulation of companies. A social licence can also strengthen a company’s competitiveness and risk management capacity, in which case recommending and promoting such interaction is also in the interests of public administration. The approximately 30-year life cycle of the wind turbines corresponds to an entire human generation, which means that continuity and flexibility of interaction is also essential in time.

[127] Pamela Lesser (2024) Scales of Trust. An Exploration of the Social Licence to Operate of Mining at the Societal Level. Acta electronica Universitatis Lapponiensis 396. ISBN 978-952-337-464-5, ISSN 1796-6310; Lind, A., Määttä, H., Berninger, K., Carus Andersen, L. K., Aasen, M., Leiren, M. D., … Have, S. (2025). Social acceptance as a prerequisite for the green transition. https://doi.org/10.6027/temanord2025-507; Lehtonen, M., Kojo, M., Kari, M., Jartti, T., & Litmanen, T. (2021). Trust, mistrust and distrust as blind spots of Social Licence to Operate: illustration via three forerunner countries in nuclear waste management. Journal of Risk Research, 25(5), 577–593. https://doi.org/10.1080/13669877.2021.1957987

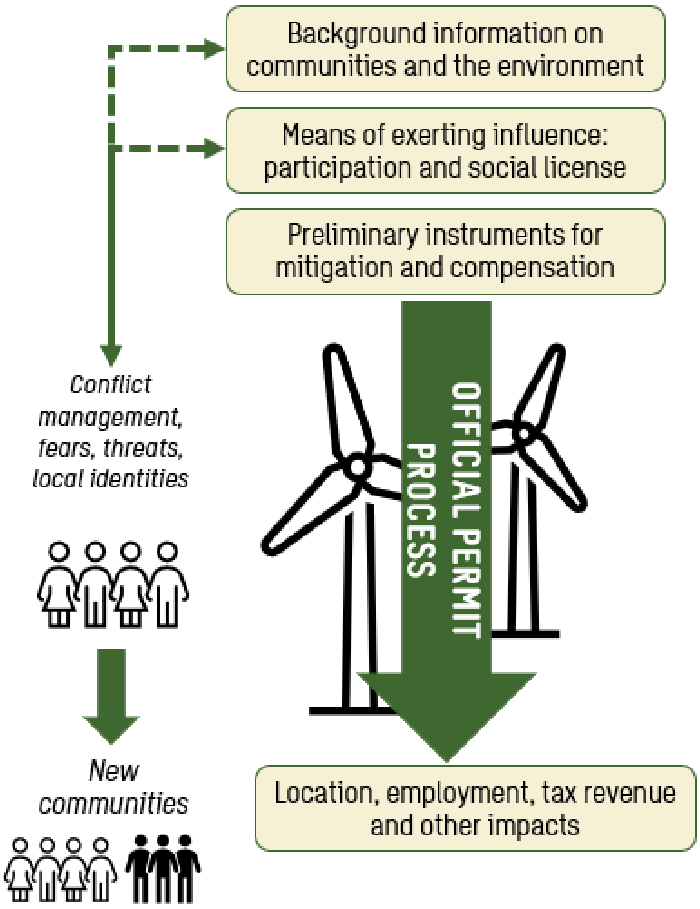


Figure 21: Building social acceptance when a plan or a project changes the target community

Appendix 1: Consultation results

A summary of the consultation results will be appended to the environmental report

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