Development of the Curonian Nord Offshore Wind Farm and Installation of the Electricity Export Cable for Offshore Wind Farm "Area D", Lithuania

Environmental Impact Assessment Report

September 2025

Developer:

UAB “Ignitis renewables”

EIA prepared by:

Public Institution
Coastal Research and Planning Institute

Development of the Curonian Nord offshore wind farm and installation of the electricity export cable for offshore wind farm "Area D", Lithuania

Environmental Impact Assessment Report

Proposed economic activity	1) Development of the "Curonian Nord" offshore wind farm in Lithuania. 2) Installation of the export cable for the offshore wind farm "Area D. The planned activities are classified as being of overriding public interest and are recognized as essential for ensuring public security.
Location of proposed economic activity	Pursuant to the Resolution No. 171 of the Government of the Republic of Lithuania of 15 March 2023, "On the designation of areas within the territorial sea of the Republic of Lithuania and/or the exclusive economic zone of the Republic of Lithuania in the Baltic Sea where it is appropriate to organize a tender (tenders) without applying support measures for the development and operation of power plants using renewable energy sources, and on the determination of the maximum allowable generation capacity and minimum installed capacity of such power plants," a specific area of the Baltic Sea has been approved for offshore renewable energy development. As part of the project of special national importance entitled "Preparation of areas necessary for connecting power plants using renewable energy sources, planned for development within the territorial sea and/or the exclusive economic zone of the Republic of Lithuania in the Baltic Sea, to the electricity transmission networks, for the development of engineering infrastructure," the connection corridor of the "Area D" offshore wind farm has been designated. This export cable will connect the offshore facilities to the 330 kV Darbėnai substation, located at Žyneliai village 9, Darbėnai eldership, Kretinga district municipality.
Environmental Impact Assessment Report Version No.	Version 01. For public presentation
Year, month of preparation	September 2025
Organizer (client) of the proposed economic activity	UAB "Ignitis renewables"
Environmental Impact Assessment Documents Prepared by	Public Institution Coastal Research and Planning Institute

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ABBREVIATIONS

Abbreviation	Explanation
AA-EQS	Annual average of environmental quality standard
AC	Alternating current
ADD	Acoustic deterrent device
AHTS	Anchor handling tug supply
ALARP	Risk reduction through sound, practical measures (as low as reasonably practical)
BAAS	Baltic acoustic spring survey
BIAS	Baltic International Acoustic Survey
BITS	Baltic International Trawling Survey
BSH	German Federal Maritime and Hydrographic Agency
BQI	Benthic quality index
BR	Behavioural response
CBRA	Cable burial risk assessment
CN	Curonian Nord
CTV	Crew Transfer Vessel
CPT	Cone penetration testing
DBBC	Double bubble curtain
DDV	Drop-down video
DHI	Danish Hydraulic Institute
DNV	Det Norske Veritas
EC	European Commission
ECMWF	European Centre for Medium-Range Weather Forecasts
EEZ	Exclusive economic zone
EIA	Environmental impact assessment
EMF	Electromagnetic field
Espoo Convention	The United Nations Economic Commission for Europe Convention on Environmental Impact Assessment in a Transboundary Context
EP 4	Equator principles
EPA	Environmental Protection Agency under the Ministry of Environment
ES50	The Hurlbert Index
ESAS	European Seabird-at-Sea data portal
EQS	Environmental quality standard
EU/BD I	Annex I to the European Union Birds Directive
EUNIS	European Nature Information System
FRD	Fire and Rescue Department
G+	The Global Offshore Wind Health and Safety Organisation
GBF	Gravity based foundation
GES	Good environmental status
GHG	Greenhouse gases
GIS	Gas insulated switchgear
GL	Germanischer Lloyd
GNS	Gillnets
GP	General plan
HAZID	Hazard identification
HAZOP	Hazards and performance and Operability
HDD	Horizontal directional drilling
HELCOM	Helsinki Commission

Abbreviation	Explanation
HOV	Horizontal angle of view
HSD	Hydro Sound Dampers
IAC	Inter array cables
ICD	International Classification of Diseases
ICES	International Council for the Exploration of the Sea
IFC	International Finance Corporation
IUCN	The International Union for Conservation of Nature
LNMRCC	Lithuanian Navy Maritime Rescue Coordination Centre
LOQ	Limit of quantification
LRS	Seimas of the Republic of Lithuania
LRV	Government of the Republic of Lithuania
LSRS	List of protected species in Lithuania
MAC	Maximum allowable concentration
MAC-EQS	Maximum allowable concentration of environmental quality standard
MARIN	Netherlands Institute for Marine Research
MoE	Ministry of the Environment of the Republic of Lithuania
MP	Monopile foundation
MSFD	Marine Strategy Framework Directive
MTR	Migration Traffic Rate
n =	Total sample size
NEIS	National Energy Independence Strategy
NERC	National Energy Regulatory Council
NF	Natural Framework
NLPM	National Landscape Management Plan
NTS	Non-technical summary
ONS	Onshore substation
OSS	Offshore substation
OSV	Offshore support vessel
OTB	Bottom otter trawl
OTM	Midwater otter trawl
OWF	Offshore wind farm
PAM	Passive acoustic monitoring
PEA	Proposed economic activity
PLGR	Pre-lay grapnel run
PPT	Particularly protected territory
PTS	Constant change in threshold
RA	Risk assessment
RES	Renewable energy resources
ROV	Remotely operated vehicle
SAC	Special Area of Conservation (important for habitats)
SEA	Strategic Environmental Assessment
SEL	Weighted sound exposure level
SLUC	Law on Special Land Use Conditions
SPA	Special Protection Area (important for bird conservation)
SPL	Sound pressure levels
SPM buoy	Single point mooring buoy
SRIS	Database of Protected Species of Lithuania

Abbreviation	Explanation
SSPA	State Service for Protected Areas under the Ministry of Environment
StUK4	German Standard Investigation of the Impacts of Offshore Wind Turbines on the Marine Environment
TL	Transmission loss
TSO	Transmission system operator
TSV	Trenching support vessel
TTS	Temporary threshold change
UNCLOS	United Nations Convention on the Law of the Sea
UPS	Uninterruptible power supply
UXO	Unexploded ordnance
VLKPAT	The most valuable panoramic viewpoints of Lithuania's landscape
VVA	Vertical Viewing Angle
W2W	Walk-to-Work
WBG	World Bank Group
WFD	Water Framework Directive
WHO	World Health Organisation
WTG	Wind turbine generator
ZVI	Zone of visual influence

UNITS OF MEASUREMENT

Unit of measurement	Explanation
cm	centimetre
g	gram
GW	gigawatts
h	hour
kg	kilogram
kg/hour	kilograms per hour
km	kilometre
kV	kilowatts
l	litre
m	metre
mm	millimetre
mg/l	milligrams per litre
µg/l	micrograms per litre
m/s	metres per second
MW	megawatts
t	ton
tCO_2e	metric tonnes of carbon dioxide equivalent

1. INTRODUCTION

Environmental Impact Assessment (hereinafter – EIA) is being conducted for the following two proposed economic activities (hereinafter – PEA):

(1) The Curonian Nord (hereinafter – CN) offshore wind farm (hereinafter – OWF) including all associated infrastructure – an offshore substation (hereinafter – OSS) and an export cable both offshore and onshore, up to the planned 330 kV substation in Darbėnai.

(2) An export cable both offshore and onshore connecting the planned OWF "Area D" and the 330 kV substation in Darbėnai.

1.1 Proposed Economic Activity (1) – Development of the CN OWF

On 12 October 2023, UAB "Ignitis Renewables" was declared the successful bidder for the utilisation of a marine area dedicated to the development and operation of an OWF, as decided by the National Energy Regulatory Council (hereinafter – NERC). The developer is set to receive a permit from NERC, granting the rights to utilise a portion of the marine area for the OWF's development and operation for a period of 41 years, as stipulated in Government Resolution No. 171, dated 15 March 2023. This resolution is titled "On the parts of the territorial sea and/or the Exclusive Economic Zone of the Republic of Lithuania in the Baltic Sea where it is appropriate to organise tenders without applying support measures for the development and operation of power plants using renewable energy sources (hereinafter – RES), and the determination of the maximum permissible and minimum installed capacity of these power plants" (hereinafter – Resolution No. 171).

For the marine area under consideration, the Government of the Republic of Lithuania (hereinafter – LRV), through Resolution No. 171 dated 15 March 2023, defined the coordinates of the Lithuanian marine territory suitable for tender organisation without support measures for RES-based power plant development and operation, along with the designated wind power capacity.

The EIA is conducted for the construction of the OWF in the area specified by LRV Resolution No. 171. This area falls within a region for which the Engineering Infrastructure Development Plan for the Territory of the Territorial Sea and/or the Exclusive Economic Zone of the Republic of Lithuania in the Baltic Sea, intended for the development of renewable energy, was prepared and approved by Order No. 1-377 of the Minister of Energy of the Republic of Lithuania on 18 November 2022. The electricity generated at the OWF is intended to be transmitted to onshore electricity networks.

UAB "Ignitis Renewables" plans to install and operate an OWF comprising up to 55 turbines in the northern sector of Lithuania's Exclusive Economic Zone (hereinafter – EEZ) in the Baltic Sea, situated approximately 36.8 km from the coast, with integration into the onshore electricity grid.

1.2 Proposed Economic Activity (2) – Installation of the Export Cable for the "Area D" OWF

According to Resolution No. 697[1], a neighbouring OWF – "Area D" – has also been planned. An EIA was conducted in 2023 at the request of the Ministry of Energy of the Republic of Lithuania. The EIA report received approval from the Environmental Protection Agency (hereinafter – EPA) on 23 October 2023, by decision No. (30-2)-A4E-10794. This EIA did not evaluate the electricity transmission connection between the OWF park and the onshore electricity grids, because the project of exceptional national importance, titled "Preparation of territories required for connecting power plants using renewable energy sources, planned for development in parts of the territorial sea and/or the Exclusive Economic Zone of the Republic of Lithuania in the Baltic Sea, to the electricity transmission grid, for engineering infrastructure development" (hereinafter – Engineering Infrastructure Development Plan), had not yet been completed. The Engineering Infrastructure Development Plan specifies that the planned OWF "Area D" will be connected to the 330 kV substation located in Darbėnai, Kretinga District Municipality, Darbėnai Eldership, Žyneliai village, No. 9.

The electricity transmission connections were planned under the aforementioned project of exceptional national importance. A Strategic Environmental Assessment (hereinafter – SEA)[2] was undertaken for this project, and the concept of the Engineering Infrastructure Development Plan was approved by Order No. 1-161 of the Ministry of Energy of the Republic of Lithuania on September 16 2024[3]. The finalised solutions of the Engineering Infrastructure

[1] https://www.e-tar.lt/portal/lt/legalAct/a0c9fb80b6bc11eab9d9cd0c85e0b745/asr

[2] In the Information System for the Preparation of the Republic of Lithuania's Territorial Planning Documents and State Supervision of the Territorial Planning Process (TPDRIS), at the address: www.tpdris.lt, TPD No. S-NC-00-22-585.

[3] Order No. R1-161 of the Minister of Energy of the Republic of Lithuania, dated 16 September 2024, "On the Approval of the Concept of the Engineering Infrastructure Development Plan for the Special National Importance Project 'Preparation of Territories Required for the Connection of Power Plants Using Renewable Energy Sources Planned to Be Developed in the Territorial Sea and/or the Exclusive Economic Zone of the Republic of Lithuania in the Baltic Sea, to the Electricity Transmission Grid, for the Development of Engineering Infrastructure'. Online access: https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/2a088342746311ef9c779dd37198d447?jfwid=-aj6u7wxfr.

Development Plan were presented to the public between January and March 2025. According to the approved alternatives, the connecting corridors of both territories are planned to be located next to each other.

1.3 Legal Basis of Environmental Impact Assessment

The developer of the OWF has initiated the EIA process to evaluate the impact on marine ecosystems and various environmental components, as well as to propose mitigation measures. The EIA also includes an assessment of social impacts.

The EIA is conducted in compliance with national legislation, the obligations set out in 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 (Marine Strategy Framework Directive; hereinafter – MSFD), recommendations from the Baltic Marine Environment Protection Commission (Helsinki Commission; hereinafter – HELCOM), and best international practices.

The EIA also considers the provisions of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (hereinafter – the Habitats Directive) and Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds.

Table 1.3.1. Activity category according to the Classification of Economic Activities[4]

Section	Division	Group	Class	Activity
D	**35**	**35.1**	**35.11**	**Electricity generation**

The PEA corresponds to the activity specified in point 3.10.1 of Annex 1 of the Law on Environmental Impact Assessment of Proposed Economic Activities of the Republic of Lithuania No. XIII-529 of 27 June 2017 (hereinafter – the EIA Law) – the construction of wind power plants in the territorial sea of the Republic of Lithuania and/or in the EEZ of the Republic of Lithuania in the Baltic Sea.

1.4 Importance of the Planned Economic Activity for advancing national strategic objectives

The establishment of an OWF in the Baltic Sea aligns with the key goals and projects outlined in the National Energy Independence Strategy[5] (hereinafter – NEIS), which aim to increase domestic electricity production from RES and reduce dependence on electricity imports. Points 107–111 of NEIS state that Lithuania could utilize the territory of its EEZ in the Baltic Sea for electricity generation by developing OWFs. In the first phase, by 2030, Lithuania plans to develop two OWFs. The total capacity of these wind farms will reach 1.4 GW, and they will be connected to Lithuania's electricity transmission system. Together, the OWFs are expected to generate approximately 6 TWh of electricity per year.

1.5 Main objectives, tasks, and parties involved in the Environmental Impact Assessment

The CN OWF developer has launched the Environmental Impact Assessment to evaluate potential effects on marine ecosystems and the environment, while also addressing social impacts and identifying measures to mitigate them.

As part of the project implementation, an environmental and social impact assessment will be carried out in accordance with national and international requirements and standards, including:

- Lithuanian environmental and social protection legislation, including but not limited to environmental protection laws, health, safety, security and environmental (HSSE) laws, and social protection laws.
- International environmental and social standards:
  - The Equator Principles (hereinafter – EP 4)
  - The International Finance Corporation (hereinafter – IFC) Performance Standards on Environmental and Social Sustainability
  - World Bank Group (hereinafter – WBG) Environmental, Health, and Safety Guidelines
  - EU Taxonomy Regulation.

According to the EIA Law, the objectives of the EIA being conducted are:

[4] Order No. DĮ-226 of the Director General of the Department of Statistics under the Government of the Republic of Lithuania of 31 October 2007 "On the Approval of the Classification of Types of Economic Activities".

[5] Approved by the Resolution No. XIV-2856 of the Seimas of the Republic of Lithuania of 27 June 2024 "On the Amendment of the Resolution No. XI-2133 of the Seimas of the Republic of Lithuania of 26 June 2012 'On the Approval of the National Energy Independence Strategy'."

- To identify, describe, and evaluate the potential direct and indirect impacts of the PEA – the installation and operation of the OWF in the maritime area defined by Government Resolution No. 171 and its associated infrastructure at sea and on land – on the following environmental elements: land surface and subsurface, water, air, climate, landscape, and biodiversity, with particular attention to species and natural habitats of European Community (hereinafter – EC) importance, as well as other protected species according to the Law on Protected Species of Animals, Plants, and Fungi of the Republic of Lithuania, material assets, immovable cultural heritage, and the interrelation of these elements.
- To identify, describe, and evaluate the potential direct and indirect impacts of biological, chemical, and physical factors caused by the PEA on public health, as well as the interactions between environmental elements and public health.
- To identify the potential impacts of the PEA on environmental elements and public health due to the PEA's vulnerability to the risk of extreme events and/or potential emergency situations.
- To define the measures intended to avoid, reduce, restore, or, if possible, compensate for anticipated significant adverse effects on the environment and public health.
- To determine whether the proposed economic activity, considering its nature, scope, location, and/or environmental impact, complies with environmental protection, public health, cultural heritage protection, fire safety, and civil safety legal requirements, and whether it will not have significant adverse effects on environmental elements, public health, and their interrelations.

Participants of the EIA process include:

- The responsible authority
- The PEA organiser (initiator)
- The EIA documentation developer
- The institution authorised by the Government to coordinate the transboundary environmental impact assessment process, as determined by the Minister of Environment
- The interested public
- EIA entities. According to Article 5 of the EIA Law, EIA entities include:
  - The municipality’s executive institution where the PEA is planned
  - Institutions authorised by the Minister of Health
  - Institutions authorised by the Minister of the Interior, responsible for fire and civil safety
  - Institutions authorised by the Minister of Culture, responsible for the protection of cultural values
  - Institutions authorised by the Minister of Environment for protected areas when the implementation of the PEA may impact state protected areas, including "Natura 2000" ecological network areas.

According to point 27.1 of Chapter V of the Regulations for Public Information and Participation in the EIA Process of Proposed Economic Activities[6], if the activity is planned in the territorial sea and/or the EEZ of the Republic of Lithuania in the Baltic Sea, information about the prepared EIA report is provided to the administrations of municipalities bordering the Baltic Sea.

The EIA report is submitted for coordination to the EIA entities responsible for administering the coastal zone areas closest to the PEA territory:

- Palanga City Municipality Administration
- Klaipėda District Municipality Administration
- Klaipėda City Municipality Administration
- Neringa Municipality Administration
- Kretinga District Municipality Administration
- Klaipėda Department of the National Public Health Centre under the Ministry of Health
- Klaipėda County Fire and Rescue Board
- Klaipėda Division of the Department of Cultural Heritage under the Ministry of Culture

[6] Approved by Order No. D1-157 of the Minister of Environment of the Republic of Lithuania of 23 May 2023 “On the Amendment of Order No. D1-885 of the Minister of Environment of the Republic of Lithuania of 31 October 2017 ‘On the Approval of the Description of the Procedure for Environmental Impact Assessment of Proposed Economic Activities’.

- State Service for Protected Areas under the Ministry of Environment.

The responsible institution is the EPA.

Public consultations during the EIA process are carried out in accordance with the provisions of the Regulations for Public Information and Participation in the EIA Process of Proposed Economic Activities[7]. During the EIA, the interested public has the right, as defined by law, to receive information about the potential environmental impact of the PEA from other participants in the EIA process. The interested public has the right, during the EIA process, to submit proposals, questions, comments, information, analysis, or opinions on the PEA and its EIA to EPA, the developer of EIA documentation, the PEA developer, and the EIA entities in accordance with the procedures established in the Regulations for Public Information and Participation in the EIA Process of Proposed Economic Activities.

[7] Approved by Order No. D1-157 of the Minister of Environment of the Republic of Lithuania dated 23 May 2023.

2. INFORMATION ABOUT THE PROPOSED ECONOMIC ACTIVITY

2.1. Legal basis for the PEA

The PEA includes:

1. construction and operation of the CN OWF and its related infrastructure in the Baltic Sea, within the territory approved by Government Resolution No. 171 (identified as “Area A” in the Engineering infrastructure development plan), including the transmission and integration of the generated electricity into the onshore transmission system operated by the Transmission System Operator (hereinafter – TSO).
2. installation and operation of the necessary electricity transmission infrastructure to connect the OWF identified as "Area D" to the onshore TSO network, including engineering infrastructure development, integration and exploitation.

For the transmission of electricity generated in the OWF to the onshore electricity grid, an Engineering Infrastructure Development Plan is being prepared. The concept[8] of this Engineering Infrastructure Development Plan has been approved. This includes the use of the following alternatives for connecting the OWFs to the transmission grid: in the marine territory – alternatives B1 and A1; in the land territory – alternatives C1 and C2. For connecting “Area A,” which is being analysed for the development of the CN OWF, the B1–C2 alternative is planned; for the planned “Area D,” the A1–C1 alternative is intended. These alternatives are further analysed in this EIA report.

The planned CN and “Area D” OWFs will be connected via export cables to the existing onshore electricity transmission system – the 330 kV “Darbėnai” substation located at Žyneliai village 9, Darbėnai Eldership, Kretinga District municipality (see Fig. 2.1.1).

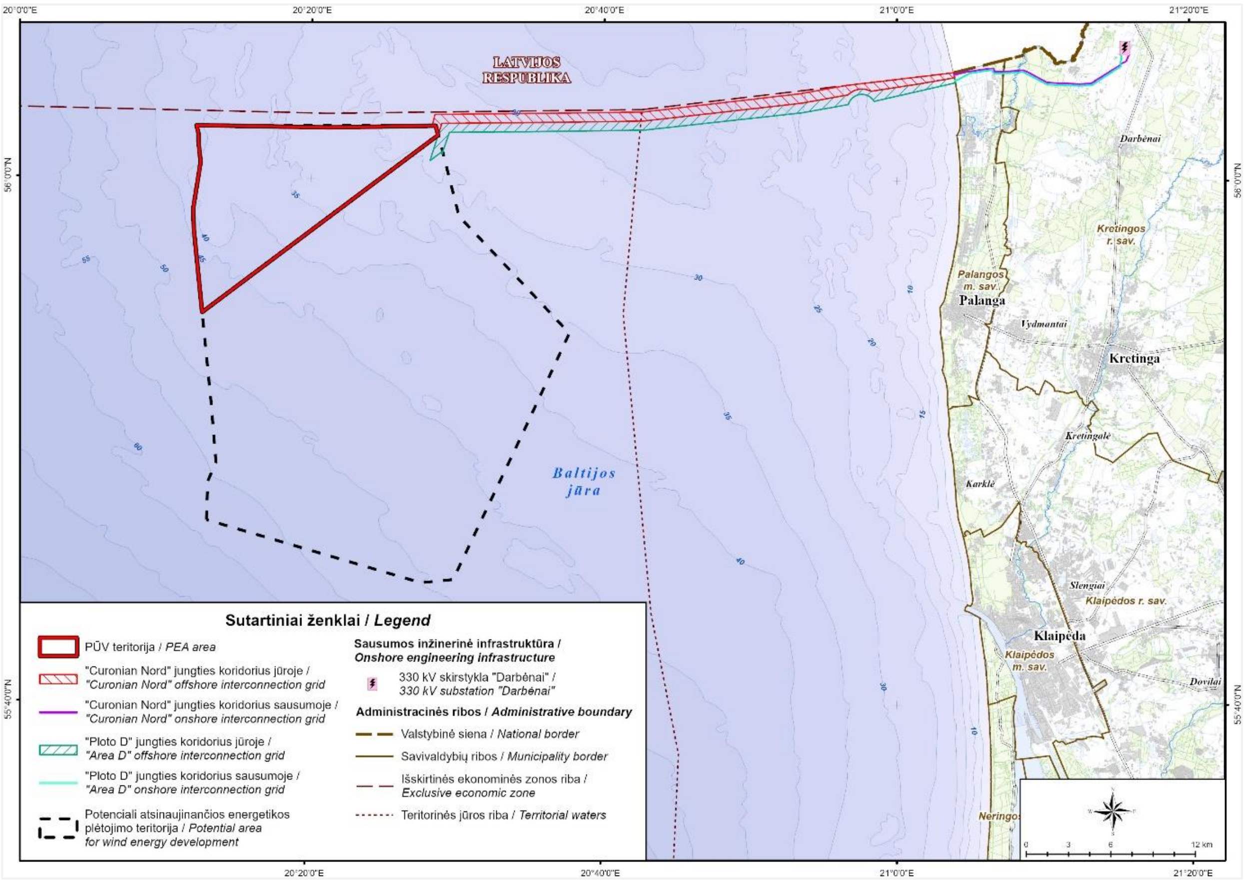


Fig. 2.1.1. Layout of the planned OWF area within the part of the territorial sea of the Republic of Lithuania and/or the Republic of Lithuania's EEZ in the Baltic Sea, where it is appropriate to organise tenders without applying support measures for the development and operation of power plants using renewable energy sources by 2030 (according to Annex 2 of Government Resolution No. 171), and the connection corridors to the 330 kV “Darbėnai” onshore substation area.

[8] Approved on 16 September 2024 by Order No. 1-161 of the Minister of Energy of the Republic of Lithuania.

2.2. Physical and technical characteristics of the proposed economic activity

According to Government Resolution No. 171, the target wind power capacity designated for development in the analysed CN OWF area is:

- Maximum allowable generation capacity: 700 MW
- Minimum installed capacity: 580 MW.

Offshore wind technologies are constantly and rapidly evolving; therefore, by the time of construction, new wind turbine generators (hereinafter – WTG) models with capacities of up to 20 MW or more may appear on the market. The tower height of WTG depends on the selected model's capacity, the site's wind class, and environmental conditions. The range of technical-physical characteristics of the offshore wind turbines to be examined during the EIA is presented in Table 2.2.1.

Table 2.2.1. Technical and physical characteristics of WTGs considered during the EIA

Parameter	Value
Power of each WTG (MW)	Up to 20 and more
Hub height (m)	Up to 170
Tip height of the WTG (m)	Up to 350
Rotor diameter (m)	Up to 300
Minimum distance from blade tip at the lowest point to mean sea level (tip clearance; m)	23
Distance between WTGs	Min. 3 x rotor diameter
Number of blades per WTG	3

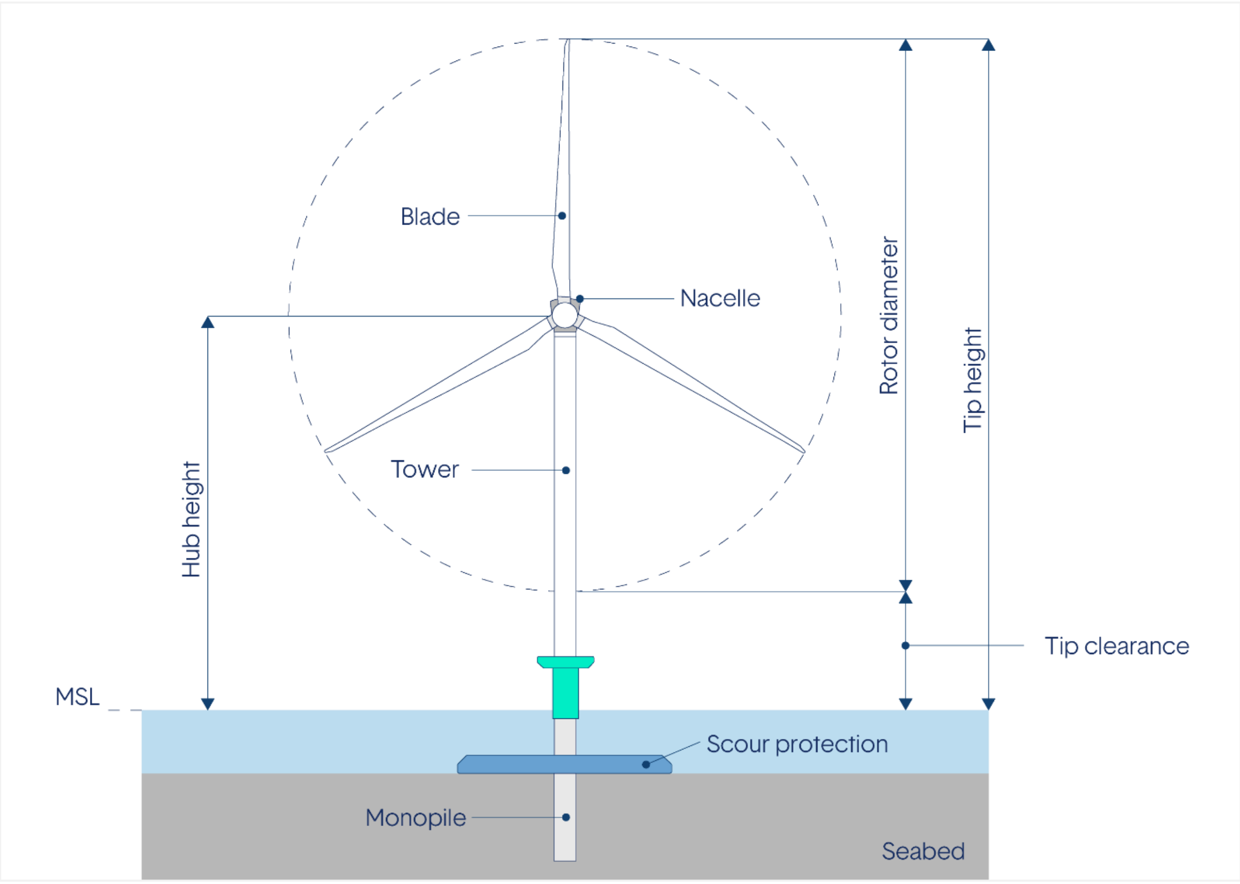


Fig. 2.2.1. Illustration of a typical WTG.

During the technical design phase, based on the developer's data and refined wind speed parameters, the most suitable WTGs will be selected, and their physical and technical specifications will be clarified, including their capacity, without exceeding the parameters specified in Table 2.2.1.

All turbines in the OWF will be connected via cables to an OSS, from which the OWF will be linked via offshore and onshore export cables to the existing onshore electricity transmission system – the 330 kV "Darbėnai" switchyard, located at Žyneliai village 9, Darbėnai Eldership, Kretinga District Municipality.

The electricity transmission system for "Area D" both at sea and onshore will also be connected to the existing onshore electricity transmission system – the 330 kV "Darbėnai" switchyard, located at Žyneliai village 9, Darbėnai Eldership, Kretinga District Municipality.

2.2.1. Wind turbines

A WTG is a facility that converts wind energy into electrical energy. The wind turns the turbine blades, which rotate the rotor and the main shaft. Depending on the type of turbine, these rotations are increased by a gearbox connected to a generator, which converts the wind energy into electricity.

The main components of a WTG include:

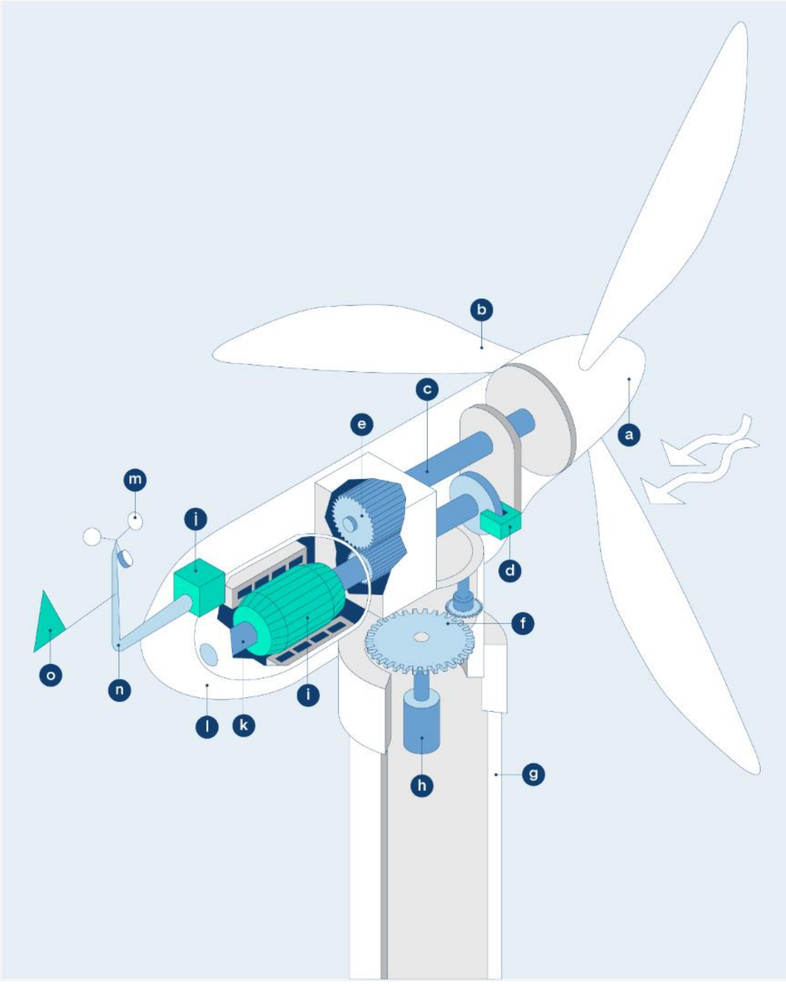


Fig. 2.2.2. Structure of a wind turbine: a – rotor, b – blade, c – low-speed shaft, d – brakes, e – gearbox, f – yaw drive, g – tower, h – yaw motor, I – generator, j – controller, k – high-speed shaft, l – nacelle, o – wind vane, m – anemometer.

- **Foundation**. This is the structure embedded into or on the seabed on which the wind turbine tower is installed and to which the OWF's cables are connected.
- **Tower**. A tubular steel structure housing the switchgear (depending on the design, the switchgear could also be in the foundation), service lift, and cable ladders used to route the 66 kV cables from the transformer in the nacelle down to the switchgear at the base. Various work platforms are installed for assembly and maintenance. The tower base includes an access door for technical staff conducting maintenance and repairs.
- **Nacelle**. Mounted atop the tower, the nacelle contains key components such as the main shaft or gearbox (depending on type), generator, transformer, blade pitch system, and control equipment.
- **Rotor**. The rotor consists of a hub with three attached blades. It is connected to the gearbox or main shaft in the nacelle, which drives the generator and converts the rotational energy into electricity.

2.2.2. WTG foundation structures

The selection of a specific type of wind turbine foundation depends on several parameters, the main ones being the size of the turbine, seabed conditions, water depth, and hydrodynamic conditions. For wind turbine installation, either monopile (with transition pieces), jacket type or gravity-based foundations are considered.

Monopile (hereinafter – MP) foundation structures are used at depths of up to 50 meters. The piles are driven into the seabed until the required penetration depth is reached, which depends on the type of wind turbine, pile diameter, geological and hydrodynamic conditions. This type of foundation has the smallest seabed footprint, but the pile-driving process generates noise. While the impact is temporary, the high intensity and broad propagation during foundation installation can significantly affect marine organisms that use hearing for communication. Due to the nature of the structure, local seabed scouring may occur, and the foundation itself can act as an artificial reef for marine life.

A jacket foundation can have three or four corner piles. The structure itself is a lattice structure, making it suitable for depths ranging from 30 to 80 meters. It features lower wave-induced loads (compared to monopiles). This is a highly reliable but expensive design, more commonly used for offshore platforms and thus potentially suitable for OSS installation.

A gravity-based foundation (hereinafter – GBF) is made from steel-reinforced concrete and is significantly heavier than MP or jacket foundations. To ensure stability on the seabed, GBF is designed with a large circular base featuring hollow chambers that can be filled with extra ballast once the structure is positioned on the seabed using a crane. Preparatory work involves levelling the seabed to ensure the stability of the foundation.

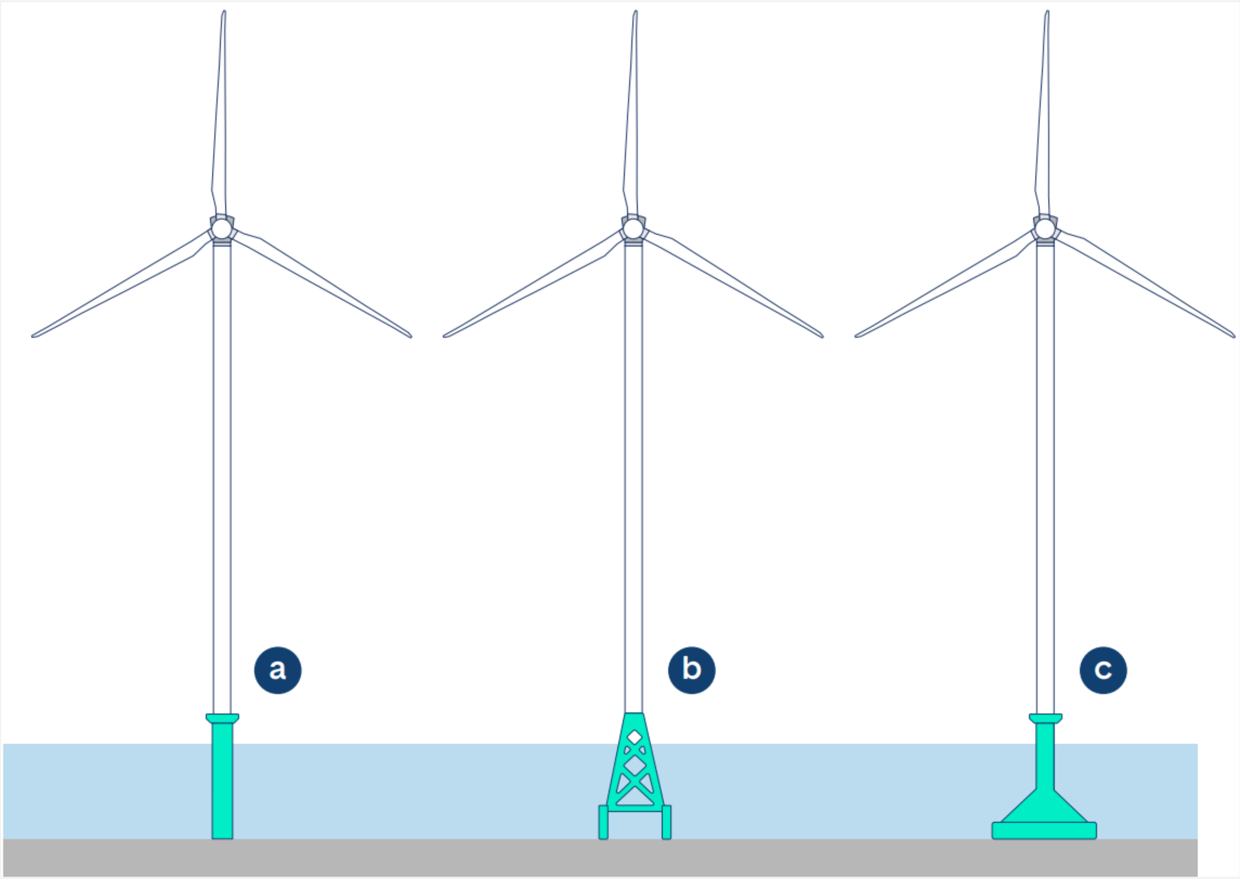


Fig. 2.2.3 Types of foundations: a – monopile, b – jacket, c – gravity based.

The type of WTG's foundation will be selected by the developer following geomechanical investigations carried out during the technical design phase of the OWF. The choice of foundation type determines the area of natural substrate that will be affected during installation and influences the extent of local hydrodynamic changes in the selected area. The characteristics of the most used WTG foundation types are detailed in Table 2.2.2.

Table 2.2.2. Characteristics of WTGs foundation types

Parameters	Value
MP	
Foundation dimensions	MP bottom diameter: 9.0–11.0 m MP upper diameter: 7.0–9.0 m MP length: 45.0–100.0 m MP weight: up to 2,900 t
Embedding depth into seabed	15.0–45.0 m
Seabed footprint	63.0–95.0 m^2
Installation methods, including pile driving program and other works (e.g. pile driving duration)	Pile driving and/or combined drilling-driving Possible installation duration (including preparatory and finishing works and pile driving): 6–7 hours (2–3 hours of actual pile driving per location).

Parameters	Value
Boulder clearing methods (if applicable)	If necessary, the seabed along cable routes and at foundation locations is cleared of boulders using a plough. Individual large boulders, if required, are removed using a remotely operated grab from a vessel or with remotely operated vehicles (hereinafter – ROVs)
Jacket foundations	
Foundation dimensions	Distance between foundation piles: 24.0–30.0 m Foundation pile diameter: 2.0–4.0 m Jacket pile length 35.0–47.0 m Top diameter 7.5–9.0 m
Embedding depth into seabed	30.0–50.0 m
Seabed footprint	500.0–1,200.0 m^2
Installation methods, including pile driving program and other works (e.g. pile driving duration)	Piling and/or drilling Possible pile installation duration: 2–3 hours continuously
Boulder clearing methods (if applicable)	If necessary, the seabed along cable routes and at foundation locations is cleared of boulders using a plough. Individual large boulders, if required, are removed using a remotely operated grab from a vessel or with ROVs.
Gravity Based Foundations	
Foundation dimensions	Foundation diameter: 45.0 m
Embedding depth into seabed	NA
Seabed footprint	~1,600.0 m^2
Installation methods	Preparatory work on the seabed includes levelling the seabed using a vessel to remove loose sediments from the upper layer. Once cleared, the area is covered with a layer of gravel to ensure stability.
Boulder clearing methods (if applicable)	If necessary, the seabed along cable routes and at foundation locations is cleared of boulders using a plough. Individual large boulders, if required, are removed using a remotely operated grab from a vessel or with ROVs.

2.2.2.1. Scour protection for foundation

Scour protection is planned to be installed around the MP foundations. This typically consists of a lower filtration layer made of stones with a diameter of 2–10 cm, and an upper protective layer composed of stones with a diameter of 10–75 cm. Depending on the hydrodynamic environment, the thickness of the first protective layer can reach up to 0.5 m, and the diameter of the affected seabed area can extent up to 40.0 meters. The size of the scour protection installed around the gravity foundations is 65.0 m. The thickness of the upper protective layer can range from 0.5 to 1.2 m, and the diameter of the occupied bottom area can be up to approximately 40.0 m, or in the case of gravity foundations, 62.0 m. In some cases, a single-layer scour protection system may be used. A typical scour protection around a monopile foundation is shown in Fig. 2.2.4, with key dimensions and volumes summarized in Table 2.2.3.

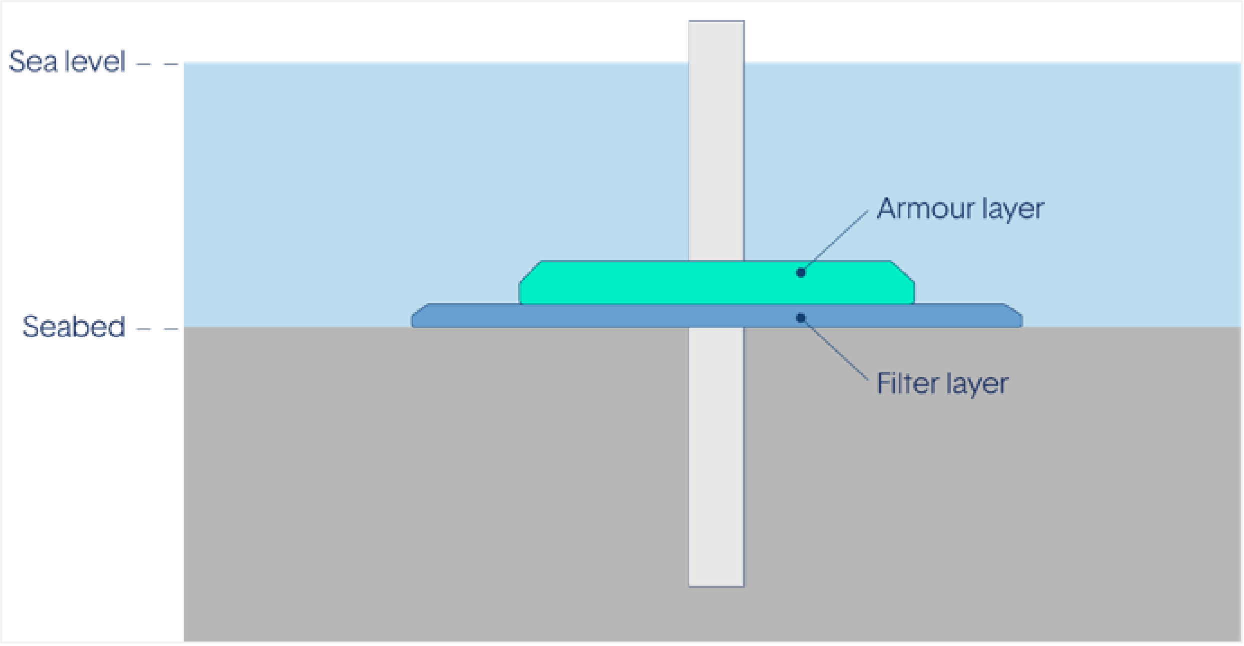


Fig. 2.2.4. Illustration of a typical protection layer for a monopole foundation.

To enhance scour protection, geotextile bags filled with gravel or stones may be used.

Table 2.2.3. Main dimensions and volumes of MP foundation and GBF scour protection

Foundation	Parameters
MPs	
Seabed area occupied by scour protection per foundation (m^2)	1,590.0
Volume of scour protection per foundation (m^3)	2,385.0
GBFs	
Seabed area occupied by scour protection per foundation (m^2)	3,318.0
Volume of scour protection per foundation (m^3)	4,977.0

If it turns out that scour protection is also necessary for jacket foundations, it would be significantly smaller (approximately 5 times less) than that used for a MP foundation.

2.2.3. OSS

The OSS is designed to receive, transform, and transmit the electricity generated offshore to the onshore grid. Electricity generated by the WTGs is transmitted to the OSS via Inter Array Cables (hereinafter – IAC), which are routed from the seabed through J-tubes installed on the substructure to the topside of the OSS. The IAC are distributed and led through a cable joints located on the cable deck to the 66 kV Gas Insulated Switchgear (hereinafter – GIS). From the GIS, electricity is transmitted to the main transformers (220/66 kV) and auxiliary transformers (66 kV/400 V), where it is transformed for both export to the mainland and to power internal systems of the OSS.

To install the OSS, substructure including piles and topside are fabricated in a dedicated yard onshore and then transported to its offshore location. The substructure is then placed on its final location using a heavy lift vessel that will then place the topside on top of the substructure.

Fig. 2.2.5. East Anglia OSS.

The main components of the OSS include electrical transformers, switchgear, backup generators, personnel quarters, water tanks, electrical cables, and a control and/or monitoring system. The OSS will also be equipped with navigational and aviation safety lighting, a fire detection and suppression system, a rainwater and oil separator, and a communication antenna.

Although the OSS platform will be remotely operated, it is designed to accommodate personnel conducting inspections and maintenance (without overnight stays). It is anticipated that up to 12 workers could be present, so the design will include access to the OSS platform and safety measures for routine and emergency situations. For routine and scheduled maintenance, access to the OSS will be possible via a Crew Transfer Vessel (hereinafter – CTV) or a special Walk-to-Work (hereinafter – W2W) gangway. In case of emergencies and/or adverse weather conditions, the OSS design will include an emergency shelter and a helicopter winch area on the roof deck.

In the event of an unplanned disconnection from the onshore transmission grid or emergency situations, the OSS will be equipped with an emergency diesel generator and/or auxiliary diesel generator for power supply, as well as an Uninterruptible Power Supply (hereinafter – UPS).

Due to the use of transformers, a diesel generator, and a diesel tank, there is a potential risk of oil spills. To ensure any leaked fluids are collected and do not enter the marine environment, the OSS will be equipped with a drip collection system, oil-water separator, and a closed drainage system.

Table 2.2.4. Information about the OSS

Parameter	Value
Information about the OSS: potential location, capacity (MW)	The OSS location is planned within the perimeter of the OWF lease area. The exact location will be determined during the electrical system design stage, once the optimal components of the OWF, its layout, and the export cable route have been established. The installed capacity, based on the letter of intent signed with the TSO AB “Litgrid,” is 700–740 MW.
Platform length	Up to 60 m
Platform width	Up to 50 m
Maximum height above mean sea level	75 m

Parameter	Value
Minimum height above mean sea level	19.5 m
Possible foundation type	Jacket, GBF or monopile, depending on platform size, weight, and water depth (to be clarified in later project stages).

The topsides of OSS's are typically installed on substructures similar to foundations used for WTGs, which may be either MP, jacket type or gravity, depending on the size of the OSS and the seabed depth at the location of OSS.

2.2.3.1. Scour protection for OSS foundation

For jacket foundations, scour protection is typically not applied. If it is found to be necessary, it will consist of a lower filtering layer (~0.5 m thick) of 5–10 cm diameter gravel and an upper protective layer (~0.5–1.2 m thick) of 10–50 cm diameter gravel. Depending on the hydrodynamic environment, the filter layer will be approximately 0.5 m thick. It is estimated that up to 5,000 m² of seabed area may be required in total. In case the jacket foundations are used, no scour protection is usually applied.

2.2.4. Electricity transmission solutions

The OWF's electrical infrastructure is a critical component that ensures the efficient transformation and transmission of generated electricity to the national grid operated by TSO Litgrid AB. This network consists of subsea and underground cables, step-up transformers, and substations strategically located to optimize performance and minimize environmental impacts.

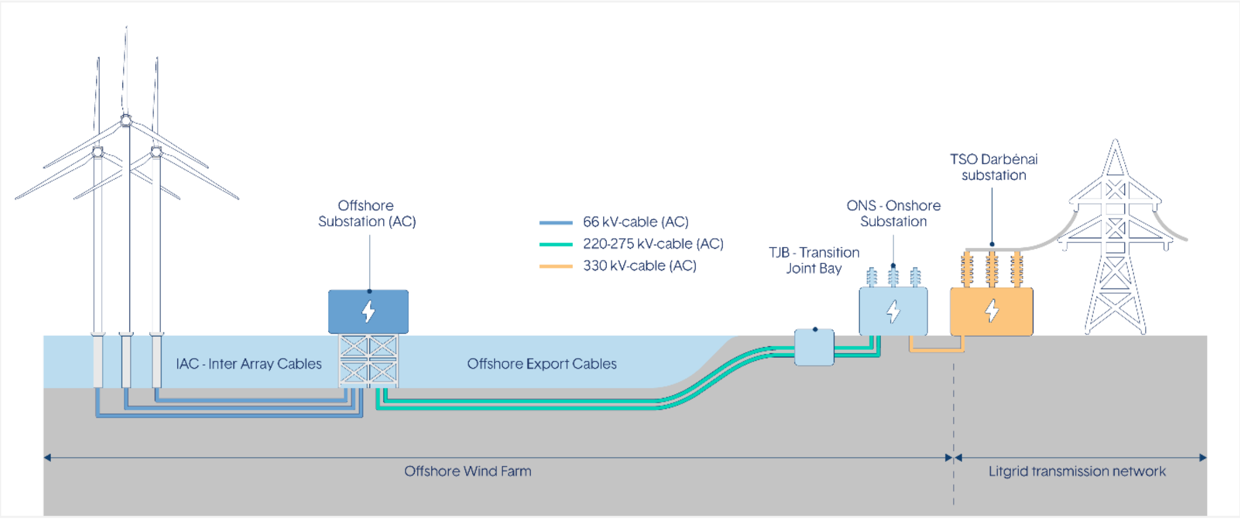


Fig. 2.2.6. General scheme of transmission of electricity generated by OWF to onshore networks.

Submarine cables are used in seas and oceans for energy transmission and communication purposes.

Table 2.2.5. OWF's electricity export cables

Parameter	Value
OWF IAC: type, voltage, length, other specifications	The 66 kV three-core cable, featuring integrated optical fibre, is designed to interconnect all WTGs to the OSS. This cabling solution ensures both efficient power transmission and robust data communication. The precise cable length will be finalised upon completion of the WTG array layout and determination of the number and strategic locations of OSS.
Transmission (export) cable: type, voltage, length, other specifications	The export cable connects OSS and onshore substation (hereinafter – ONS). At sea, two 220 kV or other voltage three-core cables with optical fibre are planned, while onshore, single-core cables should be utilised. The preliminary route length from the CN OWF's OSS to the landfall is approximately 48.25 km, and from the landfall to the planned connection point at the "Darbėnai" substation is about 14.30 km. The preliminary route length from the northern corner of "Area D" to the landfall is around

Parameter	Value
	38 km, and from the landfall to the planned connection point at the “Darbėnai” substation is about 13.9 km.
Possible cable laying methods	Several technological solutions are viable for cable installation, including trenching, horizontal directional drilling (hereinafter – HDD), and employing specialised mechanical protections to shield cables on the seabed. For intersections with existing marine cables, onshore networks, rivers, and other features, specific approaches will be determined during later stages of project development, considering seabed and surface conditions, selected technologies, and constraints identified in the EIA. On agricultural land, cables will be laid using open trench methods, whereas in designated areas, closed (trenchless) technologies will be employed (see Section 2.1.5).

2.2.5. Export cable laying technology

2.2.5.1. Technological cable laying solutions at sea

2.2.5.1.1. Inter-array cables

The WTGs and the OSS will be interconnected using three-core cables laid on the seabed. The cross-section of each core will range from 430 to 1,000 mm², contingent upon the cable's distance to the OSS and the requisite strength specifications. Cables nearest to the OSS, which connect the largest number of WTGs, will have the largest diameter, while those farther from the OSS, connecting fewer WTGs, will have the smallest diameter.

Table 2.2.6. Typical specifications and dimensions of 66 kV IAC

Parameter	Value
Approximate total cable length (km)	100–135
Cross-sectional area (mm^2)	430–1,000
Cable material	Aluminium and/or copper
Diameter (mm)	115–210
Weight in air (kg/m)	20–70

Cables will be transported in continuous lengths loaded from manufacturers facilities onto turntables/cable tanks onboard the installation contractors’ vessels. During installation, additional vessels will provide support, including: an Offshore Support Vessel (hereinafter – OSV), CTVs, Trenching Support Vessel (hereinafter – TSV), and Anchor Handling Tug Supply (hereinafter – AHTS) Vessel.

Prior to cable installation, preparatory seabed works will be conducted. The route will be cleared using specialised equipment, such as a pre-lay grapnel run (hereinafter – PLGR), to remove debris like old wires and fishing nets. Boulders, if present, will be relocated using a combination of ploughing and grabbing operations. Boulders with a diameter of 0.3 m or greater will be moved beyond the planned cable route to adjacent areas.

The cables connecting the WTGs and the OSS will typically be buried 0.3 to 1.2 metres into the seabed. During the technical design phase, seabed survey data will determine the necessary cable protection requirements. Continuous monitoring throughout the work will ensure the seabed conditions do not exhibit dynamic formations, and assessments will be conducted to ascertain if additional measures are necessary to level the route or deepen the cable installation area, thereby ensuring cable integrity during installation and operation. Based on current data, it is estimated that approximately 10% of all cable routes will require additional interventions, such as:

- Seabed deepening, excavation, or levelling to reduce seabed formations.
- Trench excavation and subsequent backfilling after cable laying.

In areas with complex seabed conditions requiring trenching, specialised equipment such as ploughs, mechanical cutters, or water jetting devices operated remotely via ROVs from the cable-laying vessel may be employed.

Cable laying operations commence with the cable-laying vessel lowering the first end of the cable from the turntables/tanks onto the seabed and pulled into the foundation using a J-tube. The vessel then progresses towards the next WTG foundation, continuously deploying the cable onto the seabed into a pre-prepared trench or directly on the surface. Upon arrival at the second location, the cable is cut to the required length and pulled into the WTG foundation.

It is anticipated that cables will be protected by burying them using an ROV equipped with a jetting tool and/or mechanical cutter. The jetting tool employs water pumps to channel water through nozzles, lifting sediments on both sides of the cable, while the mechanical cutter uses a cutting head to dislodge sediments directly beneath the cable. During jetting, the ROV moves forward, positioning the cable into the trench. The cable will be buried between 0.3 and 1.2 m deep (subject to seabed conditions). The width of the seabed affected by the jetting tool varies with seabed conditions, being approximately 1 m in clayey sediments and 2 m in sandy sediments.

These methods ensure robust protection and reliability of the cable infrastructure, accommodating the diverse seabed conditions encountered within the OWF.

Depending on specific seabed conditions, cables within the OWF may remain unburied. In such instances, protection is provided by covering the cables with rocks, gravel bags, or concrete mattresses.

The preliminary duration for installing the OWF cables is estimated to be approximately 6 months, excluding potential delays caused by adverse weather conditions.

2.2.5.1.2. Export cable (submarine export cable from OSS to the shore)

Electricity from the OSS will be exported via two high-voltage (220 kV) alternating current (hereinafter – AC) submarine export cables. These cables will be connected to two high-voltage (220 kV) onshore export cables through transitional joints. The submarine export cables will be installed parallel to each other within the cable connection corridor.

The submarine power export cable is planned to be a three-core type, featuring aluminium or copper conductors with specialised insulation. Each export cable will include an integrated optical fibre cable (see Fig. 2.2.7).

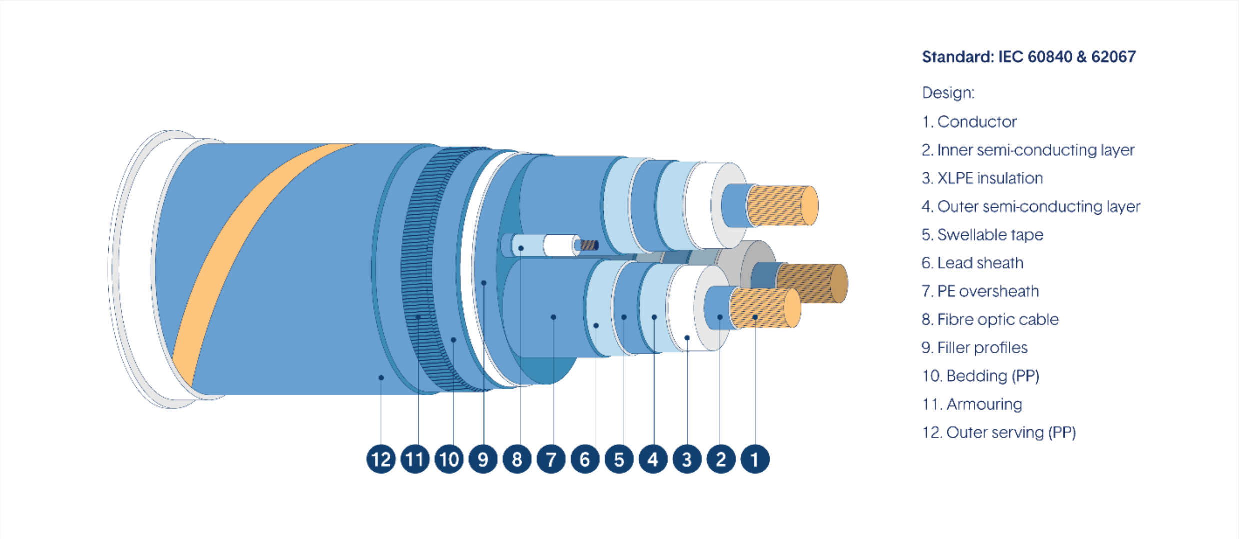


Fig. 2.2.7. Structure of a typical submarine power cable.

Prior to commencing cable laying operations, preparatory work will be undertaken, including engineering surveys, selection of cable routes and laying methods, seabed clearance along the route, and preparation of intersections with existing communications.

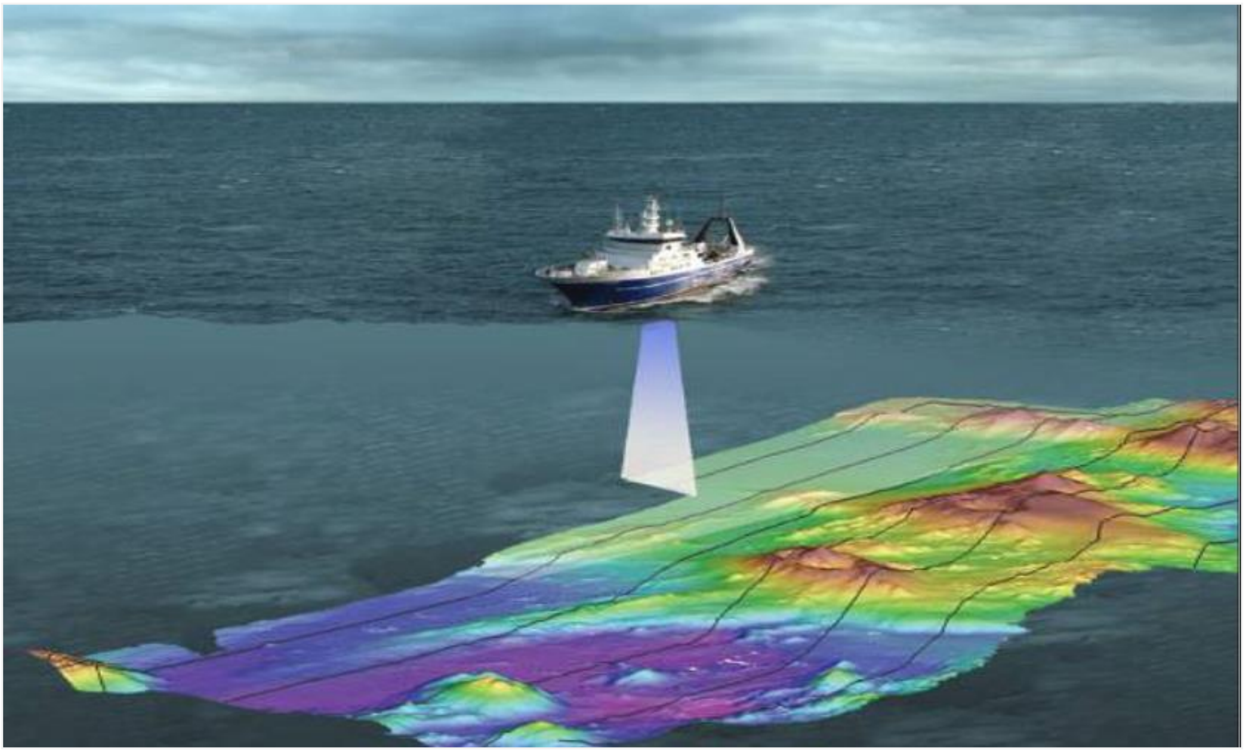


Fig. 2.2.8. Seabed research (Source: "About Submarine power Cables – 2006–2011 International cable Protection Committee Ltd.).

Export cable will be transported to the OWF site using specialised cable-laying vessels. During installation, additional vessels will provide support, including: OSV, CTV, TSV, and AHTS Vessels.

Intersections with other subsea objects will be managed by installing a protective layer over the third-party assets. The OWF export cable will then be laid atop this protective layer, with additional protection and/or stabilisation applied as necessary over the laid connection cable. The intersection design will be selected in consultation with the third-party property owner and will typically consist of stone formwork and/or concrete mattresses.

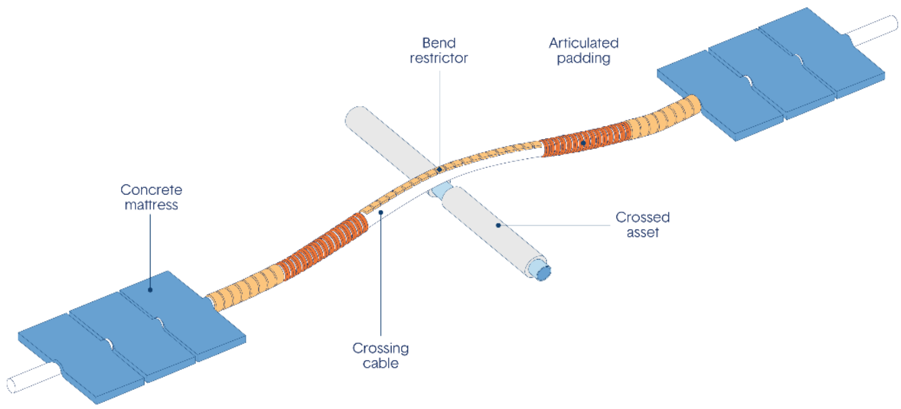


Fig. 2.2.9. Typical cable laying over infrastructure objects (source: Guidelines for safe cable crossing over a pipeline – Ahmed Reda).

The installation of the export cable at sea will follow a similar process to the installation of IAC within the OWF. The installation vessel will commence laying the cable from the shore-based HDD exit point, progressing along the seabed towards the OSS. The cable will be installed either through simultaneous laying and burial using a plough, jetting, and/or cutting techniques, or by laying it on the surface followed by subsequent burial. This burial can be achieved through jetting, cutting, or placing the cable into a pre-prepared trench, followed by burial using jetting, cutting, and/or dredging with a controlled flow.

Prior to cable laying, seabed preparation will be undertaken. The route will be cleared using specialised equipment, such as a PLGR, a device dragged along the seabed to snag and remove debris like old wires or fishing nets. If necessary, boulders will be relocated using a combination of ploughing and grabbing operations. Boulders with a diameter of 0.3 m or more will be moved beyond the planned cable route to adjacent areas.

It is preliminarily planned that the cables will be buried 0.3 to 1.2 m into the seabed (depending on the conditions). The target burial depth will be determined by assessing seabed conditions, its mobility, and the interaction risk with external threats, such as fishing gear and ship anchors. Other factors, including maintained shipping lanes, safety, and thermal conductivity, will also be considered. Prior to construction, a Cable Burial Risk Assessment (hereinafter – CBRA) will be prepared. If cables cannot achieve the target burial depth or intersect existing infrastructure, potential protective measures include rock dumping, concrete mattresses, or gravel/rock bags. Following cable installation, surveys will be conducted to verify whether the desired burial depth has been reached. During operations, monitoring will ensure that survey data do not indicate dynamic seabed morphology, and continuous evaluation will determine if additional measures are necessary to level the route or deepen the laying site to ensure cable integrity during installation and OWF operation. Based on current data, it is estimated that approximately 20% of all cable routes will require additional intervention, such as:

- seabed deepening, excavation, or levelling to reduce the extent of formed seabed features
- trench excavation and subsequent backfilling post-laying.

Cable laying and protection methods will be selected during the design phase based on seabed conditions, employing techniques such as trenching in shallow waters, trench formation using a dredger, ploughing, or high-pressure water jetting. Following cable installation, the setup will be evaluated, and protective measures will be implemented at marine cable crossings with other utilities. Shoreline ducts with inserted cables will be filled with thermally conductive material and testing will be conducted to ensure the integrity and functionality of the installation.

Fig. 2.2.10. Examples of offshore cable laying technologies.

In the engineering infrastructure development plan being prepared for the connection installation, it is anticipated that the minimum width of a cable corridor for connecting a single OWF to onshore grids – including designated potential repair zones and 100-metre protection zones on both sides of the cables, as mandated by the Law on Special Land Use Conditions – will range from 624 m in the deepest area (approximately 35 m depth) to 440 m in the shallowest area (less than 15 m depth). In locations where the installation of potential repair zones is not possible or feasible – due to proximity to other infrastructure objects or along the HDD section – the minimum assessed corridor width is reduced to 360 m.

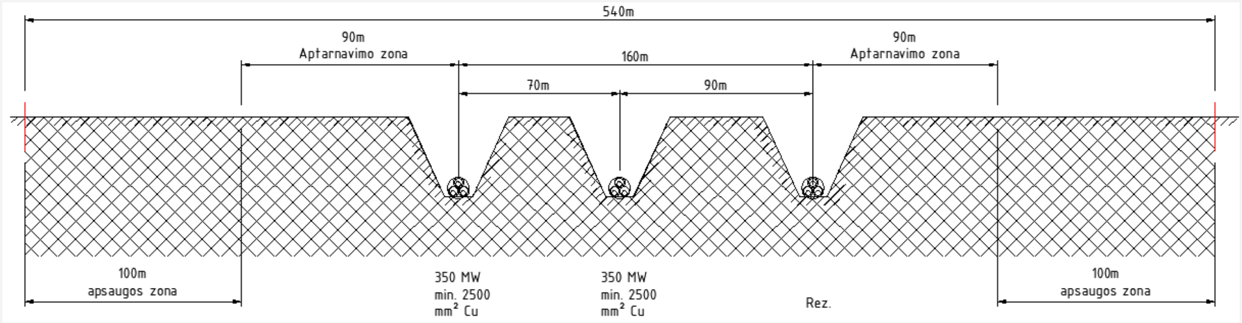


Fig. 2.2.11. Example of a profile of the offshore export cable corridor (according to the SEA report of the Engineering Infrastructure Development Plan).

2.2.5.1.3. *Cable trenchless landfall*

For cable installation in the Lithuanian coastal zone (landfall from the sea, see Fig. 2.2.12), a trenchless installation method is planned, specifically employing HDD. This advanced technique utilises specialised machinery to drill underground tunnels of the necessary diameter, allowing for the insertion of cables and pipes of suitable dimensions (see Fig. 2.2.13). During drilling operations, the operator can precisely control the borehole's trajectory and depth through sensor technology. HDD is capable of achieving trenchless sections ranging approximately from 300 to 1,200 m in length.

It is anticipated that the trenchless installation method will be applied when crossing the Būtingė Geomorphological Reserve (coastal zone), the Šventoji River and its valley on the mainland, and as needed for linear infrastructure objects such as oil pipeline and national roads.

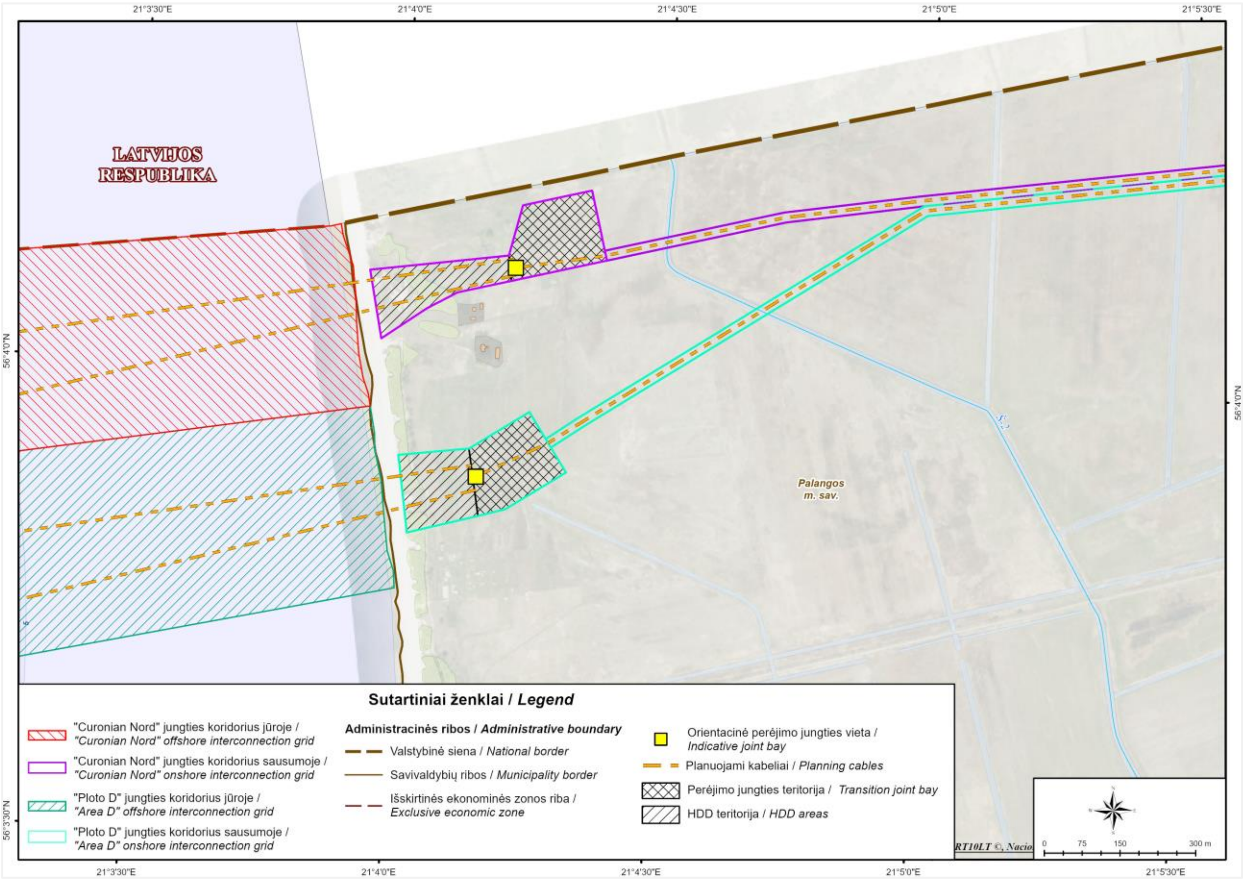


Fig. 2.2.12. Landfall area for the connection cables of the CN and "Area D" OWF.

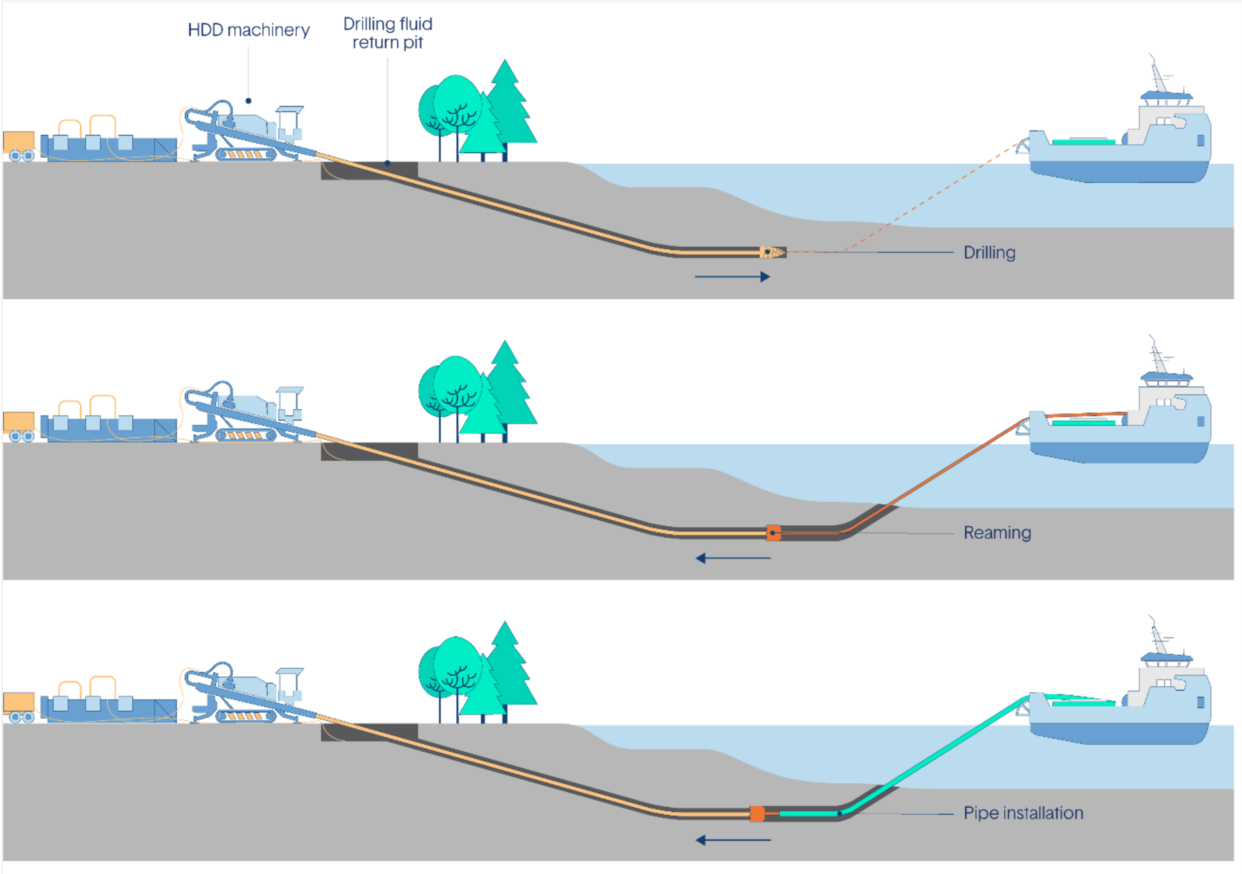


Fig. 2.2.13. Schematic diagram of a typical HDD (horizontal directional drilling) technology (source https://www.linkedin.com/company/coffeeoffshore/).

The work performed by HDD equipment can be divided into three main stages:

1. Pilot drilling – this initial stage is carried out using a special conical drill head equipped with an integrated transmitter. The hollow body of the drill head is attached to spring steel rods, ranging from 600–4,600 mm in length and 34–125 mm in diameter, connected by threaded joints. This configuration allows for precise adjustment of the tool's trajectory and navigation around underground obstacles in any direction. The drill head is designed with holes through which a special fluid composed of 95% water and 5% bentonite (a natural clay), is pumped into the borehole. The fluid is recycled on-site and reused in the process. It reduces friction, cools the tools, prevents borehole collapse, fractures rock, and cleans the borehole by transporting debris to the surface. Pilot drilling concludes when the drill head emerges at the designated exit point.
2. Borehole enlargement. The second stage involves using a special reamer, which moves in the opposite direction to the drill head, i.e., toward the HDD equipment. This process is repeated until the borehole is widened to the required diameter, usually 20–50% larger than the diameter of the pipe to be pulled through.
3. Pipe insertion – in the final stage, the pipe or casing is inserted into the borehole. The pipe is pulled into the borehole by the reamer, connected via swivel joint.

This method necessitates setting up a construction site onshore (see Fig. 2.2.14) to mobilize the drilling equipment, utilize and recycle bentonite- and clay-based drilling fluids, and store cable conduits if needed. The land area needed for welding and storing HDD pipes during construction is typically the pipe's length plus an additional 10%.

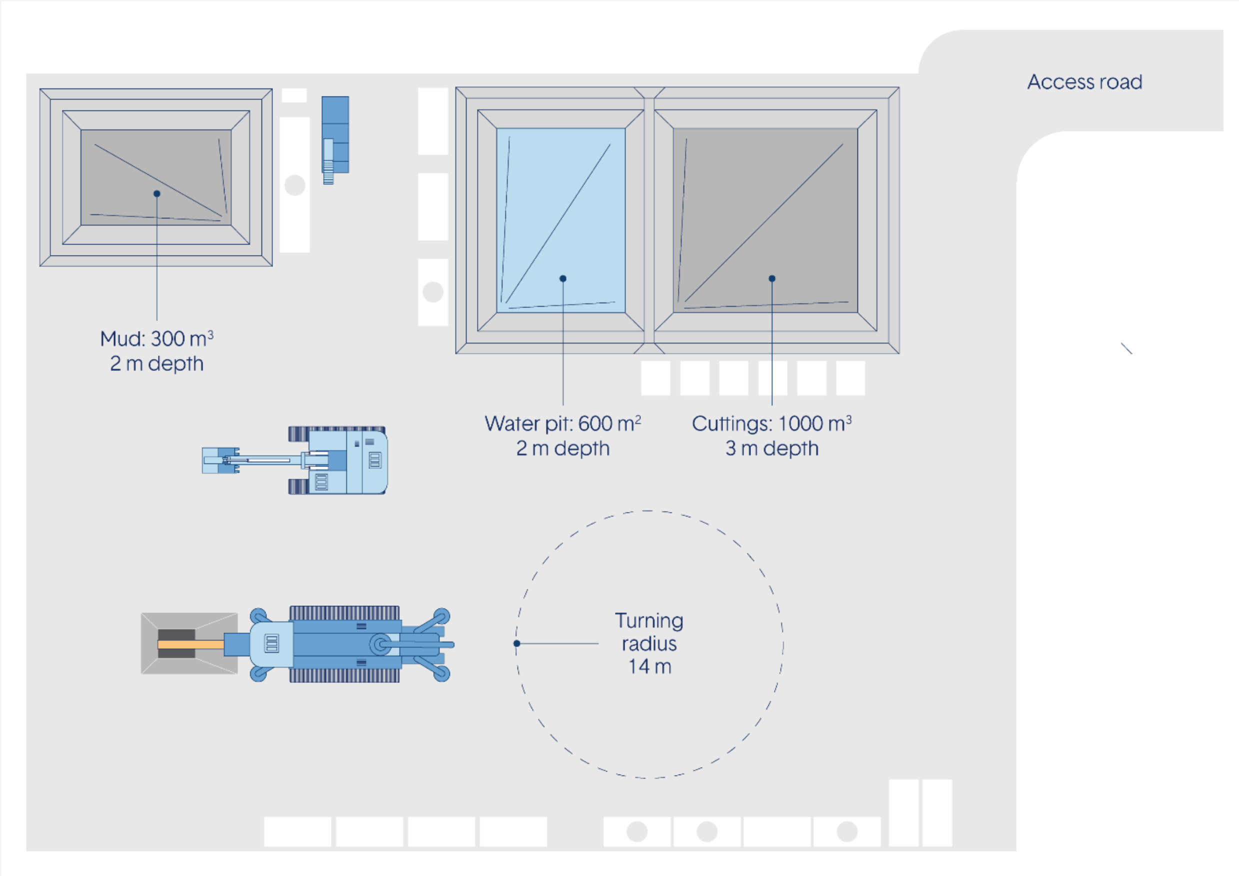


Fig. 2.2.14. Typical HDD work site, installed in the coastal zone.

The connection of subsea cables to onshore cables is planned at a transition joint, which offers a stable, clean, and safe working environment for cable connection. Typically, the transition joint is installed just beyond the beach zone to minimise the distance over which the export cables are routed on land. This approach helps reduce the tension on the subsea cable as they are brought ashore.

It is anticipated that each cable will require up to 100 m² of space for the transition joint, which will measure approximately 5 m wide, 20 m long, and 2.5 m deep. Each transition joint will be constructed from a reinforced concrete base with concrete walls, featuring a removable cover (see Fig. 2.2.15).

Fig. 2.2.15. Illustration of a typical transition joint (source: https://ccsbestpractice.org.uk/entries/prefabricated-joint-bays/).

Advantages of HDD technology:

- Autonomous drilling equipment eliminates the need for external energy sources.
- Avoidance of costly additional works, such as drainage, shoreline reinforcement, and blasting.
- Existing infrastructure, including roads, railways, and vegetation, remains intact, eliminating restoration costs.
- Preservation of the natural landscape with minimal technogenic impact on vegetation, fauna, and the environment.

2.2.5.2. Technological solutions and corridor widths for power line installation on land

Onshore cable laying for the interconnection will include the following activities:

- Marking the cable line route.
- Installing pipes at designated project locations using trenchless techniques.
- Excavating a trench while preserving topsoil.
- Installing a sand bedding for cables at designated locations.
- Installing pipes at road and utility crossings and covering them with reinforced concrete slabs.
- Laying high-voltage AC cables, covering them with a layer of sand or fine-grained soil, ensuring several meters remain uncovered near terminations and joints.
- Installing terminal joints.
- Covering terminal and joint areas with sand or fine-grained soil and compacting.

- Backfilling the trench with mineral soil and compacting.
- Spreading topsoil over the levelled surface.
- Conducting tests according to manufacturer requirements and relevant standards.
- Connecting cable lines to existing bays in the “Darbėnai” substation.

After earthworks, the ground level must be restored to pre-construction levels or adjusted according to project specifications. Excess soil that cannot be reused on site must be removed.

The Infrastructure Development Plan for the interconnection specifies a 20-meter-wide corridor for laying the underground cables of the OWF onshore. Cables will be installed to ensure that the protection zone remains within the planned 20-meter-wide corridor.

Cable installation work in the onshore area is anticipated to last up to 16 months, excluding weather-related delays.

2.2.5.2.1. Interconnection cables from landfall to the 220/330 kV Pelėkiai Transformer Substation

It is planned that 220 kV (or other voltage) AC export cables will be laid from the OWF to the newly built Pelėkiai Transformer Substation onshore. Each interconnection will consist of 2 export cables, each containing 3 single-core cables, totalling 6 phases and/or cables per interconnection, plus 2 fibre optic cables. Joint manholes will be required approximately every 450 m (their exact locations and numbers will be determined during the detailed design phase following system studies).

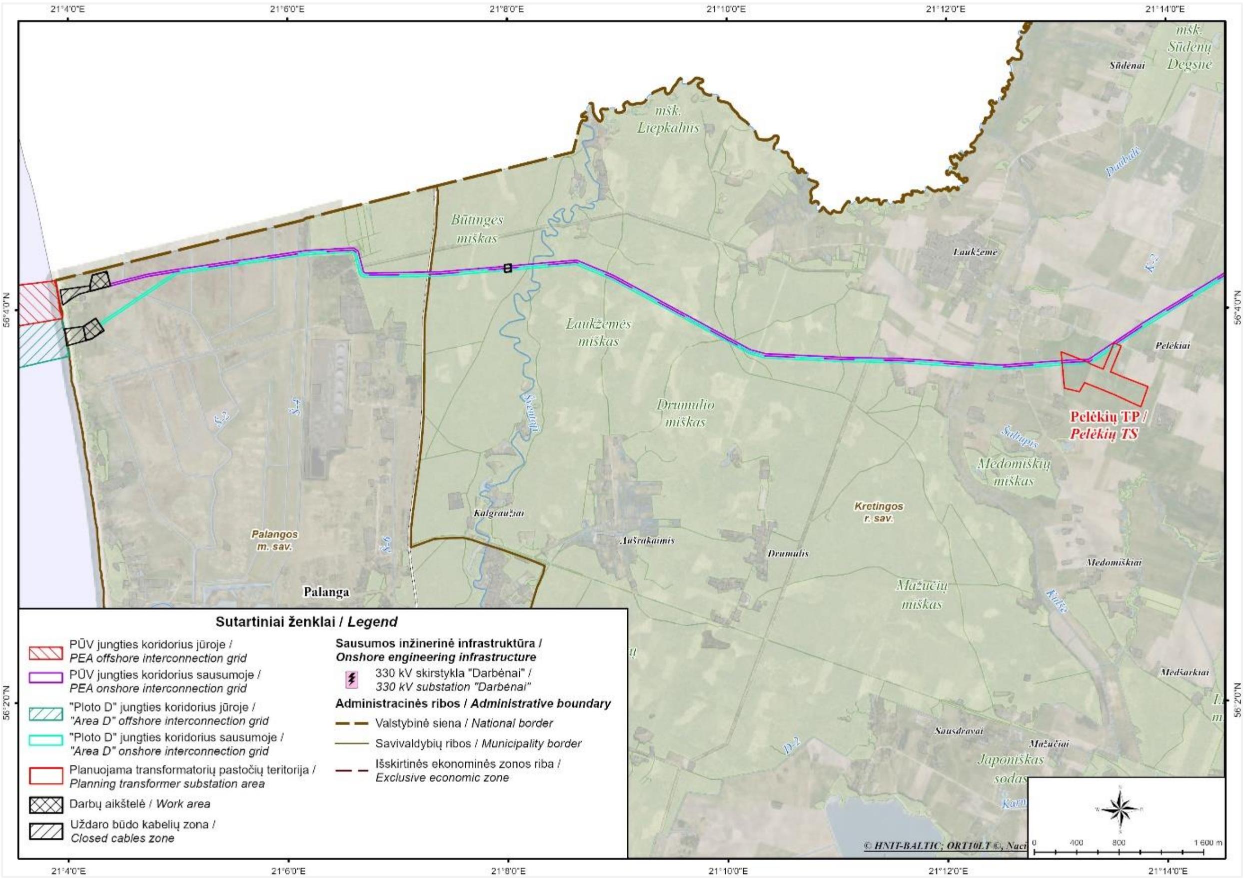


Fig. 2.2.16. Connection cable routes from the landfall area to the Pelėkiai Transformer Substation.

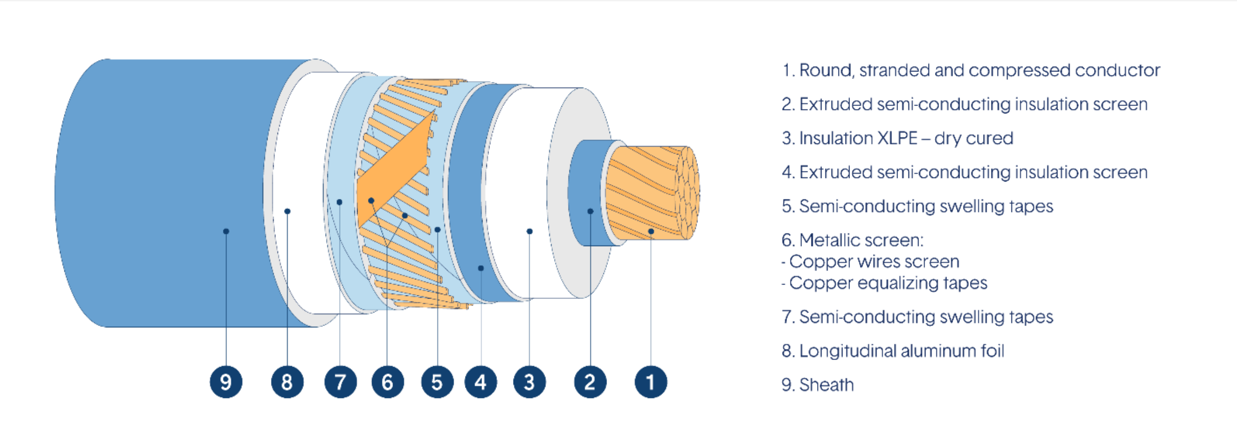


Fig. 2.2.17. Structure mainland electrical cable.

2.2.5.2.2. *Interconnection cables from the 220/330 kV Pelėkiai Transformer Substation to the Darbėnai switchyard*

It is planned that for each OWF interconnection from the Pelėkiai Transformer Substation to the existing Darbėnai switchyard will utilise two underground 330 kV cables (composed of 3 single strings each). These cables for one interconnection will be laid within a designated 20-meter-wide corridor. Along this section of the route, joint manholes will be installed approximately every 1 km. The precise number of joint manholes will be determined during the design phase, considering the cable's size, weight, diameter, and transport logistics.

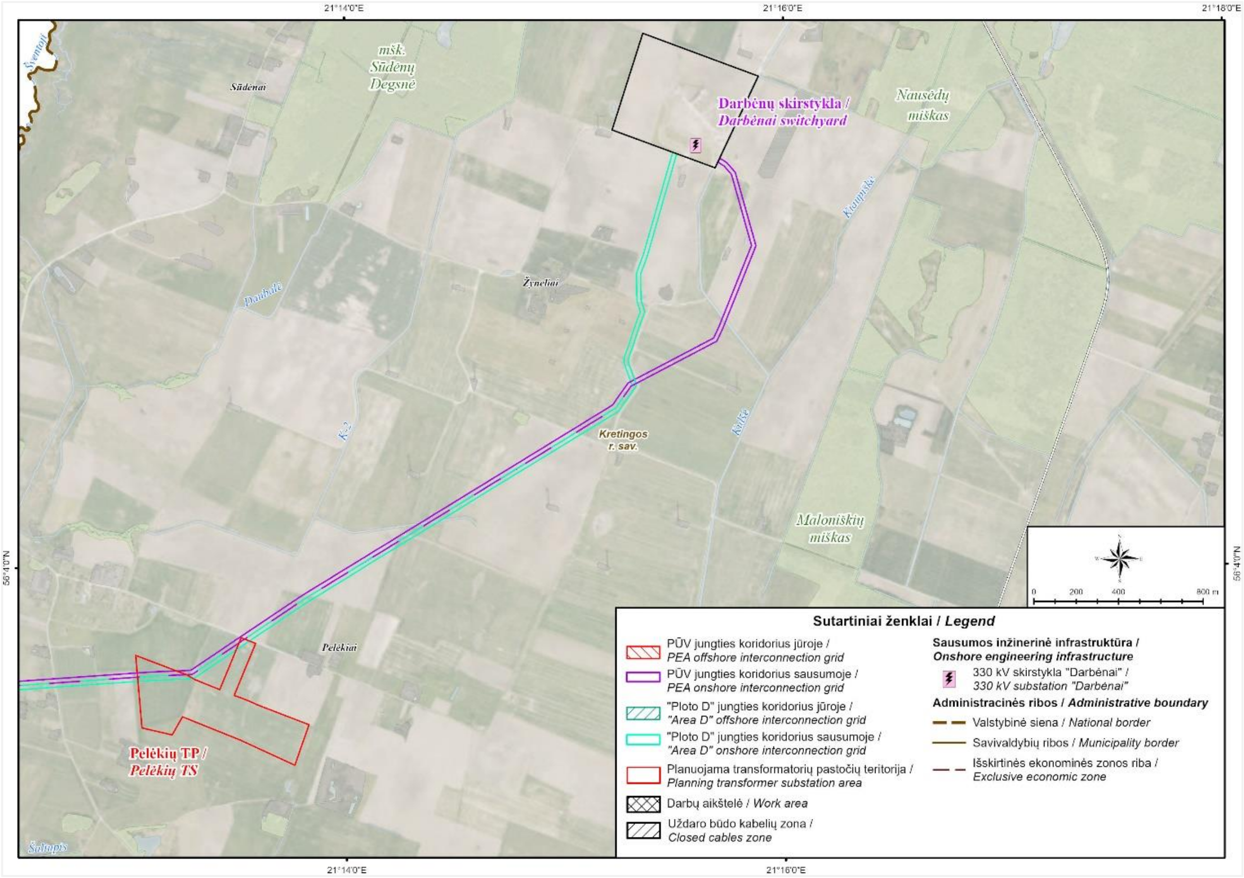


Fig. 2.2.18. Cable routes from the Pelėkiai Transformer Substation to the existing Darbėnai switchyard.

Export cables for a single interconnection from the 220/330 kV Pelėkiai Transformer Substation to the existing Darbėnai switchyard will comprise two sets of three single-core cables, made from insulated aluminium or copper conductors. Additionally, each cable system will include two optical fibre communication cable.

2.2.5.2.3. Open-trench installation of interconnection cables

The cables are planned to be laid using the open-trench method, except at crossings with existing infrastructure and the Šventoji River are encountered. In these areas, alternative installation techniques will be employed to ensure minimal disruption and protect sensitive environments.

Fig. 2.2.19. Cable laying using the open-trench method.

While alternatives of cable installation, and their configuration, within the open trench shall be defined during the design stage, example of preliminary specifications is as follows:

- Burial depth: the cable must be buried at a minimum depth of 1.5 m from the top of the cable, with a maximum depth of 2 m, except at intersection points.
- Base layer thickness: a minimum base layer thickness of 0.2 m is required to provide adequate support and protection for the cables.
- Fill thickness: the fill thickness above AC cables must be at least 0.2 m.
- Backfilling: excavated soil will be used to fully backfill the trench, when possible.
- Trench dimensions: the distance from the trench edge to the cable must be at least 0.2 m, while the distance between cables within the trench is approximately 0.4–0.5 m.

To facilitate cable installation and maintenance, connection pits will be installed approximately every 500 m along the cable route. These pits enable the pulling and joining of cable sections as needed. It is estimated that up to 40 connection pits will be required from the landfall to the Pelėkiai Transformer Substation, with 20 pits for each circuit. Each pit will cover an area of up to 65 m², measuring approximately 13 m long, 5 m wide, and 1.5 m deep.

For the technological alternative involving open-trench cable laying at the crossing with the Šventoji River, a tracked excavator equipped with a long-reach bucket will be used to form the trench. Temporary access roads and work sites measuring 20 m by 10 m will be constructed on both sides of the river. Given the Šventoji River's designation as part of the “Natura 2000” SAC, stringent mitigation measures to prevent significant environmental impacts will be implemented, such as strategies to capture and reduce the dispersion of sediments and debris during excavation, scheduling work to avoid fish spawning periods in the river, thereby minimising ecological disruption.

2.2.5.2.4. Cable laying using the trenchless method

In areas where open cable laying is unsuitable or impractical, cables will be installed using trenchless methods, such as HDD or other similar technologies. HDD involves the use of specialised drilling equipment, necessitating a work site of approximately 100 m² at one end of the operation. At the opposite end, a designated area is required for pulling and installing pipes, with its size contingent on the drilling length.

The HDD process begins with drilling from one side beneath the specified crossing point. As the drill is retracted, a protective conduit for the cable is simultaneously installed. Subsequently, the conduit housing the cable is filled with bentonite, which improves the heat dissipation and reduces the electrical resistance. This prevents overheating and ensures cables operate at their optimal capacity. The typical external diameter of these conduits ranges from 250 to 450 mm.

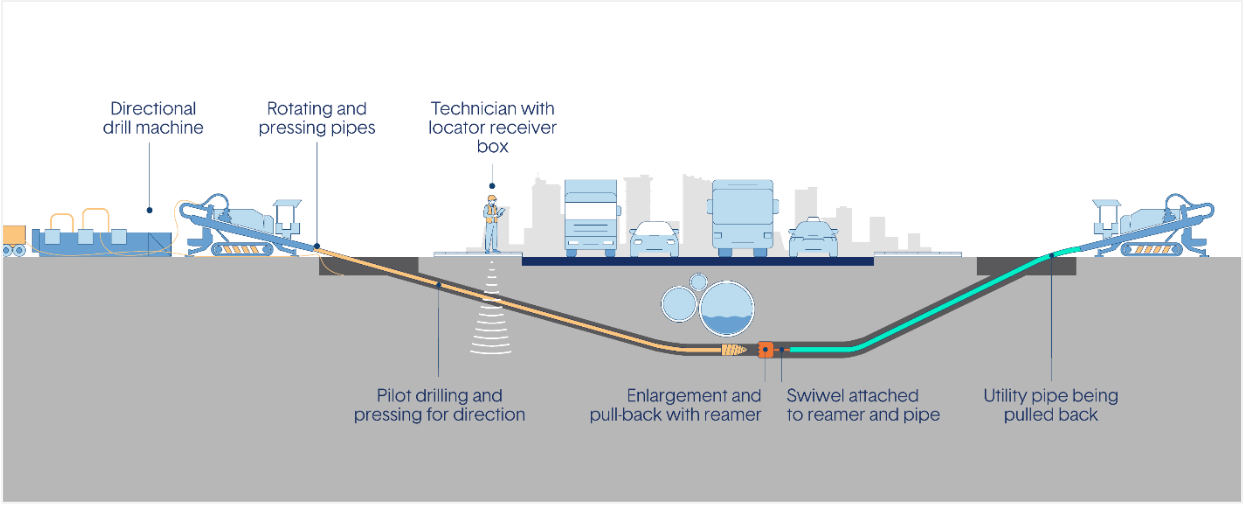


Fig. 2.2.20. Illustration of HDD technology.

Typically, trenchless underground boreholes range from 15 to 300 m in length, although longer sections can be drilled in exceptional circumstances. Boreholes beneath water bodies must maintain a minimum depth of 1 m below the waterbed to ensure stability and environmental safety.

Soil conditions are critical in determining the feasibility of underground drilling. To establish a suitable drilling profile, individual soil samples may be collected. Preliminary investigations are essential to ensure the safe execution of drilling operations and to mitigate the risk of blowouts, which occur when bentonite or drilling fluid surfaces above the drilling site.

2.2.6. 220/330 kV Pelėkiai Transformer Substations

A new 220/330 kV Pelėkiai Transformer Substation is planned for each connection, approximately 4 km from Darbėnai, at the location designated as Pelėkiai, Darbėnai Eldership, Kretinga District Municipality.

The Pelėkiai Transformer Substation is preliminarily estimated to occupy up to 10 hectares. However, the precise area required for the substation, its related infrastructure, and access roads will depend on the specific shape of the location, which impacts the layout and technical solutions selected by the developers.

The EIA evaluates the territory for Pelėkiai Transformer Substation installation, which falls within the areas designated in the Engineering Infrastructure Development Plan where substation construction is possible. (see Fig. 2.2.21).

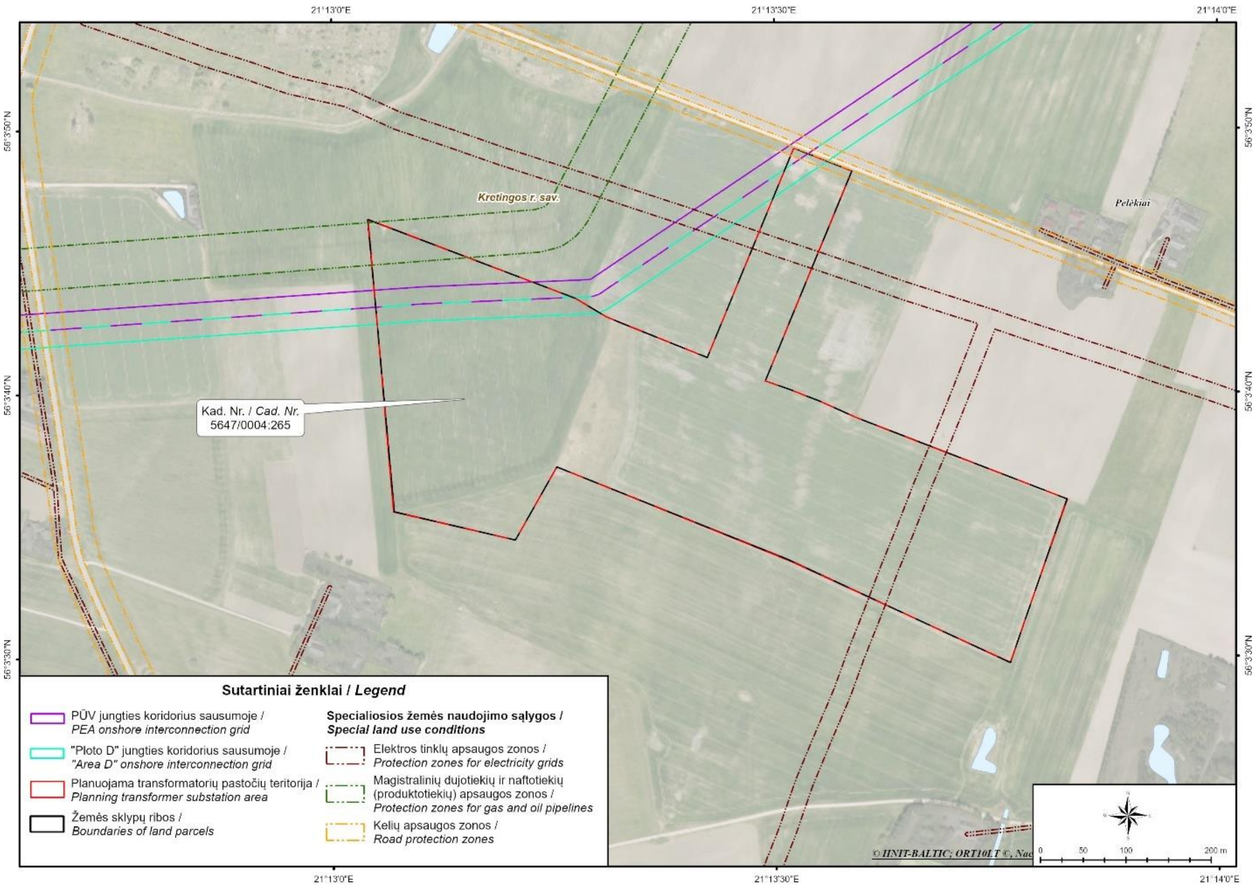


Fig. 2.2.21. The area planned for the installation of the Pelėkiai Transformer Substation.

Pelėkiai TS is planned on land plot No. 5647/0004:256, formed by merging four land plots No. 5647/0004:213, 5647/0004:26, 5647/0004:190 and 5647/0004:220. Details regarding the land plots designated for the facilities of the Pelėkiai TS are outlined in Table 2.2.7.

Table 2.2.7. Information on land plot within the planned territory of Pelėkiai Transformer Substation (according to extract from the Real Estate Register database, see Annex 1)

Cad. No.	Address	Area, hectares	Primary Intended Land Use and Method of Use	Data on Registered Territories Subject to Special Land Use Conditions (SLUC)
5647/0004:256	Kretinga District Municipality, Darbėnai Eldership, Medomiškės village	19.8270	Agricultural. Other agricultural land plots	Electrical network protection zones (Chapter III, Section Four) 5,585 m^2, from August 8th, 2025 Main gas pipelines and oil pipelines (product pipelines) (Chapter III, Section Five) 3,027 m^2, from August 8th 2025

The substations are designed to operate at voltage levels, including 0.4 kV, 1 kV, 10 kV, 30 kV, 220 kV, 330 kV, and potentially others. Provision for emergency auxiliary power supply and/or a backup emergency generator may be included. Additionally, a solar power plant could be installed as a supplementary power source.

No new roads are planned for the construction and servicing of the 220/330 kV Pelėkiai TS. If necessary, local roads may be improved. However, existing local roads may be improved if necessary. The substation area will be enclosed with fencing and equipped with security systems and alarms. Fire alarm systems will be designed and installed in accordance with LST EN 60849 and LST EN 54 series standards, ensuring that fire hazard signals are integrated into the security alarm and dispatch control systems.

The planned Pelėkiai TS plots include special conditions for protected reclaimed land and reclamation structures. According to these conditions, several activities are prohibited on reclaimed land: driving over reclamation ditches at unauthorised locations, damming ditch beds, grazing animals on ditches and their slopes, lighting fires, storing timber or other construction materials, fodder, or fertilisers, dumping soil or waste, discharging wastewater into drainage systems, and ploughing closer than 1 metre from the upper edge of the ditch slope (except when re-sowing perennial grasses).

If necessary, reclamation equipment located on the land plots will be relocated during substation construction without disrupting their system function. On reclaimed land, unless approval is obtained from the municipal authority for the project or proposed activity according to the Construction Law or regulations of the Minister of Agriculture, it is prohibited among other restrictions to:

1. conduct excavation, extract soil for construction, add imported soil, or undertake any underground work
2. construct buildings, install equipment, or engage in mining activities.

To ensure compliance with regulations regarding reclamation systems, the responsible authorities will be consulted to establish conditions, and substation construction activities will be coordinated accordingly.

In road protection zones, it is prohibited to construct buildings not related to the service of vehicles and road users, install external advertising, use signs that imitate road signs or symbols. According to the Law on Special Land Use Conditions (hereinafter – SLUC), activities in road protection zones are allowed only with approval from the road owner or manager under the relevant planning or construction laws, or by the order of the Minister of Transport.

In electricity network protection zones, it is prohibited to construct buildings and/or install equipment without approval from the electricity network owner or manager, as stipulated by the Construction Law, Planning Law, or the Minister of Energy's regulations. Exceptions apply only to activities not restricted by this law's article 1.

The protection zone for main gas pipelines and oil/product pipelines extends 25 m on both sides of the pipeline axis, encompassing the airspace above, and the ground and water below and above the strip. In these protection zones, it is prohibited to: construct buildings, install facilities for public gatherings, place hazardous material containers or storage units, build or install parking or storage areas for any type of vehicle or machinery, lay other utilities within 3 m on both sides of the pipeline wall, plant or grow vegetation (except grass) within 6 m from the pipeline axis, store any materials, stop vehicles or machinery in intersection areas with national roads, create ruts or drive vehicles across undeveloped land.

Moreover, without approval from the pipeline owner or manager, as per the Construction Law, Planning Law, or Energy Minister's regulations, it is prohibited to: build structures, install drainage pipes parallel to the pipeline within 3 m, conduct land reclamation, irrigation, or drainage, perform excavation or underground work deeper than 0.3 m, alter the land surface altitude by more than 0.3 m, use impact or vibrating equipment, cut or chop vegetation (except grass), or drive heavy vehicles without a designated road.

2.3. Stages of project implementation and operation

2.3.1. Main planned installation works

The construction of the CN OWF is scheduled to commence in Q1 2027, with operations preliminarily expected to begin in Q2 2029. Commercial operations of the OWF are planned to start in Q1 2030.

During the construction phase, OWF components will be transported to the construction site by vessels and assembled. The main installation works for the OWF (detailed in Table 2.3.1) include:

- Foundation installation
- WTG installation
- Installation of IAC within the OWF
- Installation of the OSS
- Installation of power export cables offshore and onshore
- Construction of the Pelėkiai Transformer Substation onshore and OWF connection to the power transmission system.

The main installation works for the connection cables of the "Area D" OWF will be carried out in a similar approach to those for the CN OWF, as outlined in Table 2.3.1.

Table 2.3.1. Main installation works of the project

Stage of work	Activities
	CN OWF
Foundation installation	The foundation structures of the OWF are loaded onto transport vessels / barges at the manufacturing harbour and transported to the marshalling port for storage. The installation vessel will loadout the foundation structures at the marshalling harbour/ storage site and transport these to the OWF. Installation activities at the site vary according to the selected foundation type, which may include pile driving, potentially drilling, or seabed preparation (levelling) works for gravity-based foundations. Upon arrival at the OWF installation site, the transported foundation structures are installed. Pile foundations can be installed using either jack-up vessel or a floating vessel. Gravity-type foundations may be too heavy to be lifted with conventional ship cranes. Therefore, they may be towed to the installation site using their buoyancy and then lowered to the seabed using ballast.
Installation of the WTG	Preparation of the WTG components at the marshalling harbour where individual WTG components, such as the nacelles, hubs, towers, and blades, are received from various manufacturing sites. Once manufacturing is complete, these components are transported to the marshalling harbour, where they undergo preparation, assembly, and testing before being loaded onto the installation vessel. Pre-assembly of the tower: due to its size and weight, the tower is delivered to the marshalling harbour in several sections, usually ranging from three to five. These sections are transported horizontally, lifted, and assembled vertically into a single completed tower. Personnel and/or service lifts, cables, controls, and other necessary equipment are installed within the assembled tower. The completed tower is stored at the quay, ready to be loaded onto the installation vessel. The nacelle is prepared and tested at the port. If not standard, a turning device for horizontal blade installation is fitted into the nacelle. The nacelle is then transported to the quay for loading onto the installation vessel. Blades arriving at the assembly site are inspected for transport damages and transported to the quay for loading onto the installation vessel. Offshore installation of the WTG and mechanical completion: the WTGs installation is carried out using a jack-up vessel, which elevates above the water to provide stability during lifting operations, mitigating movement from waves and swells. Before installation on the transition piece of the foundation, including the transition piece, the flange is cleaned and inspected for damage. The entire tower is then lifted onto the transition piece and bolted to the top flange. The nacelle, complete with the hub, is lifted and positioned atop the tower, where it is bolted to the tower's top flange. Each blade is lifted horizontally and attached to the hub sequentially. After securing the first blade, the turning device rotates the hub 120° to position the next blade for horizontal mounting. Medium voltage IAC and control cables are routed from the nacelle or transformer to the switchgear at the tower's base or within the transition piece. Following a thorough cable inspection, the turbine is connected to the grid via the internal transfer gear. Various tests and adjustments are conducted to ensure functionality and safety before commissioning the WTG.
OSS installation	The installation of the OSS includes transporting the foundation (e.g. jacket structure) and topside from the manufacturing site to the OWF and installing the foundation and topside using a heavy-lift vessel.
	CN and "Area D" OWF connection cables
Cable laying	In the offshore section, special marine cables are utilised for connecting the OWF and transmitting electricity. Depending on the geological conditions of the site, these cables are either laid in a trench excavated on the seabed or placed directly on the seabed with proper protective measures. Cable laying is conducted using a specialised vessel equipped for the task. The methods employed for cable laying include preparatory ploughing, ploughing, trenching, or jetting. When trenching is used, the cable is typically backfilled with the same excavated material, when possible.

Stage of work	Activities
	For cable routing in the Lithuanian coastal zone, from the sea to land, closed drilling technologies, such as HDD, are planned, wherein a tunnel of the required diameter is drilled underground and a pipe with a cable is pulled through. Other closed drilling methods may also be utilised, depending on specific site requirements and conditions. Onshore, cables are installed using open trenching methods. At crossings with natural features or infrastructure, HDD or other closed drilling methods may be employed.
Installation of a Pelėkiai TS on the mainland	The onshore installation of the Pelėkiai TS involves both infrastructure construction and the installation of electrical equipment. AC electricity transmitted from the OWF via submarine cables arrives at the Pelėkiai TS, where it is stepped up to 330 kV, and only then connected to the 330 kV electricity transmission grid.

2.3.2. Operational phase

During the operation phase of the OWF, activities encompass the generation and transmission of electricity to the grid, alongside ongoing maintenance, repair, and inspections. Ensuring the safety of personnel engaged in maintenance or repair tasks is of utmost importance. To facilitate this, it is crucial to carefully select reliable equipment and procedures for accessing the OWF.

Special vessels (CTV and/or SOV) can be used for maintenance work on OWFs, which can conveniently dock and moor at the offshore wind farm, and from which it would be safe for the maintenance personnel to access the offshore wind farm service platform. If there is a need to perform larger repairs, such as replacing blades or the entire offshore wind farm, larger capacity maintenance vessels will be used.

Within both the offshore and onshore sections, maintenance and, when necessary, repair works of the Pelėkiai Transformer Substation and electricity transmission lines are planned throughout the operation phase.

2.3.3. Decommissioning stage

The decommissioning phase involves the removal of offshore infrastructure following the conclusion of its operational life, along with the disposal of equipment. The primary components considered for removal during the OWF decommissioning process include WTGs, foundations (fully or partially), transition pieces, submarine cables (both IAC and export cables), meteorological masts, OSS, and associated onshore facilities (Topham & McMillan, 2017).

All OWF components are transported to shore and allocated for reuse, recycling, or disposal.

Currently, the applicable legal framework stipulates that upon expiry of the electricity generation permit, the procedure and timeline for decommissioning the power plants, as well as the procedure and conditions under which electrical networks and other infrastructure essential for connecting the WTG may or may not be decommissioned, will be determined by the LRV. As of now, explicit criteria, scopes, and procedures are not established, but future regulations may incorporate provisions for life extension and the repowering (renewal or upgrading) of certain components or turbines.

2.4. Materials to be used

For the construction of the OWF in the offshore area, new, certified products that comply with European Union standards will be utilised. Only the assembly, configuration, and installation of individual devices will occur at the installation sites. When selecting OWF components, it is advisable to prioritise components manufactured from recyclable materials.

During the PEA, here are no plans to use or store hazardous chemical substances or mixtures, radioactive materials, or hazardous/non-hazardous waste as outlined in the “Regulations on the Prevention, Elimination, and Investigation of Industrial Accidents” and the “List of Hazardous Substances and Mixtures, the Determination of Their Qualifying Quantities, and the Criteria for Classifying Chemical Substances and Mixtures as Hazardous” approved by Government Resolution No. 966 of 17 August 2004.

Lubricating and transformer oils, along with cooling fluids, are utilised in offshore wind power facilities. While these substances may contain hazardous components, none are classified as hazardous to the aquatic environment.

Each WTG utilises up to 40 l of high-viscosity oil in the yaw gear lubrication system (such as Castrol Optipit or equivalent) and approximately 240 l in yaw gear systems (such as Castrol Optigear Synthetic X 320 or equivalent). The main bearing lubrication systems use around 270 l of synthetic oil, which is characterised by its high resistance to temperature fluctuations ranging from -50°C to +150°C. These oils and greases are not classified as flammable liquids, with a flash point of 150–200°C or higher. The total volume of lubricating oils and greases per OWF turbine amounts to about 450 litres.

OSS utilise approximately 140,000 litres of transformer oil. OWFs commonly employ biodegradable ester-based transformer oil (such as Midel 7131 or equivalent). Ester oil is not classified as hazardous to the aquatic environment, and in the event of a spill into water, the impact is generally minimal. Final type of oil will be established during the design and procurement phase of the HV equipment. All Oil filled equipment is expected to be bunded and any bund is designed to capture any oil escape, however small, to ensure containment of oil is secure until it can safely be removed from the OSS.

OSS utilise about 1,800 l of ethylene glycol-based coolant. Ethylene glycol dissolves rapidly and is biologically degradable, ensuring that higher concentrations in water remain short-lived.

All hazardous chemical substances used during operations must be handled in accordance with the requirements outlined in their respective safety data sheets.

2.5. Waste management

Certain amounts of waste may be generated during each analysed phase in the PEA: during the construction stage, during the operation of the OWF, and during the decommissioning phase. It is anticipated that the waste generated from the PEA will be managed in accordance with the principles of the waste management hierarchy, as outlined in Directive 2008/98/EC (refer to Table 2.5.1)[9].

Table 2.5.1. Waste management hierarchy priorities

Priority	Explanation
Avoid Reduce	Avoid waste generation whenever possible and reduce the quantity of waste when avoidance is not feasible. Waste avoidance: the primary priority is to prevent the generation of waste whenever possible. While complete avoidance is often impractical, it is crucial to apply waste reduction principles and thus reduce the amount of waste generated to a minimum.
Reuse	Utilise products for as long as possible. Reusing items can significantly reduce both waste generation and CO_2 emissions. All materials that cannot be avoided or reduced will be assessed for reuse before being recycled. Waste that cannot be reused on-site, such as wood or topsoil, will be stored separately for reuse elsewhere. If waste is to be reused at another location, it must be certified as suitable for the intended purpose.
Recycle	Recycle when reuse is not possible to create new products. This applies to materials that cannot be reused in their current form but can be recycled into new products. These materials will be classified as off-site recyclable and transferred to licensed waste handlers.
Recover	To recover materials or energy from waste when it cannot be recycled. Such waste is mainly used as fuel to generate energy or composted.
Remove	Dispose of waste in landfills or through other designated methods when materials or energy cannot be responsibly recovered or recycled. When waste cannot be managed according to any other waste management hierarchy principle, it will be transferred to the appropriate waste managers. This approach also applies to hazardous waste generated on-site.

During the technical design phase of the OWF, a waste management plan will be developed. The construction contractor must provide detailed information regarding the intended use of materials and the disposal methods for waste generated during construction prior to obtaining a construction permit.

2.5.1. Construction phase

The construction of WTGs will be executed using specialised vessels. During the installation of WTG foundations and cables, as well as during the transportation and assembly of WTG components, small amounts of waste may be

[9] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. Online access: https://eur-lex.europa.eu/legal-content/LT/TXT/?uri=celex:32008L0098

generated. All waste produced during the construction of the OWF will be transported by vessels to servicing ports and handed over to specialised waste handlers.

During the laying of the connection cable in the onshore part of the territory, small amounts of construction waste may be generated. It is planned that temporary containers for storing construction waste will be placed at the construction site established in the area of the connection cable laying works. All construction waste generated during the works will be sorted and stored in containers until they are removed and handed over to waste handlers. Construction waste will be managed in accordance with the Construction Waste Management Rules (approved by the Minister of Environment of the Republic of Lithuania on December 29, 2006, by Order No. D1-637).

During construction, all waste will be accounted for through the Products, Packaging, and Waste Accounting Information System (GPAIS) in accordance with the "Rules for Waste Generation and Management Accounting and Reporting" approved by the Minister of Environment of the Republic of Lithuania on May 3, 2011, by Order No. D1-367.

Waste will be sorted, temporarily stored, collected, transported, and processed in a manner that does not negatively impact public health and the environment.

At the construction site, the following waste types will be sorted and temporarily stored separately:

- Municipal waste – food residues, textile products, other household and similar waste that, by nature or composition, are similar to household waste.
- Inert waste – concrete, bricks, ceramics, and other waste that do not undergo any noticeable physical, chemical, or biological changes.
- Waste suitable for recycling and reuse, secondary raw materials – packaging, paper, glass, plastic, and other waste suitable for direct recycling and/or materials derived from waste suitable for recycling or reuse.
- Hazardous waste – solvents, paints, adhesives, resins, their packaging, and other harmful, flammable, explosive, corrosive, toxic, corrosive substances, or those with other properties that may negatively affect the environment and human health.
- Waste unsuitable for recycling (insulation materials, mineral wool, etc.).

Sorted waste must be handed over to companies authorised to manage such waste under contracts for their utilisation and disposal. Dust-generating waste from the construction site will be transported by road exclusively with covered bodies to prevent dispersion.

Upon completion of construction works, the construction site must be thoroughly cleaned to ensure that no waste generated during the works remains

2.5.2. Operation of the OWF

During operation, waste may be generated primarily during maintenance activities. Such waste will be managed in accordance with legal requirements and handed over to authorised waste handlers. The quantity of waste is expected to be minimal, given that new WTGs can operate for extended periods with minimal maintenance. The operational lifespan of the WTGs is approximately 30 years, after which reconstruction may occur. Waste generated during the operation of the OWF will be transported by vessels to servicing ports and handed over to waste handlers.

It is anticipated that during the construction of the OWF, waste types listed in Table 2.5.2 may be generated. These waste types have been identified based on the waste specifications outlined in the waste management plans of similar projects.

Table 2.4.2. Information on waste generated during the construction and operation of the OWF and their management methods

Waste code[10]	Description of potential waste	Possible handling methods	Priority treatment method according to the waste hierarchy
13	Waste petroleum products and waste liquid fuels (except edible oil and those specified in chapters 05, 12 and 19)		
13 02	**Engine, gearbox and lubricating oil waste**		
13 02 08*	Other engine, transmission and lubricating oil	Handle as hazardous waste	Recovery

[10]According to the Waste Management Rules, approved by Order No. 217 of the Minister of the Environment of the Republic of Lithuania of 14 July 1999 (as amended by Order No. D1-831 of the Minister of the Environment of the Republic of Lithuania of 9 October 2017).

Waste code[10]	Description of potential waste	Possible handling methods	Priority treatment method according to the waste hierarchy
13 08	**Waste petroleum not otherwise specified**		
13 08 99*	Waste not otherwise specified	Spills are handled using absorbents, which are transferred to licensed hazardous waste handlers	Recovery
15	Packaging waste; absorbents, wipes, filter materials and protective clothing not otherwise specified		
15 01	**Packaging (including separately collected municipal packaging waste)**		
15 01 01	Paper and cardboard packaging	Separate and remove from site for recycling	Recycling
15 01 02	Plastic (including PET (polyethylene terephthalate) packaging	Separate and remove from site for recycling	Recycling
15 01 03	Wooden packaging	Separate and remove from site for recycling	Recycling
15 01 06	Mixed packaging	Separate and remove from site for recycling	Recycling
15 01 04	Metal packaging	Separate and remove from site for recycling	Recycling
15 01 10*	Packaging containing residues of or contaminated with hazardous substances	Hand over to a licensed waste manager	Disposal
15 02	**Absorbents, filter materials, wipes and protective clothing**		
15 02 02*	Absorbents, filter materials (including grease filters not otherwise specified), wipes, protective clothing contaminated with dangerous substances	Recovery using the services of a competent contractor	Recovery
16	Waste not otherwise specified in the list		
16 01	**End-of-life vehicles of various purposes (including non-self-propelled machines) and waste from dismantling end-of-life vehicles and waste from the operation of vehicles (except those mentioned in 13, 14, 16 06 and 16 08)**		
16 01 07*	Oil filters	Transfer to a licensed waste manager	Recovery
16 02	**Waste electrical and electronic equipment**		
16 02 13*	Disused equipment containing hazardous components not specified in the codes 16 02 09–16 02 12 of the Regulations	Transfer to a licensed waste manager	Recovery
16 02 14	obsolete equipment not specified in the codes 16 02 09–16 02 13 of the Rules	Separate and remove from site for recycling	Recycling, recovery, disposal as electronic waste
16 05	**Gases in pressurized containers and unnecessary chemicals**		
16 05 04*	Gases in pressure containers (including halons) containing hazardous substances	Recovery using the services of a competent contractor	Recovery
16 06	**Batteries and accumulators**		
16 06 01*	Lead-acid batteries	Transfer to a licensed waste manager	Recovery
16 07	**Wastes from cleaning of transport containers, tanks and vats (except those specified in chapters 05 and 13)**		
16 07 08*	Waste containing oils	Transfer to a licensed waste manager	Recovery
17	Construction and demolition waste (including excavated soil from contaminated sites)		
17 01	**Concrete, bricks, tiles and ceramics**		

Waste code[10]	Description of potential waste	Possible handling methods	Priority treatment method according to the waste hierarchy
17 01 01	Concrete	Shredded and reused where appropriate / excess removed from job site for recycling	Recycling
17 02	**Wood, glass and plastic**		
17 02 01	Tree	Reused where appropriate / surplus removed from job site for recycling	Reuse, recycling
17 02 02	Glass	By recycling	Recycling
17 02 03	Plastic	By recycling	Recycling
17 02 04*	Glass, plastic and wood containing or contaminated with hazardous substances	Hand over to a licensed waste manager	Disposal
17 04	**Metals (including their alloys)**		
17 04 01	Copper, bronze, brass	Reused where appropriate/recycled	Reuse, recycling with potential for sale
17 04 02	Aluminium	Reused where appropriate/recycled	Reuse, recycling with potential for sale
17 04 03	Lead	Reused where appropriate/recycled	Reuse, recycling with potential for sale
17 04 04	Zinc	Reused where appropriate/recycled	Reuse, recycling with potential for sale
17 04 05	Iron and steel	Reused where appropriate/transferred to metal waste handlers	Reuse, recycling with potential for sale
17 04 06	Tin	Reused where appropriate/recycled	Reuse, recycling with potential for sale
17 04 07	Metal mixtures	Recovery/recycling/transfer to metal waste handlers	Reuse, recycling with potential for sale
17 04 09*	Metal waste contaminated with hazardous substances	Hand over to a licensed waste manager	Recovery, disposal
17 04 10*	Cables containing oil, coal tar and other hazardous substances	Hand over to a licensed waste manager	Disposal
17 04 11	Cables not specified in the Code 17 04 10 of the Regulations	Separate and remove from site and hand over to metal waste handlers	Recycling with potential for sale
17 05	**Earth (including excavated soil from contaminated sites), rocks and pumped sludge**		
17 05 03*	Soil and rocks containing hazardous substances	Hand over to a licensed waste manager	Disposal
17 05 04	Soil and stones not specified in the codes 17 05 03 of the Regulations	Reuse on site	
17 05 05*	Pumped sludge containing hazardous substances	Hand over to a licensed waste manager	Disposal
17 05 06	Pumped sludge other than those mentioned in 17 05 05 of the Regulations	Reuse on site where appropriate or remove for reuse elsewhere.	Reuse
17 06	**Insulation materials and building materials containing asbestos**		
17 06 01*	Insulation materials containing asbestos	Hand over to a licensed waste manager	Disposal
17 06 03*	Other insulating materials containing or consisting of hazardous substances	Hand over to a licensed waste manager	Disposal

Waste code[10]	Description of potential waste	Possible handling methods	Priority treatment method according to the waste hierarchy
17 06 04	Insulating materials other than those mentioned in the codes 17 06 01 and 17 06 03 of the Regulations	Reuse where appropriate or recycle	Reuse, recycling
17 06 05*	Building materials containing asbestos	Hand over to a licensed waste manager	Disposal
17 08	**Gypsum insulating building materials**		
17 08 01*	Gypsum insulating building materials contaminated with hazardous substances	Hand over to a licensed waste manager	Disposal
17 08 02	Gypsum insulating building materials not specified in the Code 17 08 01 of the Regulations	Separate and remove from site for recycling	Recycling
17 09	**Other construction and demolition waste**		
17 09 03*	Other construction and demolition waste (including mixed waste) containing hazardous substances	Hand over to a licensed waste manager	Disposal
17 09 04	Mixed construction and demolition waste other than those mentioned in 17 09 01, 17 09 02 and 17 09 03 of the Regulations	Store and transfer to licensed waste managers	Disposal
20	Municipal waste (household waste and similar business, industrial and organizational waste), including separately collected fractions		
20 01	**Separately collected fractions (except those mentioned in 15 01)**		
20 01 01	Paper and cardboard	Collect and hand over for transfer	Recycled
20 01 13*	Solvents	Hand over to a licensed waste manager	Recovery at a recycling centre
20 01 27*	Paints, inks, adhesives and resins containing hazardous substances	Hand over to a licensed waste manager	Recovery at a recycling centre
20 01 39	Plastics	Separate and remove from site for recycling	Recycling
20 03	**Other municipal waste**		
20 03 01	Mixed municipal waste	Store in covered storage areas and hand over to licensed waste handlers.	Disposal in specially equipped landfills/composting
20 03 04	Septic tank sludge	Hand over to licensed waste managers	Recycling, disposal
20 03 06	Sewage treatment waste	Hand over to licensed wastewater treatment plants	Disposal

(* hazardous waste)

2.5.3. Decommissioning phase

During the decommissioning phase, dismantled technological equipment and individual components will be transported by vessels to a designated service port, storage, or recycling facility, or handed over to a waste collection company authorized to manage such waste.

Waste generated upon the cessation of WTG operations includes towers, generators, and all metal parts, which will be delivered to a waste collection company authorised to manage such waste.

Following the dismantling of the OWF, some components will be repurposed for secondary use; if this is not feasible, they will be recycled or disposed of at designated facilities in accordance with Lithuanian legal requirements. The decommissioning project for the OWF must include a comprehensive waste management plan.

Preliminary mitigation measures:

- All waste will be classified, accounted for, separated, when necessary, with appropriate management methods selected based on the waste management hierarchy principles and prevailing legal regulations.
- Waste storage locations will be carefully chosen, with separate containers for different types of waste to prevent contamination.
- Meetings with contractors will be held to coordinate the waste management plan and provide training to personnel.
- Best practices will be considered when establishing waste storage sites.
- Appropriate waste storage containers will be selected.
- Waste will be covered or otherwise isolated when necessary.
- Monitoring of potential leakage from waste storage sites will be implemented.
- Waste will be stored for the shortest possible duration to ensure prompt and appropriate management.
- Efforts will be made to minimise waste transportation distances.
- Waste handlers will complete waste management records detailing all types and quantities of waste generated, reused, recycled, or disposed of, specifying the waste handler and the location where the waste was managed or disposed of, alongside other measures selected based on the nature of the work.

3. INFORMATION ABOUT THE PROPOSED ECONOMIC ACTIVITY AREA

3.1. Geographical and administrative location of the proposed economic activity area

The WTGs of the CN OWF are planned to be installed in the Baltic Sea designated by Government Resolution No. 171. In this area, it is intended to organise a tender (or tenders) for the development and operation of power plants using renewable energy sources, without applying support measures, until 2030.

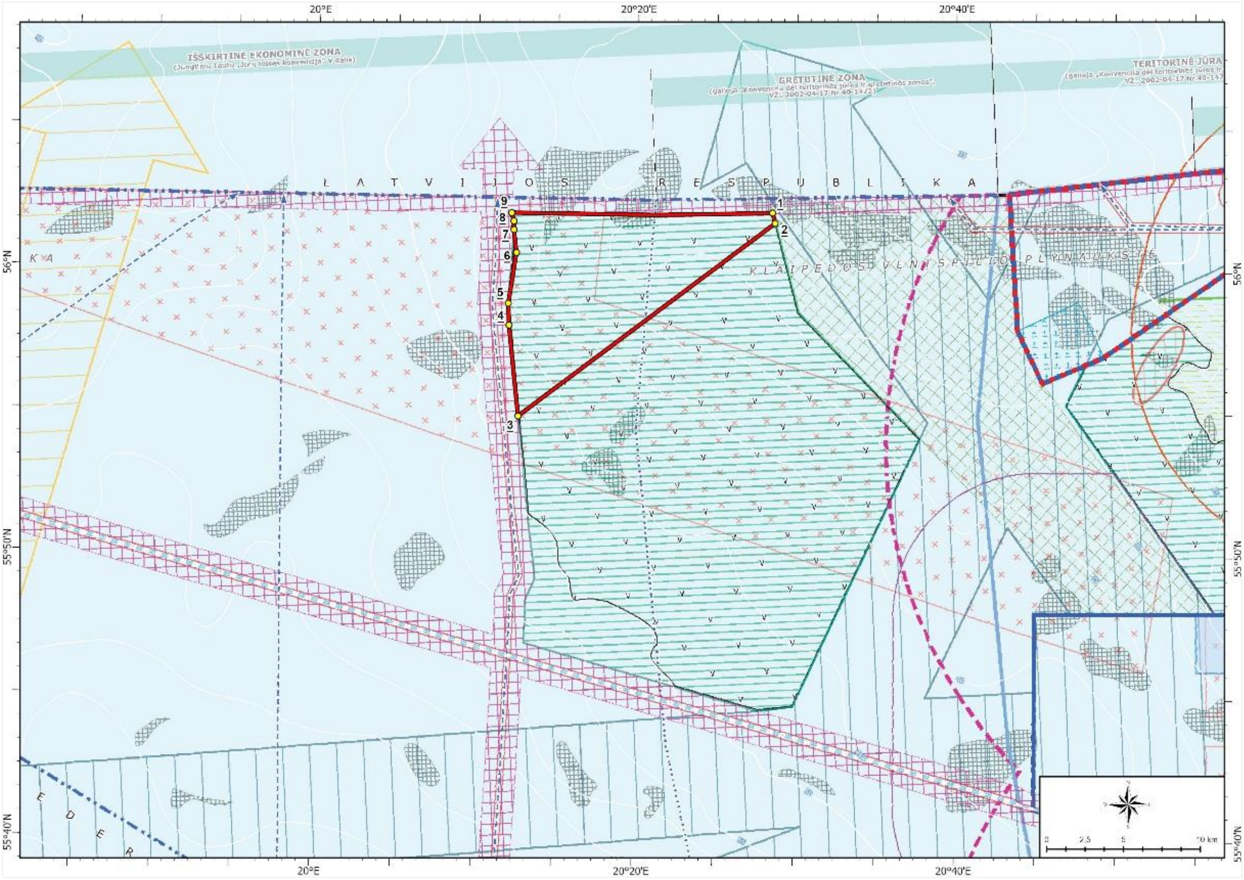


Fig. 3.1.1. The territory of the OWF in the Baltic Sea, approved by the Resolution No. 171 of the LRV (excerpt from Resolution No. 171[11] of the LRV).

Table 3.1.1. Coordinates of the territory approved by Resolution No. 171 of the LRV

Area point no. (see Figure 3.1.1)	Coordinates	
	In the global coordinate system 1984 (WGS–84)	In the Lithuanian coordinate system 1994 (LKS–94)
1	20°28.495`E 56°2.065`N	X-6216759.48; Y-280352.25
2	20°28.665`E 56°1.706`N	X-6216084.82; Y-280494.68
3	20°12.684`E 55°54.870`N	X-6204290.59; Y-263208.21
4	20°12.052`E 55°58.047`N	X-6210216.11; Y-262874.74
5	20°11.997`E 55°58.821`N	X-6211654.96; Y-262896.88
6	20°12.466`E 56°0.598`N	X-6214921.48; Y-263564.85
7	20°12.293`E	X-6216430.60;

[11] https://www.e-tar.lt/portal/lt/legalAct/39556540c6ed11ed9978886e85107ab2

Area point no. (see Figure 3.1.1)	Coordinates	
	In the global coordinate system 1984 (WGS–84)	In the Lithuanian coordinate system 1994 (LKS–94)
	56°1.406`N	Y-263467.99
8	20°12.289`E 56°1,700`N	X-6216974.54; Y-263493.90
9	20°12.151`E 56°1.998`N	X-6217535.33; Y-263380.89

The main characteristics of this area:

- Area – 119.5 km^2.
- Depth – 27-49 m.
- The shortest distance to the coastline / Palanga city – 36.8 km.
- The shortest distance to Klaipėda seaport – 50.3 km.
- The average wind speed at an altitude of 200 m is about 8.6 m/s.

From the border of the OWF territory, the distance to the Latvian EEZ is approximately 0.9 km, to the Swedish EEZ about 69 km, and to the Russian Federation EEZ approximately 35.8 km.

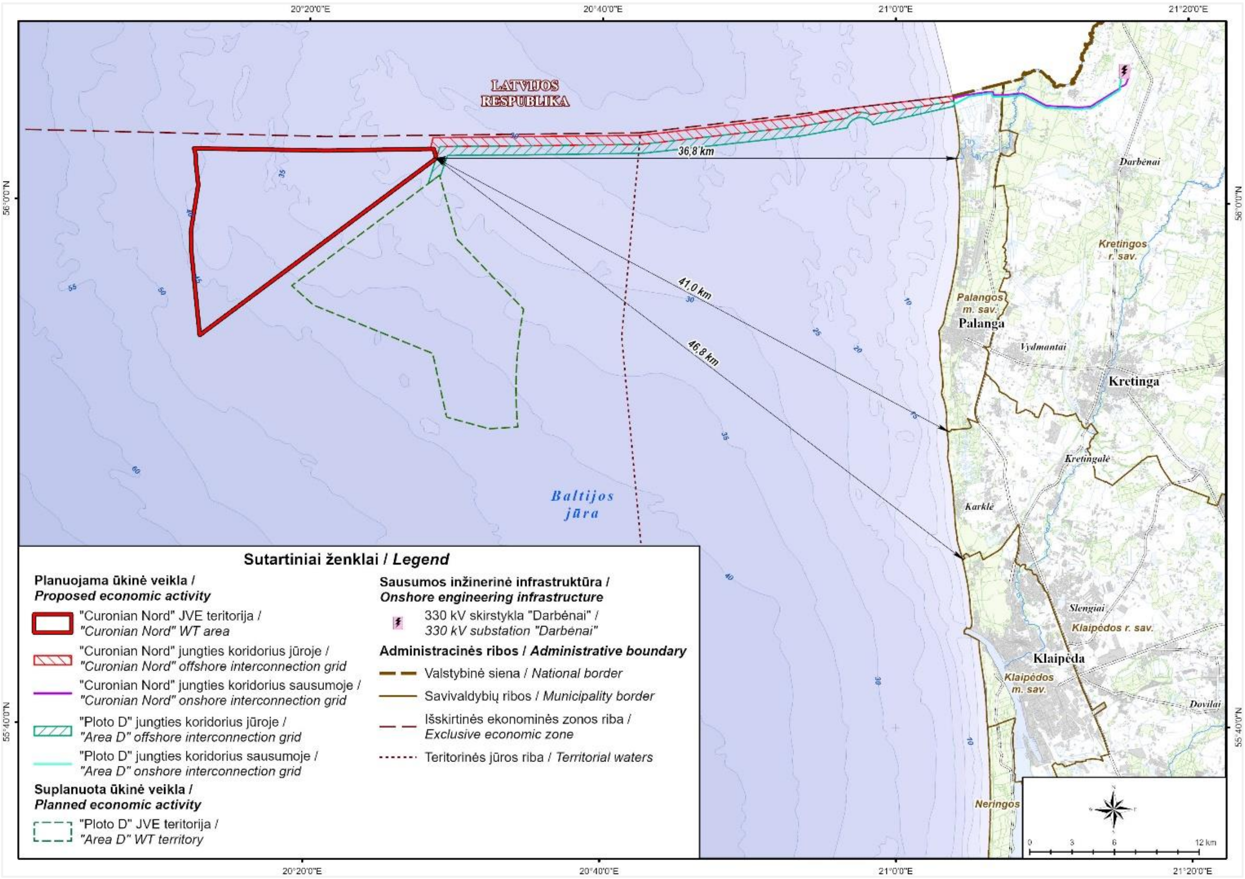


Fig. 3.1.2. Geographical and administrative location of PEA objects.

A Development Plan for Engineering Infrastructure has been prepared to determine the locations of connection corridors for the project of special national importance: “Preparation of territories necessary for connecting power plants using renewable energy sources, planned to be developed in the territorial sea and/or exclusive economic zone of the Republic of Lithuania in the Baltic Sea, to the electricity transmission grid.” Within the concept of the engineering infrastructure development plan, which has undergone strategic environmental assessment, and in the detailed solutions, the connection point is designated within the boundaries of the Palanga City Municipality and the Kretinga District Municipality, considering the planned cable landfall points and the connection location to the Darbėnai 330 kV substation (Fig. 3.1.2).

3.2. Current use of the area

Lithuania's EEZ and territorial sea are used for navigation and commercial fishing, intersected by various engineering communication routes. Other economic activities, such as sand extraction, soil dumping, renewable energy development, military activities, are also conducted or planned. The Lithuanian coastline is particularly popular for recreation and possesses significant marine tourism potential. A substantial portion of the marine area is occupied by national protected areas and "Natura 2000" territories, which are being expanded: Curonian Spit National Park, Coastal Regional Park, Baltic Sea Thalassological Reserve, among others (see section 5.4.1).

The area of the PEA does not fall within designated international shipping routes, port roads, or anchorage areas. The distance from the eastern boundary of the OWF area to the nearest international shipping corridor is approximately 340 meters. Planned alternatives for the power export cable corridors intersect existing shipping routes.

Currently, the primary activity in the PEA is fishing. However, due to the cod fishing ban, fishing intensity has decreased in recent years. According to the ICES, Lithuania's maritime territory falls into statistical squares 40H10, 40G9, and 39H10 of the 26th fishing area, where trawls and gillnets are used. The nearshore connection corridor crosses the 29th fishing strip (see section 5.8.1).

Part of the area falls into potentially hazardous zones where former minefields have been identified. Another part overlaps with territories where, based on national security criteria, the design and construction of OWFs (tall structures) may be restricted.

Further information on current and planned uses of the marine area and adjacent zones is provided in Chapter 5 of the EIA report, which examines the impact of the economic activity on various environmental components.

Onshore, the connection route crosses the territories of Palanga City Municipality and Kretinga District Municipality, leading to the 330 kV Darbėnai substation.

3.3. Links with existing territorial planning documents, strategic plans, and programmes

According to point 6 of Annex 1 of the Description of the Procedure for EIA of PEA, the preparation of EIA involves analysing the location of the land plot or territory of the PEA based on approved territorial planning documents. This includes specifying:

- the main development direction of the territory, functional zones, and types of use
- determining whether the PEA aligns with the land use types outlined in the approved territorial planning document
- assessing whether it will be necessary to change the land use purpose and method
- and attaching an extract from the existing condition drawing of the approved territorial planning document, with the location of the PEA and the boundaries of the land plot or territory marked.

The following section provides information on the territorial planning documents applicable to the analysed territory and presents a graphical analysis of the PEA solutions, illustrating them on the decision drawings of the current territorial planning documents.

3.3.1. General Plan of the Territory of the Republic of Lithuania[12]

In the 2015 supplement to the General Plan (hereinafter – GP) of the Territory of the Republic of Lithuania, concerning maritime territories, it was indicated that "considering the rapid development of the offshore wind energy sector in Europe, including the Baltic Sea, areas for the installation of offshore wind farms and corridors for their connection to onshore networks should be designated. It is advisable to initiate the creation of an integrated offshore wind power network in the Baltic Sea region, enabling the connection of planned energy parks in the maritime territories of Lithuania and other Baltic countries to the EU-funded network of Denmark, Poland, Sweden, and Germany." In the graphical part of the GP supplement with maritime solutions, highlighted potential areas most suitable for the development of renewable energy projects, including wind energy, at sea.

These plans have been incorporated into the current GP solutions, where point 310 emphasises the importance of developing offshore energy: "Develop the installation of offshore wind farms and the expansion of the electricity transmission grid to connect these OWFs to onshore networks."

[12] Approved by the Government of the Republic of Lithuania on 29 September 2021 by Resolution No. 789 "On the Approval of the Comprehensive Plan of the Territory of the Republic of Lithuania".

Section three of the GP solutions, "Responsible Use of the Sea and Coast," emphasises the importance of promoting maritime and marine-related activities to develop a competitive blue economy in Lithuania.

Point 55[1] of the GP indicates that developing new activities at sea creates new experiences, thereby gaining an advantage in the Baltic Sea region and providing opportunities to realise these internationally. The installation and operation of OWFs, the development of aquaculture, the exploitation of subsurface resources, and the application of innovative maritime inventions constitute a new economic direction. Therefore, it is essential to foster sustainable activity expansion and consistent growth of activities at sea by establishing strategic directions for the blue economy and creating legal and administrative prerequisites for the formation and installation of stationary objects such as ports, harbours, piers, resource exploitation facilities, and objects and territories on the coast and in the maritime territory of the Republic of Lithuania.

Point 58[3] of the GP designates three priority areas for the construction and installation of renewable energy objects: in the territorial sea near Palanga, between the Baltic Sea Thalassological reserve and the shipping lane, where the installation of OWFs is strictly limited; to the north of Klaipėda, a 20–50 m depth zone on the Klaipėda-Ventspils rise; and further west – Klaipėda Bank, where there are no restrictions on the installation of OWFs. In the first area, priority is given to the development of renewable energy that does not violate the area's restrictions (such as waves, currents, sun, etc.). All objects in the specified areas must meet national security and environmental protection requirements. To mitigate the visual impact of OWFs on the marine landscape, their construction is possible beyond the territorial sea limits, approximately 30 km from the shore.

The analysed territory falls within the priority area for renewable energy development marked in the GP solutions (refer to Fig. 3.3.1).

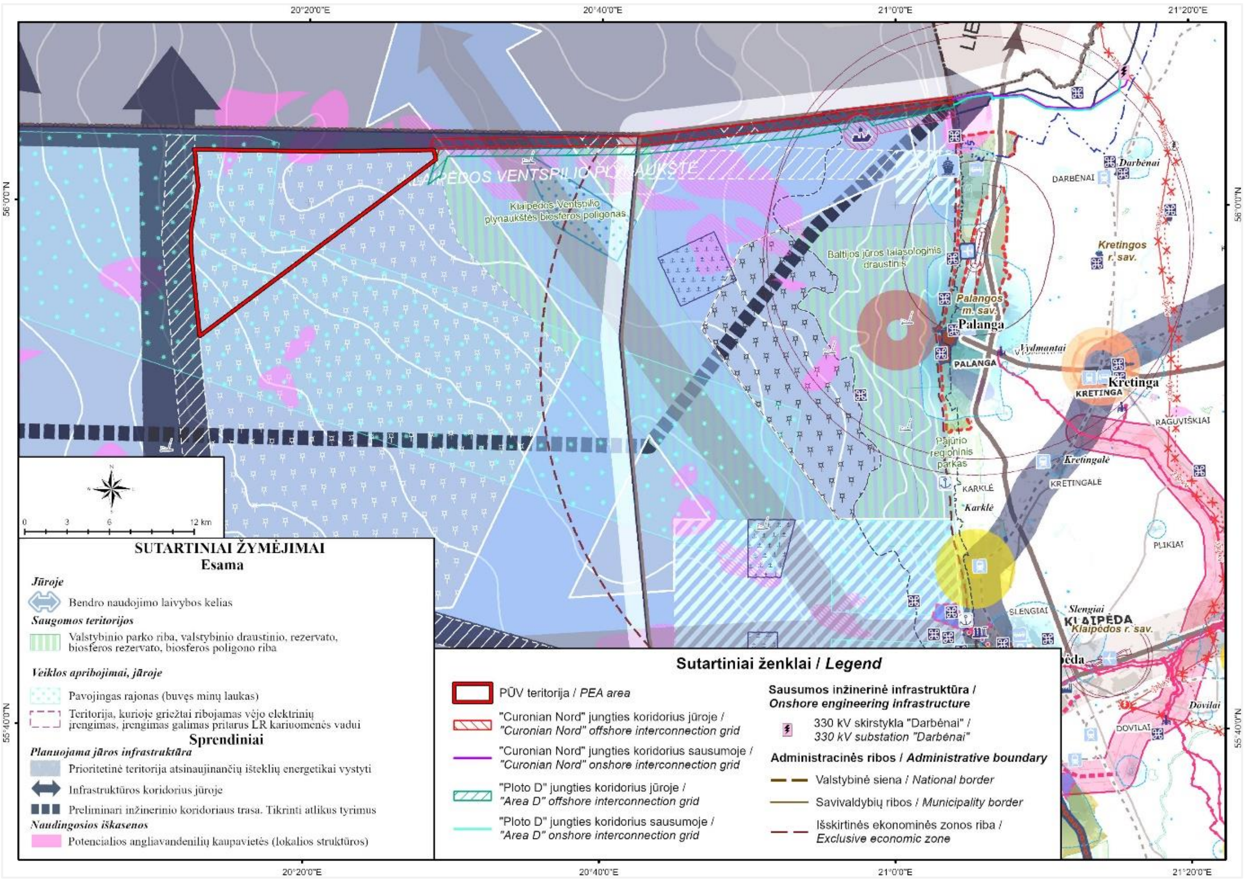


Fig. 3.3.1. Layout of the PEA area in relation to the drawing of the GP "Responsible Use of the Sea and Coastline" (map base: GP's drawing "Responsible Use of the Sea and Coastline").

3.3.2. Engineering Infrastructure Development Plan of the Territory of the Republic of Lithuania's Territorial Sea and/or Exclusive Economic Zone in the Baltic Sea, Designated for Renewable Energy Development

In accordance with the Order No. 1-253 of the Minister of Energy of the Republic of Lithuania dated August 17, 2020, "On the Initiation of the Preparation of the Development Plan for Engineering Infrastructure of the Territory of the Republic of Lithuania's Territorial Sea and/or Exclusive Economic Zone in the Baltic Sea, Designated for Renewable

Energy Development, and the Establishment of Planning Objectives", the Engineering Infrastructure Development Plan was prepared. This plan aims to facilitate electricity production from wind energy in the Baltic Sea, thereby increasing the share of renewable energy sources in Lithuania's domestic energy production and final energy consumption balance. It was approved by Order No. 1-377 of the Minister of Energy of the Republic of Lithuania on November 18, 2022.

In the specified solutions of the Engineering Infrastructure Development Plan, the territory designated in the GP of the Republic of Lithuania as a priority area for renewable energy development is divided into separate plots, where the development of facilities utilising RES will be carried out in stages. In the Engineering Infrastructure Development Plan, the PEA area is marked as "Area A" (see Fig. 3.3.2).

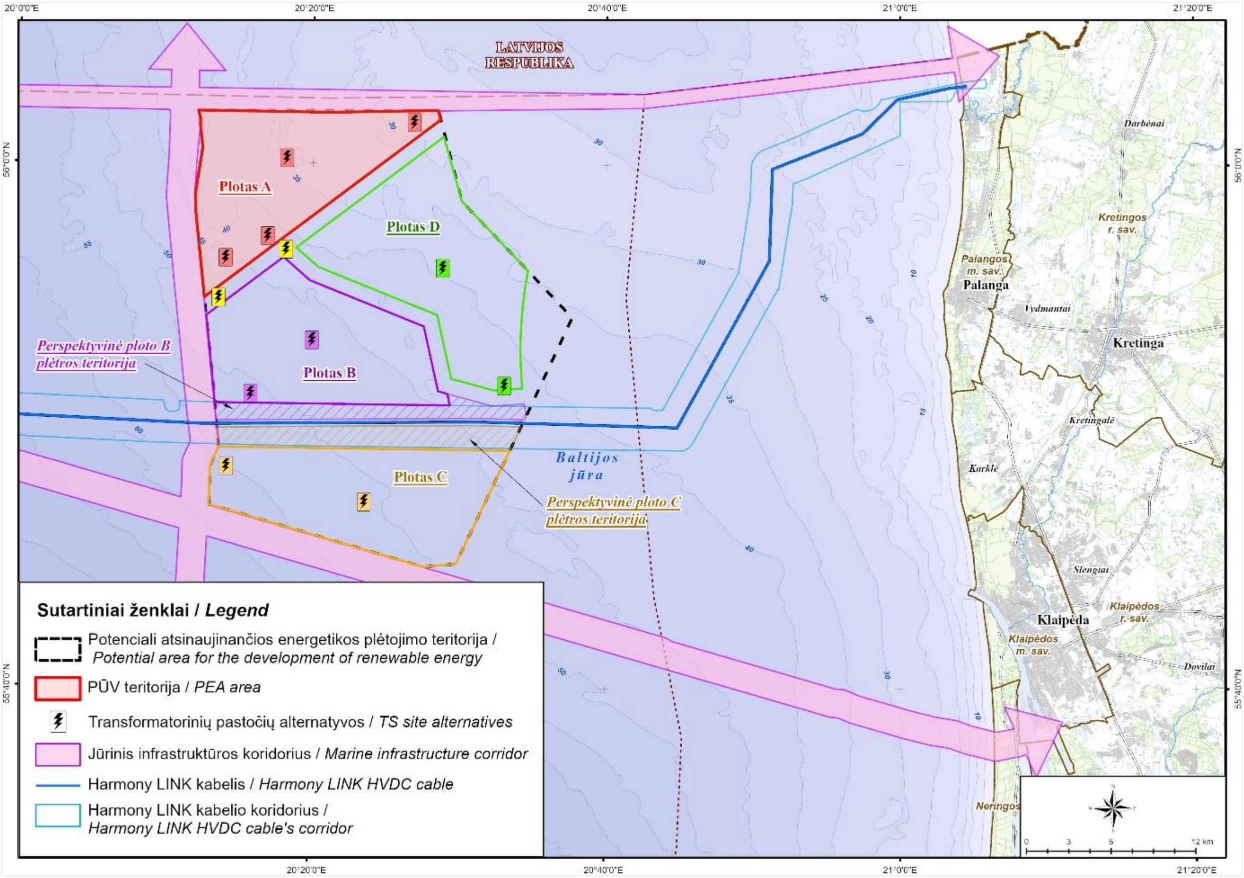


Fig. 3.3.2. Territory of the Republic of Lithuania's EEZ in the Baltic Sea designated for renewable energy development.

3.3.3. Strategic plans and programs

3.3.3.1. National Sustainable Development Strategy[13]

The National Sustainable Development Strategy envisages more efficient use of natural resources. One of the main principles of implementing this strategy is substitution, where substances hazardous to the environment and human health must be replaced with non-hazardous ones, and exhaustible resources with renewable ones. It is expected that the wider use of RES (wind, etc.) in energy and transport will make it possible to reduce the use of fossil fuels and the directly related air pollution, and greenhouse gas emissions will also decrease.

3.3.3.2. National Environmental Protection Strategy[14]

In the National Environmental Protection Strategy, one of the four priority areas of environmental protection is the sustainable use of natural resources. The vision of Lithuania's environment provided for in this strategy states the aspiration that by 2050, renewable energy resources will be used in all sectors of the country's economy (energy, industry, transport, agriculture, and others).

[13] Approved by the Government of the Republic of Lithuania of 11 September 2003 Resolution No. 1160 "On the Approval and Implementation of the National Sustainable Development Strategy".

[14] Approved by the Seimas of the Republic of Lithuania of 16 April 2015 Resolution No. XII-1626 "on the approval of the national environmental protection strategy".

3.3.3.3. National Energy Independence Strategy[15]

The NEIS indicates that in 2016 energy produced from RES accounted for about 25.5% of the final energy consumed in Lithuania and it is envisaged that in implementing the strategic RES goal, the aim will be to increase the share of RES in the country's total final energy consumption: by 2020 – 30%; by 2030 – 45%; by 2050 – 100%. Energy from RES will become the main one in all sectors – electricity, heating and cooling energy, and transport.

3.3.3.4. National Climate Change Management Policy Strategy[16]

This strategy sets out objectives and measures to reduce greenhouse gas (hereinafter – GHG) emissions. The strategy sets out a vision for climate change management policy until 2050: by 2050 Lithuania will ensure the adaptation of the country's economic sectors to environmental changes caused by climate change and climate change mitigation (reduction of GHG emissions), develop a competitive low-carbon economy, implement eco-innovative technologies, achieve increased efficiency in energy production and consumption, and use RES in all sectors of the country's economic sector (energy, industry, transport, agriculture, etc.).

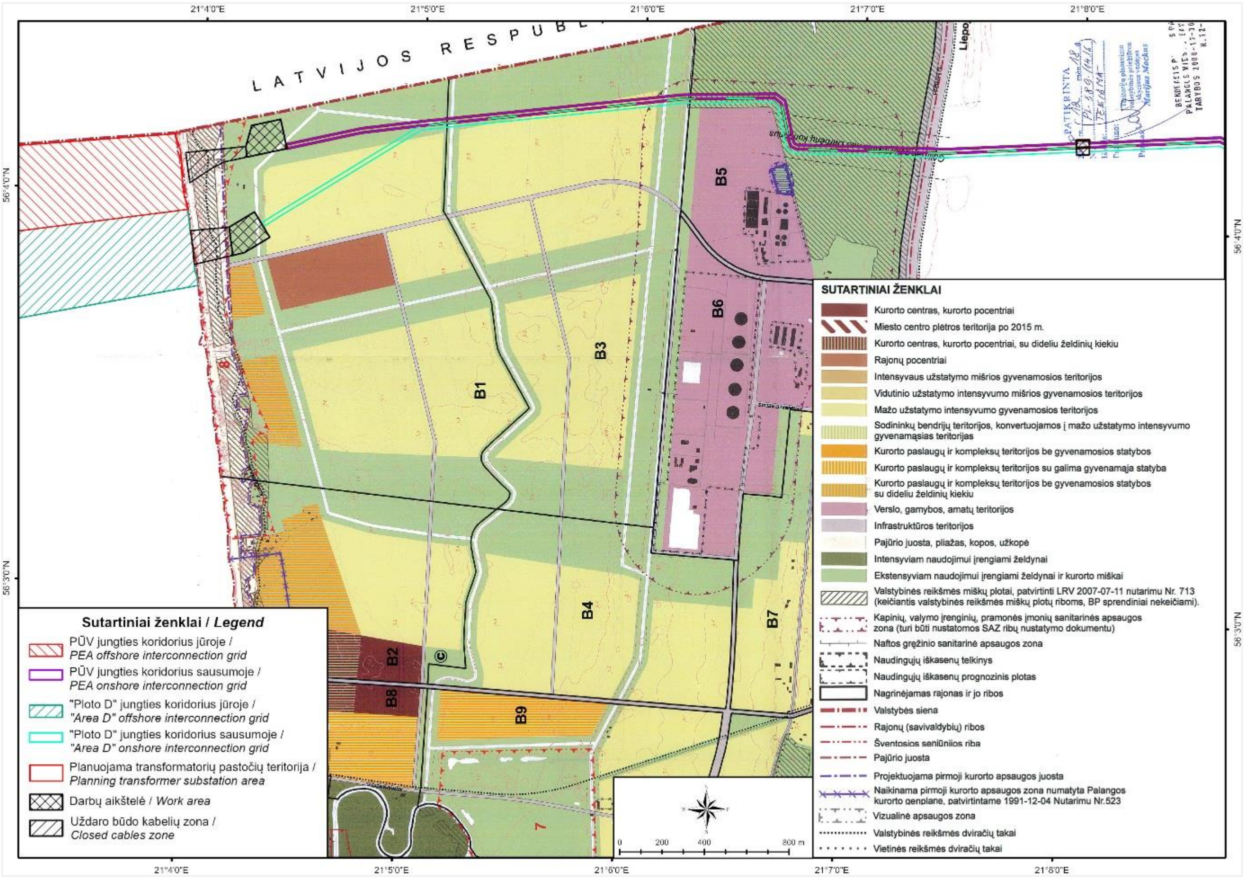
3.3.4. General Plans of Municipal Territories

In the onshore part, the connection cables will cross the territories of two municipalities: Palanga City Municipality and Kretinga District Municipality, where General Plans for Municipal Territories have been approved.

3.3.4.1. Palanga City Master Plan[17]

The connecting routes in the Palanga city territory cross the outskirts of low-density residential areas and green areas for extensive use, as well as forests of state importance (Fig. 3.3.3).

In the decisions of the Palanga City General Plan adjustment, determining priority territories for the development of municipal infrastructure, these territories are marked as non-priority development territories and infrastructure corridors are reserved for state needs (based on the decisions of the Regional Development Plan of the Republic of Lithuania).



[15] Approved by the Seimas of the Republic of Lithuania of 26 June 2018. Resolution No. XI-2133 "on amending the Seimas of the Republic of Lithuania of 26 June 2012. Resolution No. XI-2133 "on approving the national energy independence strategy".

[16] Approved by the Seimas of the Republic of Lithuania in 2012 m. November 6 by resolution No. XI-2375 "on the approval of the national climate change management policy strategy".

[17] Approved by the decision of the Palanga City Municipality Council No. T2-317 of December 30, 2008.

Fig. 3.3.3. Location of connection routes in relation to the solutions of the Master Plan of the Palanga City (map basis: Master Plan of the Palanga City).

3.3.4.2. General Plan of the territory of Kretinga District Municipality and the City of Kretinga[18]

In the General Plan the territory of Kretinga District Municipality is divided into non-urbanized areas and urbanized and urbanizing areas. The largest portion of the municipality's territory is agricultural land – 57%. This is followed by forested land – 36%, land for other uses – 4.9%, water management land – 0.8%, and conservation land – 0.5%.

In all functional zones, the following types of land use are possible: engineering infrastructure corridors, engineering infrastructure areas, water abstraction sites, public spaces, green areas, and squares (in residential areas). All functional zones must consider existing cultural heritage sites, and new cultural heritage property plots are also permitted in all zones. Forest land plots may be included in all functional zones.

The planned routes of the connections are located on forest land and in the functional zones marked as Zk and Za in the general plan of Kretinga city (see Fig. 3.3.4). These zones allow for the development of transportation and engineering infrastructure facilities, engineering network corridors, and energy supply infrastructure areas.

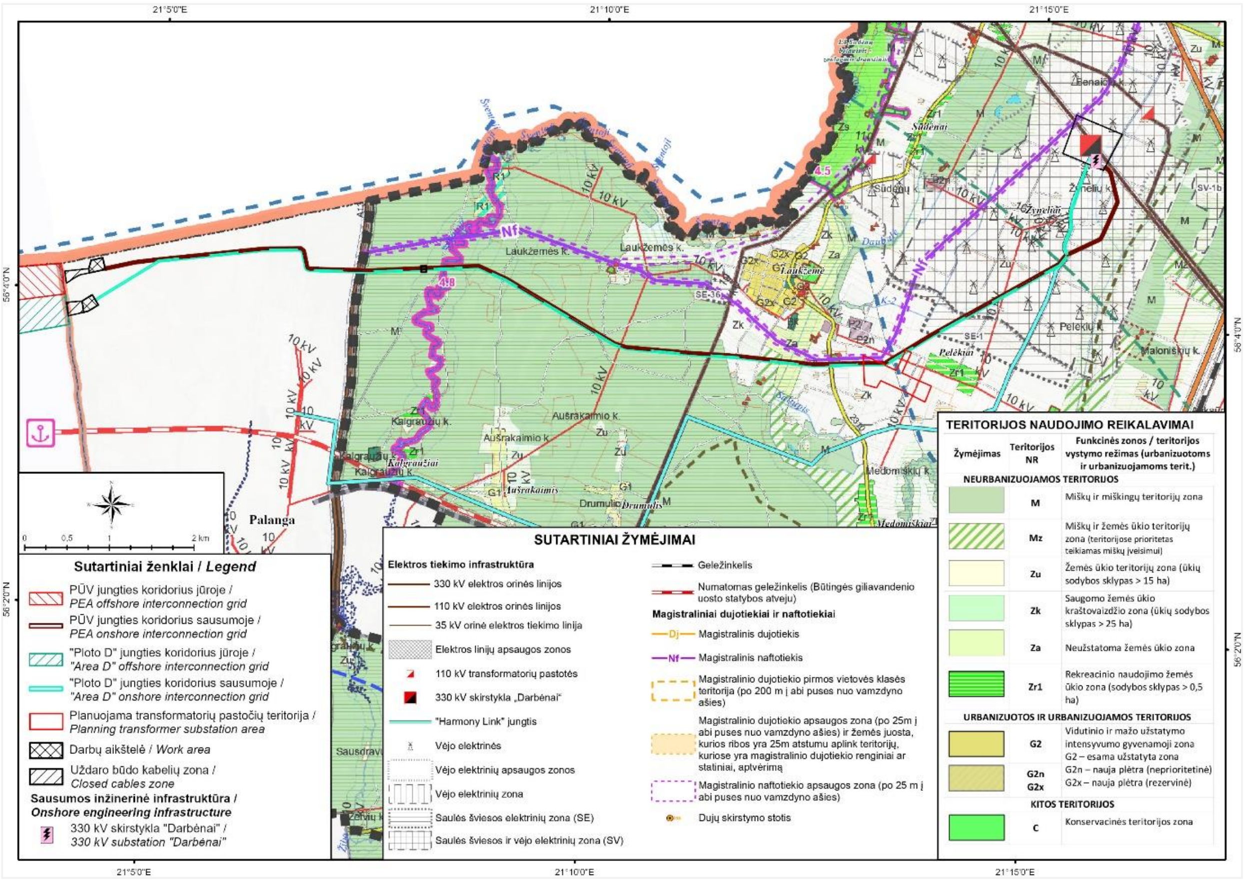


Fig. 3.3.4. Layout of the connecting routes in relation to the solutions of the main drawing of the Kretinga District territory and its part – the Kretinga City General Plan adjustment (map base and legend: main drawing of the Kretinga district territory and its part – the Kretinga City General Plan adjustment in the planned part of the territory).

3.4. Development of WTGs in adjacent areas designated for renewable energy development

The PEA area falls within a territory designated for the development of renewable energy facilities, which is divided into four separate plots. In Territory No. 1 (see Fig. 3.4.1), an EIA was conducted during 2022–2023, and an EIA report was prepared by the Coastal Research and Planning Institute, with the Ministry of Energy of the Republic of Lithuania as the organiser. Based on this report, the EPA issued decision No. (30-2)-A4E-10794 on 23 October 2023, stating that "The PEA of the Ministry of Energy of the Republic of Lithuania – the installation and operation of an offshore wind farm in Lithuanian maritime territory, according to the implementation of project alternative III (development of the offshore wind farm where installation locations are set back 2 km from the boundary of the Klaipėda-Ventspils Plateau Biosphere

[18] Approved by the Kretinga District Municipality Council of 2008-12-18 Decision No. T2-322; Amended by the decision of the Kretinga District Municipality Council of 13 May 2021 No. T2-178 On the approval of amendments to the general plan of the territory of the Kretinga District Municipality and its part - the city of Kretinga.

Polygon and WTGs models up to 350 m in height are used), upon implementation of the measures and conditions specified in parts 6 and 11 of this decision, complies with the requirements of legal acts concerning environmental protection, public health, protection of immovable cultural heritage, fire safety, and civil safety."

In part of Territory No. 2 (see Fig. 3.4.1), an EIA has been conducted for the installation of an OWF. On 4 March 2022, EPA issued decision No. (30.2)-A4E-3820 regarding the extension of the validity of the EIA decision for the feasibility of the installation and operation of an OWF in Lithuanian maritime waters of the Baltic Sea, as planned by UAB "AVEC" in an adjacent maritime territory within the boundaries of the development area outlined in the Scope of the Engineering Infrastructure Development Plan.

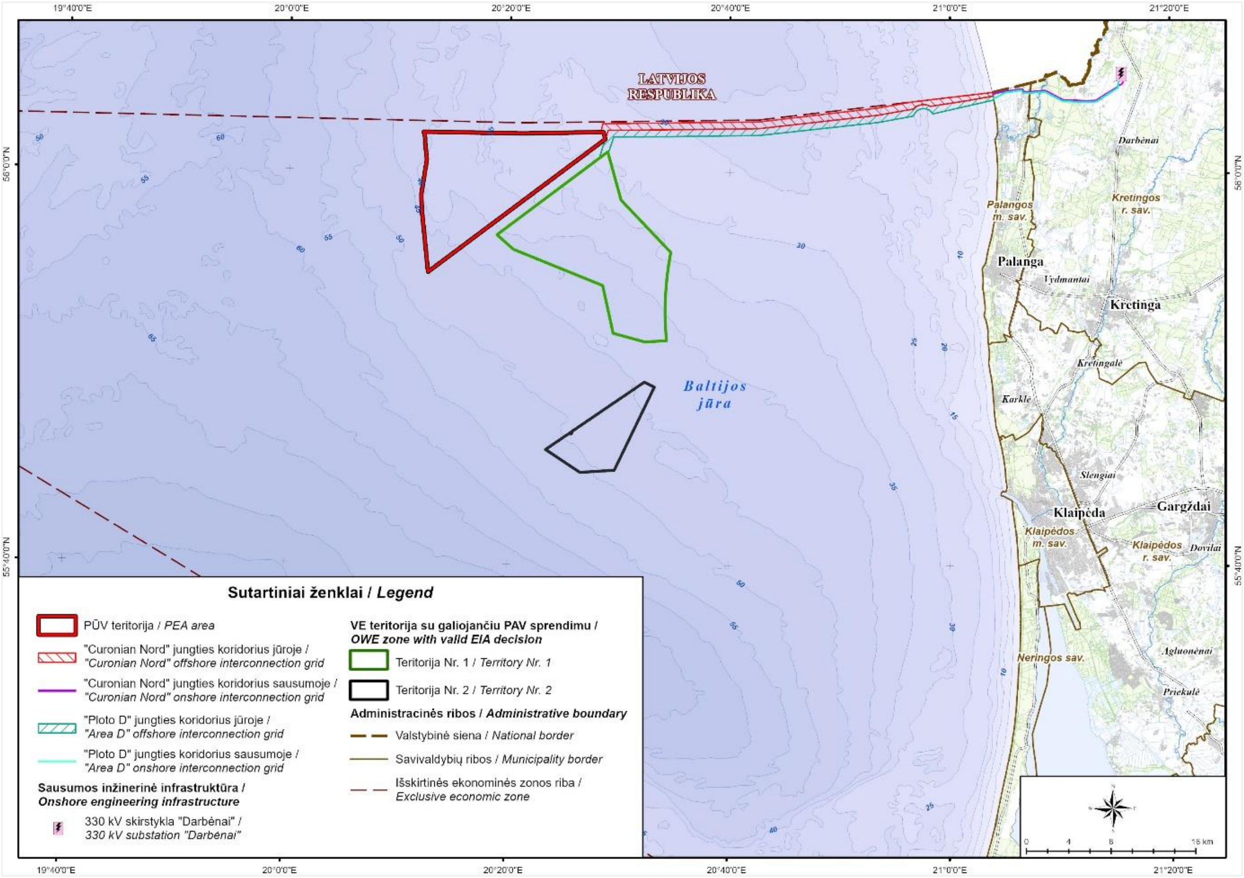


Fig. 3.4.1. OWFs planned in adjacent territories.

4. TECHNICAL INFORMATION FOR ALTERNATIVE DEVELOPMENT

The EIA report evaluates two primary alternatives for the CN OWF: **the "zero" alternative**, i.e., no activity is undertaken, and the **development alternative**, which involves establishing an OWF in Lithuania's maritime territory.

The "zero" alternative, which entails no action, represents the current situation and environmental state, where no changes would occur from the PEA. Importantly, this scenario would impede the implementation of the European Union's energy and climate change policies and the objectives of the NEIS, which aim to reduce GHG emissions.

The OWF Development Alternative involves the establishment and operation of an OWF with a capacity of up to 700 MW in the territory approved by Government Resolution No. 171. The developer may establish an OWF exceeding 700 MW capacity, provided the environmental impact limitations outlined in the EIA (such as OWF size and number of turbines) are adhered to and permitted by prevailing legal regulations.

The EIA report bases the OWF development alternatives on the results of conducted studies, identified significant environmental impacts, and/or the feasibility of applying impact avoidance and mitigation measures.

4.1 Technical solutions for the OWF

Considering the trends in advanced OWF technologies, the technical solutions of existing OWFs in the Baltic and North Seas, and the economic efficiency associated with implementing these advanced technologies, the initial assessment phase for establishing an OWF with an installed capacity of up to 700 MW includes consideration of WTG models with capacities of up to 20 MW potentially exceeding this. Such turbines could reach heights of up to 350 m.

According to Government Resolution No. 171, the specified capacities for WTG in the analysed territory are:

- Maximum allowable generation capacity: 700 MW.
- Minimum installed capacity: 580 MW.

Table 4.1.1. Physical and technical characteristics of WTGs analysed in the EIA report

Parameter	Maximum value
Preliminary power, MW	Up to 20 and more
Maximum number of installed WTGs, units	Up to 68
Maximum tip height, m	350
Maximum rotor diameter, m	300

4.1.1. Principles of WTG layout in the PEA area

The WTG layout will be designed for maximum energy output by minimising the turbine interaction losses (blockage and wake losses) while also respecting minimum inter-WTG distances defined by the WTG manufacturer for safe operation and allow for safe navigation between WTGs.

Considering the decisions outlined in the Development Plan and aiming to maximise the use of the entire area, the outermost WTGs are planned to be positioned at a distance equal to the cable protection zone (100 m) from the boundaries of the territory, thereby structuring the entire grid of wind turbines accordingly.

Considering sea depth, the configuration of the planned area for WTGs installation, seabed conditions, and current land use, two alternatives for the development of the OWF are analysed in the EIA report:

1st Alternative – the maximum development alternative for the OWF. WTGs are arranged throughout the entire area designated for the OWF, applying geometric layout principles. Under this alternative, up to 68 WTGs may be installed (see Fig. 4.1.1).

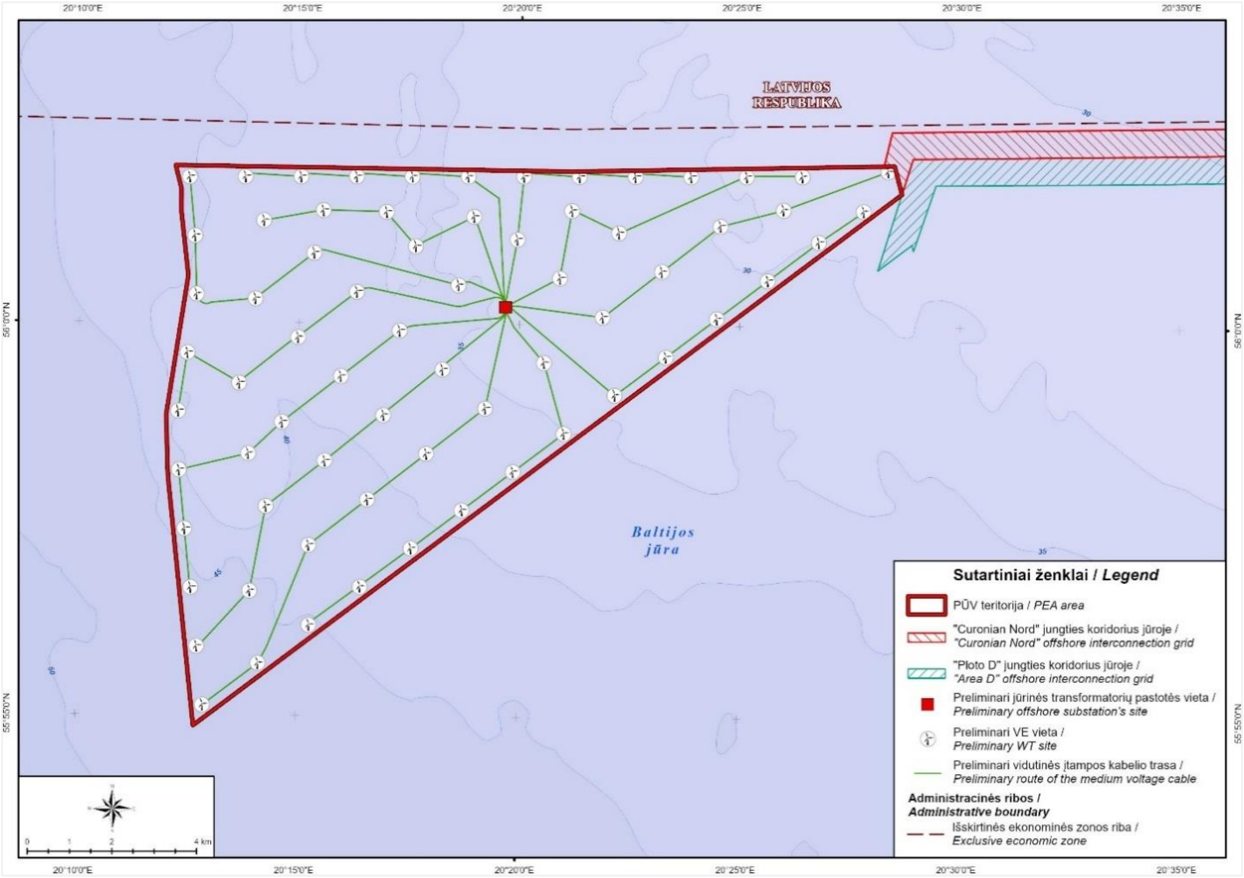


Fig. 4.1.1. Preliminary layout of WTGs in the first maximum development alternative of the CN OWF.

2nd Alternative – optimal development alternative. WTGs are arranged within the area designated for the OWF, maintaining a 2 km setback from the boundaries of the "Natura 2000" Special Protection Area (hereinafter – SPA) and taking into account seabed habitats. Under this development alternative, up to 55 WTGs may be installed (see Fig. 4.1.2).

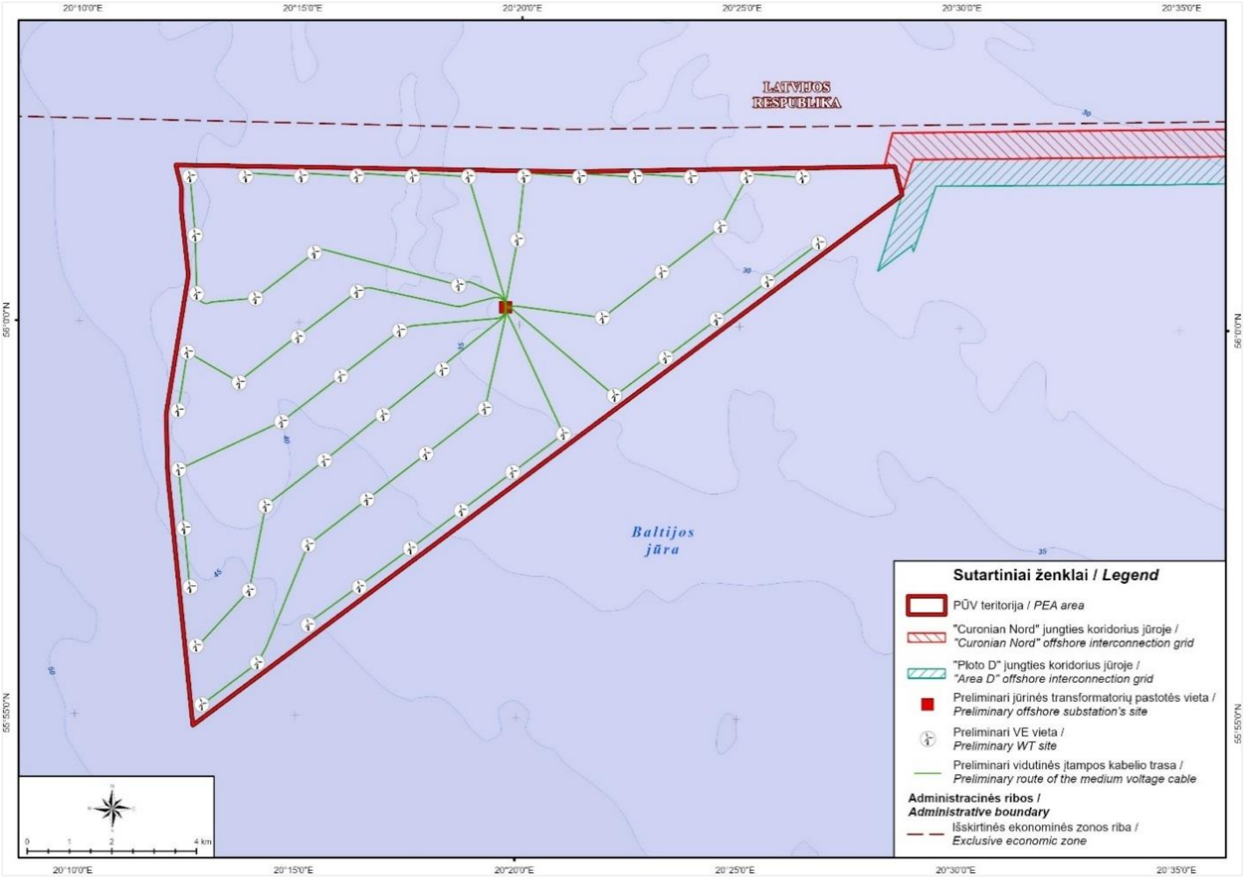


Fig. 4.1.2. Preliminary layout of WTGs according to the second optimal development alternative of the CN OWF.

At the technical design stage, after selecting a specific WTG model and determining its physical-technical parameters, the layout and number of WTGs may be adjusted based on the results of the EIA.

4.1.2. OSS installation solutions

The OSS is intended to collect the apparent power generated by the CN OWF, transform it, and transmit the electricity further into the transmission grid. Typically, the OSS is built at the centre of the generated power or in another location suitable for routing medium- and high-voltage cable lines. The step-up OSS in the OWF does not occupy a significant area[19] – the foundation size is similar to that of a WTG.

The OSS location is also determined by factors such as:

- Sea depth – economically, it is more favourable to build in shallower waters.
- Lengths of medium-voltage cables and energy losses – it is most efficient to construct the OSS at the centre of the generating sources.
- Planned high-voltage connections to onshore and other OWFs.
- Additional wind turbulence caused by the OSS as a structure.

Several alternative locations for the OSS have been proposed In the Engineering Infrastructure Development Plan (see Fig. 4.1.3).

[19] https://www.nordseeone.com/engineering-construction/offshore-substation.html

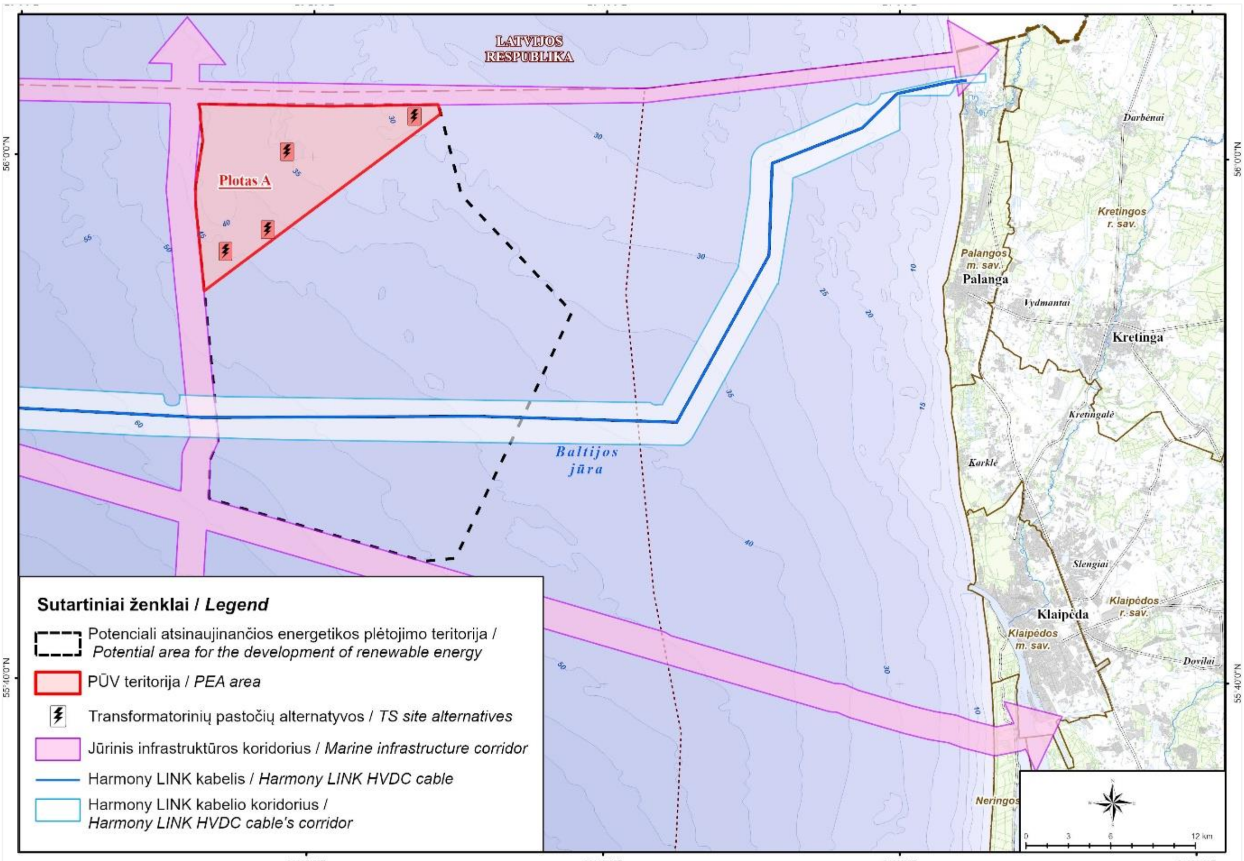


Fig. 4.1.3. Alternatives for the OSS locations of the CN OWF considered in the Engineering Infrastructure Development Plan.

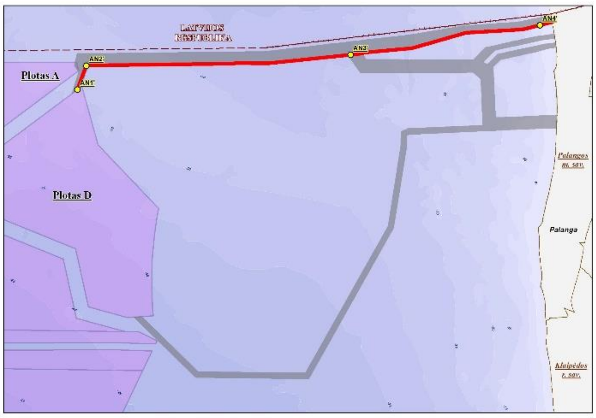
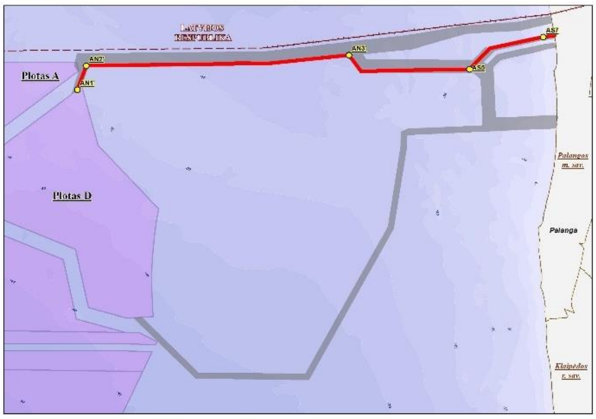
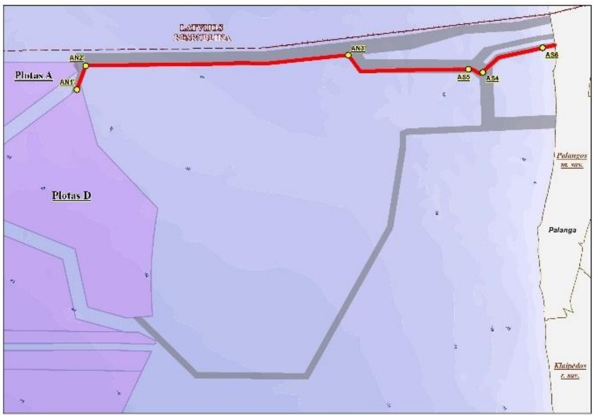
At the EIA stage, the developer selected a location for the OWF in the central part of the OWF (see Fig. 4.1.1–4.1.2). The exact location of the substation and the connection scheme to the electrical grid will be determined during the technical design phase.

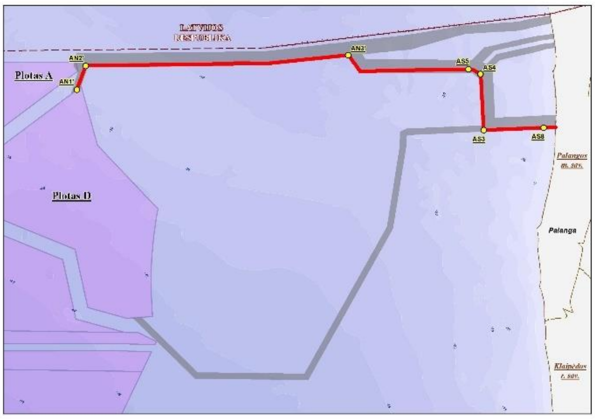
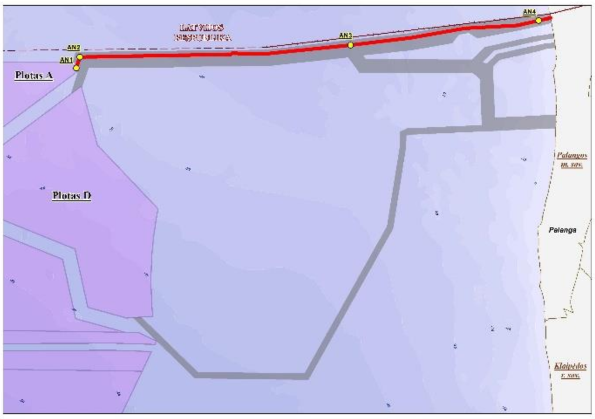
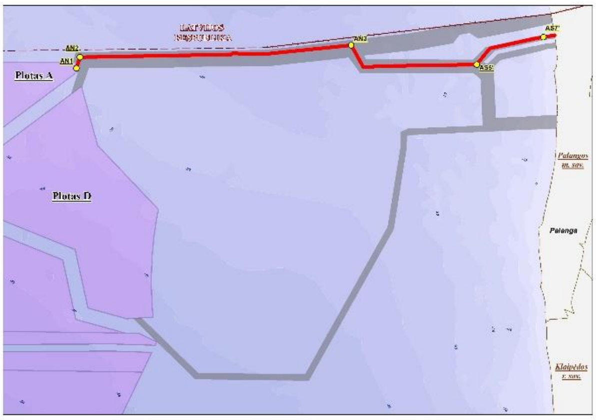
4.2 Connection alternatives for OWF, analysed in the Engineering Infrastructure Development Plan

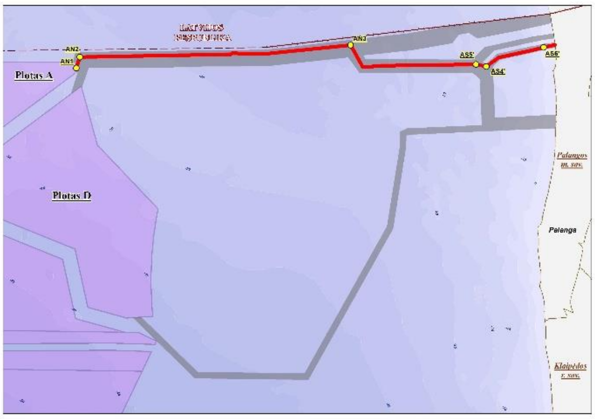
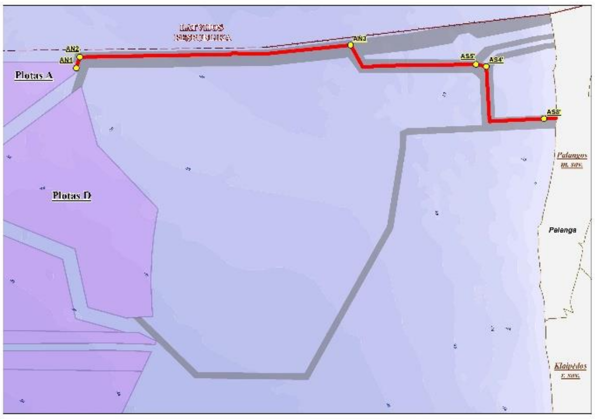
The optimal selection of cable route connections has been conducted within the concept of the Engineering Infrastructure Development Plan for a project of special national importance (see Annex 1) and analysed in the SEA report.

In the SEA report, four route alternatives (A1–A4) were evaluated for the marine section of the corridor connecting the "Area D" OWF to the mainland. Similarly, four route alternatives (B1–B4) were analysed for the marine section of the corridor connecting the CN OWF area to the mainland.

Table 4.2.1. Description of cable route alternatives in the marine section considered in the SEA report

No.	Section numbering and length	Scheme	Characteristics
		Export cabling alternatives for "Area D" OWF	
A1	**AN1'-AN2'-AN3'-AN4'** **37 km**		The alternative follows the northern infrastructure corridor formed by the GP at the Lithuanian–Latvian border. Segment AN1'–AN3': crosses "Natura 2000" marine protected areas (SPA and Special Area of Conservation, hereinafter – SAC) and 1 telecommunications cable. Segment AN3'–AN4': crosses another telecommunications cable.
A2	**AN1'-AN2'-AN3'-AS5-AS7** **38.5 km**		The alternative follows the northern infrastructure corridor defined by GP and partially utilises the protection zone of one telecommunications cable and part of the "Harmony Link" infrastructure corridor. Segment AN1'–AN3': crosses "Natura 2000" SPA and SAC areas and one telecommunications cable. Segment AN3'–AS7: crosses another telecommunications cable, enters the protection zone of one cable, overlaps with the northern part of the "Harmony Link" cable corridor, and crosses the Būtingė terminal tanker fairway.
A3	**AN1'-AN2'-AN3'-AS5-AS4-AS6** **38.5 km**		The alternative follows the northern corridor defined by GP and partially utilises the protection zone of one telecommunications cable, as well as the entire "Harmony Link" corridor. Segment AN1'–AN3': crosses "Natura 2000" SAC and SPA areas and one telecommunications cable. Segment AN3'–AS6: crosses another telecommunications cable, enters the protection zone of one cable and the southern part of the "Harmony Link" cable corridor, and crosses the Būtingė terminal tanker fairway and Šventoji port roadstead.

No.	Section numbering and length	Scheme	Characteristics
A4	**AN1'-AN2'-AN3'-AS5-AS4-AS3-AS8** **42 km**		The alternative follows the northern corridor defined by the GP and utilizes the protection zone of one cable, crossing the "Harmony Link" infrastructure corridor with landfall planned south of the Šventoji port roadstead. Segment AN1'–AN3': crosses "Natura 2000" SPA and SAC areas and one telecommunications cable. Segment AN3'–AS8: transitions into a cable corridor, crosses the Būtingė terminal fairway, the planned "Harmony Link" HVDC cable, and three existing telecommunications cable routes. Landfall is planned in front of the Šventoji cultural heritage zone (onshore).
		Export cable alternatives for CN OWF	
B1	**AN1-AN2-AN3-AN4** **35.5 km**		Follows the northern corridor defined by GP at the Lithuanian-Latvian border. Segment AN1–AN3: crosses "Natura 2000" SCA and SPA and one telecommunications cable. Segment AN3–AN4: crosses another telecommunications cable.
B2	**AN1-AN2-AN3-AS5'-AS7'** **37 km**		Uses the corridor defined by GP, one telecommunications cable corridor, and partially the "Harmony Link" corridor. Segment AN1–AN3: crosses "Natura 2000" SCA and SPA and one telecommunications cable. Segment AN3–AS7': crosses another telecommunications cable, continues through a cable corridor and the northern part of the "Harmony Link" cable corridor, and crosses the Būtingė terminal fairway.

No.	Section numbering and length	Scheme	Characteristics
B3	**AN1-AN2-AN3-AS5'-AS4'-AS6' 37 km**		Uses the corridor defined by GP, a telecommunications cable corridor, and the entire "Harmony Link" corridor. Segment AN1–AN3: crosses "Natura 2000" SCA and SPA and one telecommunications cable. Segment AN3–AS6': crosses another telecommunications cable, continues through a cable corridor and the southern part of the "Harmony Link" corridor, and crosses the Būtingė terminal fairway and Šventoji port roadstead.
B4	**AN1-AN2-AN3-AS5'-AS4'-AS8' 40.5 km**		Uses the corridor defined by GP and a telecommunications cable corridor, crossing the "Harmony Link" corridor with landfall planned south of the Šventoji port roadstead. Segment AN1–AN3: crosses "Natura 2000" SCA and SPA and one telecommunications cable. Segment AN3–AS8': transitions into a cable corridor, crosses the planned "Harmony Link" HVDC cable corridor and the Būtingė terminal fairway, and intersects three existing telecommunications cable routes. Landfall is planned in front of the Šventoji cultural heritage zone (onshore).

Considering the landfall locations of the export corridor alternatives in the onshore part of the territory, the SEA report analysed 24 route alternatives for the connections (see Fig. 4.2.1).

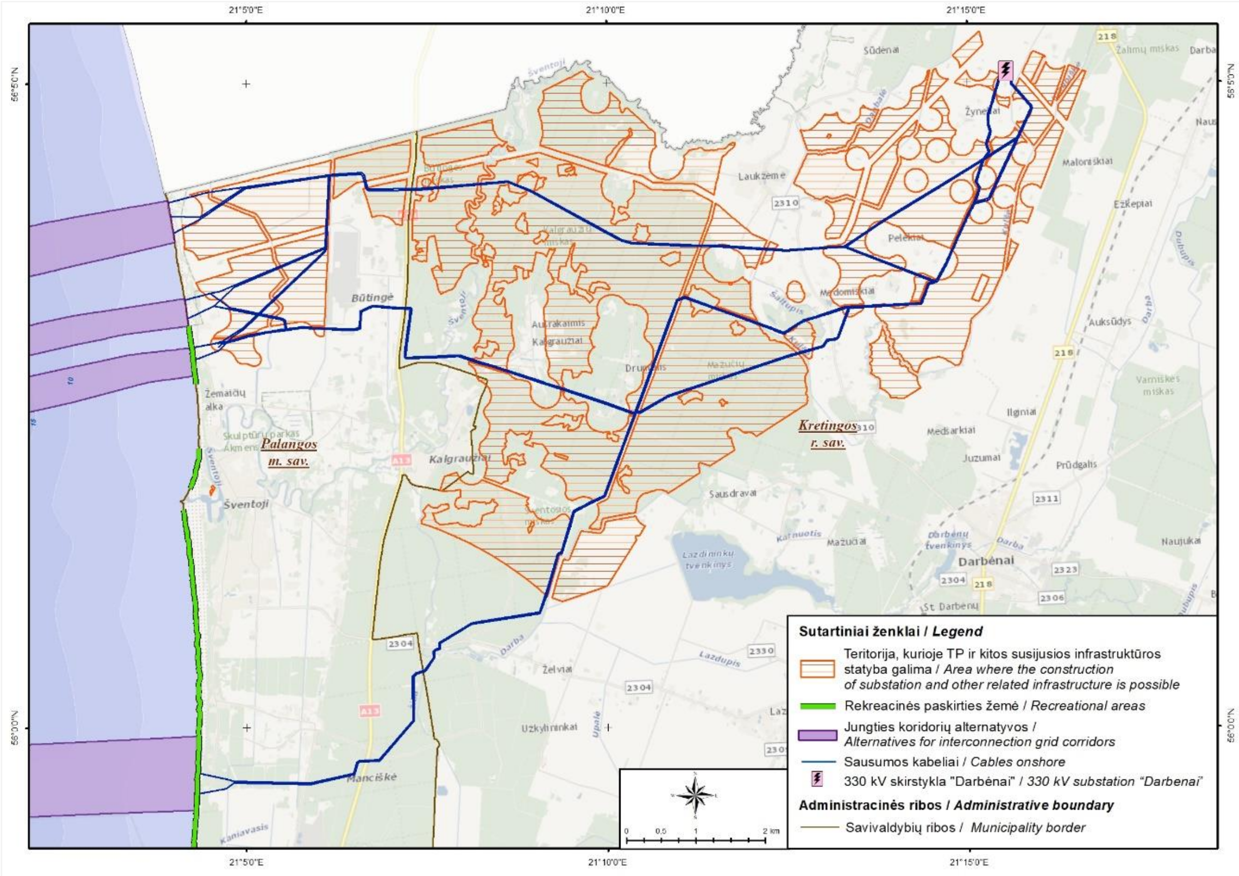


Fig. 4.2.1. Planned connection alternatives situational map for the onshore area.

According to the concept of the Engineering Infrastructure Development Plan and the SEA conducted for "Area A", which analyses the feasibility of connecting the CN OWF to the shore, the B1–C2 alternative is proposed (see Fig. 4.2.2). For the connecting the planned "Area D" OWF, the A1–C1 alternative is suggested (see Fig. 4.2.3). These alternatives are further analysed in this EIA report. Other connection route alternatives are no longer considered in this EIA report.

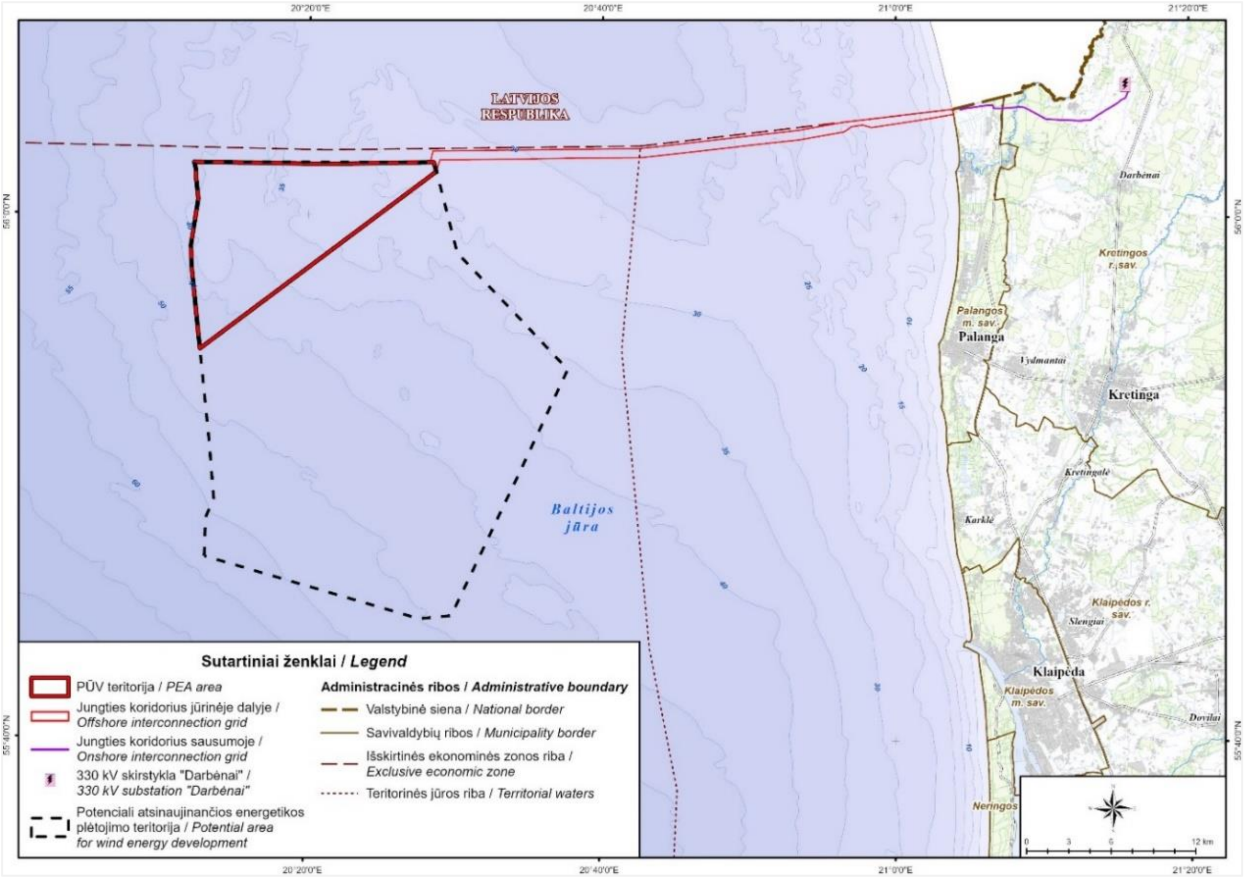


Fig. 4.2.2. Planned connection alternative of the CN OWF situational map for the offshore and onshore.

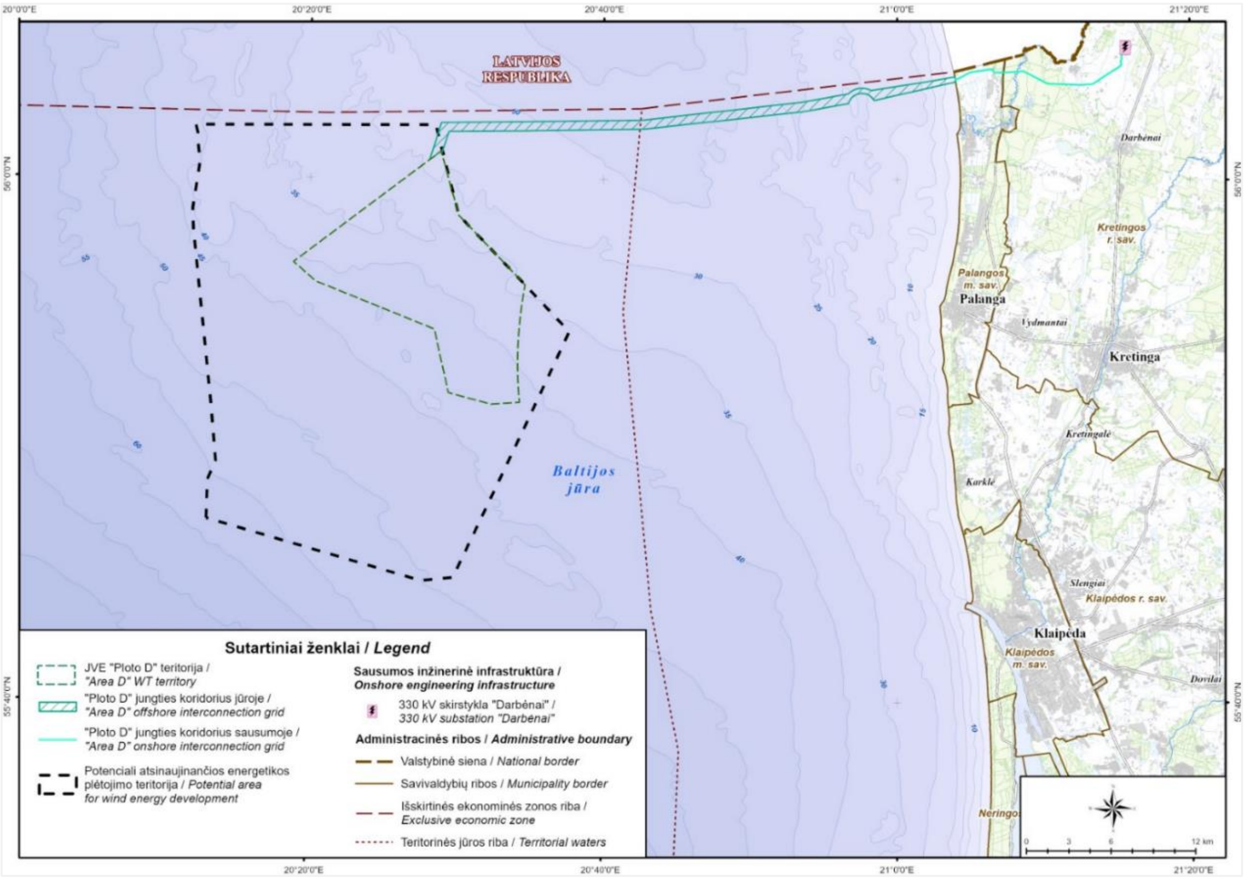


Fig. 4.2.3. Planned connection alternative of the “Area D” OWF situational map for the offshore and onshore.

5. EXPECTED SIGNIFICANT IMPACT OF THE PEA. MEASURES TO PREVENT, MITIGATE AND COMPENSATE FOR SIGNIFICANT ADVERSE IMPACT ON THE ENVIRONMENT

This section outlines the potential significant impacts of the CN OWF and the “Area D” transmission grid across all development stages – construction, operation, and decommissioning – on environmental elements. These elements include water (surface and subsurface), soil, air, climate, landscape, and biodiversity, with particular emphasis on species and natural habitats of Community interest and other species protected under the Act on Protected Species of Animals, Plants, and Fungi. Additionally, the section covers areas of environmental importance, material assets, immovable cultural assets, and the interaction between these elements. It also addresses public health, including the interaction between environmental elements and public health.

5.1 Water

This section provides information about surface water bodies located within and in the immediate vicinity of the PEA area, including the Baltic Sea. It details existing hydrological, hydrodynamic, and hydrochemical conditions, as well as rivers intersected by the onshore connection route. Additionally, it discusses groundwater resources and the potential impacts of the PEA on these water elements.

5.1.1. Survey methods

The current hydrodynamic status in the OWF development area and the surrounding territory in the Baltic Sea was assessed using several sources. These include measurements from the Fugro Lidar buoy SWLB94 taken from February 2024 to February 2025 within the OWF area, the latest hydrological and hydrochemical data from the field campaign conducted in the PEA area in March 2024, the “MetOcean Study for Curonian Nord” (Deltares, 2024), open data from Baltic Sea models, and publicly available scientific literature.

Numerical model results used in the EIA:

- “Metocean study for Curonian Nord” a modelling study for the PEA, was prepared by Deltares in 2024.
- To characterise the open sea conditions, results from the Copernicus Marine Service's Baltic Sea mathematical models were utilised. The Baltic Sea Physics Reanalysis model[20] provided data on currents, salinity and water temperature for the period 2015–2021. This is a 3D numerical model for the Baltic Sea, covering all main hydrodynamic parameters (currents, temperature, salinity, water level). The horizontal resolution is 2x2 km with 56 layers on a vertical axis.
- Wave height and direction data for the period 1993–2023 were obtained from the Baltic Sea Wave Hindcast model[21]. These are the results of the WAM 4.7 cycle model published by the Swedish Meteorological and Hydrological Institute, based on meteorological data from the European Centre for Medium-Range Weather Forecasts (hereinafter – ECMWF) ERA5 reanalysis model (recalculated with measured data). The model grid resolution is 1 nautical mile.
- Ice cover data were analysed from the open access data product on Copernicus Marine Service called Baltic Sea ice concentration, extent, and classification time series[22]. This provides timeseries on ice concentration, distribution and classification based on the satellite data. These are the results of the WAM 4.6.2 cycle model published by the Finnish Meteorological Institute, based on meteorological data from the ECMWF ERA5 reanalysis model.

The current hydrochemical status was assessed using EPA environmental monitoring data collected near the PEA area for the period 2014–2019. During the EIA in March 2024, water samples for hydrochemical analysis were collected within the PEA area, with sampling points illustrated in Fig. 5.1.1. Water samples were obtained using a "Hydrobios" bathometer at eight sites (5, 18, 27, 29, 33, 39, 41, 46) from both the surface layer (at a depth of 0.5 m) and the bottom layer (approximately 0.5 m above the seabed). Additionally, two samples (station No. 101, 102) were taken from the bottom layer adjacent to a sunken object to assess its potential impact on seawater quality.

Pollutants such as petroleum hydrocarbons (C10-C40), polyaromatic hydrocarbons (PAHs), heavy metals (As, Cd, Cr, Cu, Ni, Pb, V, Zn, Hg) were analysed in the certified laboratory of Vandens tyrimai, UAB, in accordance with LST EN ISO/IEC 17025:2018 standards.

[20] Copernicus Marine Service Baltic Sea Physics Reanalysis model https://doi.org/10.48670/moi-00013

[21] Copernicus Marine Service Baltic Sea Wave Hindcast https://doi.org/10.48670/moi-00014

[22] Copernicus Marine Service Baltic Sea ice concentration, extent, and classification time series https://doi.org/10.48670/moi-00131

5.1.1.1 Potential impact assessment methods

The potential impact on water was assessed from several perspectives:

- **Hydrological, hydrochemical, and hydrodynamic conditions:** examined at the WTG foundation installation sites and along the planned cable-laying routes.
- **Chemical condition of the sea area**, evaluated in terms of pollutant concentrations in water, as well as the potential effects of future works on existing conditions and on compliance with the characteristics of GES were evaluated. This assessment is based on the standards outlined by the Order of the Minister of Environment of the Republic of Lithuania (4 March 2015, No. D1-194) *"On the Approval of the Characteristics of Good Environmental Status of the Sea Area of the Republic of Lithuania"*.
- **Expected hydrodynamic and hydrochemical changes** during construction, operation, and decommissioning of WTGs due to new infrastructure introduced into the marine environment.
- **Compliance with Land Use Conditions:** it has been evaluated whether the proposed cable-laying works in the continental territory adhere to the requirements of the Special Land Use Conditions.

5.1.2. Study area

Research area includes present state study area, PEA area as well as potential impact assessment area both offshore and onshore.

5.1.2.1. Marine area

In analysing the current state, primary focus was given to measurements conducted within the PEA territory and the marine area of the interconnection grids. The locations of data collected in 2024 are indicated in Figure 5.1.1. Modelling data were analysed within the PEA territory and a surrounding area with a 10–20 km radius, marked with a grey rectangle on the map. Additionally, the common hydrodynamic and hydrochemical conditions for the southeastern Baltic Sea were described.

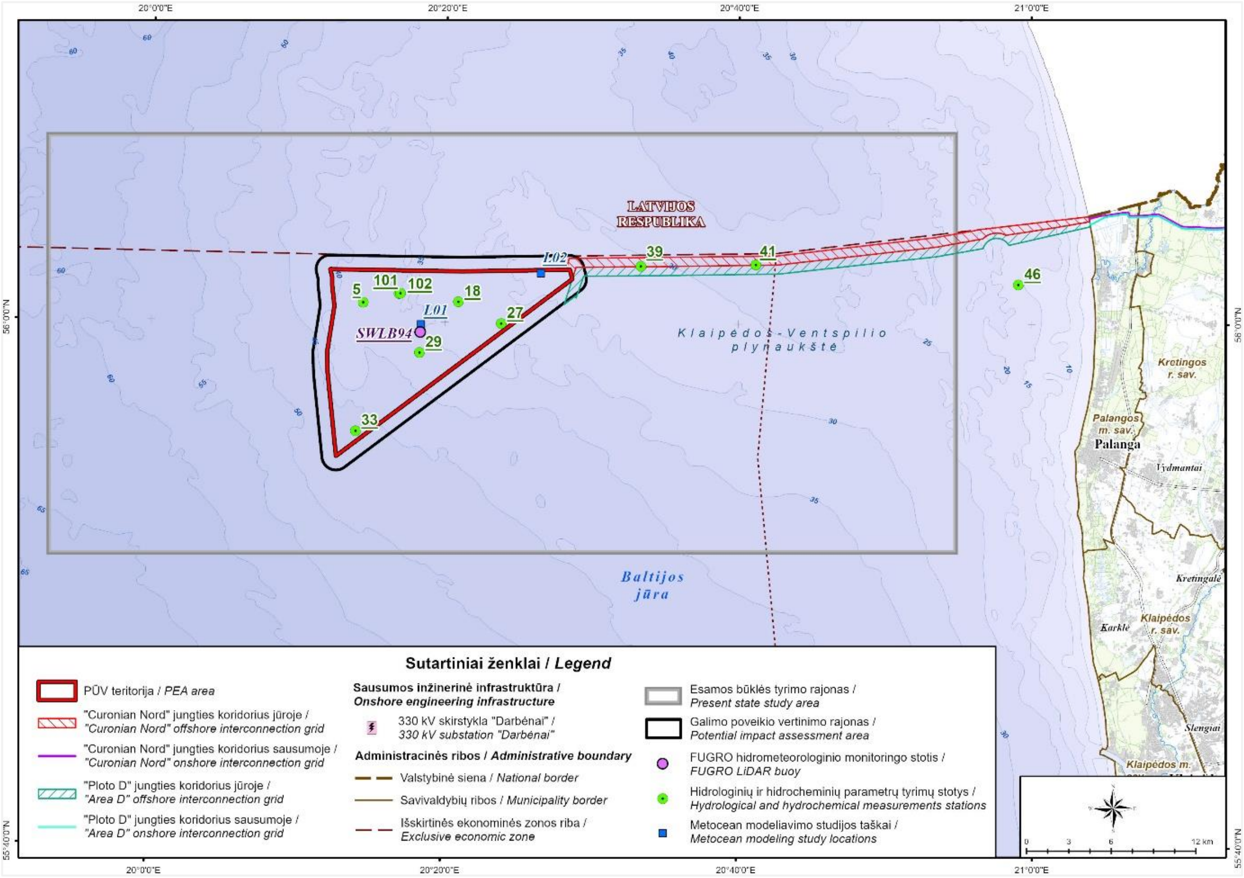


Fig. 5.1.1. Marine part of the water survey area.

5.1.2.2. Continental area

The onshore surveys encompassed areas adjacent to the onshore export cable installation site. The following chapters provide maps detailing the areas adjacent to groundwater bodies, areas significant to groundwater bodies and their protection zones, and areas of importance regarding flooding and inundation.

5.1.3. Current status

5.1.3.1. Offshore

5.1.3.1.1. Hydrological and hydrodynamic regime of the Lithuanian marine area

PEA is in Lithuania waters, in the southeastern part of the Baltic Sea. The hydrological and hydrodynamic conditions prevailing in this area – including the open sea, territorial sea, and coastal areas – are representative of the general situation in the Baltic Sea Region (Žaromskis, Pupienis, 2003).

5.1.3.1.2. Waves

The Baltic Sea is a closed sea, not characterised by tidal waves; wind-driven waves dominate, making the wave regime primarily dependent on wind patterns. Along the Lithuanian coast, the average annual wave height is approximately 0.7 meters. Of the total observed wave heights, 50% are up to 0.6 m, and 90% are up to 2 m high. According to Kelpšaitė et al. (2011), high waves (exceeding 5 m) occur on average once every 10 years in the coastal area. The calmest wave conditions are typically observed from May to August, while the highest swell (wave height >2.5 m) generally occurs during the cold season (October to February, particularly December) when strong westerly, southwestern, or west winds prevail. Waves from the eastern direction are relatively small, usually being less than 0.5 meters. This typical wave regime is characteristic of the coastline down to a depth of 20–25 meters. Additionally, a mixed wave climate is frequently observed, with waves of 2–3 m in height accompanied by swell.

The latest data, measured from February 2024 to February 2025 using the Fugro Seawatch LiDAR observation systems (SWLB94) installed in the PEA area, revealed that the highest waves in the adjacent planned OWF were recorded during a storm on January 3rd, 2025. On that day, wave heights exceeded 10 m twice within a half-hour period, with a maximum height of 10.38 meters. There was one instance of a wave height over 9.5 m, and other recorded wave heights varied between 6 and 8.5 m, predominantly from the southwest. In other months, maximum wave heights ranged from 4.9 m in February 2025 to 9.2 m in December 2024, with the mean direction being southwest (see Fig. 5.1.2). Comparatively, during measurements conducted from July to December 2022 in the planned “Area D” OWF, the highest waves were observed in September–October, with a maximum of 6.69 m (CORPI, 2022–2023). In the summer months, the highest wave reached 3.77 m in July and 5.5 m in August. It was found that the highest waves occurred from September to December, while the smallest were recorded in July and August. During the summer, waves were generated by western winds, whereas in autumn, they were driven by southwestern winds, and in December, by southern winds.

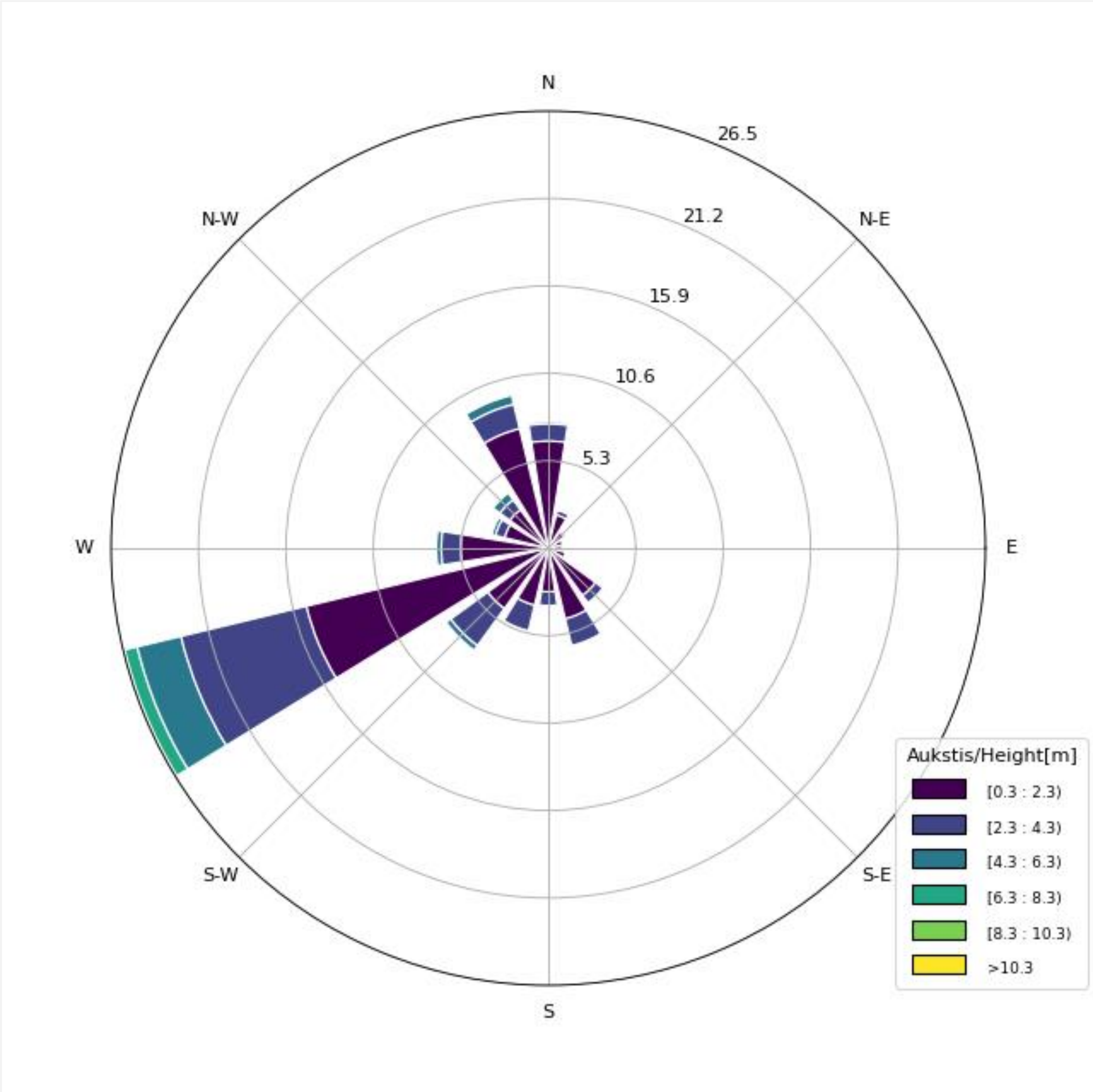


Fig. 5.1.2. Wave rose compiled from the raw SWLB94 buoy data.

To characterise open sea conditions, during EIA an analysis of modelled waves for the Baltic Sea was conducted. Significant wave heights and other wave parameters were obtained from two sources:

- Metocean study for CN (Deltares, 2024), were the hydrodynamic and wave modelling study was prepared for the PEA area.
- the Copernicus Marine Service open access Baltic Sea wave model for the period 1993–2023.

Waves modelling in the Metocean study was performed with a SWAN model for the period from 1979 until 2023. A spatial resolution of the model varied from a maximum of 280 m in the PEA area to a maximum of 1,800 m further offshore. The model was well-calibrated and validated. Results of the 45-year simulation showed that the waves are predominantly from West and Southwest and more extreme and longer from the West. The significant wave height was simulated being close to 1.3 m, the standard deviations close to 0.94 meters. Maximum wave height ranged between 9.1 m and 9.4 meters. At the northeastern, shallower edge of the OWF wave heights are lower (Fig. 5.1.3).

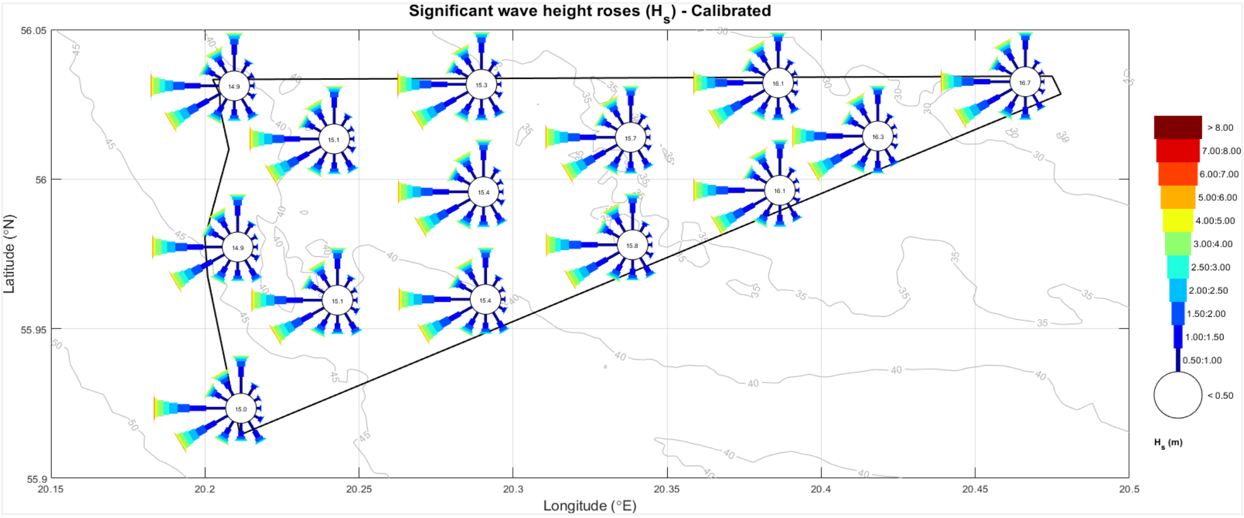


Fig. 5.1.3. Significant wave roses for the PEA area based on the SWAN model simulations for the period 1979–2023 (compiled by Deltares, 2024).

The modelling data were analysed by season (Fig. 5.1.4). As in the coastal area, higher waves are observed during the cold season – October to February – with an average of 1.4–1.65 m, while in the warm season, the wave height fluctuates around 0.7–0.85 m. Notably, waves in the western part of the PEA area are, on average, 0.05 m higher. Hourly model data were also analysed to determine the maximum modelled wave height. According to the 2015–2023 period of modelled data, the largest modelled wave heights were more than 8 m and recorded twice: 8.87 m on January 11, 2015, during Hurricane Felix, and 8.6 m on March 12, 2020, during Storm Laura. Wave heights up to 2 m accounted for 85% of the modelled period.

The figures do not depict the direction of the waves; however, wave direction was calculated for the period 2011–2020 for all PEA area using the same model data. Results showed that prevailing wave directions are from west (23.5% from all directions) and southwest (18% from all directions) directions that agree with typical whole south-eastern Baltic Sea conditions.

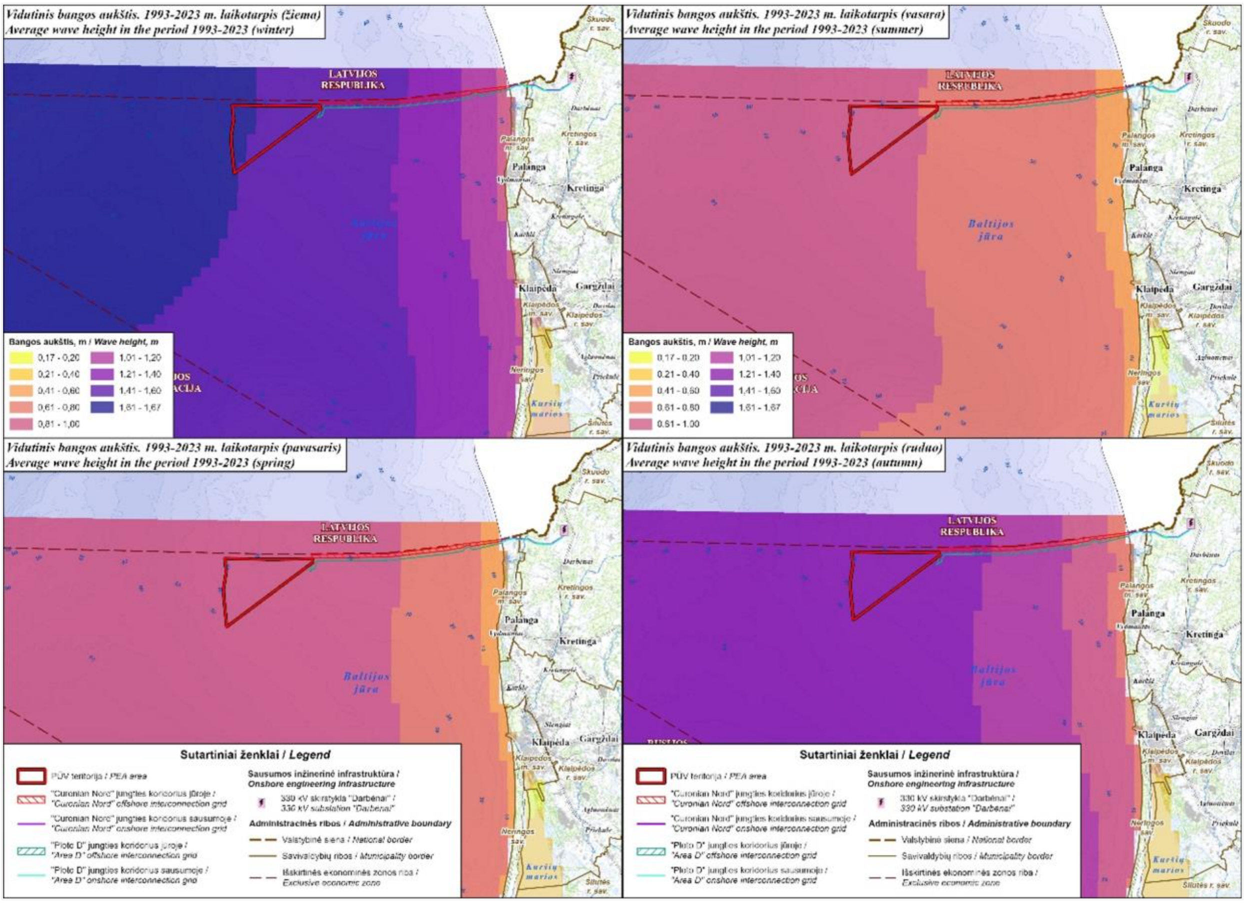


Fig. 5.1.4. Average wave height by season based on 1993–2023 Copernicus Marine Service Baltic Sea wave model data.

5.1.3.1.3. Currents

The Lithuanian waters are characterised by a "cyclonic" direction of the Baltic Sea currents (counterclockwise) (Žaromskis, 1996) that form a predominantly south to north transport of water along the coast. However, the interaction with the atmospheric processes and inert water mass forms a complex structure at surface and deeper areas. The different activity of atmospheric processes over the Baltic Sea at different times of the year is also reflected in the annual variation of flow velocities. It is observed that the lowest flow velocities occur in the spring-summer season and the highest in the autumn-winter season. In addition, wind-driven flow velocities decrease with depth.

According to long term monitoring data for the period 1960–2001, in the south-eastern part of the Baltic Sea, the surface layer of 0-10 m is dominated by weak and moderate currents, with velocities usually not exceeding 0.20 m/s (Žaromskis, Pupienis, 2003). In the area up to the 35 m isobath, northward currents prevail. Flows are much less frequent in a southerly direction, and least frequent in a south-westerly direction. To the North from Klaipėda, the freshwater flow from the Curonian Lagoon also influences the direction of flows (forming a relatively constant northward flow). Further offshore, at the depths 35–45 m, south-westerly, southerly and westerly flow directions prevail. Further to the West, beyond the 45 m isobath, flows are directed to the east and north-east.

In the intermediate layer (10–30 m), different flow regimes develop. In the marine area up to 35 m depth, similarly as in the surface layer, northward flows prevail. Less frequently, flows are directed to the south and west. Beyond the 45 m isobath, north and north-easterly flows predominate. In the intermediate layer, flow velocities range from 0.11 to 0.14 m/s.

The bottom layer is mostly dominated by weak flows of 0.07–0.09 m/s. In the marine area up to 35 m depth, north-westerly and south-easterly flow directions prevail. North-westerly, westerly and south-westerly directions dominate in depths between 35 and 45 m, and northerly deeper than 45 m (Žaromskis & Pupienis, 2003).

The latest measured data for the period from February 2024 to February 2025 from the Fugro Seawatch LiDAR observation systems (SWLB94) showed that the average current speed at 2 m depth is 10.4 cm/s, at 25 m depth – about 8 cm/s and close to the bottom – 5.5 cm/s. The maximum surface current speed was 112.75 cm/s (June 24, 2024) and direction was to the East. The current roses from the raw buoy data for different measured depths are presented in Figure 5.1.5.

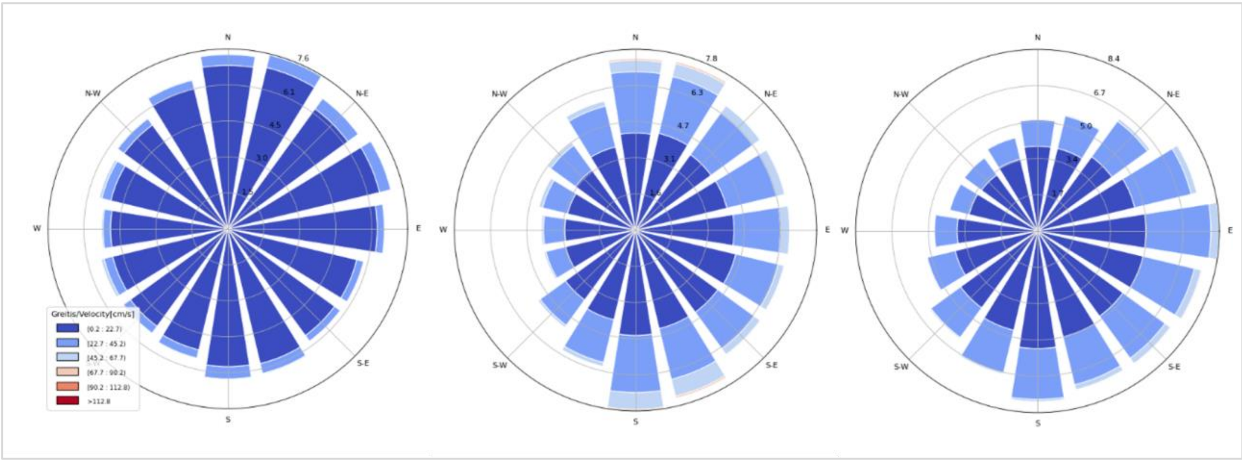


Fig. 5.1.5. Currents rose compiled from the raw SWLB94 buoy data (left – at 2 m depth, middle – 20 m depth, right – bottom layer, 39 m depth).

In the “Metocean study for the Curonian Nord” (Deltares, 2024), the modelling results were provided by two models: i) 2DH Flow-FM hindcasts (covering the 45-year period from 1979 until 2023); ii) the 30-year 3D Flow-FM hindcasts period (1979–2023). The results showed that the currents in the PEA area are generally low (<0.3 m/s) and the tidal component of less than 0.1 m/s. The detailed analysis for two sites representing the PEA and the export cable corridor area were generated in this report. Site CN-01 is in the middle of the PEA area and CN-02 is close to the export cable corridor area, representing the shallower part of the PEA (sites are shown in Fig. 5.1.1.). Analysis of the presented current roses (Fig. 5.1.6.) revealed that in the centre of the PEA the current directions are directed to the north and north-east on a surface mostly with the speed up to 0.4 m/s. While the prevailing direction of the bottom currents were directed to north, other significant directions were to northwest, northeast and southeast, with the speed up to 0.15 m/s. The CN-02 site showed the higher variability for the current direction with the prevailing direction from north to southeast, while the current speed was like the CN01 site. The most often bottom layer directions were to the northeast, west and southwest.

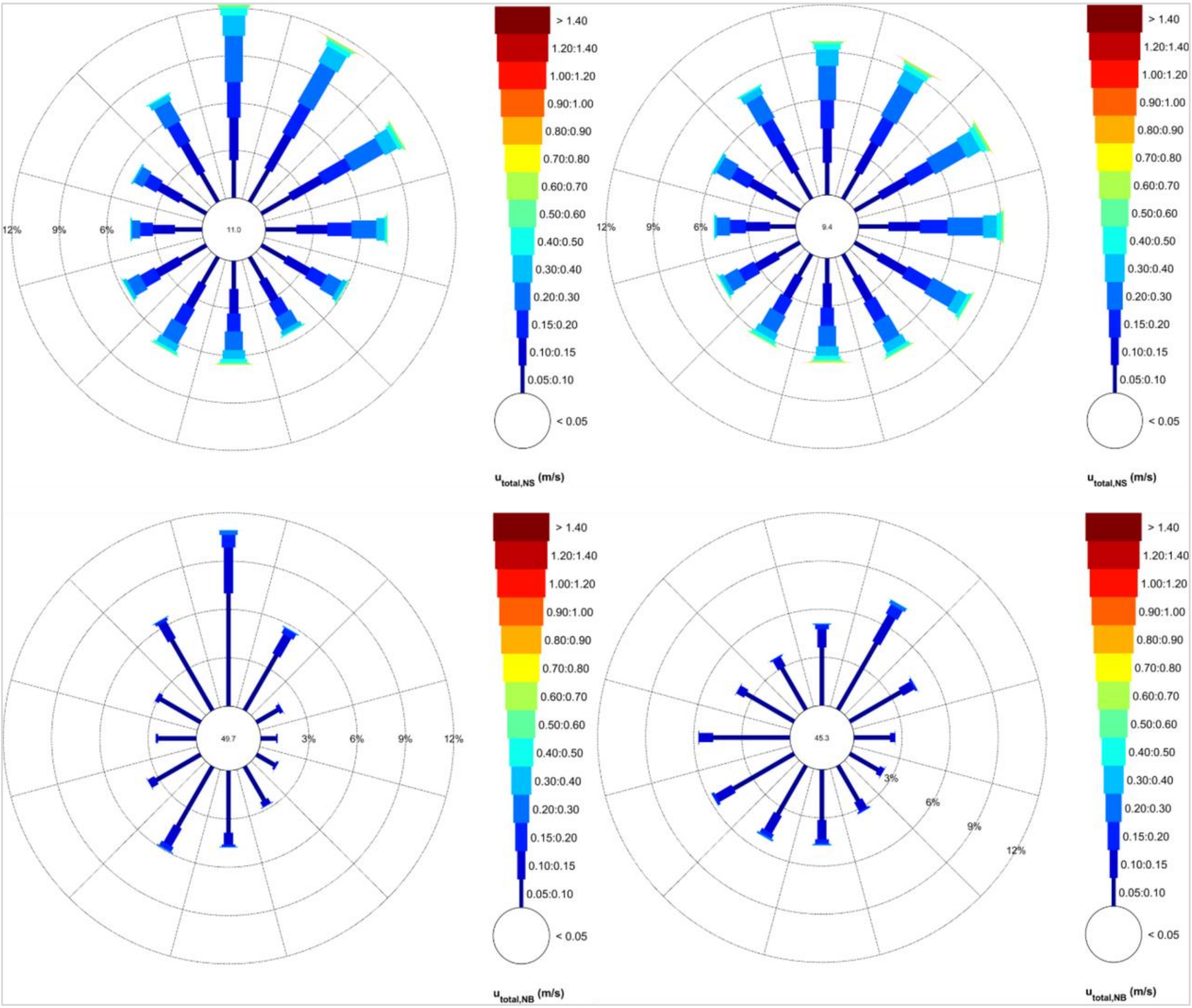


Fig. 5.1.6. Current roses from the Metocean modelling study. Surface currents on the top panels and bottom currents on the bottom panels. On the left, the results for the CN-01 site and on the right for CN-02 site is shown (compiled from Deltares, 2024).

As part of this EIA, a more detailed flow analysis was carried out based on the Copernicus Marine Service's open-source Baltic Sea Physics Reanalysis model. From the model average monthly northward and eastward sea water velocity for the period 2015–2021 were extracted and maps of average flow velocity (m/s) and direction (in degrees) for individual seasons (spring, summer, autumn, winter) were produced. Overall statistics were calculated from the daily model data for the same period.

It was determined that in general the OWF area is dominated by low surface and bottom currents, with average speed up to 3–4 cm/s in the surface layer and 1–3 cm/s in the bottom layer in the area within the OWF and the surrounding area (Fig. 5.1.7–5.1.8). The maximum flow velocity calculated from the daily data was 25 cm/s.

The differences between the average surface currents in individual seasons are shown in the figures 5.1.7 and 5.1.8. In spring, the current velocities in the OWF area are the lowest, about 2 cm/s on average, with current directions to the North and Northwest. In summer, current velocities vary between 2.5 and 3.3 cm/s, with a more southerly or south-easterly direction. In autumn, surface currents are the strongest with a speed 2–4 cm/s and predominantly East-Northeast directions. In winter, the speed of the surface currents was 3–4 cm/s in the Northeast direction. In the bottom layer, southward currents of 1–1.5 cm/s prevail in spring. In summer, 5 cm/s speed with East to Sout East direction currents; in autumn, 2–3 cm/s speed with East to Northeast direction; in winter, the speed is ~1.5 cm/s and prevailing direction to Northeast.

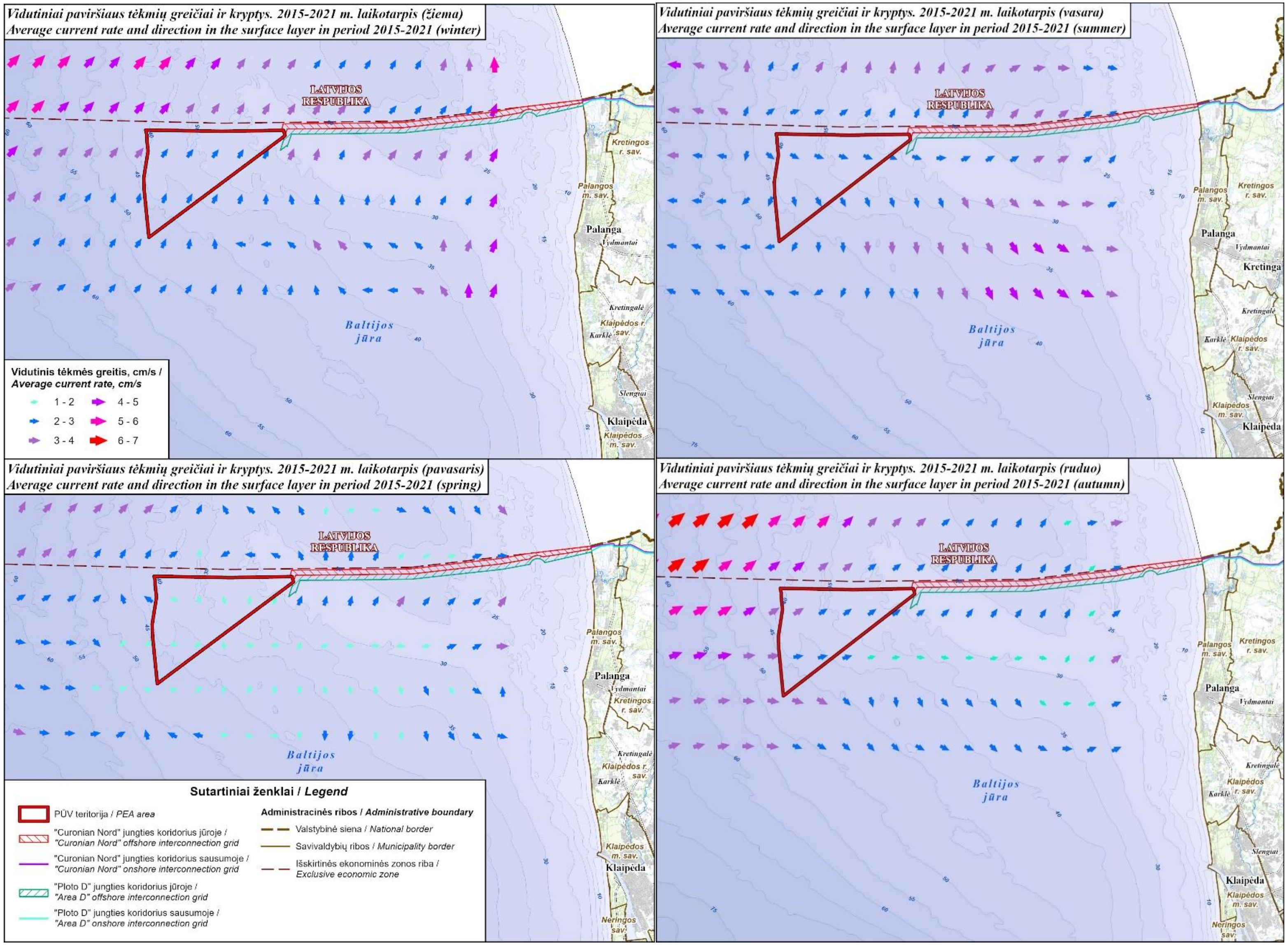


Fig. 5.1.7. Average speed and direction of currents in the surface layer (based on the results of the Copernicus Baltic Sea Physics model).

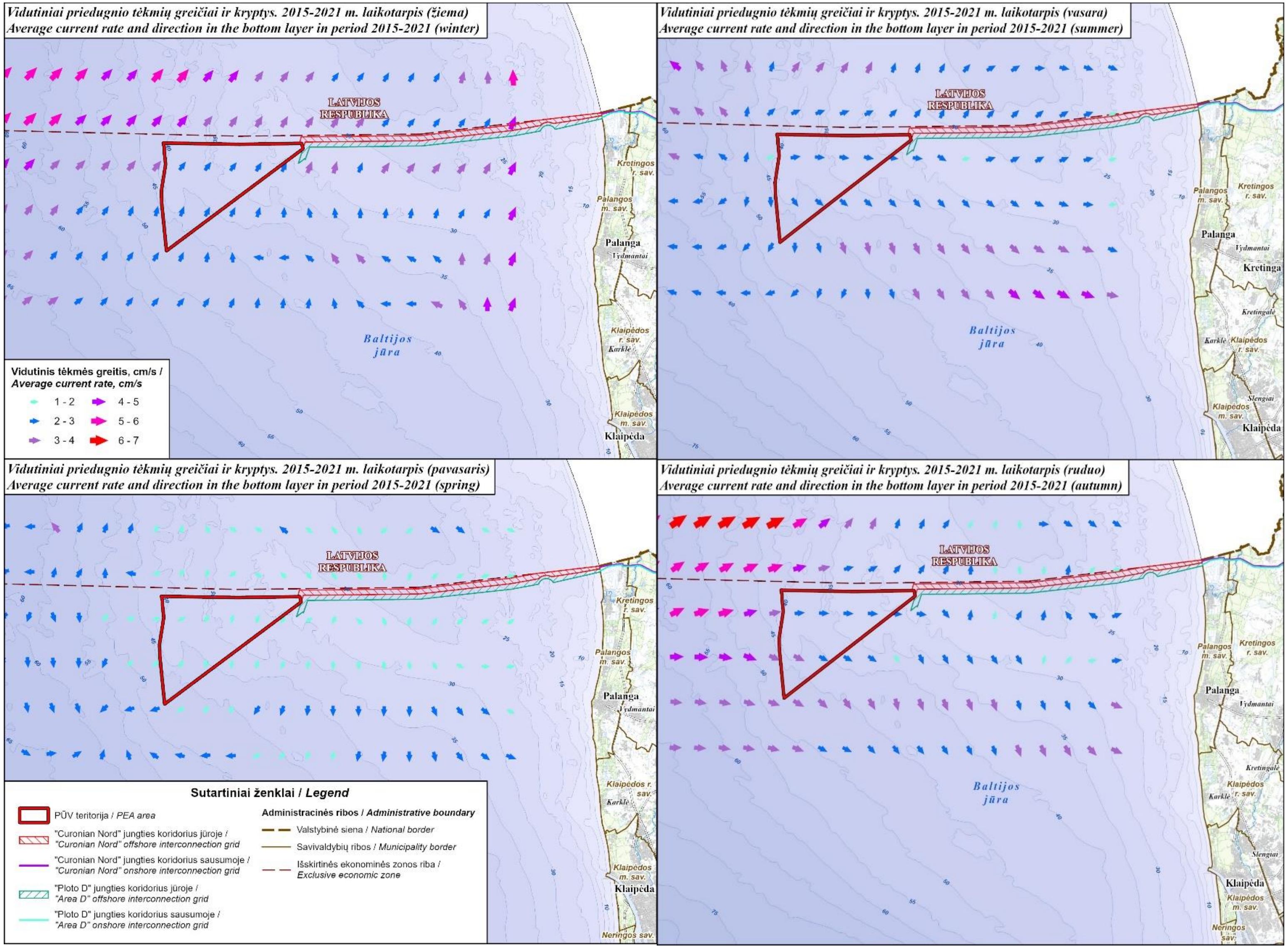


Fig 5.1.8. Average speed and direction of currents in the bottom layer (based on the results of the Copernicus Baltic Sea Physics model).

5.1.3.1.4. Water temperature, salinity and transparency

The Lithuanian Baltic Sea is relatively shallow, so its thermal regime responds very quickly to seasonal changes in climatic conditions (Dailidienė, et al., 2011). The water cools down the most in February (to -0.5°C below zero) and warms up the most in July–August (up to 28.2°C).

The Baltic Sea coast, territorial waters and the open sea are characterised not only by a distinctive horizontal distribution of water temperature from year to year, but also by some vertical stratification of the water associated with temperature differences. A homeothermic layer due to convective and turbulent mixing forms at the sea surface down to a depth of 10 m in all seasons. A summer thermocline (a layer of rapid temperature decline) forms at depths of 10–40 m, with a water temperature gradient in this layer of 0.5–1.0°C/m. The thermocline separates the warm surface water mass from the intermediate cold layer. At that time, the difference between the water temperature in the nearshore and the deep sea can be 15°C or more. In the halocline area and deeper, temperature fluctuations over time are negligible.

In autumn, offshore waters intermingle and maintain uniform thermals down to a depth of 40 m (Vyšniauskas, 2003). Also, an intense convective mixing is dominant with stronger winds and higher waves.

Changes in salinity in the south-eastern Baltic Sea, which includes the Lithuanian marine area, are influenced by freshwater input from rivers and changes in salinity in the central Baltic. The average salinity of the water in the Lithuanian basin is about 7‰. The western part of Lithuanian territorial waters is a part of the Central Baltic area, which is characterised by a two-layered water structure. The salinity in the upper layer (from 0 m to about 60 m depth) is between 6 and 8‰. This layer is separated from the more saline deeper water by a permanent halocline. In the central Baltic, the boundaries of the halocline are at depths of 64–90 m, with its centre at 74 m, and the salinity in this layer increases sharply from 7.7 to 10.4‰ (Matthäus, 1990). At the deeper areas separated by the halocline, the oxygen saturation of the water decreases. The bottom layer experiences a lack of oxygen and hydrogen sulphide zones are formed.

In the coastal water and offshore to depths up to 55–60 m depth, no clear and consistent stratification due to salinity occurs and a homogeneous, well-mixed water mass prevails (Dailidienė et al., 2011).

According to hydrological surveys carried out in the OWF area (March 2024, Fig. 5.1.9.), relatively stable water temperatures of around 3°C have been measured at all survey stations throughout the entire depth range. Salinity values varied between about 7 and 7.5‰. Neither a thermocline nor a halocline layer was recorded during the measurements. These layers are typical of the warmer season. Flow velocities of up to 0.4 m/s were recorded at all the stations, while the direction of the flows is very variable and highly dispersed, but the most frequent flow direction could be northward. Flow velocities at the survey stations vary on average between 0 and 25 cm/s. The highest fluctuations and velocities (around 30 cm/s) were measured at the southernmost and deepest point of the OWF area, station No. 33. The two closest stations, No. 101 and 102, differ in flow velocity and flow directions with depth, confirming the variability of the flows and the complexity of forecasting. The flow velocities around the export cable corridor are not significantly different from the overall area of the PEA territory. It could be noted that flow velocities are slightly higher in the coastal waters and flow velocities are generally higher at the seabed.

The variation of other parameters at different measurement stations is very similar. The vertical variation of hydrological parameters (flow velocity and direction, temperature, salinity) at different sampling sites is depicted in the profiles, which are presented in Annex 2 of the EIA report.

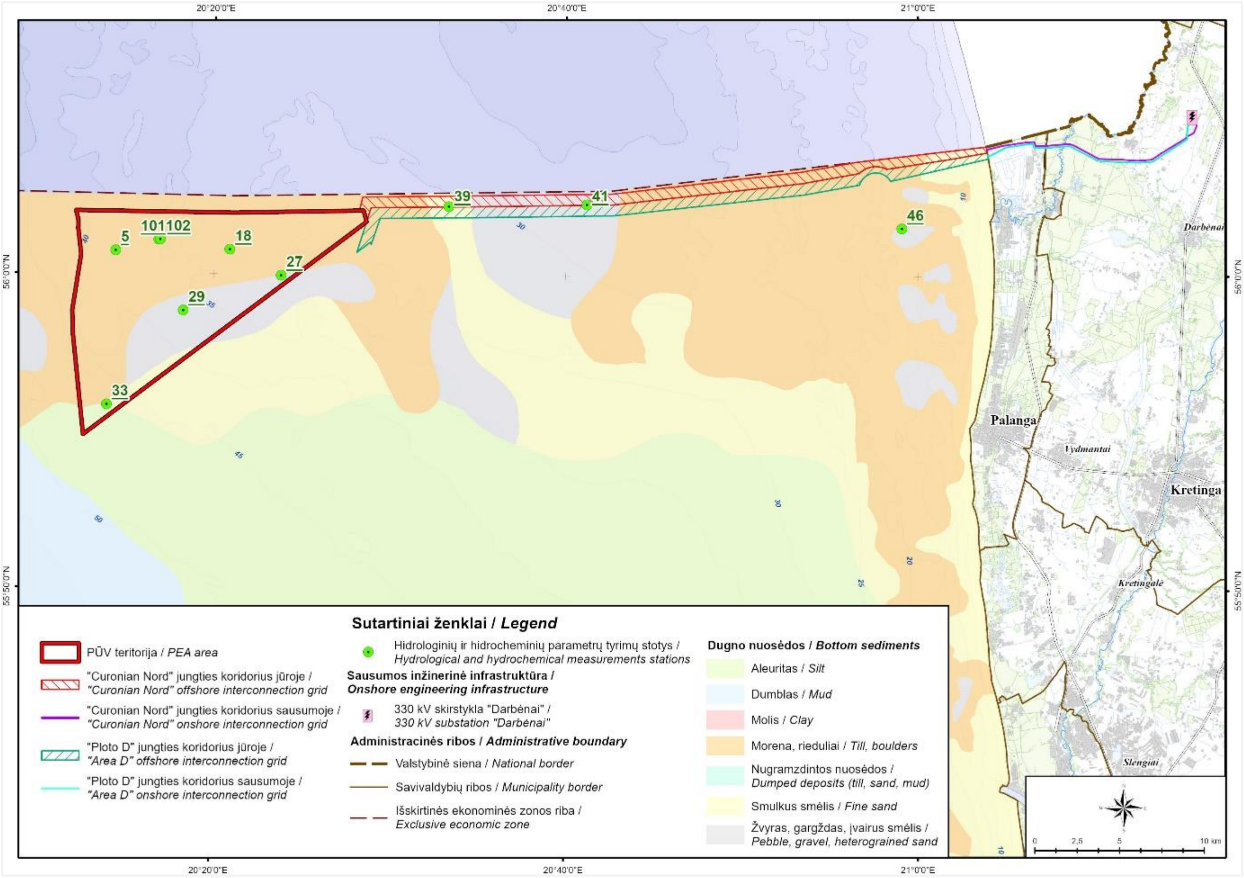


Fig. 5.1.9. Hydrological and hydrochemical sampling stations.

Based on the Copernicus Marine Service, Baltic Sea Physics Reanalysis[23] model results, the seasonal mean water temperature maps for surface and bottom layers for the period 2015–2021 for all PEA and surrounding areas were prepared (Fig. 5.1.10–5.1.11). Also, the annual surface and bottom salinity maps were compiled (Fig. 5.1.12).

It is estimated that in the PEA territory in spring the surface temperature is about 5.5°C, in summer it is on average about 17°C, in autumn – 13°C, and in winter – 4.5°C. Eastward from the PEA territory towards the coastal, sea surface temperature increases by about 2–3°C in spring and summer, and decreases in autumn and winter.

The lowest bottom temperatures are in spring and fluctuate around 4°C. In summer, the bottom warms up much slower than the surface and temperatures of 6.5–7°C prevail here, a thermocline layer forms. The highest bottom temperatures are in autumn and can reach up to 12°C. In winter, the bottom temperature is about 5°C. Going east from the PEA territory towards the coast, the bottom temperature follows the bathymetry profile and increases with decreasing depth, except in the winter season.

Salinity in the southeastern open Baltic Sea varies around 7‰. After calculating the averages for the period 2015–2021, the mean multi-year salinity value obtained in the PEA territory is 7.1‰ at the surface and 7.4‰ at the bottom. Lower salinity is observed only in the coastal area, which is affected by the outflow of freshwater from the Curonian Lagoon. In the coastal zone near Šventoji, annual salinity averages fluctuate around 5‰ at the surface and 6.5‰ at the bottom.

[23] Copernicus Marine Service, Baltic Sea Physics Reanalysis

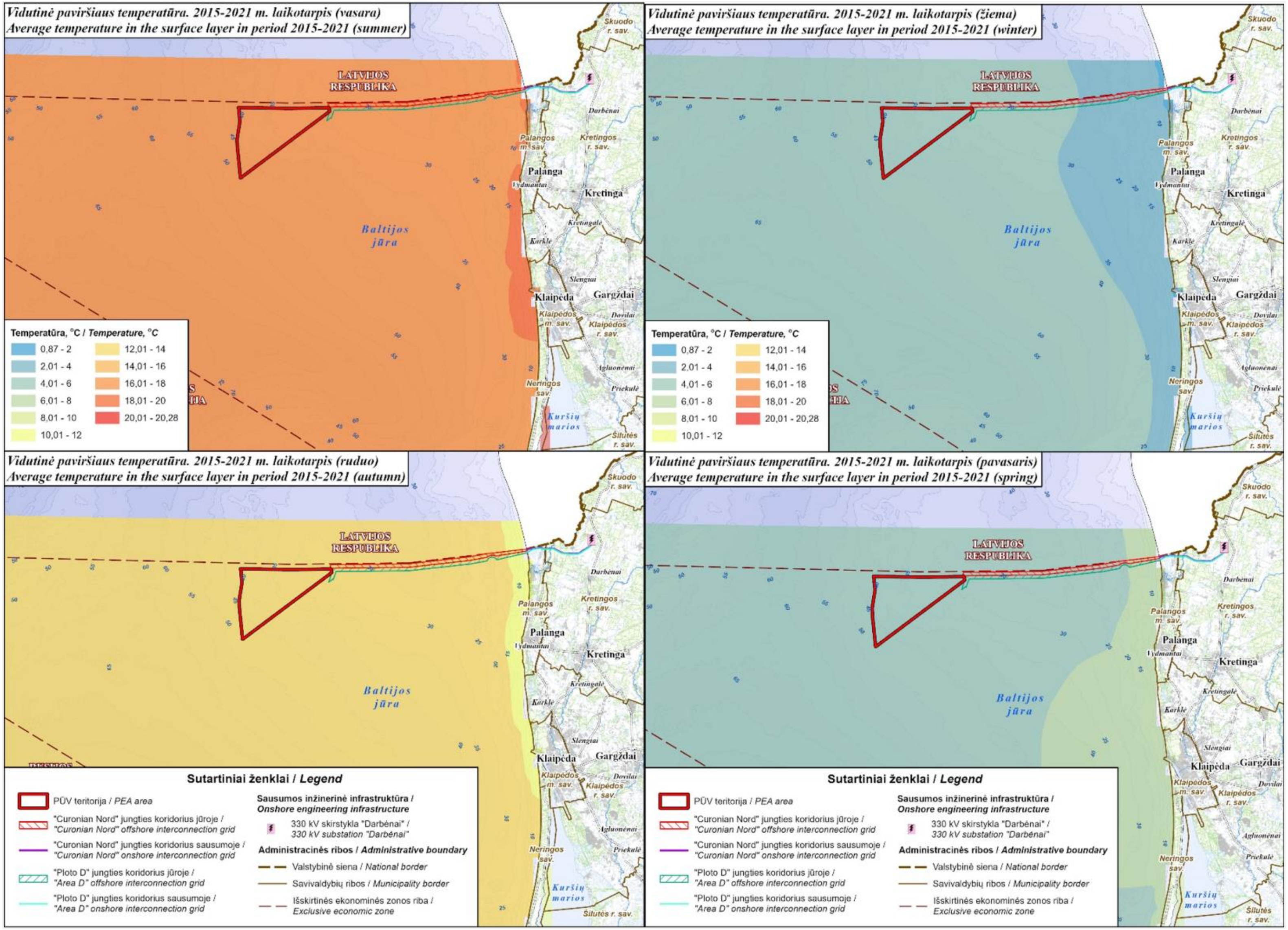


Fig. 5.1.10. Average seasonal water temperature in the surface layer (based on the results of the Copernicus Marine Service Baltic Sea Physics model).

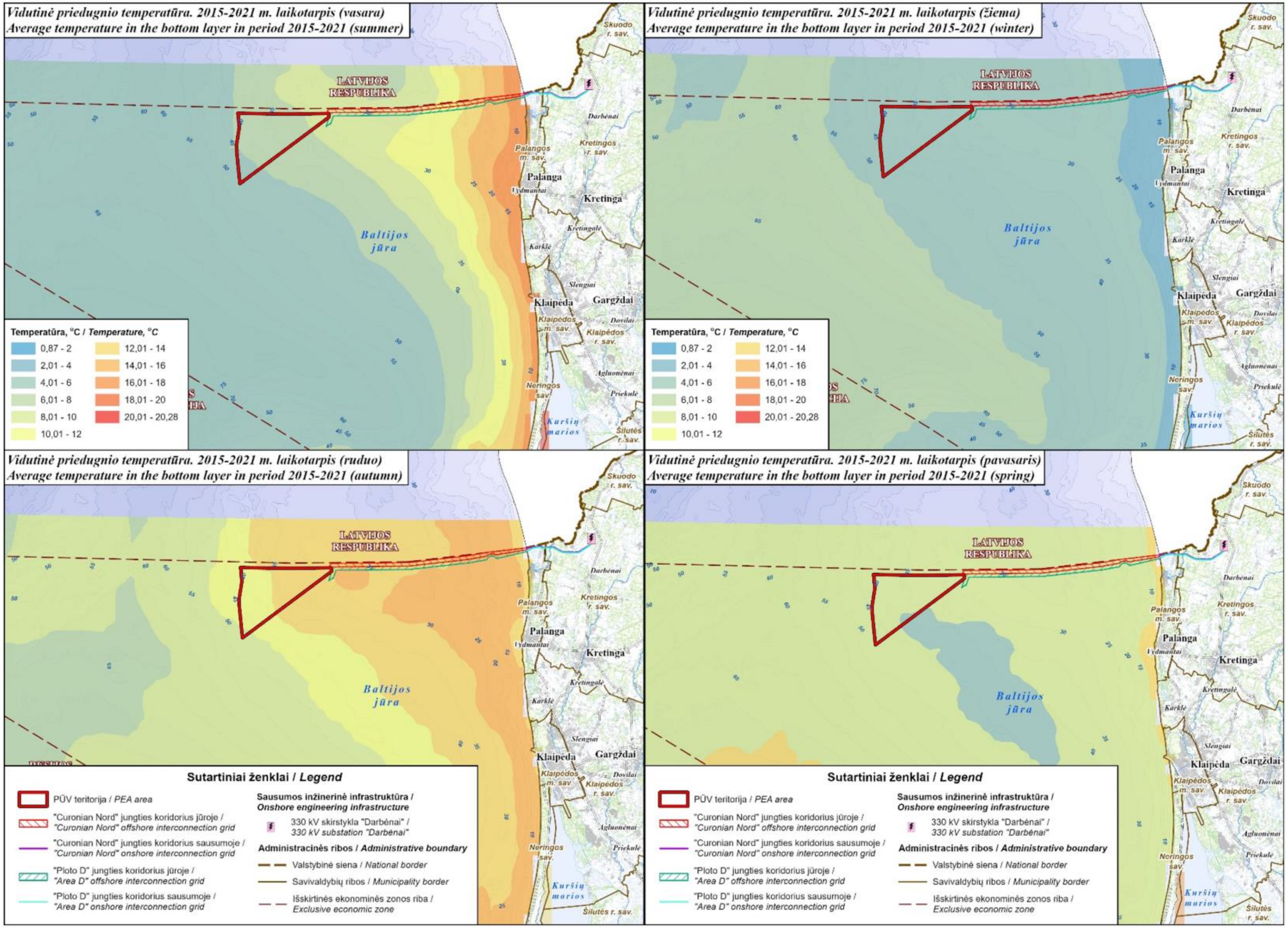


Fig. 5.1.11. Average seasonal water temperature in the bottom layer (based on the results of the Copernicus Marine Service Baltic Sea Physics model).

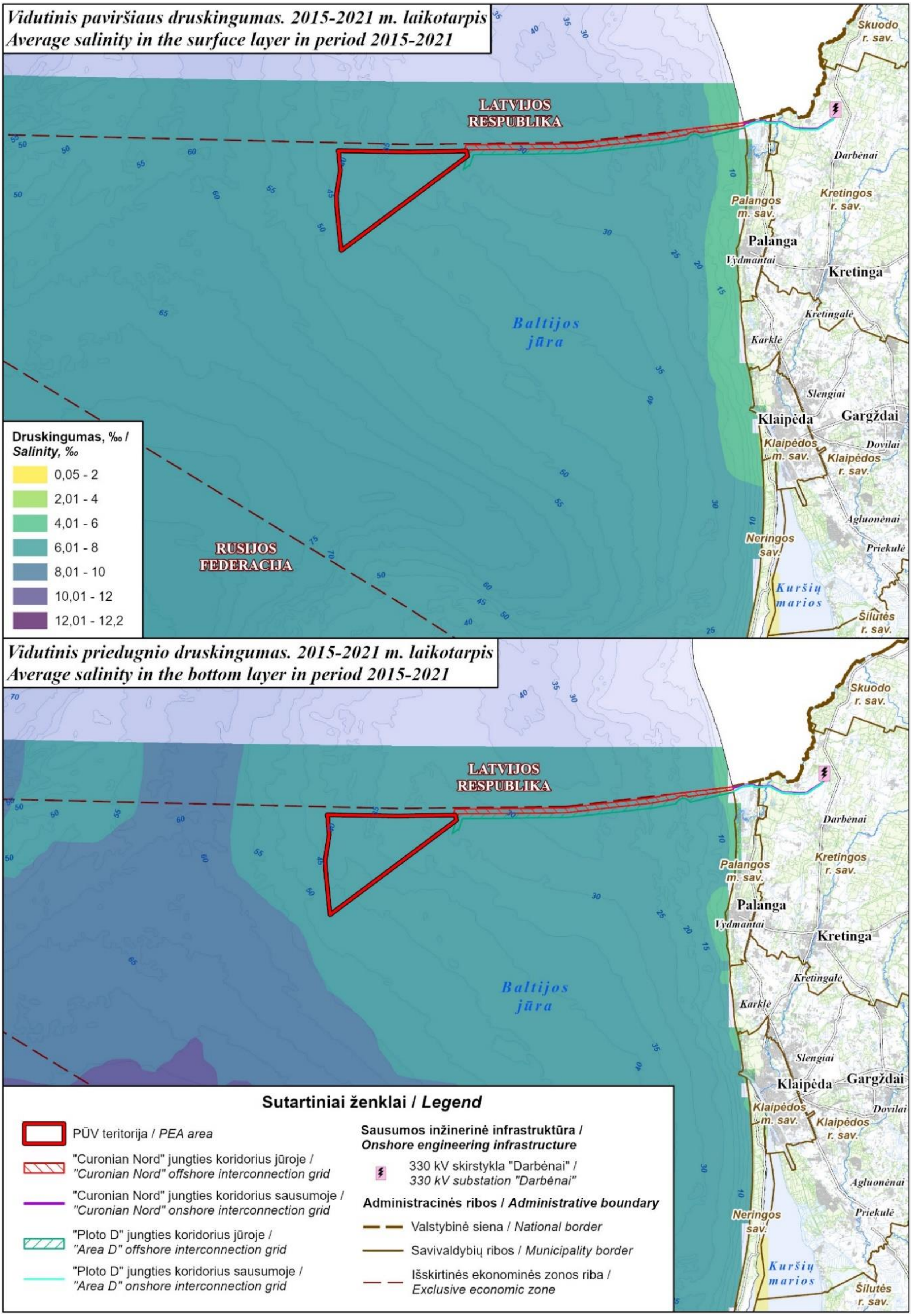


Fig. 5.1.12. Average annual salinity in the surface and bottom layers (based on the results of the Copernicus Marine Service Baltic Sea Physics model).

5.1.3.1.5. Ice cover

In the Lithuanian part of the Baltic Sea, the formation of ice cover during the cold season is determined by meteorological conditions. The sea coast is subject to ice sheets ranging from a few metres to several kilometres in width during average and cold winters. It is usually made up of ice sheets that have been blown and crushed by wind and water currents close to the shore and remain stable only in calm and cold weather. The ice sheet usually forms up to 1.5–15 km from the shore. Drifting ice sheets up to 10 cm thick form ice drifts further offshore. According to the Copernicus Marine Service's open time series of Baltic Sea ice concentration, distribution and classification based on remote SAR data, ice cover is also recorded in the PEA area. The thickest ice cover of up to 12 cm was recorded in 2011, with at least part of the area of the OWF covered by ice between 15 February and 5 March 2011. In subsequent years, ice cover was observed for at least several consecutive days in 2012–2014 (11–15 days with ice cover), 2018 (9 days with ice cover) and 2021 (8 days with ice cover). In the OWF area, if ice cover forms, it is on average 1 cm thick at the beginning and at the end of the period and up to 5 cm thick in the middle of the period.

However, ice cover is one of the most vulnerable to climate change and there is a decline in the number of days with ice events in the Baltic Sea. Close to the coast of Lithuania, the average duration of ice events has decreased by about 50 % over the period 1961–2009 (Dailidienė et al., 2012). Overall, the Baltic Sea is projected to experience a thinning of the ice cover and a decrease in the duration with ice cover, but it is emphasized that year-to-year changes are difficult to predict (Meier, et al., 2022)

5.1.3.1.6. Hydrochemical conditions and water quality

In Lithuania, the ecological and chemical status of the Baltic Sea is constantly monitored through the state environmental monitoring of the Curonian Lagoon and the Baltic Sea. Chemical status is determined for transitional waters, coastal waters, marine area, and EEZ by assigning the status with one of the two quality grades: good or not meeting good status. The chemical status of a surface water body is considered good if the concentrations of all substances specified in Annex 1 and Annex 2, Parts A and B (List B1) of the Wastewater Management Regulation[24] do not exceed the environmental quality standards based on the annual average of environmental quality standard (hereinafter – AA-EQS) and/or the maximum allowable concentration of environmental quality standard (hereinafter – MAC-EQS), and/or environmental quality standard (hereinafter – EQS) specified for biota. If the concentration of at least one substance is exceeded, the water body does not meet the criteria for good status.

When assessing the chemical status of the Lithuanian Baltic Sea area based on the concentrations of pollutants in bottom sediments, the Order of the Minister of the Environment of the Republic of Lithuania of 4 March 2015, No. D1-194 "On the Approval of the Characteristics of Good Environmental Status of the Sea Area of the Republic of Lithuania" and the average annual limit values of pollutants of good environmental status (hereinafter – GES) in bottom sediments specified therein are followed.[25]

According to the data of environmental monitoring carried out in the period of 2014–2019, chemical status of waters and bottom sediments near the PEA territory (according to the data of the monitoring station No. 65) was good without exceeding the limit values established by the Order of the Minister of Environment of the Republic of Lithuania no. D1-194 of 4 March 2015 “On Approval of the Requirements for Determining the Characteristics of the Good Environmental Status of the Lithuanian Marine Area”, i.e. corresponded with the good environmental status (Fig. 5.1.13).

[24] Order No. D1-236 of the Minister of the Environment of the Republic of Lithuania of 17 May 2006 “On the Approval of the Regulation on Wastewater Management”.

[25] Order of the Minister of Environment of the Republic of Lithuania no. D1-194 of 4 March 2015 “On Approval of the Requirements for Determining the Characteristics of the Good Environmental Status of the Lithuanian Marine Area.”

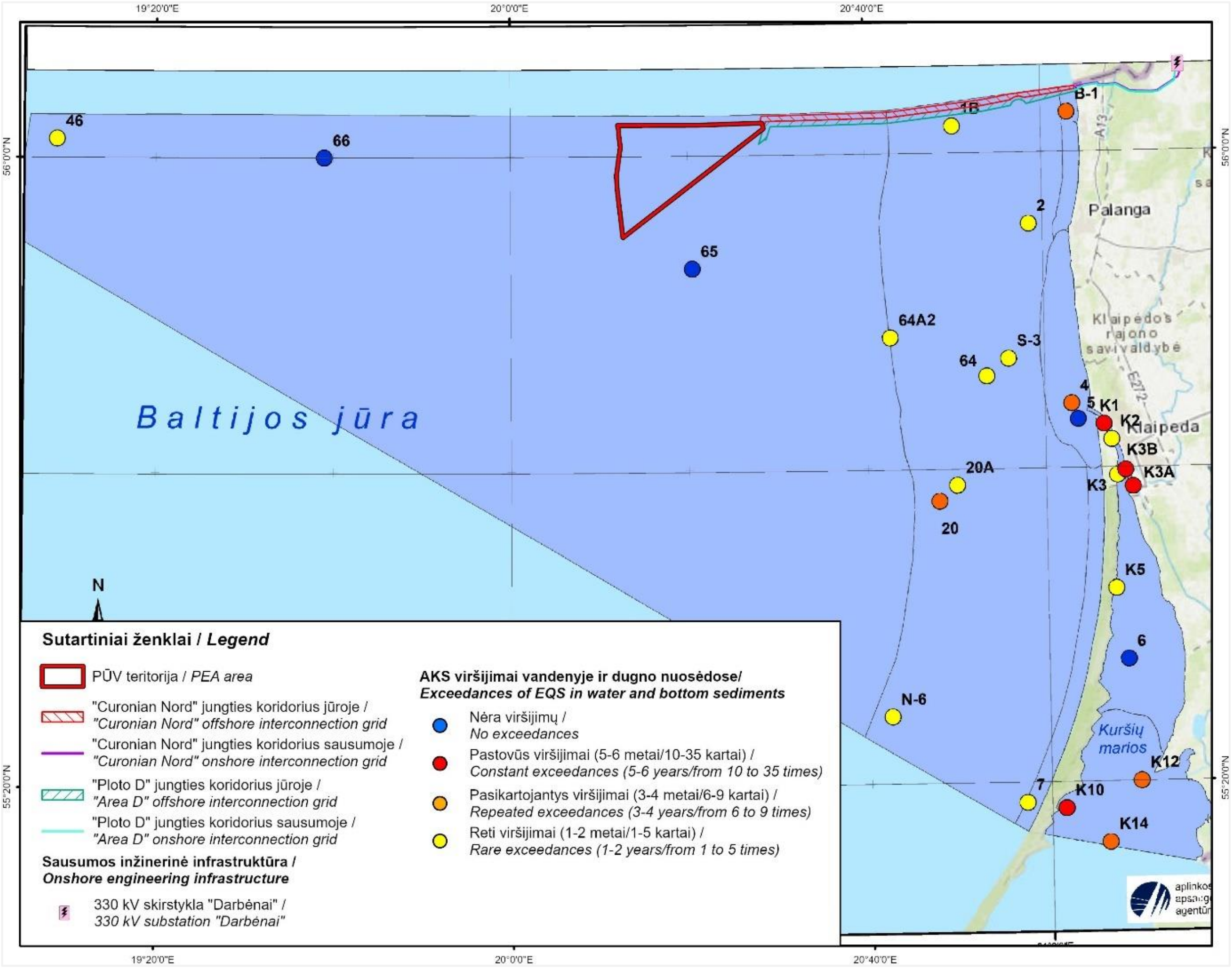


Fig. 5.1.13. Summary of chemical status assessment data from the environmental monitoring of the Baltic Sea and the Curonian Lagoon for 2014–2019 (EPA data).

During the period 2014–2019, one-time instantaneous increases in Hg concentrations in water were recorded on the open sandy coast of the Baltic Sea (0.088 µg/l, state monitoring station No. B-1), to the south of the planned OWF transmission grid.

In 2015, the annual mean concentration of benzo(a)pyrene in water at monitoring site B-1 exceeded the established environmental quality standard, expressed as AA-EQS. Benzo(a)pyrene is considered as a marker for other polyaromatic hydrocarbons (PAHs) and is recommended as a key indicator of PAH toxicity. It is worth mentioning that momentary increases in the concentrations of individual PAH compounds (benzo(a)pyrene, fluoranthene) in the vicinity of the Būtingė oil terminal were also recorded previously (Garnaga et al., 2008; Feasibility..., 2009), and therefore, this part of the territorial sea remains an area of elevated PAH risk. In 2015, values of 4-nonylphenol concentrations above the AA-EQS were recorded throughout the Lithuanian Baltic Sea coastline (research stations: B-1, 2, 4, 7). 4-n-nonylphenol is a product of industrial processes and can enter the aquatic environment from many industries.

According to the environmental monitoring data for the period 2020–2021, the chemical condition of water and bottom sediments adjacent to the PEA territory (according to the data of monitoring station No. 65) and in the offshore part of the export corridor (according to the data of monitoring stations No. 1B and B-1), was good and did not exceed the limit values established by the Order of the Minister of the Environment of the Republic of Lithuania of March 4, 2015 No. D1-194 "On the Approval of the Characteristics of Good Environmental Status of the Marine Area of the Republic of Lithuania".

Within the scope of the EIA, in March 2024 water samples for the hydrochemical analysis were collected in the PEA area (sampling points shown in Fig. 5.1.9). Water samples were collected with “Hydrobios” bathometer in 8 sites (5, 18, 27, 29, 33, 39, 41, 46) from the surface layer (depth of 0.5 m) and bottom layer (about 0.5 m above the bottom). Two more samples (station No. 101, 102) were taken from the bottom layer adjacent to the sunken object to assess its potential impact on seawater quality.

The pollutants (oil products C10-C40, polyaromatic hydrocarbons, heavy metals As, Cd, Cr, Cu, Ni, Pb, V, Zn, Hg) in water samples were determined in the certified laboratory of Vandens tyrimai, UAB (as per LST EN ISO/IEC 17025:2018).

According to the obtained data the concentration of the hazardous heavy metal mercury (Hg), exceeding the EQS, was detected in the bottom layer of the only monitoring site (No. 18), reaching 0.26 µg/l (Table 5.1.1). Mercury is found on Earth in various forms and once released into the environment, can circulate in it for hundreds or thousands of years between air, water, bottom sediments, various plant and animal species. In the European Union, bans and restrictions on the extraction, export and import of mercury have led to a decrease in emissions of this metal into the atmosphere (from 1990 to 2014 by about 73%) and its entry into water (from 2007 to 2014 by about 71%). According to the data of the state environmental monitoring, in recent years, the average AA-EQS of mercury have a clear downward trend, and values exceeding the MAC-EQS (0.07 µg/l) in the Baltic Sea water are recorded only accidentally. Slightly higher, but reflecting the natural hydrochemical background, concentrations of arsenic (As) were determined only at a few sampling sites (No. 5 and 18). The concentrations of other potentially hazardous heavy metals in the territory of the PEA do not indicate significant pollution.

Table 5.1.1. Results of heavy metal analysis in the water (Vandens tyrimai, UAB, research protocol No. 240322GC020)

Sample No.		Metals, µg/l								
		As	Cd	Cr	Cu	Ni	Pb	V	Zn	Hg
5-1	Surface	9,3	< 0,3	1,0	< 1	< 2	< 1	< 20	< 40	< 0,1
5-2	Bottom	6,9	< 0,3	2,6	2,9	< 2	< 1	< 20	< 40	< 0,1
18-1	Surface	6,0	< 0,3	< 1	< 1	< 2	< 1	< 20	< 40	< 0,1
18-2	Bottom	5,2	< 0,3	< 1	< 1	< 2	< 1	< 20	< 40	0,26
27-1	Surface	4,0	< 0,3	< 1	< 1	< 2	< 1	< 20	< 40	< 0,1
27-2	Bottom	3,5	< 0,3	< 1	< 1	< 2	< 1	< 20	< 40	< 0,1
29-1	Surface	3,6	< 0,3	1,1	< 1	< 2	< 1	< 20	< 40	< 0,1
29-2	Bottom	3,3	< 0,3	< 1	< 1	< 2	< 1	< 20	< 40	< 0,1
33-1	Surface	3,1	< 0,3	< 1	< 1	< 2	< 1	< 20	< 40	< 0,1
33-2	Bottom	3,3	< 0,3	< 1	< 1	< 2	< 1	< 20	< 40	< 0,1
39-1	Surface	2,5	< 0,3	< 1	< 1	< 2	< 1	< 20	< 40	< 0,1
39-2	Bottom	2,9	< 0,3	< 1	< 1	< 2	< 1	< 20	< 40	< 0,1
41-1	Surface	2,2	< 0,3	< 1	1,6	< 2	< 1	< 20	< 40	< 0,1
41-2	Bottom	2,5	< 0,3	< 1	< 1	< 2	< 1	< 20	< 40	< 0,1
46-1	Surface	2,0	< 0,3	1,8	2,3	< 2	< 1	< 20	< 40	< 0,1
46-2	Bottom	1,8	< 0,3	< 1	1,5	< 2	< 1	< 20	< 40	< 0,1
101-2	Bottom	3,5	< 0,3	< 1	< 1	< 2	< 1	< 20	< 40	< 0,1
102-2	Bottom	2,3	< 0,3	< 1	< 1	< 2	< 1	< 20	< 40	< 0,1
	AA-EQS*	**5**	**0,2**	**5**	**5**	**8,6**	**1,3**	**5**	**20**	**-**
	MAC-EQS**	**-**	**-**	**-**	**-**	**34**	**14**	**-**	**-**	**0,07**

* AA-EQS;
** MAC-EQS.

The analysis of the concentration of petroleum hydrocarbons in water allows for a partial assessment of anthropogenic activities related to the transportation of oil and its products, intensive shipping, and illegal discharge of oily waters into the open sea. Polyaromatic hydrocarbons (PAH) is the most dangerous oil component, which remains in the water for a long time and accumulates in seabed sediments and living organisms. PAH is a range of compounds, starting with naphthalene ending with coronene. The most toxic PAH are anthracene, fluorene, naphthalene, and phenanthrene. PAH compounds with high molecular weight, e.g. benzo[a]pyrene, are cancerogenic.

Analysis of concentrations of petroleum hydrocarbons (C10–C40) in the waters of the proposed wind farm area showed no traces of significant pollution. Maximum allowable concentration (hereinafter – MAC) of oil hydrocarbons – 200 µg/l, was not exceeded in any sampling site. The detected concentrations were below the method's limit of quantification (hereinafter – LOQ).

The analysis of the concentrations of individual PAH compounds in seawater also did not show significant pollution (Table 5.1.2). The concentrations of priority (fluoranthene, naphthalene) PAHs at all monitoring sites were below the method LOQ, the same applies to the distribution of concentrations of priority hazardous PAHs (benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, anthracene). Water samples for pollution studies were taken in May 2022 by the "Hydrobios" bathometer at 5 sampling stations (VP1, VP3, VP4, VP8, VP10) from two horizons: surface (at a depth of about 0.5 m) and bottom (about 0.5 m from the seabed surface). Pollutants (petroleum hydrocarbons C10-C40, polycyclic aromatic hydrocarbons, heavy metals – As, Cd, Cr, Cu, Ni, Pb, V, Zn, Hg) were determined in the accredited (according to LST EN ISO/IEC 17025:2018) laboratory of UAB “Vandens tyrimai”.

Vertical variations of hydro-chemical parameters (pH, dissolved oxygen, suspended matter) in different study sites, are presented in profiles available in Annex 2.

Table 5.1.2. Results of analysis of oil products (C10–C40) and polyaromatic hydrocarbons in the water (Vandens tyrimai, UAB, research protocol No. 240322GC020)

Sample No.	Oil, µg/l	PAH, µg/l														
		NFT	ACNFT	FLR	FEN	ANT	FRT	PIR	BZA	CHRZ	BZB	BZK	BENZA	DBAH	BENZGHI	IND123
5-1	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
5-2	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
18-1	110	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
18-2	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
27-1	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
27-2	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
29-1	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
29-2	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
33-1	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
33-2	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
39-1	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
39-2	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
41-1	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
41-2	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
46-1	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
46-2	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
101-2	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
102-2	< 100	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	< 0.005	< 0.010	< 0.005	< 0.005	< 0.002	< 0.002	< 0.002	< 0.005	< 0.005	< 0.005
AA-EQS*	**200**	**2**	**-**	**-**	**-**	**0.1**	**0.0063**	**-**	-	-	**0.00017**	**0.00017**	**0.00017**	**-**	**0.00017**	**0.00017**
MAC-EQS**	**-**	**130**	**-**	-	-	**0.1**	**0.12**	**-**	-	-	**0.017**	**0.017**	**0.027**	**-**	**0.00082**	**-**

Abbreviation: NFT – naphthalene; ACNFT – acenaphthene; FLR – fluorene; FEN – phenanthrene; ANT – anthracene; FRT – fluoranthene; PIR – pyrene; BZA – benz[a]anthracene; CHRZ – chrizene; BZB – benzo[b]fluoranthene; BZK – benzo[k]fluoranthene; BENZA – benzo[a]pyrene; DBAH – dibenzo[a,h]anthracene; BENZGHI – benzo[g,h,i]perylene; IND123 – indeno[1,2,3-cd]pyrene.

* AA-EQS
** MAC-EQS

5.1.3.2. Onshore

5.1.3.2.1. Surface and groundwater bodies in the onshore export cable route

In the mainland, the larger rivers (Šventoji, Kulšė) crossing the planned export cable corridors belong to the Šventoji basin (Šventoji) of the Venta River Basin District.

The export cable route going from the sea towards the land crosses following surface waterbodies: Š-2 (right tributary of the Šventoji River), Š-4 (right tributary of the Šventoji River, Šventoji) and Kulšė (Figure 5.1.14).

Export cable of the "Area D" OWF will go through the same waterbodies, except for the last two intersections with the Kulšė River just before joining the Darbėnai ONS (Fig. 5.1.19).

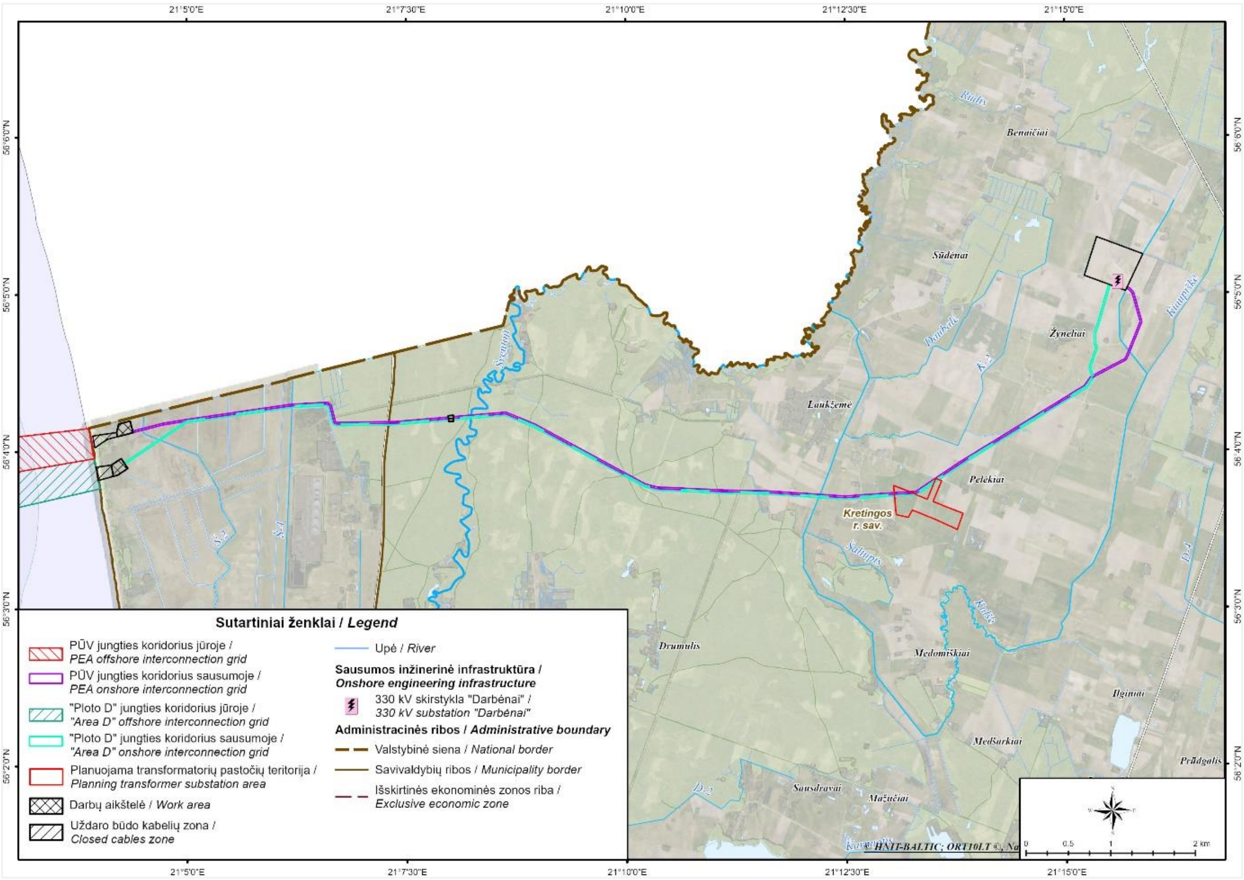


Fig. 5.1.14. Surface water bodies in relation to the planned onshore export cable route.

Within the boundaries of Palanga City Municipality, the export cable route will cross two tributaries of the Šventoji River: Š-2 (cadastral ID 20010210, length – 4.23 km), Š-4 (cadastral ID 20010190, length – 6.11 km) with a 3 m protection strip and zone and a series of smaller land reclamation channels installed in the territory (Fig. 5.1.15–5.1.16).

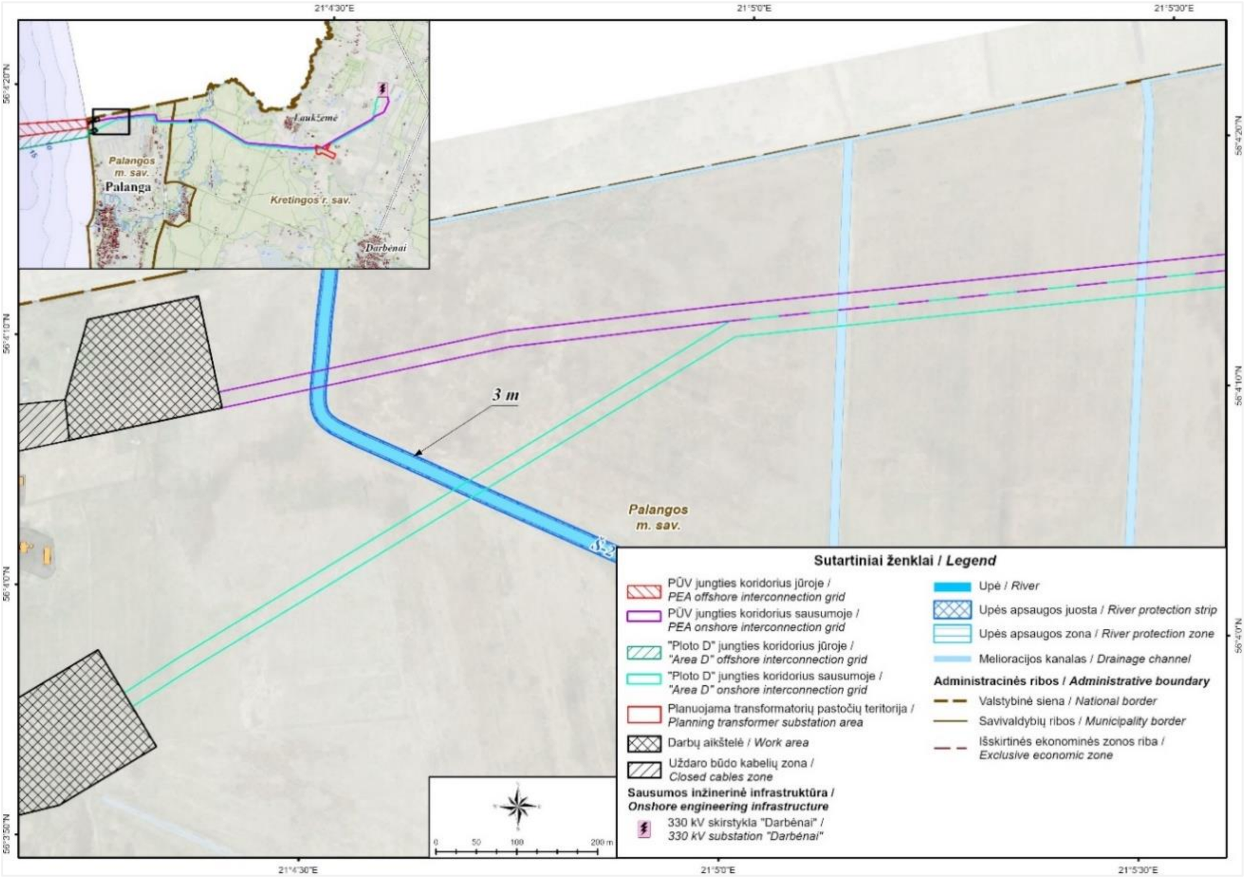


Fig. 5.1.15. Intersection of the export cable corridor with the Š-2 water body and drainage channels.

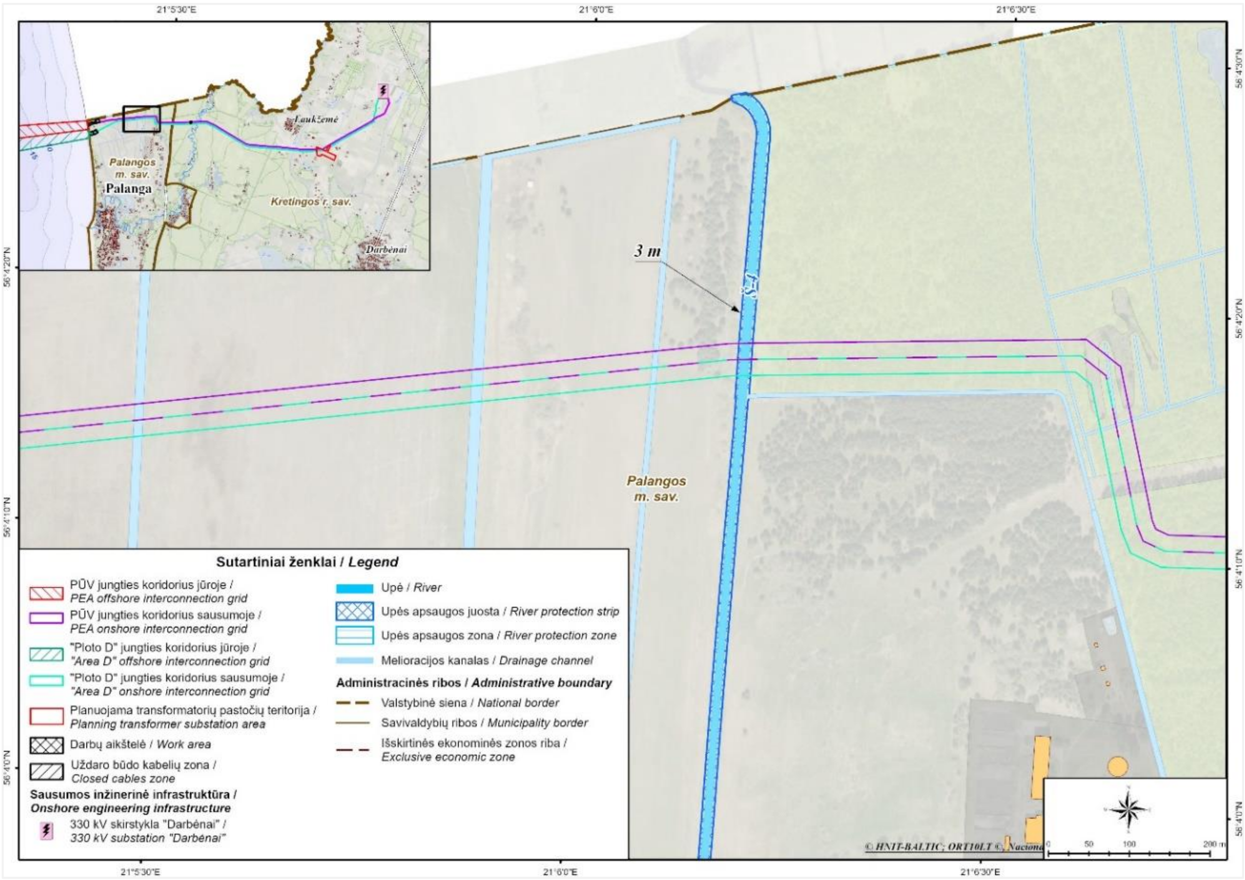


Fig. 5.1.16. Intersection of the export cable corridor with the Š-4 water body and drainage channels.

Going further towards the ONS area, the planned export cable corridor crosses the Šventoji River (Figure 5.1.17). The Šventoji River is 68.4 km long (more than 30 km of which run along the state border between Lithuania and Latvia). It begins in the Western Samogitian Plain, in the Šatraminiai area, 8 km northwest of Salantai. The upper reaches flow to the northwest, and after flowing into the Lukne (48 km from the mouth) it turns southwest; for 31.8 km, the river runs along the border between Lithuania and Latvia. It flows into the Baltic Sea in Šventoji. The upper reaches up to Večiai are regulated, the bed width is 4–10 m, the depth is 1–2 m. The natural bed is very winding in places, 5–15 m wide, 0.6–2 m deep. The average slope is 0.77 m/km. Water flow in the upper reaches at Večiai (59 km from the mouth): average 0.43 m/s, maximum spring floods 8.12 m/s, maximum rain floods 9.19 m/s. Average flow in the mouth 5.14 m^3/s. In the dry summer, the upper reaches are very low. The lower reaches are marshy in places. Pursuant to Order No. 540 of the Minister of Environment of 7 November 2001 "On the Approval of the Description of the Procedure for Establishing Surface Water Protection Zones and Coastal Protection Strips" a coastal protection strip for Šventoji River has been established, extending 10 m in both directions from the riverbed, as along with a protection zone extending 200 m.

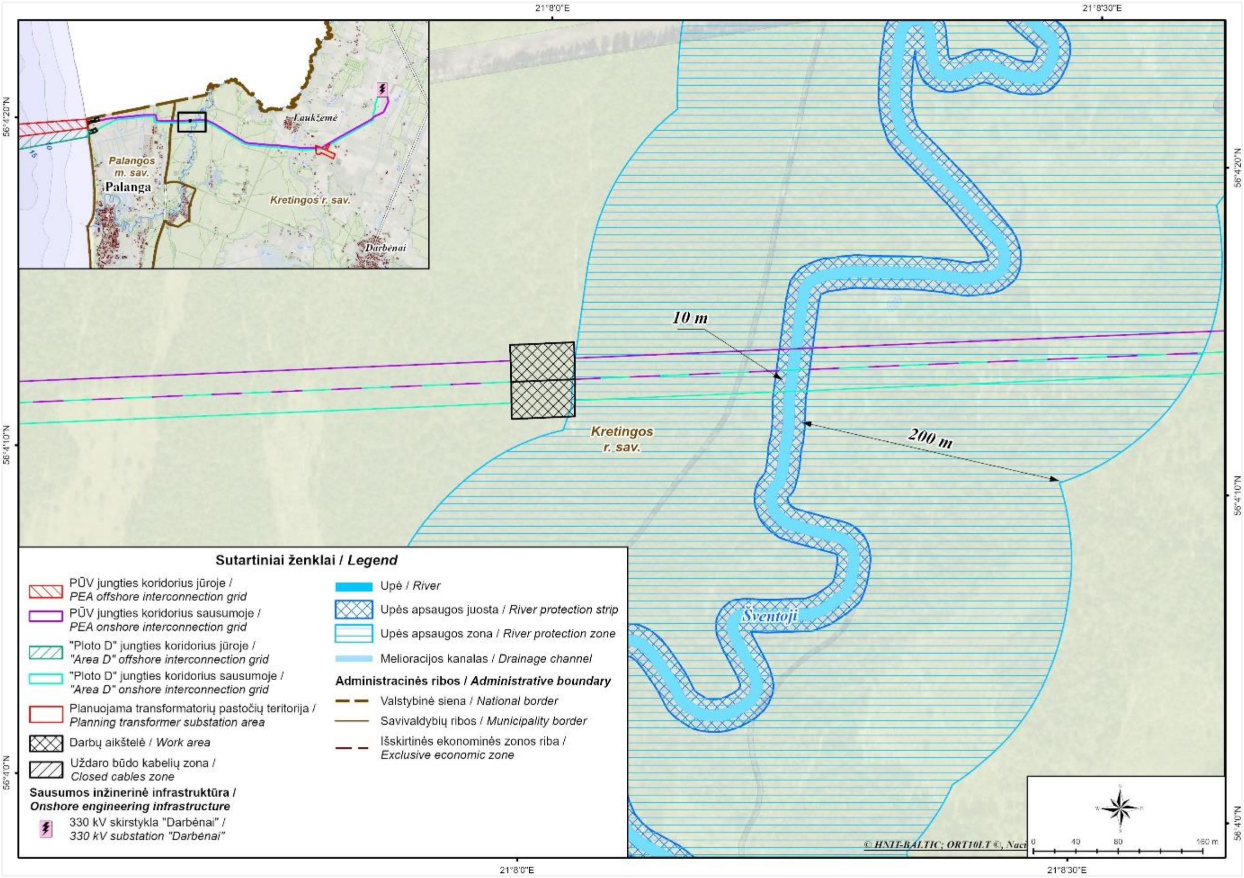


Fig. 5.1.17. Intersection of the export cable corridor with the Šventoji River.

The route of the planned CN OWF export cable in the territory of Kretinga District Municipality crosses the Kulšė River in 3 places, while the “Area D” crosses the Kulšė River only in one place. For Kulšė River a 3 m buffer strip and a 100 m protection zone have been established (Fig. 5.1.18–5.1.19). The Kulšė is a left tributary of the Šventoji River. The largest part of the river has been converted into a land reclamation channel.

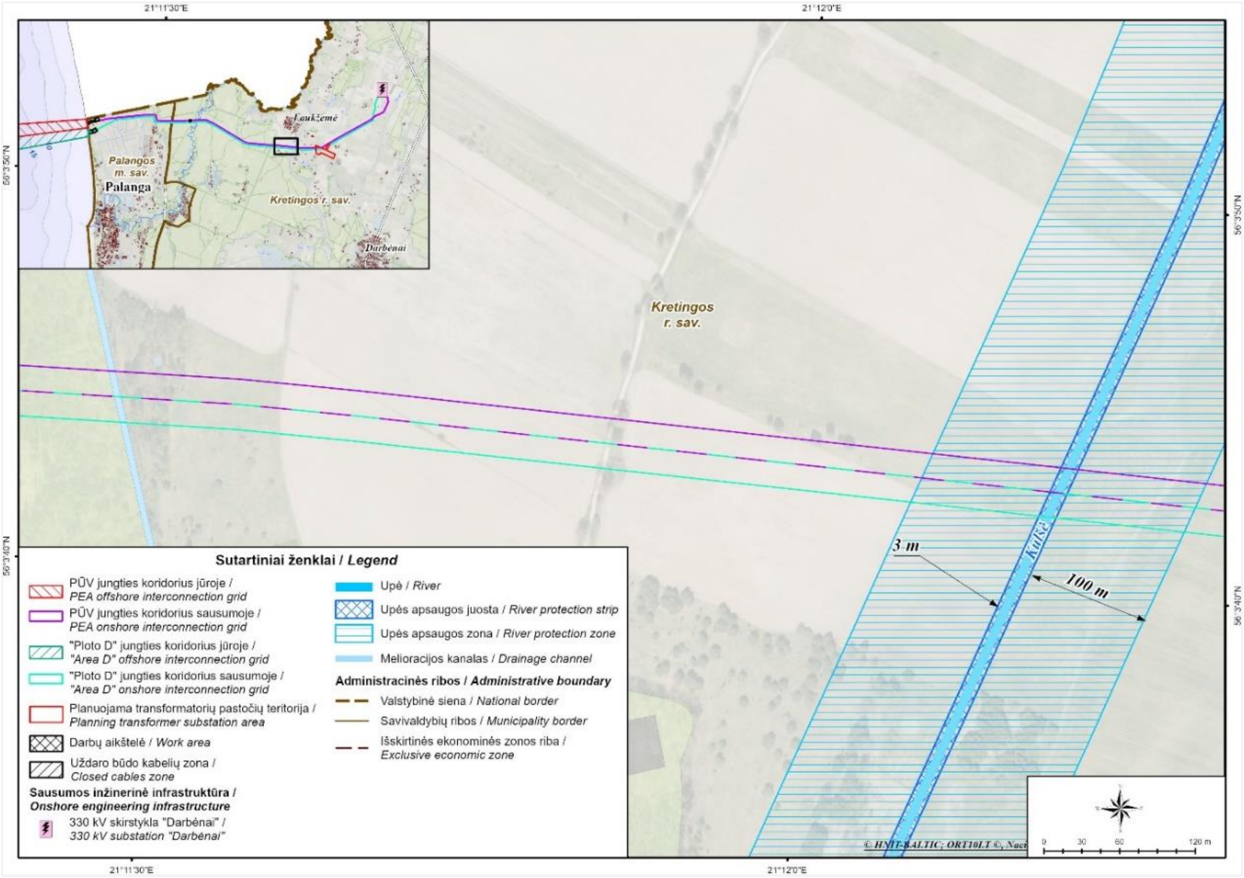


Fig. 5.1.18. Intersection of the export cable corridor with the Kulšė River (1): crosses both transmission grids.

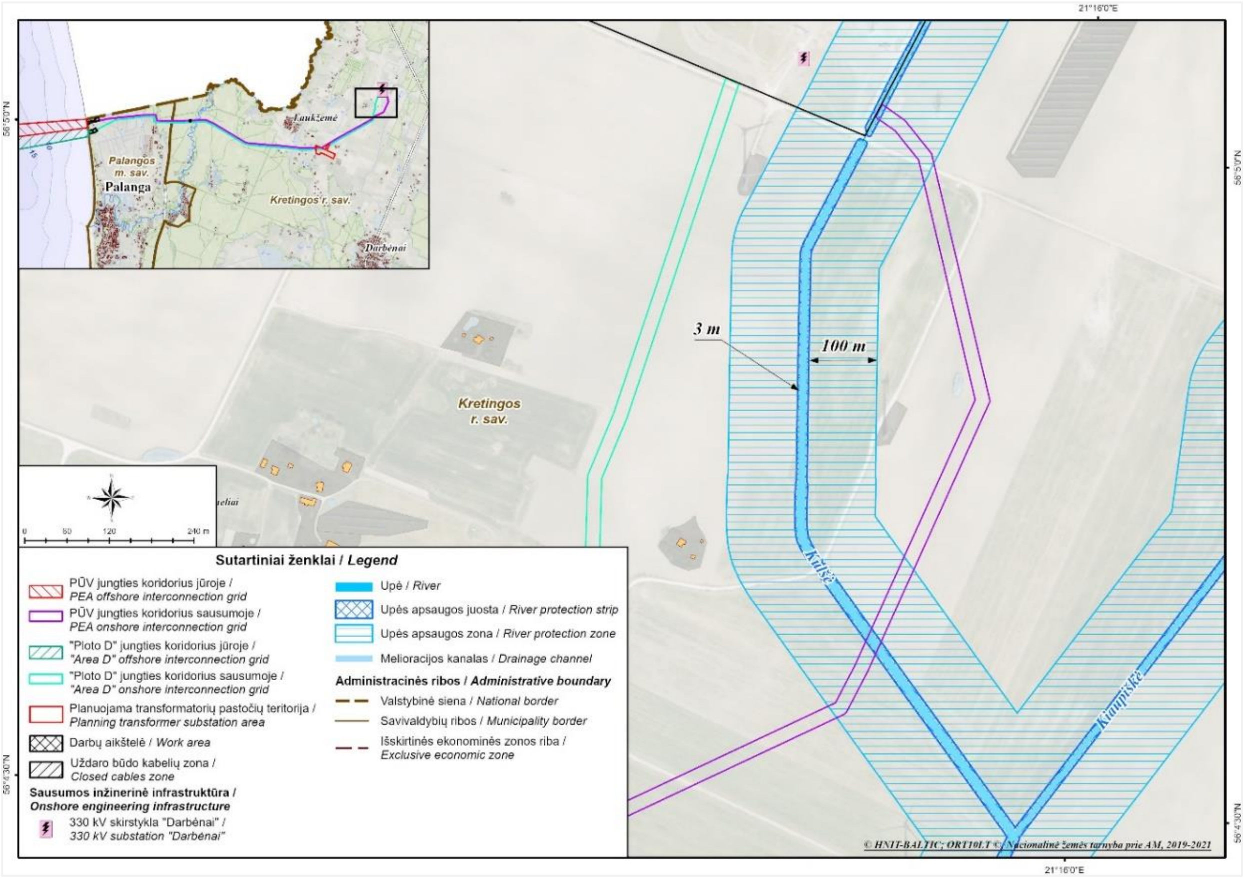


Fig. 5.1.19. Intersection of the export cable corridor with the Kulšė River (2): crosses CN OWF transmission grid.

According to data from the Lithuanian Geological Survey, there are currently 1,780 groundwater abstraction sites registered in the Subsurface Register in Lithuania, with 39% of these sites utilising surveyed and approved resources. The distribution of groundwater abstraction sites within the territories of Palanga City Municipality and Kretinga District Municipality is illustrated in Figure 5.1.20.

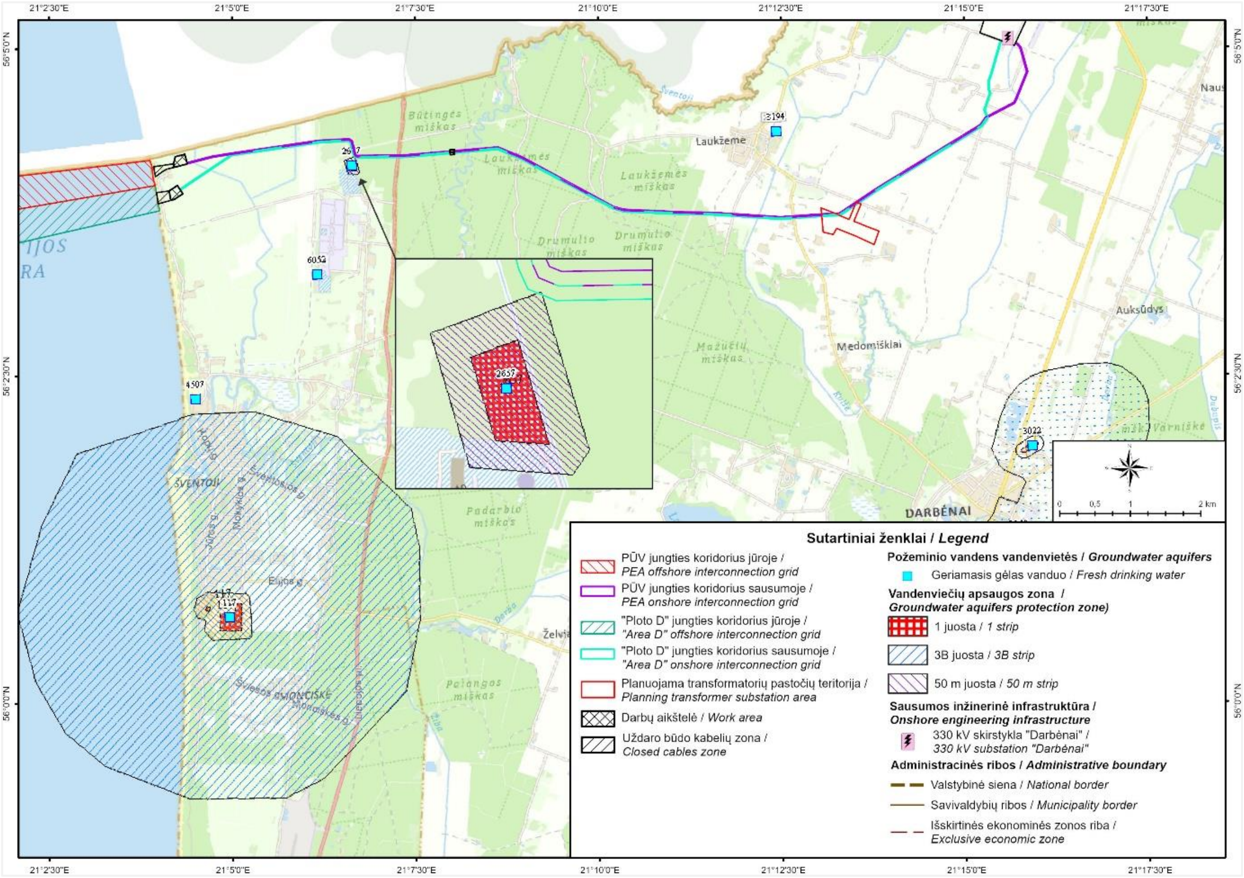


Fig. 5.1.20. Groundwater abstraction sites in relation to the planned export cable corridor.

5.1.3.2.2. Flooding and inundation areas caused by surface waterbodies

Information about flooding and inundation areas is provided in flood hazard and risk maps prepared and constantly updated by the EPA[26]. Regarding the export cable corridor, there is a low probability (0.1%) flood risk along the coastal section bordering the Baltic Sea (Figure 5.1.21). It is noteworthy that the SLUC for areas with a low probability of flood hazard do not impose restrictions on the planned electricity connection construction works.

[26] https://aaa.lrv.lt/lt/veiklos-sritys/vanduo/upes-ezerai-ir-tvenkiniai/potvyniu-rizikos-valdymas/potvyniu-gresmes-ir-rizikos-zemelapiai/

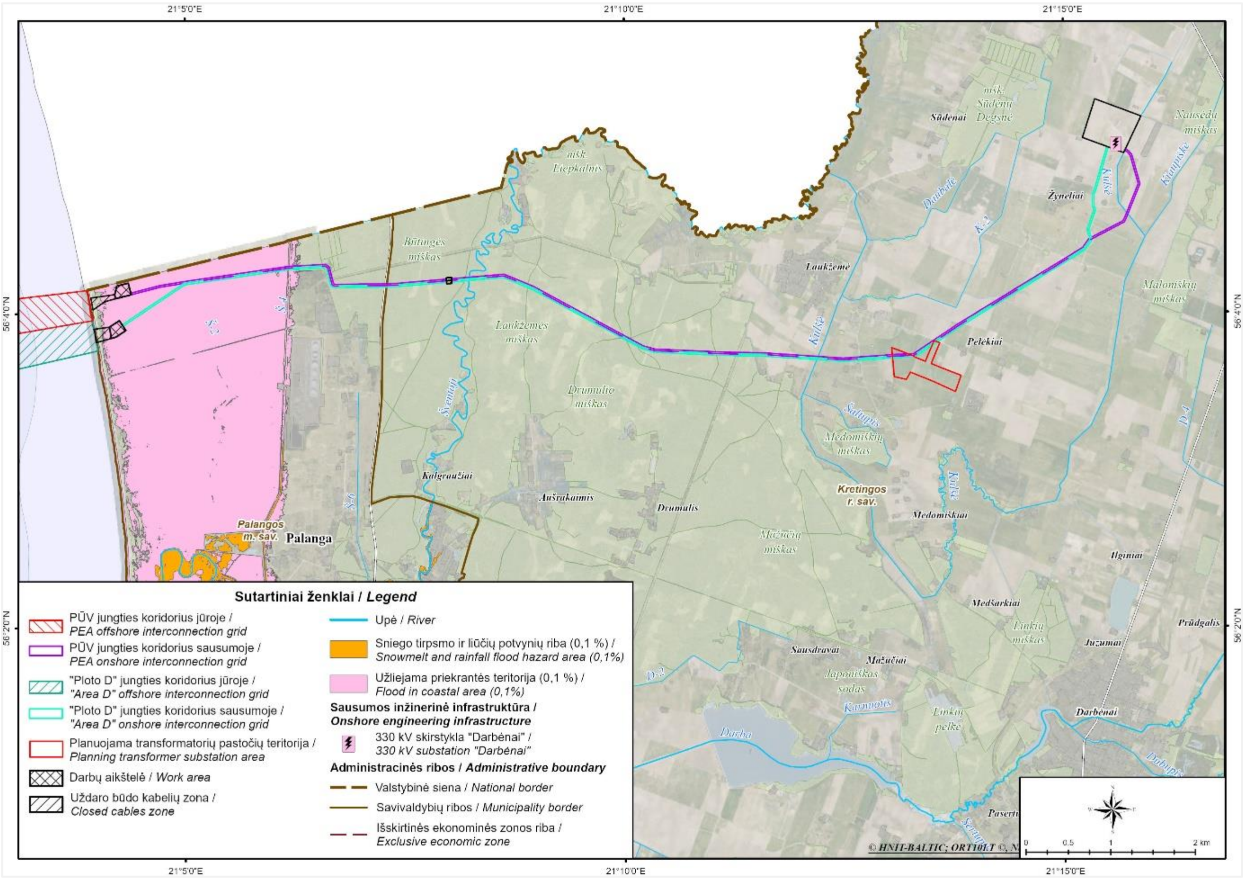


Fig. 5.1.21. Flooding zones and flooded coastal areas in relation to the planned export cable corridor.

5.1.4. Potential impact on water

5.1.4.1. Offshore

5.1.4.1.1. Potential impact on hydrodynamic status

The impact of OWF installation on hydrodynamic situation will largely depend on the foundation type and size. MP structures, with foundation diameter reaching 10–12 m and spaced more than 1,000 m apart, typically do not significantly affect the water current regime. A smaller distance between foundation structures may cause the so-called "cascade effect" which creates vortices downstream and enhances the mixing of water masses. For comparison, studies conducted in an OWF in Denmark showed that in 72 WTGs OWF, where diameter of each turbine foundation is up to 5 m and the turbines are 480 m apart, the impact on water current dynamics was insignificant (<10–15%) (SEAS Distribution, 2000). The installation of gravity base foundations is anticipated to slightly affect the water flow regime in the bottom layer due to their relatively larger foundation diameter compared to single-pile structures. However, the impact on flow dynamics at the water surface will be negligible, due to the tapering design of the foundation structure (ICF 2020).

The 2002 study conducted by the United Kingdom scientists (Cooper et al., 2002) has assessed the potential impacts of OWF on the coastal area processes with a special focus on the scale of changes in waves, current and sediment regime and its further impact on the general sediment transport. The assessment was carried out using different scenarios, i.e. "best", "worst acceptable" and "typical" using numerical models. The generalised results of the simulation of all scenarios allowed for a conclusion that the impact of OWF on waves, currents and sediment transportation is insignificant. The wave speed after colliding with the foundations reduces by one percent, while the direction alters by approximately 0.5°, and the wave height reduces by approx. 0.5–1.5%. The results of simulation of OWF impact on wave regime carried out in 2009 in the Yangtze estuary and the Hangzhou Bay revealed that fluctuations of wave amplitudes could reach up to 1 mm or 0.3% (Zhang, et al., 2009). The study also stated that impact of WTGs on changes in currents is subject to the number of MPs, distance between the MPs and angle between the prevailing current and OWF location.

The 2010 analysis (simulation) of 0.1 m/s current changes around one pile established that the current speed by the MPs sides has increased by approx. 0.1 m/s, whereas the current speed registered at the downwind part reduced to 0.01–0.025 m/s (Ahrendt, Schmidt, 2010). The study above also included the simulation of current changes around

144 MP structures at 0.128 m/s background current. The generalised study results stated that the total current speed in the OWF reduced by approximately 3%.

Recent studies by Hoseini et al. (2025) examined changes in wind wave and current speeds in a North Sea OWF. The results of the modelling study showed that wave and current speeds can be reduced by up to 5% due to OWFs and are observed up to 1 km. The study by Arneborg et al. (2024) modelled the impact of all OWFs planned in the Baltic Sea. The modelling results showed a lower halocline depth, higher salinity and water temperature values in the bottom. However, the change in values is not large and is insignificant compared to the impact of climate change.

Laying of export cables in the offshore section may affect the change in the wave and flow regime in the shallow coastal zone due to the change in the bottom relief during the cable trenching works. However, considering the hydrodynamic situation in the examined marine area, it is predicted that the restoration of the bottom to its original state will occur relatively rapidly, therefore the impact of cable laying on the prevailing wave and flow regime should be assessed as local and short-term and will not have a significant negative impact on the overall hydrodynamic situation.

5.1.4.1.2. Potential impact on water quality from the installation, operation, and dismantling of the OWF due to increased suspended matters (turbidity)

The installation of the foundations of the OWF and the laying of export cables in the offshore section during the construction and dismantling phases may lead to a temporary increase in the amount of suspended matter (turbidity) in the water column of the planned OWF area and the export cable corridors. US experts, assessing the environmental impact of the planned 130 WTGs OWF in the Horseshoe shoal in Nantucket Sound, Massachusetts (USA), provided data that water turbidity may increase in the area of about 0.1 ha around each installed pile during the foundation installation works (Cape wind energy project, Draft Environmental Impact Statement, 2008). Installation of OWF in the Belgium-owned Northern Sea area revealed that the foundation installation caused no significant changes in turbidity and increase in the number of suspended matters in the water column compared to natural conditions in the part of the North Sea mentioned (Van den Eynde et al., 2010).

The EIA for the installation of an OWF in the Polish Baltic Sea assessed the impact of cable laying on the resuspension of suspended matter in the water column. Based on the results of the suspended matter dispersion modelling, it was determined that, depending on the properties of the bottom sediments, the maximum suspended matter concentration will usually not exceed 10 mg/l (OWF Bałtyk II). The concentrations of suspended matter in the Baltic Sea water range from 0.3 to almost 500 mg/l. In the open sea, the average concentration of suspended matter reaches 3–3.3 mg/l (Pustelnikov, 1977; Emelyanov, 2002). In the coastal zone and lagoons, the concentrations of suspended matter reach tens and even hundreds of mg/l (Eisma et al., 1991; Emelyanov, 2002; Schiewer, 2008), higher concentrations (1.3–12.9 mg/l) are also characteristic of deeper areas of the Baltic Sea (Burska et al., 2005).

In the Baltic Power EIA conducted in Poland, modelling results have demonstrated that the most significant release of suspended matter occurs during underwater operations, specifically during the initial seabed cleaning at shallower depths with cohesive sediments and the installation of cables using the jetting method in cohesive soils at greater depths. These activities produce similar effects on the marine environment, characterized by the following parameters: maximum concentrations of suspended matter reach 80 mg/l at a distance of 100 m from the work site, decreasing to 15 mg/l at a distance of 2 km. The sediment deposition from suspended matter at 100 m does not exceed 2 mm in thickness. The retention time for suspended matter with a concentration of 30 mg/l is limited to 3 hours, whereas trace concentrations of 4 mg/l can persist for up to 13 hours, with slightly elevated parameters observed during the cable installation process. In the Baltic Power EIA it is stated that underwater works related to linear infrastructure, where suspended matter is disturbed in a manner defined as a “moving source” (moving vessel or device), generate significantly smaller volumes of newly formed sediments from suspended matter sedimentation than in the case of stationary works (MEWO S.A., 2022). Moreover, the studies of the cumulative effect of suspended matter impact in the Baltic Power OWF in the case of underwater works carried out in the area and its close vicinity showed that slight increases in suspended matter concentration, the range of its impact or the retention time of suspended matter in water may occur. However, these short-term and local changes resulting from the cumulative impact are responsible only for the minimum (practically negligible) change in the suspended matter impact. It is concluded that the effect of accumulation of newly formed sediments caused by various human activities during the construction phase (preparatory works and cable sinking) is possible, however the cumulative impacts will have only a local and short-term impact (MEWO S.A., 2022).

The PEA of the CN OWF is similar to the Polish studies, therefore it is expected that during the construction of export cable corridors a greater increase in turbidity will occur only locally, i.e. at the laying site, and the works will not cause significant large-scale changes in turbidity and an increase in the amount of suspended matter compared to natural conditions in the part of the Baltic Sea under consideration.

During the dismantling of the OWF and related infrastructure (removal of foundations and power transmission cables), a short-term and local increase in suspended matter (turbidity) is also expected at the site of the works. The dismantling works will not result in significant large-scale changes in turbidity and an increase in suspended matter compared to natural conditions in the examined part of the Baltic Sea.

5.1.4.1.3. Potential impact of the construction of the OWF and export cable corridors on the chemical status of seawater

During the installation and dismantling of the OWF and related infrastructure (electricity transmission cables, foundations, OSS), secondary (indirect) water pollution by chemical substances (heavy metals, organic compounds) accumulated in the composition of fine-dispersed (muddy) sediments is possible during the movement of bottom sediments. The probability of secondary water pollution increases mostly in the areas that are parts of the seabed which is technologically affected (in areas of soil dredging, in the territory of buried chemical weapons, etc.). In the offshore part, the installation of the OWF and the laying of the export cable are planned in areas where glacial moraine deposits, fine and medium-grained sands, gravel, pebble and boulder fields prevail, which are not characterised by significant, historically formed chemical contamination, therefore, significant negative consequences for water due to secondary pollution are not expected.

Under normal working conditions, OWF operation would have no impact on sea water quality. However, WTG blades are often made of epoxy resins and glass/fibre composites that may contain flame retardants, including environmentally hazardous polybrominated diphenyl ethers (PBDEs). As WTG's blades age, these substances may be released into the aquatic environment (Epoxy Resin Committee, 2015). PBDEs may also be released into the marine environment through wear and tear or accidents of electrical equipment containing flame retardants, as well as accidental damage to WTG's components during transportation, installation, and maintenance.

A potential additional water pollution with chemicals is typically related to an accidental collision of tankers and OWF, in adverse weather conditions, or in case of a vessel breakdown. In such a case, most of the problems would be caused by oil spillage into the marine environment from the tanker wreck. The PEA territory is outside the shipping routes, roadstead, anchorage sites, therefore, the risk of collision is relatively low.

Smaller-scale pollution of the marine environment with synthetic compounds is also possible due to spillage of hydraulic liquids and lubricating oil from the systems operating in the OWF nacelle (Bonar et al., 2015). Total amount of oil in each turbine can reach 200 to 1,400 l, depending on the size of the turbine[27]. There is not enough scientific data on accidental spillage of chemicals from OWFs. It is however supposed that the amounts are very small compared with the operation of offshore oil extraction plants (Kirchgeorg et al., 2018).

Modern WTGs are design to reduce the possibility of potential spillage of potentially dangerous chemicals to the minimum. Depending on the WTG model, corresponding reservoirs are installed under nacelles to collect hydraulic liquids and lubricating oil to prevent the pollution of marine environment in case of unscheduled spillage due to turbine breakdown. The risk of spillage is also reduced by ensuring the watertight integrity of WTG systems (Bonar et al., 2015).

5.1.4.1.4. Potential impacts of the OSS related to stormwater generation

The topside of the planned OSS (preliminary area of approximately 3,000 m^2) will consist of a steel platform, which will serve as the basin for temporary accumulation of rain and sea water and further generation of rainwater flow. Considering that the OSS will be equipped with main transformers, diesel generators, diesel tanks, etc., there is a risk of spillage of hazardous substances (oil products) and their entry into rainwater and drainage, and further to the marine environment.

There are no legal regulations governing the discharge of surface runoff and/or setting limit concentrations of certain pollutants for OWFs and other marine infrastructure. Surface runoff management in Lithuania are regulated by the Surface Runoff Management Regulation, approved by Order No. D1-193 of the Minister of the Environment of the Republic of Lithuania of 2 April 2007 "On the Approval of the Surface Runoff Management Regulation" (hereinafter – the Regulation).

In accordance with the requirements of paragraph 15 of the Regulation, "surface runoff generated on potentially polluted territories with an area (water collection area) exceeding 0.01 ha must be treated in wastewater treatment plants to specified concentrations before being released into the environment. The conditions under which surface runoff can be discharged into surface water bodies are specified in point 18 (sub-point 18.1). To ensure the implementation of the requirements of Section 15 of the Regulation, surface runoff generated on the surface of the OSS will be directed to an automatic oil and water separator before release into the environment, where the instantaneous concentration of oil

[27] ExxonMobil Energy Factor

(petroleum) products will be recorded. If it is determined that the instantaneous amount of petroleum products in surface runoff is higher than 7 mg/l, the discharge of water into the environment will be stopped and contaminated surface runoff water will be directed to the closed wastewater system installed in the OSS.

To reduce the risk of spills, it is also planned to install additional technical measures for retaining and collecting oil products (oil drip trays, sump tanks) in the OSS. When designing/planning a surface runoff treatment mechanism, it is necessary to follow the requirements of the Regulation on the Application of Wastewater Treatment Plants, approved by the Order of the Minister of the Environment of the Republic of Lithuania of 11 September 2006 No. D1 412 “On the Approval of the Regulation on the Application of Wastewater Treatment Plants”.

5.1.4.2. Onshore

5.1.4.2.2. Potential impact on surface and groundwater bodies crossed by the export cable corridors

Most onshore cabling operations are planned to be carried out via open trenching equal to or deeper than 1.5 meters.

Some of the smaller water bodies (Š-2, Š-4, Kulšė) and drainage channels will be crossed using the open excavation method using submerged cable technology, trenchless method might be foreseen during the design stage. When using this method, the cable is buried in a trench excavated in the riverbed to protect it from damage. This method may involve specialised equipment to excavate the riverbed and lay the cable. Open excavation methods may cause temporary increases in suspended matter in the waters and interference with the riverbed. The impact discussed above will be local and short-term.

At the intersection with the Šventoji River (and possibly Kulšė), which is a "Natura 2000" area, HDD technology is planned to be used to avoid direct impacts from excavation works on the water bodies. This closed cable laying technique utilises approximately 100 m² of land on one bank for operating the HDD equipment, while on the opposite bank, further connection works are conducted for the cable laid beneath the water body's bottom. HDD is executed from one side, with cables encased in plastic protective casings that are later filled with bentonite to improve the heat dissipation and reduce the electrical resistance. This prevents overheating and ensures cables operate at their optimal capacity. The outer diameter of a typical casing pipe ranges from 250 to 450 mm.

The typical length of boreholes ranges from 15 to 300 m, the exact length of the borehole is selected depending on the width of the object being crossed. Underwater boreholes must be at least 1 m below the riverbed and not less than 1 m below the design water body bottom level. Given the scope of excavation work, no significant impact on the hydrological and hydrodynamic regime of water bodies is expected.

Onshore cabling must be planned pursuant to the requirements specified in Articles 98–100 and 106 of the SLUC for activities near groundwater and surface water bodies, not to violate the hydrological regime of the territories, and to provide for the restoration of land reclamation systems, if such are affected.

When laying the cable at intersections with surface water bodies, the existing shoreline may be changed. In accordance with the requirements of Article 98 of the SLUC, it is prohibited to regulate (dam and otherwise change the water level, depth and (or) shoreline) rivers, lakes and intermediate waters in surface water bodies, except for cases when land reclamation structures, engineering networks, communication lines, special-purpose buildings are being constructed and (or) reconstructed.

During cable laying work, heavy machinery will operate in the protection zones and strips of surface water bodies. In accordance with the requirements of Article 99 of the SLUC, it is prohibited to drive motor vehicles in the protection zones of surface water bodies and to park them closer than 25 m from the shoreline of the water body, except in cases where: c) permitted agricultural or forestry, land reclamation, maintenance of inland waterways and construction of structures are carried out; f) engineering infrastructure exploitation works are carried out.

In accordance with the requirements of Article 100 of the SLUC, it is prohibited to carry out earthworks, change the shoreline, relief and surface of the land in the coastal protection zones of surface water bodies, except in cases where roads and engineering networks crossing the coastal protection zone of surface water bodies are being built or installed.

In the protection zones of groundwater bodies, it is prohibited to install wells intended for the exploration and/or use of hydrocarbon (oil and/or gas) resources; to directly discharge treated and untreated municipal, industrial and surface wastewater, radioactive and chemical substances into underground aquifers.

The alternatives for the export cable corridors have been selected to bypass groundwater aquifers and their protection zones, and in this regard, no negative impact, and therefore no consequences, are expected. Considering the volume of excavation work carried out during cable laying, no significant impact on the hydrological regime is expected.

5.1.4.2.3. Possible cumulative impact of the installation, operation and dismantling of the OWF on water quality while simultaneously implementing other OWF construction projects

According to the specific solutions of the Development Plan, the area defined as a priority territory for the development of renewable energy is divided into separate areas, in which the development of objects using RES will be carried out in stages.

Given that the installation of other OWFs is scheduled to occur in distinct phases rather than simultaneously, a cumulative impact assessment on water quality is not presently considered necessary. By aligning the timing and location of each OWF project with territorial planning documents, any cumulative impact can be effectively managed and is not anticipated to lead to significant adverse effects.

5.1.5. Preventive, mitigation and compensatory measures for impacts on water

5.1.5.1. Offshore

In this case, minimum distance between the WTGs will be approximately 1,100–1,300 m (according to the preliminary layout of the WTGs locations depending on the alternative, see Chapter 4), therefore the impact on the hydrodynamic situation will be insignificant and the application of additional measures is deemed necessary.

The OWF area is planned at depths exceeding 28 m, indicating that MP, GBF, or jacket foundation structures are likely to be utilized. The impact of these foundations on the hydrodynamic environment is anticipated to be minimal due to their offshore placement and the stable geological conditions. Unlike the dynamic sandy substrates typical of coastal zones, the OWF site is characterized by firm moraine or stable gravel and cobble sand mixtures from earlier geological periods. Research has shown that scour formation is common for monopile structures, occurring primarily in sandy coastal areas. The intensity of scour formation is greatest during the initial stages of OWF operation and gradually decreases until reaching maximum depth. To mitigate scour, gravel bed reinforcement measures are typically applied at the foundations. However, given that the project area predominantly consists of solid bedrock, significant foundation scour – and thus the necessity for extensive mitigation measures – is unlikely or expected to be minimal.

The increase in turbidity will occur only at sites of foundation installation and cable laying; therefore, its impact should be considered local (affecting the bottom layer) and temporary (limited to the installation period), with no significant long-term effects on hydrochemical water parameters or Baltic Sea water quality. The distance from the PEA area to the nearest recreational areas and beaches of Palanga Municipality is approximately 36.8 km, ensuring that significant impacts on the Palanga coastline from the installation and operation of the OWF will be avoided. Consequently, the application of additional measures is not necessary.

The OWF area is outside existing roadstead and anchorage sites. The nearest existing shipping route to the OWF area is about 340 m away. Planned alternatives for export cable corridors intersect shipping routes, and the risk of collision by passing ships is assessed in the Section of Risk Analysis and Assessment.

To select appropriate technological solutions for the OWF development and evaluate the impact of the proposed OWF structures on hydrodynamic conditions, current measurements (along with other parameters) have been conducted since February 2024 at the approaches to the OWF (Seawatch SWLB94, see Fig. 5.1.1). It is recommended that monitoring of the current regime continue after construction is completed.

During OWF installation, there is a potential for local and temporary impacts on water quality and additional water pollution from chemicals (heavy metals, oil hydrocarbons, polyaromatic hydrocarbons) due to intensified shipping activities. To determine whether pollutant concentrations align with GES values, it is advisable to include pollutant research in the environmental monitoring programme, scheduling research prior to construction (background concentration), during construction (foundation installation, cable laying), and after construction is completed (3 to 6 months post-completion). To reduce or prevent the spillage of heavy metals (particularly zinc or aluminium) into the water, corrosion control methods with enhanced eco-friendly parameters should be utilised during OWF construction and operation. One viable alternative, already applied in the Baltic Sea region, involves using a mixture of metallic anti-corrosion coatings (Al, 350 μm) and organic coatings applied via thermal spraying on pile structures (Kirchgeorg et al., 2018).

5.1.5.2. Onshore

To prevent potential impacts from construction works on surface water bodies, construction equipment sites and temporary access roads must not be established within coastal protection zones of water bodies or closer than 25 m to the shore of any water body.

During construction activities within protection zones and areas surrounding water bodies, it is essential to adhere to the requirements specified in Articles 98, 99, and 100 of the SLUC.

Table 5.1.3. Summary of potential impacts of the OWF on water in the offshore area and mitigation measures

Stage	Impact	Nature	Scale	Duration	Significance	Measures
			Water quality			
Construction	Increase of turbidity	Direct. Increase in suspended matter in the water column at the site of foundation structures and cable trenches.	Local. At the installation site of OWF and cable trenches.	Short-term	Insignificant	Not applicable.
	Secondary water pollution by chemicals contained in bottom sediments	Direct. Secondary pollution in areas of contaminated bottom sediments.	Local. At the installation site of OWF and cable trenches.	Short-term	Insignificant	Not applicable (the seabed sediments in the planned installation sites are not contaminated).
	Pollution with anti-corrosion agents	Direct. Secondary pollution with heavy metals from sacrificial anodes.	Local. At the installation site of OWF and cable trenches.	Short-term	Insignificant (when applying mitigation measures)	More environmentally friendly corrosion control methods should be applied, e.g. ICCP Impressed current cathodic protection system, metallic anti-corrosion coatings (Al, 350 µm) with sacrificial anodes and organic coatings by thermal spraying on pile structures.
Operation and maintenance	Increase of turbidity	Direct. Due to maintenance works	Local. At the installation site of OWF.	Short-term, only during maintenance	Insignificant	Not applicable.
	Oil products entering the marine environment from surface runoff	Direct. It is possible that oil products may enter surface runoff from transformers, diesel generators, diesel tanks, etc. installed in the OSS.	Local. At the site of OSS.	Long-term: entire operation time	Insignificant (when applying mitigation measures)	Diversion of surface runoff to the oil and water separator. Additional technical measures for retaining and collecting oil products (oil drip trays, wastewater tanks).
	Pollution with anti-corrosion agents	Direct. Secondary pollution with heavy metals from sacrificial anodes.	Local. At the installation site of OWF.	Long-term: entire operation time	Insignificant (when applying mitigation measures)	More environmentally friendly corrosion control methods should be applied, e.g. ICCP Impressed current cathodic protection system, metallic anti-corrosion coatings (Al, 350 µm) with sacrificial anodes and organic coatings by thermal spraying on pile structures.

Stage	Impact	Nature	Scale	Duration	Significance	Measures
Decommissioning	Increase of turbidity	Direct. Increase in suspended matter in the water column at the site of foundation structures and cable trenches.	Local. At the site of OWF decommission.	Only during decommission, if the foundation of the OWF will be dismantled	Insignificant	Not applicable.
	Secondary water pollution by chemicals contained in seabed sediments	Direct. Secondary pollution in areas of contaminated seabed sediments.	Local. At the site of OWF decommission.	Only during decommission, if the foundation of the OWF will be dismantled	Insignificant	Not applicable (the seabed sediments in the planned installation sites are not contaminated).
			Hydrodynamic situation			
Construction	Changes in direction and speed of currents	Direct. Local change in the hydrodynamic regime due to new objects in the water	Local. At the installation site of OWF.	Short-term, during construction.	Insignificant	Not applicable.
	Damping or changes in wave direction and speed	Direct. Local change in the hydrodynamic regime due to new objects in the water	Local. At the installation site of OWF.	Short-term, during construction.	Insignificant (when applying mitigation measures)	Selection of the appropriate distance between WTGs.
Operation and maintenance	Changes in direction and speed of currents	Direct. Local change in the hydrodynamic regime due to new objects in the water	Local. At the OWF.	Long-term, more intense at the beginning of activity, later stabilizes.	Insignificant (when applying mitigation measures)	Selection of the appropriate distance between WTGs.
	Damping or changes in wave direction and speed	Direct. Local change in the hydrodynamic regime due to new objects in the water	Local. At the OWF, depends on dimensions, amount and density of the foundations.	Long-term, occurs only at shallower area.	Insignificant (when applying mitigation measures)	Selection of the appropriate distance between WTGs.
Decommissioning	Changes in direction and speed of currents	Direct. Local change of hydrodynamic regime after removal of obstacles.	Local. At the OWF.	Short-term, more intense at the beginning of activity, later stabilizes.	Insignificant	Not applicable.

Stage	Impact	Nature	Scale	Duration	Significance	Measures
	Damping or changes in wave direction and speed	Direct. Local change of hydrodynamic regime after removal of obstacles.	Local. At the OWF	Short-term	Insignificant	Not applicable.

Colour code

(green)	Positive impact
(light blue)	No impact or impact insignificant (not to be considered, no measures are applicable)
(blue)	Minor impact: decisions during design, preventive or mitigation measures
(light orange)	Moderate impact: addressed by mitigation measures
(orange)	Significant impact: mitigation and/or compensation measures are necessary.

Table 5.1.4. Summary of potential impacts of the OWF on water onshore and mitigation measures

Stage	Impact	Character	Scale	Duration	Significance	Measures
Construction	Increase of suspended matter (turbidity)	Direct. Increase in suspended matter at the site of cable trenching using open excavation technology.	Local. At the installation site of cable trenches.	Short-term (construction stage only)	Insignificant (when applying mitigation measures)	Application of HDD or similar technology when laying export cables at the landfall and at the intersection with the Šventoji River (and possibly Kulšė).
Operation and maintenance	No impact on water quality under normal operating conditions				Insignificant	Not applicable.
Decommissioning	Increase of suspended matter (turbidity)	Direct. Increase in suspended particles at the site of cable decommissioning.	Local. At the site of cable decommissioning.	Short-term (decommission stage only if the laid cable will be dismantled)	Insignificant	Not applicable.

Colour code

(light green)	Positive impact
(light blue)	No impact or impact insignificant (not to be considered, no measures are applicable)
(blue)	Minor impact: decisions during design, preventive or mitigation measures
(light orange)	Moderate impact: addressed by mitigation measures
(orange)	Significant impact: mitigation and/or compensation measures are necessary.

5.2. Ambient air and climate

In the context of climate change, the use of RES is especially beneficial, as it positively contributes to mitigating the adverse effects of climate change. Wind energy, for example, reduces the use of fossil fuels and thus the emission of CO_2 and other pollutants into the atmosphere. Wind energy plays a significant role in combatting climate change by reducing GHG emissions in the energy sector. There are likely to be indirect climate benefits through the implementation of PEAs.

No stationary sources of ambient air pollution or emissions are expected from electricity generation in the OWF. However, air pollution may occur during the construction, maintenance, and decommissioning of the OWF and the export cables. Vehicles and construction machinery are the main sources of ambient air pollution during the construction, operation and decommissioning phases of the OWF.

5.2.1. Survey methods

5.2.1.1. Methods for assessing current state

The existing hydrometeorological conditions were defined based on the results of long-term modelling of wind strength, as well as wind speed measurements taken between 2022 and 2024. Fugro LiDAR wind speed measurements for 2024 and two-year measurements in the area adjacent to the planned OWF were also used.

5.2.1.2. Methods for assessing potential impacts

Wind energy plays a significant role in mitigating climate change by reducing GHG emissions in the energy sector. Consequently, the development of the OWF is a climate-mitigating factor. The potential impacts on ambient air and climate of the planned CN OWF were assessed based on the principles of avoided CO_2 emissions and life cycle assessment, using the GHG emissions assessment prepared by Tetra Tech RPS Energy (2024).

Data on the prevailing marine conditions in the study area, such as mean Baltic Sea surface temperature, sea level rise and mean wind speed, were collected using literature sources including Dutheil et al. (2022), European Space Agency (2021) and Offshore Wind Parks (2023). Mean Baltic Sea surface temperatures, sea level rise and mean wind speeds were obtained as these are relevant to the location of the CN OWF's marine elements.

The prevailing climatic conditions in the continental part of the study area were assessed based on the observation data of the Lithuanian Hydrometeorological Service (2024), as well as on multi-year observation data (1991–2020) of climatic conditions (average air temperature, average annual precipitation, and wind speed) typical for the Klaipėda region.

5.2.2. Study area

The study area covers both marine and terrestrial parts where offshore wind development and related engineering infrastructure are planned and is located within the territorial waters and the exclusive economic zone of the Republic of Lithuania, including the nearshore zone and the land area within Palanga city and Kretinga district municipalities.

5.2.3. Current state

5.2.3.1. Prevailing climatic conditions offshore

Global climate change has the most significant impact on the prevailing climatic conditions in the marine area of the CN OWF. According to a study by Dutheil et al. (2022), the Baltic Sea has been considered one of the fastest-warming semi-enclosed seas in the world in recent decades. The sea surface temperature increased by 1.35°C between 1982 and 2006, raising the risk of marine heatwaves and potentially altering local biogeochemical conditions. Data from the European Space Agency (2021) indicate that the average sea level in the southern Baltic Sea has risen annually by 2–3 mm from 1995 to 2019. Summarising data from Marine Wind Parks (2023), the average wind speed in 2022 near the Lithuanian coast of the Baltic Sea was between 8.1 at 100 m and 8.9 m/s at 250 m altitudes, with the maximum annual wind speed reaching 22.8 m/s.

The primary meteorological factor that determines favourable conditions for offshore wind energy development is wind strength. Long-term wind strength modelling results (see Fig. 5.2.1) show that wind speed increases as one moves farther from the shore, ranging from 7 to 10 m/s. The latest wind measurements (2022–2024) revealed that in the CN OWF area, the average wind speed at 200 m altitude can reach approximately 8.6 m/s, based on wind speed measurements from the Fugro Lidar observation station.

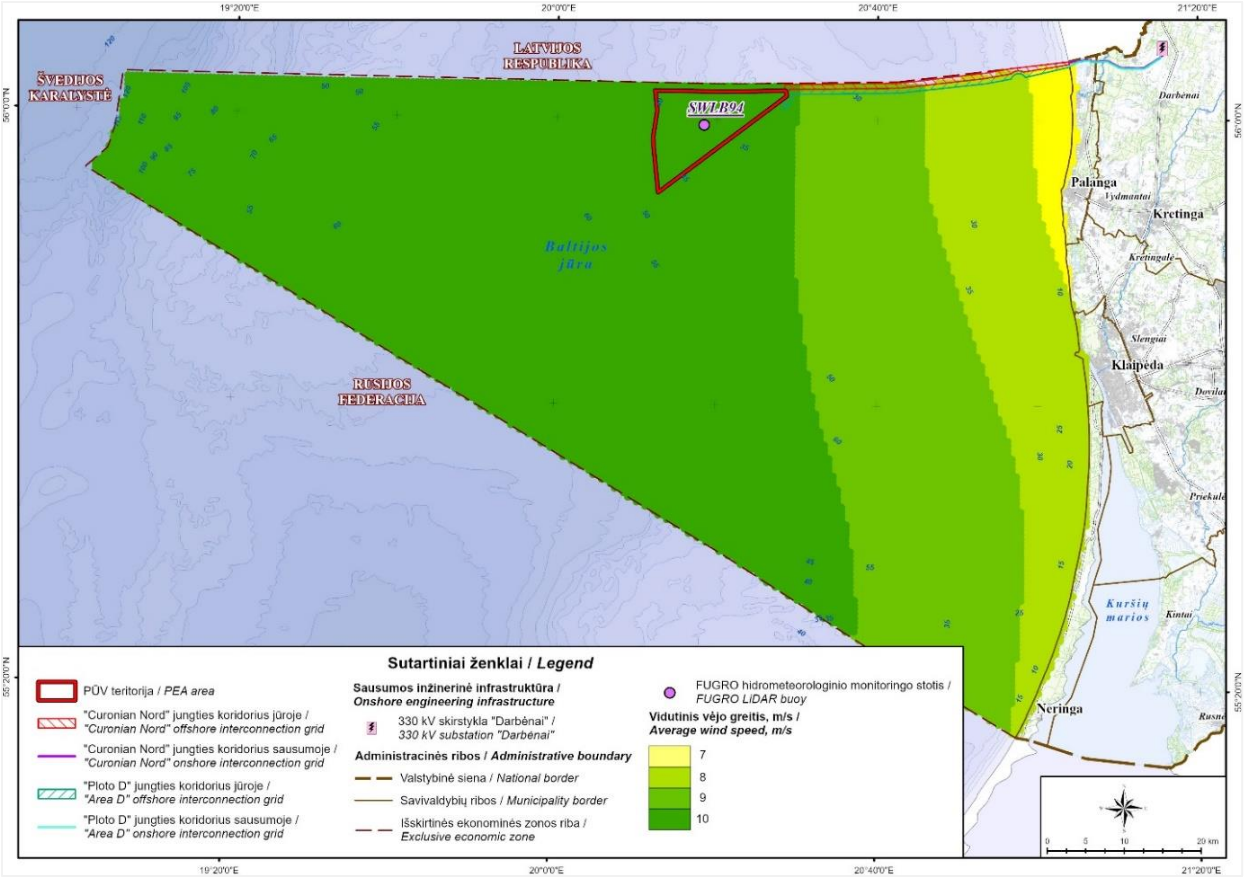


Fig. 5.2.1: Average wind speed at sea (100 m above sea level).

5.2.3.2. Prevailing climatic conditions onshore

The onshore elements of the PEA are foreseen in the Klaipėda region (Palanga and Kretinga municipalities). A comparison of multi-year hydrometeorological data (table 5.2.1) reveals that the Klaipėda region has higher average air temperatures, precipitation levels, and wind speeds than Lithuania as a whole.

Table 5.2.1. Hydrometeorological data for the Klaipėda region and Lithuania, based on data from the Hydrometeorological Service (2024)

	Average air temperature (°C)	Average rainfall (mm)	Average wind speed (m/s)	Number of days with maximum wind speed ≥15 m/s
Klaipeda region	8.2	761	4.1	51.8
Lithuania	7.4	695	3.1	23.8

5.2.4. Potential impacts on ambient air and climate

5.2.4.1. Ambient air pollution and climate impact during construction and installation

5.2.4.1.1. Offshore

The installation of the offshore elements of the CN OWF is anticipated to have short-term and localised impacts on ambient air quality due to construction and maintenance activities, including repair and servicing. These activities may lead to emissions of carbon monoxide, nitrogen oxides, volatile organic compounds, sulphur dioxide, and particulate matter from ships' combustion engines. These emissions have been converted into carbon dioxide equivalent emissions based on the rate of 2.77 kg CO2e per litre of marine fuel.

The requirements of MARPOL Annex VI (Regulation for the Prevention of Air Pollution from Ships) limit emissions from ships' internal combustion engines.

Table 5.2.2. Emission standards for marine engines (source: Air Emissions from Marine Vessels. Report of the Joint Standing Committee on Natural Resources. Maine Department of Environmental Protection Bureau of Air Quality. 2005)

Standard	Vessel engine type				Emissions (g/kW/hour)				Year of manufacture
	Category	Volume	Power (kW)	Speed, rpm	NOx	NOx and THC**	PM	CO	
MARPOL			>130	N<130	17.0	-	-	-	2005-05-19*
				130<N<2,000	$45.0 \times N^{-0.20}$				
				N>2,000	9.8				
EPA Tier 1	1, 2, 3	>2.5	>37	N<130	17,0	-	-	-	2004–2006
				130<N<2,000	$45.0 \times N^{-0.20}$				
				N>2,000	9.8				
EPA Tier 2	1	<0.9	Any	-	-	7.5	0.40	5.0	2007
		0.9–1.2	Any			7.2	0.30	5.0	2007
		1.2–2.5	Any			7.2	0.20	5.0	2007
		2.5–5.0	Any			7.2	0.20	5.0	2007
	2	5.0–15.0	Any	-	-	7.8	0.27	5.0	2007
		15.0–20.0	<3,300			8.7	0.50	5.0	2007
		15.0–20.0	>3,300			9.8	0.50	5.0	2007
		20.0–25.0	Any			9.8	0.50	5.0	2007
		25.0–30.0	Any			11.0	0.50	5.0	2007

* MARPOL VI entered into force on 19 May 2005 and applies to engines for ships built after 1 January 2000.
** Total hydrocarbons.

The offshore environment provides favourable dispersion conditions so that emissions are easily dispersed and do not have a significant negative impact on the environment.

5.2.4.1.2. Onshore

Installing the underground electricity transmission cable will have short-term, localised impacts on ambient air quality due to construction and maintenance activities, such as repairs and servicing. These activities may result in emissions of carbon monoxide, nitrogen oxides, volatile organic compounds, and particulate matter from mobile sources like vehicles and machinery with internal combustion engines. The installation of the export cable and Pelėkiai Transformer Substation will require at least five excavators, five dump trucks, a front-end loader, a vibrating roller, and other machineries. Exact number of required machineries for installation works and their time of use shall be foreseen during the design stage. It is assumed that the construction and cable-laying machinery will operate for 12 hours per day over a total of 480 days. The total estimated fuel consumption for installing the downstream engineering infrastructure is approximately 1 t of diesel per day.

The calculation of mobile source air pollution is performed according to the European Environment Agency air pollutant emission inventory guidebook (EMEP/EEA air pollutant emission inventory guidebook; 2023). Emissions from construction and goods vehicles have been calculated using the CORINAIR (1.A.4 non-road mobile machinery) Tier 1 transport emissions methodology, which is based on calculating emissions according to fuel consumption and specific emission factors (g/t fuel).

Table 5.2.3. Estimated annual emissions of pollutants from mobile sources

Name	Name of pollutant	Emission factor, g/t fuel	Fuel consumption, t	Emissions to ambient air, t/year
Construction and cable-laying machinery	Carbon monoxide (CO)	10,774	480	5.17
	Oxides of nitrogen (NOx)	32,629		15.66
	Volatile organic compounds (VOCs)	3,377		1.62
	Particulate matter (PM)	2,104		1.01
			Total	**23.46**

When installing export cables in forested areas, an engineering corridor (20 m wide for each export cable) will be established, requiring the removal of trees and shrubs. Based on the planned length of the export cable route, approximately 11.3307 ha of vegetation will be cleared for the CN OWF connection and 11.2648 ha for the "Area D" OWF connection, potentially releasing accumulated carbon into the atmosphere. Using the indicator of accumulated carbon per hectare of forest in Europe (53.6 tC/ha) provided by the Food and Agriculture Organization of the United Nations (FAO, 2020), and applying the carbon sequestration factor of 3.67, it is calculated that the installation of the CN OWF export cable on the mainland will contribute to 2,223 tCO2e emissions, while the "Area D" OWF connection will contribute to 2,216 tCO2e emissions.

5.2.4.2. Ambient air pollution and climate impact during operation

No stationary sources of ambient air pollution are anticipated during the operation of both the onshore and offshore elements of the CN OWF.

The use of renewable energy is particularly beneficial in the context of climate change as it helps mitigate its effects. Wind energy, as a form of renewable energy, reduces reliance on fossil fuels and consequently decreases CO_2 and other atmospheric emissions. Wind energy plays a crucial role in combating climate change by reducing GHG emissions in the energy sector. The implementation of the PEA is expected to lower GHG emissions and positively impact the climate.

Lifecycle analysis studies are increasingly utilised to assess the climate impact of renewable energy, allowing for comparison of the climate impact of various energy production technologies. These impacts are expressed in terms of global warming potential, measured in gCO_2 eq/kWh. According to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Part 2: Energy, one megawatt-hour (MWh) of thermal energy produced by burning liquid fuels emits approximately 0.27 t of CO_2. In contrast, studies by Anna Garcia-Teruel et al. (2022) and Barbara Mendecka and Lidia Lombardi (2019) indicate that the global warming potential of OWFs ranges from 25 to 133 g CO_2 eq/kWh, depending on the technological parameters of the OWF. This is significantly lower than the emissions associated with fossil fuel energy production.

5.2.4.3. Ambient air pollution impact on the climate during the decommissioning

The potential emissions during the decommissioning of OWF are similar to those during construction. Any potential air pollution from mobile sources or machinery during the decommissioning phase will be localised, temporary and insignificant.

5.2.5. Measures to prevent, reduce and compensate for impacts on ambient air and climate

Due to the GHG emission reduction factor, no air and climate-related mitigation measures are required or planned for the installation of the OWF.

Measures to reduce the potential impact of construction or material transportation activities on ambient air:

- Ships operating must comply with the requirements of international organisations (MARPOL).
- Employ low-emission equipment during construction, cable laying or other earth-moving activities and during operation.
- When transporting dusty construction materials or bulk cargo, adhere to the Order of the Minister of the Environment of the Republic of Lithuania No. D1-682 of 11 November 2020 "On Approval of the Minimum Requirements for Dust Reduction during Storage, Loading and Transportation of Loose Solids".

Table 5.2.4. Potential impact of the OWF on the ambient air and climate, and summary of mitigation measures

Operational stages	Impact	Nature	Scale	Duration	Significance	Mitigation measures
Offshore						
Construction	Pollutant emissions from engines of vessels/ construction machinery	Direct impact having no significant impact on ambient air quality	At a vessel's/technical machinery's workplace	Only at the time of construction phase	Insignificant	Not applicable
Operation and maintenance	Pollutant emissions from service vessels	Direct impact having no significant impact on ambient air quality	At a vessel's/technical machinery's workplace	Only at the time of maintenance/repair works	Insignificant	Not applicable
	Electricity production from RES	Indirect, positive impact reducing the use of fossil fuels and emissions of CO_2 and other GHGs into the ambient air	Regional / global	Long-term, at the time of OWF's operation	Positive contribution is significant for mitigating the climate change impacts	Not applicable
Decommission	Pollutant emissions from engines of vessels/ construction machinery	Direct impact having no significant impact on ambient air quality	At a vessel's/technical machinery's workplace	Only at the time of work	Insignificant	Not applicable
Onshore						
Construction	Pollutant emissions from construction equipment engines	No direct impact with significant influence on ambient air quality	Local, at the workplace	Only during the construction phase	Insignificant	Not applicable
Operation and maintenance	Pollutant emissions from construction equipment engines	No direct impact with significant influence on ambient air quality	Local, at the workplace	Only during maintenance/repair work	Insignificant	Not applicable
Decommission	Pollutant emissions from construction equipment engines	No direct impact with significant influence on ambient air quality	Local, at the workplace	Only during work	Insignificant	Not applicable

Colour code

(light green)	Positive impact
(light blue)	No impact or impact insignificant (not to be considered, no measures are applicable)
(blue)	Minor impact: decisions during design, preventive or mitigation measures
(light orange)	Moderate impact: addressed by mitigation measures
(orange)	Significant impact: mitigation and/or compensation measures are necessary.

5.3 Seabed, subsurface, and topsoil

5.3.1. Survey methods

5.3.1.1 Methods for assessing the current state

Subsurface research was conducted in several stages to investigate the current condition of the area from different perspectives:

- Analysis of geological information stored in the archives of the Lithuanian Geological Survey.
- Hydrographic surveys: seabed morphology and object investigations using multibeam echo sounding, side-scan sonar, and marine magnetometer.
- Geotechnical seabed and export cable corridor surveys: collection of surface sediment samples for grain size composition analysis in laboratories; shallow vibro-coring followed by lithological and geomechanical laboratory analysis of retrieved core samples; Cone Penetration Testing (hereinafter – CPT) and deep drilling (up to 60 m) to assess geomechanical soil properties in the planned OWF area.
- Shallow seismo-acoustic surveys to determine subsurface geological layer structures and distribution in the survey area using sub-bottom profiler (SBP; 0–10 m depth) and 2D ultra-high-resolution seismic (2D UHRS; approximately 50–60 m sediment thickness).
- Deep marine seismic surveys using a multi-channel seismic system (a seismic source of 4 air guns and data recording with hydrophone receivers), to determine the spatial layout of potential oil-bearing structures and clarify seismic fault systems intersecting or near the project area. This deep seismic system targets geology up to approximately 1,500–2,000 m below seabed level.
- Geochemical soil composition analysis to identify potential chemical pollution sources and/or geochemical background, which serves as the basis for assessing secondary pollution potentially generated during construction.

Main research methods:

- Deep marine seismic survey:
  - The vessel was equipped with multi-channel seismic system (with a seismic source of 4 air guns and data recording with hydrophone receivers). The vessel sailed in a pre-determined profiles located at 1 km distance from each other while collecting data. The survey targeted geology up to approximately 1,500–2,000 m deep below seabed level with a purpose to determine the spatial layout of potential oil-bearing structures and clarify seismic fault systems intersecting or near the project area.
- Hydrographic-geophysical seabed surveys were conducted in three stages:
  - First stage: the vessel was equipped with multibeam echo sounder for seabed morphology and depth studies, side-scan sonar for object detection on the seabed and surface sediment distribution, a magnetometer for magnetic anomaly detection on the seabed), and a sub-bottom profiler (shallow seabed structure. As the vessel moved along the survey profiles, all equipment operated simultaneously to collect the data.
  - Second stage: seabed samples were collected to interpret the side-scan sonar data and evaluate the type and distribution of surface sediments.
  - Third stage: the vessel was equipped with a 2D ultra high-resolution seismic system to investigate the seabed structure down to approximately 50–60 m below seabed. Data were collected along every other survey line from the first stage.
- Geotechnical investigations include four main methods: vibro-coring to extract cores up to 3–5 m long (or less, depending on instrument penetration), CPT until reaching refusal or maximum cone resistance, particularly in dense and hard soils, collection of surface sediments with Van Veen type grab samplers, and laboratory analysis of collected soil for lithological and geomechanical properties.
- Geochemical analysis assesses the existing geochemical background (via laboratory tests), the initial level of soil contamination both in the OWF construction zone and along the export cable corridor. Contaminants such as petroleum products (C10–C40), polyaromatic hydrocarbons (PAHs), and heavy metals (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg) were analysed in an accredited laboratory (UAB “Vandens tyrimai,” accredited under LST EN ISO/IEC 17025:2018). The chemical status of the Lithuanian Baltic Sea area was evaluated using guidelines from the Minister of Environment Order No. D1-194 (March 4, 2015), which includes average annual concentration thresholds for pollutants in seabed sediments.

The methods and scope of the conducted studies are detailed in the main reports, which served as the basis for the EIA:

- Hydrographic surveys of the OWF area: Fugro Netherlands Marine B.V, 2024. *Geophysical Survey Results Report*.
- Geological-engineering surveys of the OWF area: Geo, 2024 *LTOF02 Lithuania OWF WTG Locations Geotechnical Survey Field Operations & Preliminary Results Report* and Fugro Netherlands Marine B.V, 2024, *Lithuania Offshore Wind Farm Geotechnical Survey Baltic Sea Operations/Field Report Geotechnics*.
- Hydrographic surveys of the export cable corridor: PTPI, 2023. *Seabed Surveys*.
- Report of the geotechnical investigations on the export cable corridor for development of offshore wind energy park in the Lithuanian territory of the Baltic Sea: Geobaltic, 2025.

5.3.1.2 Methods for potential impact assessment

The potential impacts were assessed from several perspectives:

- How stable the seabed is in the areas where WTG foundations and trenches for export cables are planned.
- What the lithological composition of the surface seabed sediments is, whether the seabed exhibits significant lithological diversity/fragmentation, and to what extent the upcoming seabed disturbance works will affect the geological conditions of the seabed, including how much the seabed integrity will be impacted and how communities associated with different seabed types will be affected.
- How the planned OWF construction activities align or conflict with potential oil and other mineral resource extraction, and how safe the wind farm layout is for the project itself – considering zones of possible seismic activity and existing tectonic fault systems.

5.3.2. Study area

5.3.2.1. Offshore

The direct study area at sea includes three zones (see Fig. 5.3.1):

1. The 120.9 km² CN OWF area, where water depths range from approximately 27 m to 49 m below mean sea level.
2. Approximately 40 km² area, or marine corridor 40 km long and 1 m wide, is planned for laying export cables for the CN OWF and “Area D” OWF, connecting the OSS with the onshore electricity transmission grid. Water depths in this corridor range from 0 to 39 meters.
3. ~1,200 km² seismic survey area, extending between 55°49.1452' – 56°3.76900' North latitude and 21°11.7828' – 21°0.7313' East longitude.

5.3.2.2. Onshore

Onshore, the study area stretches from the coastline to the Darbėnai ONS. It does not focus solely on the export cable routes but also includes the surrounding territory up to the border with Latvia (see Fig. 5.3.1).

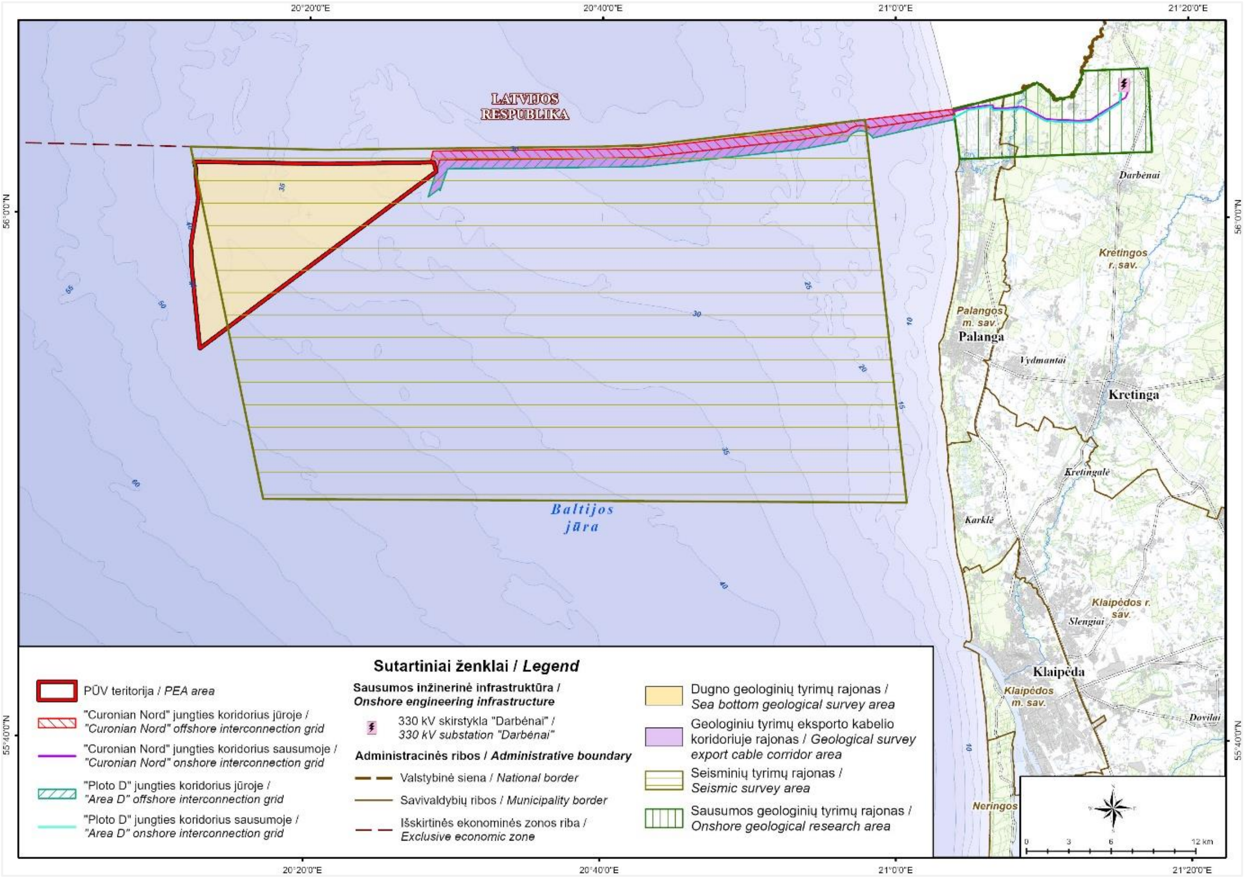


Fig. 5.3.1 CN OWF study area.

5.3.3. Current state

5.3.3.1. Offshore

5.3.3.1.1. Depths and Morphology of the Lithuanian Marine Area

The present-day seabed relief of Lithuania's Baltic Sea territory was largely shaped by glacial activity during the Pleistocene glaciations, when ice covered the entire sea area. As the glacier retreated, it left behind various accumulative (hills, ridges) and erosional (depressions, thresholds, shoals) landforms (Trimonis, 2002). Meltwater deposits from the glacier filled moraine depressions and formed accumulative plains. Later, the seabed was further shaped by processes related to fluctuations in sea levels during different stages of the Baltic Sea's evolution and by modern sedimentation processes. These processes formed positive seabed relief features – plateaus and banks – while the gently sloping plains separating them form negative relief features – depression slopes.

In Lithuania's marine territory, the main geomorphological structures (see Fig. 5.3.2) are the Klaipėda-Ventspils and Sambia-Curonian plateaus (Gelumbauskaitė, 1986), the Gdańsk and Gotland depressions, and the slopes connecting them. Additionally, specific seabed structures are distinguished, such as the Klaipėda Bank and the presumed Nemunas paleo valley (Gelumbauskaitė, 2010).

The Klaipėda-Ventspils Plateau in the northern part of Lithuania's marine area begins at the Gulf of Riga and extends along the coast, turning southwest near the latitude of Liepāja, wedging between the Gotland and Gdańsk depressions. At the point of this interposition, more prominent elevations are found. One such elevation, located in the northwestern part of Lithuania's EEZ, is known as the Klaipėda Bank. The sea depth here reaches up to 47 m (Gelumbauskaitė et al., 1999). To the west, this bank descends steeply into the Gotland Depression.

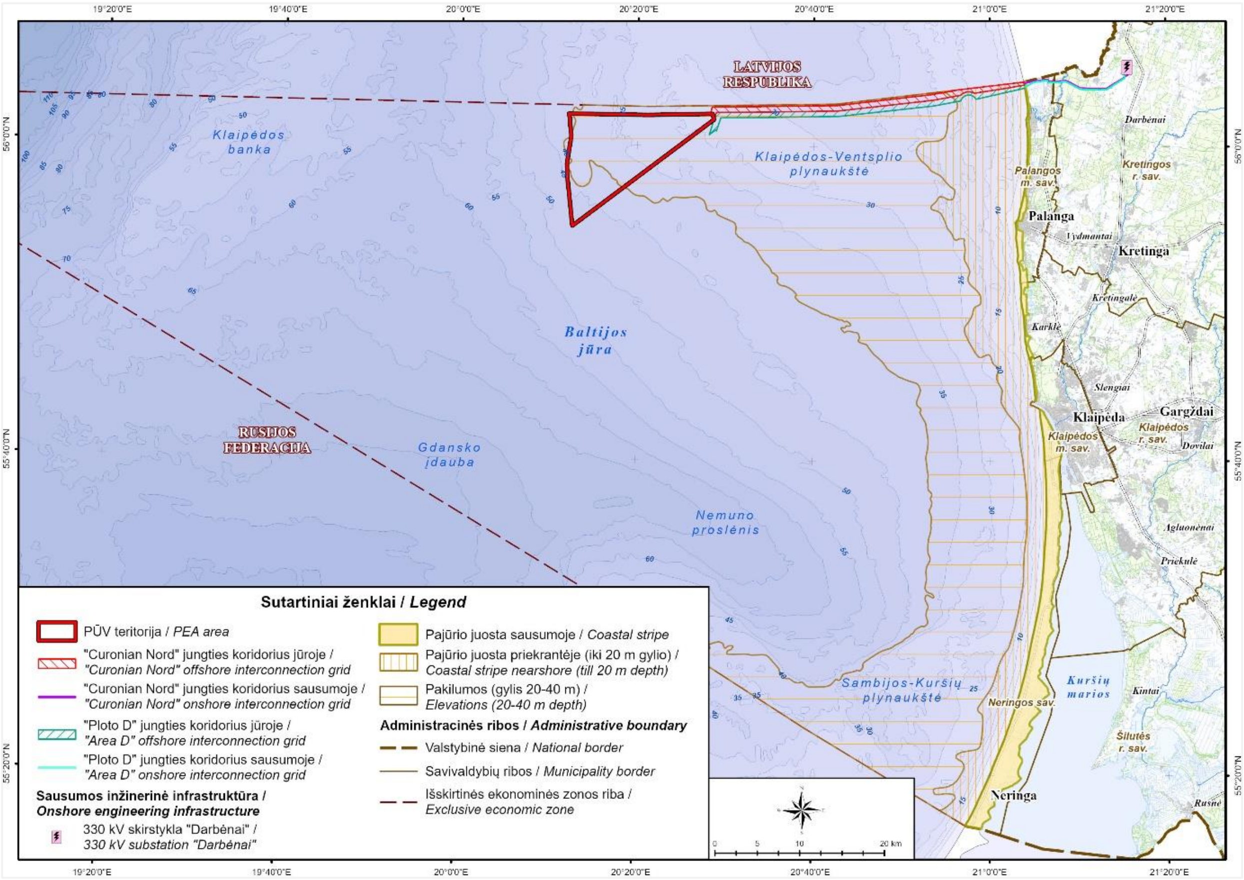


Fig. 5.3.2. Geomorphological zoning of the seabed in the Lithuanian marine area.

In relation to the assessed project area, the most important geomorphological features are the Klaipėda-Ventspils Plateau, which transitions into the nearshore shallows up to the coastline, and the northeastern slope of the Gdańsk Depression, where the offshore wind energy development zone is located. The deeper northern slope of the Gdańsk Depression, the Klaipėda Bank in the west, the slope of the Gotland Depression, and the Nemunas Paleo valley are not within the boundaries of the evaluated area.

Focusing on current fixed foundation technologies, the most favourable conditions for OWF installation are in zones closest to the shore, where the sea depth reaches up to 50 meters. In Lithuania, the use of the sea up to a depth of 20 m is regulated by the Coastal Zone Law (Republic of Lithuania, 2002), and the installation of permanent engineering structures in the nearshore is not permitted.

According to the most recent bathymetric measurements (Fugro Netherlands Marine B.V, 2024. Geophysical Survey Results Report), the water depth in the planned OWF installation area ranges from 27.0 m to 49.0 m (see Fig. 5.3.3), and seabed slopes range from 0° to 20°. In some locations, such as gullies and ridges, slopes exceed 60°. The seabed terrain in the area is quite complex, shaped by glacial and post-glacial hydrodynamic processes. The seabed features asymmetrical hills, sand bars and waves, extensive boulder fields, and less frequent flat surface zones – glacial plains.

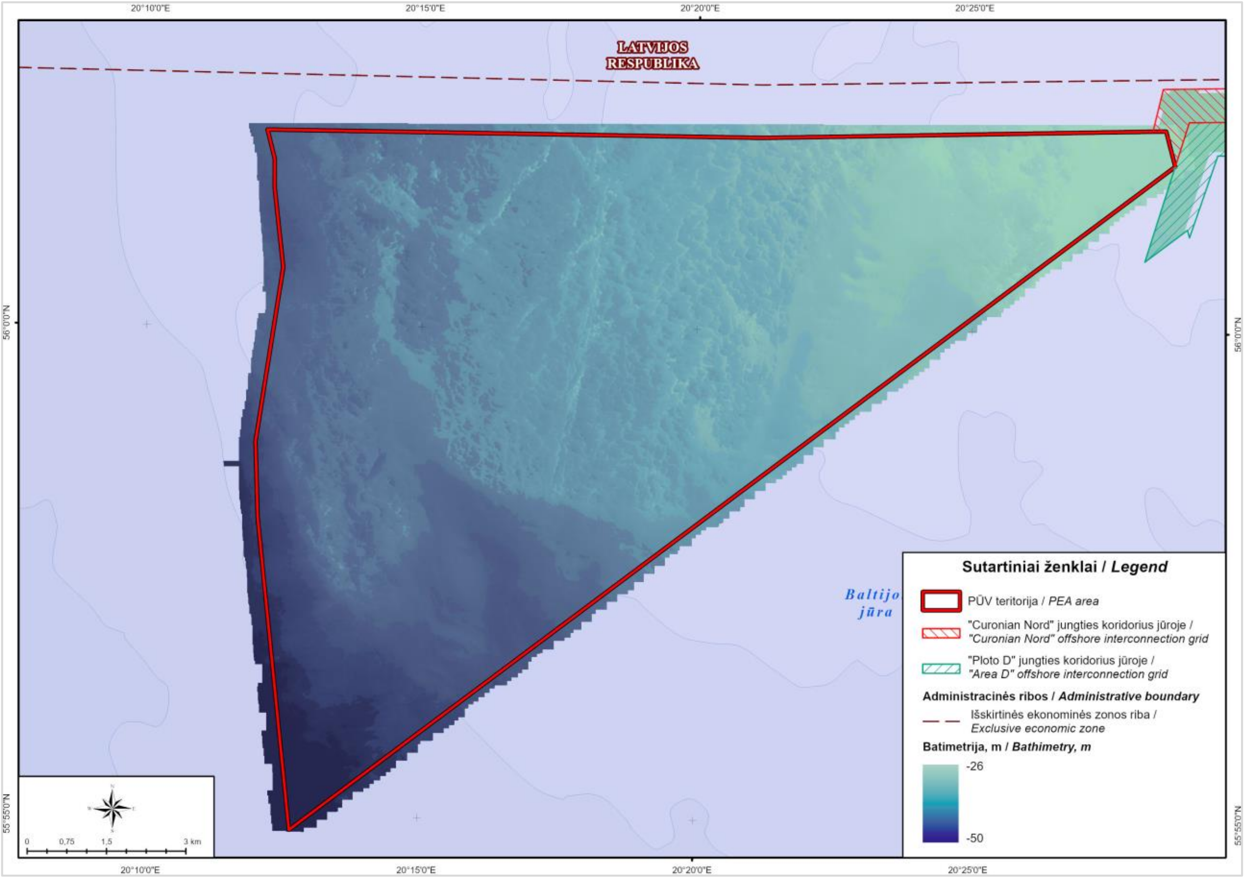


Fig. 5.3.3. Sea depth in the planned OWF area.

Following detailed seabed investigations in the planned export cable corridor (PTPI, 2023. Seabed Surveys), the seabed relief and depths were identified, and a bathymetric (sea depth) chart was created (Fig. 5.3.4). It was determined that the sea depth in the planned export cable corridor ranges from 0 m (at the coastline) to approximately 39 m in the deepest (central) part of the zone.

Morphologically, the seabed can be divided into four characteristic parts:

- Western: relief of the Klaipėda-Ventspils moraine elevation and its slopes, characterised by a rugged surface of weathered moraine.
- Central: a homogeneous, even plain-like relief with low articulation and a gentle slope. The surface is characteristically smooth, typical of moraine plains, with scattered stones and distinct erosional shoals in the eastern section.
- Eastern: a morphologically complex zone, showing signs of moraine base erosion, fields of sand and gravel ripples, and prominent zones of relict moraine ridges (drumlins), including individual and clustered drumlin fields.
- Nearshore: a gradually shallowing zone toward the coast, featuring a relatively uniform sandy plain with a dynamic zone of low shoals (0.5–1 m high) formed at the shoreline.

Fig. 5.3.4. Bathymetric map and longitudinal seabed profile of the export cable corridor at sea.

5.3.3.1.2. Distribution of seabed sediments

The seabed in the Lithuanian marine area is covered by both modern and relict seabed sediments (Gulbinskas, 1995). Relict sediments are deposits and sediments formed during the glacial period and at various stages of the Baltic Sea's development. These are found in hydrodynamically active marine areas where the accumulation of modern sediments no longer occurs or where seabed erosion is ongoing. In many such areas, glacial deposits (moraine) have been heavily washed out, and their surfaces are covered by boulders, gravel, pebbles, and/or sand of varying grain size.

Modern seabed sediments are found in accumulative zones. The main sediment types include sand (predominantly fine-grained), silt, and mud (Emelyanov et al., 2002). Fine sand is typically found on elevations/plateaus, while silty sediments accumulate on slopes of depressions at depths of around 45–65 meters. Mud deposits, composed of fine-silty and silty-clayey mud, cover the seabed in the Gdańsk and Gotland depressions (at depths greater than 60 m).

Relict deposits and sediments also cover the surface of the Klaipėda-Ventspils Plateau, which encompasses most of the planned project area. Here, glacial origin (washed moraine) unsorted mixed deposits of sand, pebbles, and boulders lie directly atop moraine base material (sandy loam and loam of glacial origin). In the remaining part of the territory, modern marine sand, silty sand, and clayey sand sediments are prevalent. These are found in terrain depressions and along the slopes of the Klaipėda-Ventspils Plateau (see Fig. 5.3.5).

The thickness of the loose surface deposits is not significant; beneath them lie solid glacial-origin deposits.

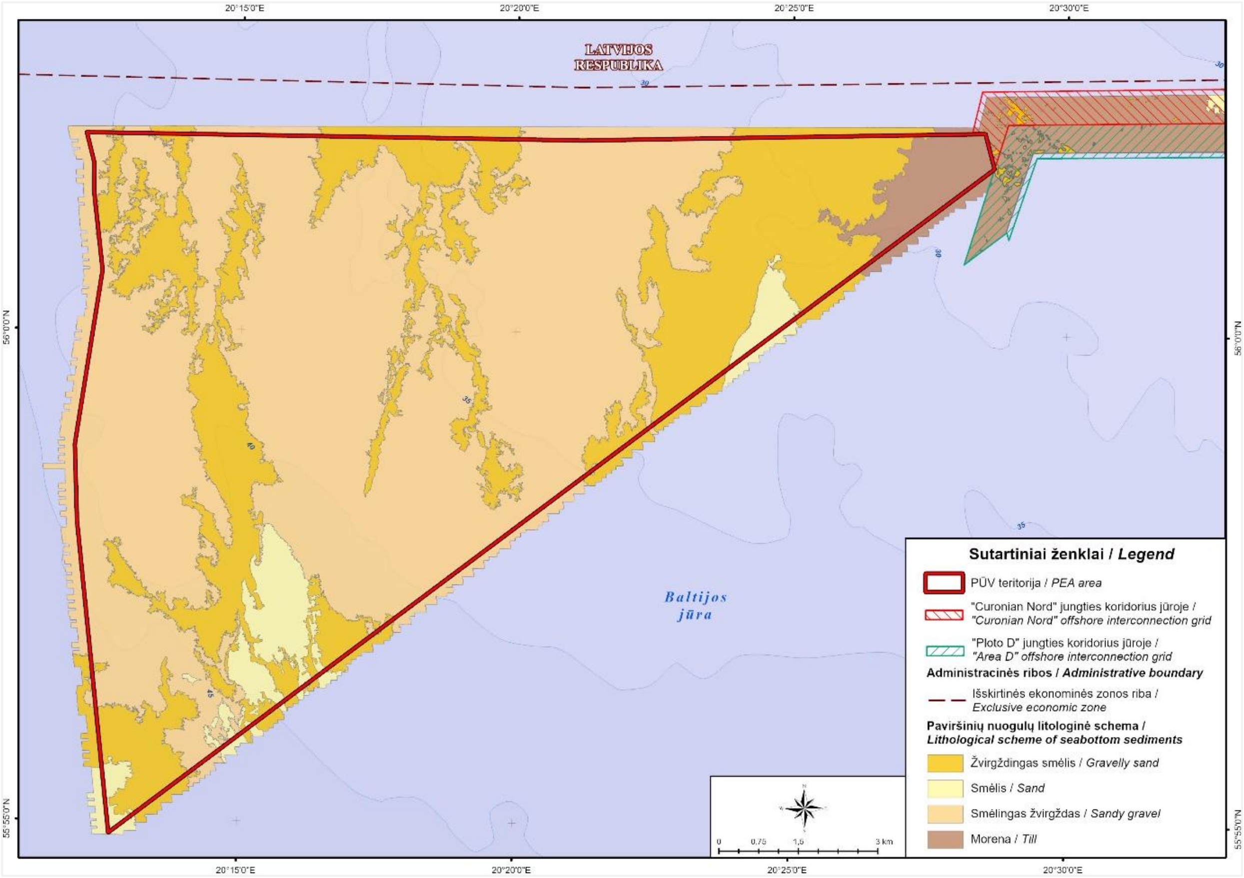


Fig. 5.3.5. Lithological composition of seabed sediments in the planned OWF area (Source: Fugro Netherlands Marine B.V, 2024. Geophysical Survey Results Report).

Surveys conducted in the planned export cables corridor (Geobaltic, 2024. Engineering Geological Survey Report) identified the distribution of surface sediments (see Fig. 5.3.6). The compiled lithological map distinguishes three main sediment groups:

- Nearshore zone: this area is predominantly characterised by fine and medium-grained sand, found up to approximately 14–16 m in depth.
- Easternmost and westernmost parts of the export cable's corridor: these areas contain glacial-origin sediments (clay and sandy clay), which are overlain by gravel and boulders of varying sizes. Additionally, the erosion of the original moraine loam sediments has formed pebble wave structures.
- Central part of the corridor: this area is dominated by coarse-grained soils accumulated on the moraine plain. Fragments of coarse sediment ripple features indicate the presence of intense hydrodynamic conditions on the seabed.

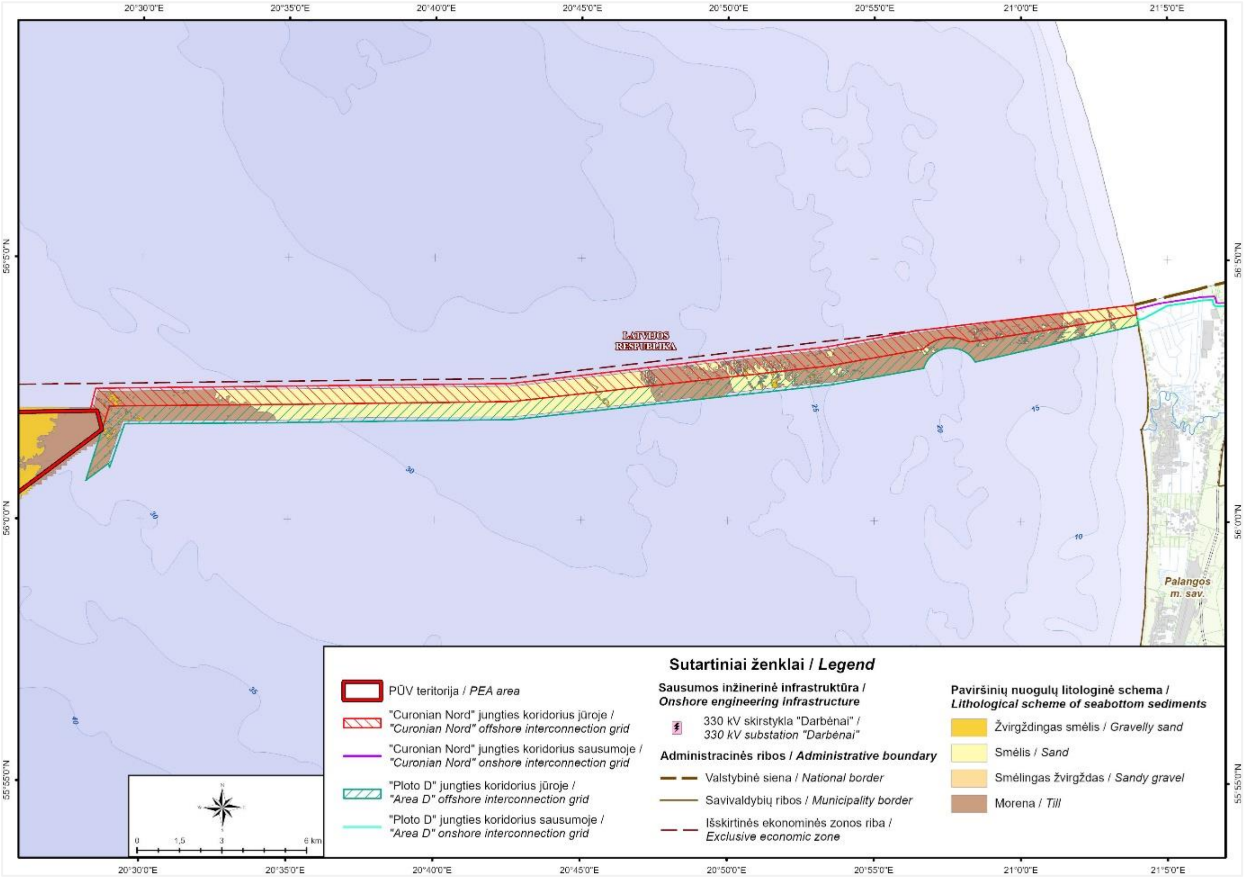


Fig. 5.3.6. Lithological composition of seabed sediments in the planned export cables corridor

5.3.3.1.3. Pollutants in Seabed Sediments

The analysis of concentrations of potentially hazardous heavy metals and arsenic in modern seabed sediments within the planned OWF area and along the export cables route (samples location provided in Fig. 5.3.9) did not indicate significant pollution (see Table 5.3.1), with the exception of sampling station No. 102, located near a sunken object (eastwards at a distance of 59 m). At this station, an anomalously high concentration of arsenic (As) was recorded – 42 mg/kg, which exceeded the established environmental quality threshold[28] for good environmental status (GES) by a factor of 14.

Slightly elevated concentrations of mercury (Hg) were found in a few other sampling stations. These areas naturally accumulate mercury in finer sandy sediments, which tend to better retain deposited pollutants and organic matter.

Table 5.3.1. Results of heavy metal analysis in seabed sediments (UAB "Vandens tyrimai", Research Protocol No. 40327GC022)

Station No.	Sediment Type	Concentration, mg/kg							
		As	Cd	Cr	Cu	Ni	Pb	Zn	Hg
3	Poorly sorted sand	3	<0.15	4	6	<4	0.7	<20	0.18
18	Poorly sorted sand	4	<0.15	<2	<4	<4	0.6	<20	0.09
25	Evenly sorted sand	3	<0.15	<2	<4	<4	1	<20	<0.05
26	Evenly sorted sand	3	<0.15	4	<4	<4	0.8	<20	<0.05
27	Sandy gravel	3	<0.15	4	<4	<4	1	<20	0.07
28	Gravelly sand	2	<0.15	4	<4	<4	2	<20	0.05
29	Gravelly sand	2	<0.15	<2	<4	<4	2	<20	<0.05
32	Evenly sorted sand	1	<0.15	<2	<4	<4	1	<20	<0.05
33	Silty gravelly sand	2	<0.15	6	<4	9	5	<20	<0.05
38	Poorly sorted sand	2	<0.15	<2	<4	<4	2	<20	0.09

[28] https://www.e-tar.lt/portal/lt/legalAct/2a93e590c98011e48a1edbba9d2aea36/asr

Station No.	Sediment Type	Concentration, mg/kg							
		As	Cd	Cr	Cu	Ni	Pb	Zn	Hg
39	Evenly sorted sand	2	<0.15	<2	<4	<4	2	<20	<0.05
40	Evenly sorted sand	1	<0.15	<2	<4	<4	1	<20	0.12
41	Slightly silty-clayey sand	1	<0.15	<2	<4	<4	2	<20	0.13
43	Sandy gravel	3	<0.15	4	<4	<4	2	<20	0.08
44	Gravelly sand	2	<0.15	4	<4	<4	1	<20	0.05
45	Evenly sorted sand	1	<0.15	<2	<4	<4	0.9	<20	0.11
46	Gravelly sand	3	<0.15	4	<4	<4	2	<20	<0.05
47	Sandy gravel	2	<0.15	<2	<4	<4	2	<20	0.06
101	Sandy gravel	3	<0.15	4	<4	<4	2	<20	0.10
102	Gravelly sand	42	<0.15	7	<4	5	4	<20	0.06
	GES*	**3**	**0.5**	**30**	**10**	**10**	**20**	**60**	**0.1**

* GES value – average annual pollutant concentrations in seabed sediments, mg/kg of dry weight. Results below the detection limit are marked with “<”.

The anomalously high concentration of arsenic (As) was detected in gravelly sand sediments near a wreck site, indicating the presence of potential anthropogenic pollution. One potential source of such contamination in the Baltic Sea is leakage from chemical munition dumped after World War II, which contained toxic chemical substances such as mustard gas, adamsite, chloroacetophenone, tabun, tear gas, phosgene, arsenide, and others.

Alternatively, elevated arsenic levels could also originate from other anthropogenic sources such as arsenic-based antifouling paints or hull coatings, or from arsenic-bearing industrial cargo that the vessel could have transported.

Arsenic is a persistent component of many chemical agents historically disposed of in the Baltic Sea and is often used as an indicator of possible leakage from dumped munitions into the marine environment. Therefore, elevated levels of arsenic in sediments near wreck may warrant further investigation to determine whether chemical leakage is occurring.

To objectively assess the potential extent of anthropogenic pollution in the vicinity of the wreck, additional detailed geochemical investigations were conducted at nine sampling stations located within the potential impact zone of the object (see Fig. 5.3.7).

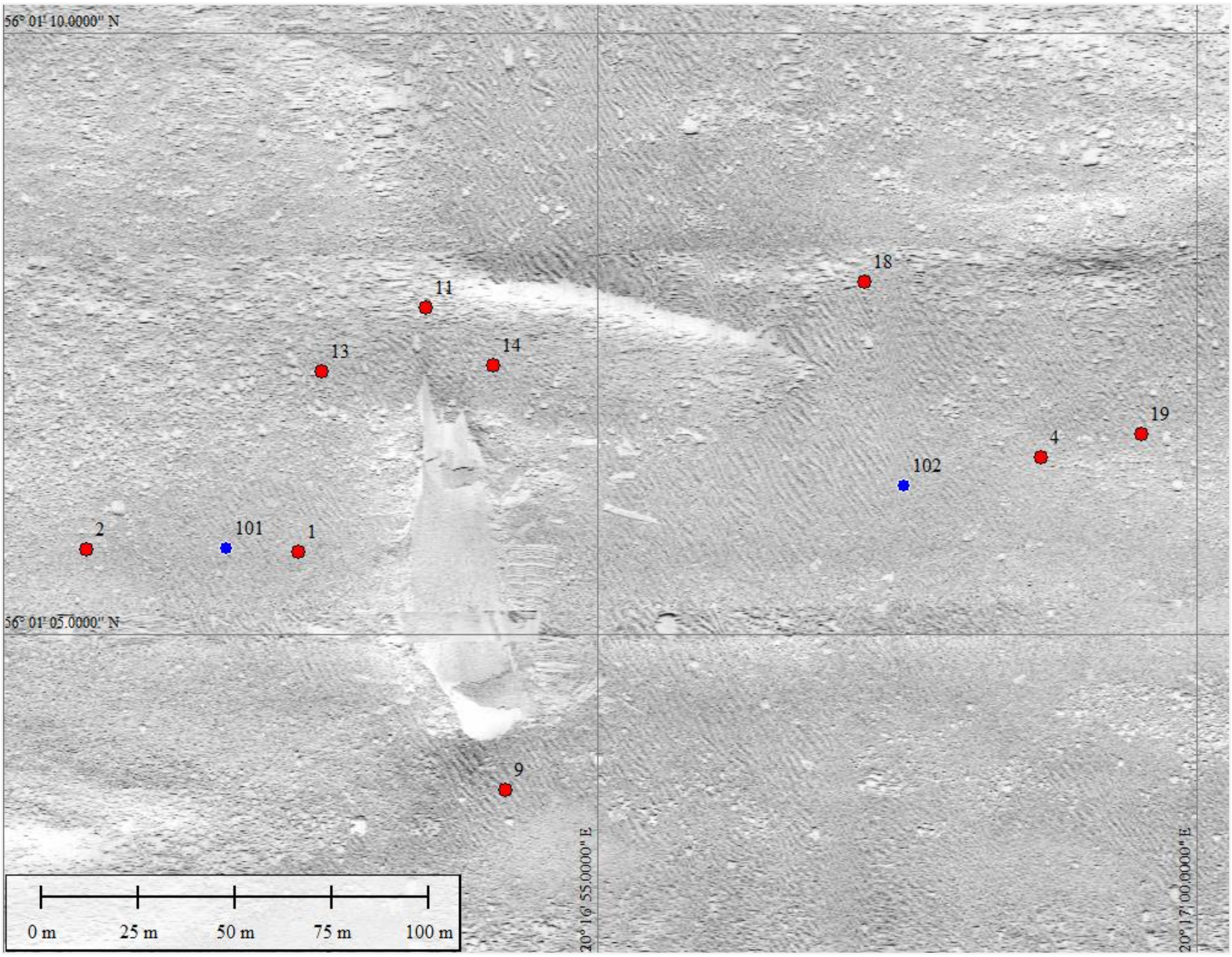


Fig. 5.3.7. Samplin stations where the geochemical composition of seabed sediments was analysed (blue – primary sampling stations; red – additional sampling stations).

The analysis of potentially hazardous heavy metals and arsenic concentrations in sandy sediments near the wreck did not reveal any signs of significant contamination (see Table 5.3.2). A slightly elevated copper (Cu) concentration was detected only at a single sampling station (No. 1) on the western side of the wreck.

More detailed geochemical investigations around the wreck (PTPI, 2024. Pollution investigations around identified wreck) disproved the previously suggested arsenic (As) anomaly within the ship's impact zone. The previously recorded anomalously high arsenic concentration (Station 102, 42 mg/kg) is now interpreted as an isolated occurrence and not representative of the actual extent of contamination.

Table 5.3.2. Results of heavy metal analysis in seabed sediments (UAB "Vandens tyrimai", Research Protocol No. 241106GC128)

Station	Sediment Type	Concentration, mg/kg							
		As	Cd	Cr	Cu	Ni	Pb	Zn	Hg
1	Gravel with medium sand	2.0	<0.15	12	14	7.0	1.0	23	<0.05
2	Coarse sand with medium sand	0.9	<0.15	3.0	<4	<4	2.0	<20	<0.05
4	Medium sand with gravel and pebbles	1.0	<0.15	5.0	<4	<4	5.0	<20	<0.05
9	Evenly sorted sand	0.7	<0.15	4.0	<4	<4	2.0	<20	<0.05
11	Gravel with fine sand	1.0	<0.15	7.0	7.0	<4	4.0	<20	<0.05
13	Coarse sand with medium sand	<0.5	<0.15	3.0	<4	<4	2.0	<20	<0.05
14	Coarse sand with medium sand	<0.5	<0.15	5.0	<4	<4	4.0	<20	<0.05
18	Coarse sand with gravel	0.6	<0.15	3.0	<4	<4	3.0	<20	<0.05
19	Medium sand with gravel and pebbles	0.5	<0.15	4.0	<4	<4	2.0	<20	<0.05

Station	Sediment Type	Concentration, mg/kg							
		As	Cd	Cr	Cu	Ni	Pb	Zn	Hg
	GES*	3	0.5	30	10	10	20	60	0.1

*GES value – average annual pollutant concentrations in seabed sediments, mg/kg of dry weight. Results below the detection limit are marked with “<”.

It is important to emphasize that the concentrations of other potentially hazardous metals (Cr, Cu, Ni, Pb, Zn) in seabed sediments within the study area are either below the quantitative detection limit or do not exceed established threshold values, indicating that assessed component correspond to a good environmental status in the examined marine area.

The analysis of petroleum hydrocarbon concentrations in seabed sediments provides a partial assessment of anthropogenic activities related to oil and petroleum product transportation, intensive shipping, and illegal discharge of oily waters into the open sea. PAHs (Polycyclic Aromatic Hydrocarbons) – a group of compounds ranging from naphthalene to coronene – are the most hazardous components of oil. They persist in water, accumulate in seabed sediments and living organisms. The most toxic PAHs include anthracene, fluorene, naphthalene, and phenanthrene. High molecular weight PAH compounds (e.g., benzo(a)pyrene) are carcinogenic.

No petroleum products (C10–C40) were detected in seabed sediments within the planned project area. Hydrocarbon concentrations in all locations of the study area were below the method’s quantitative assessment limit (see Table 5.3.3).

The analysis of individual PAH compound concentrations in seabed sediments also did not indicate significant pollution. Concentrations of the priority substance fluoranthene in the study area ranged from 1.8 to 8.6 µg/kg, while concentrations of another priority substance, naphthalene, were below the method’s detection threshold.

It is notable that relatively higher concentrations of many PAH compounds were found in seabed sediments near the previously mentioned wreck (sampling station No. 101), indicating the ongoing release of pollutants from the wreck and their gradual accumulation in the sediments. However, follow-up petroleum product (C10–C40) testing at nine additional stations around the identified wreck (see Fig. 5.3.7) showed no pollution, and hydrocarbon concentrations were below the detection limit in all areas (see Table 5.3.3).

The analysis of individual PAH compound concentrations again revealed no significant pollution. Fluoranthene concentrations in the study area ranged from 1.1 to 8.7 µg/kg, while naphthalene levels in most stations were below the detection threshold. The concentrations of most PAH compounds suggest long-term, gradual dispersion from the wreck and subsequent accumulation in seabed sediments. Nevertheless, the total PAH concentration is 6 to 700 times lower than the established GES value, and therefore, the overall chemical status of sediments in the entire study area is assessed as good.

Table 5.3.3. Results of petroleum hydrocarbons (C10–C40) and PAH analysis in seabed sediments *(*UAB "Vandens tyrimai", Research Protocol No. 240327GC022*)*

Station No.	Oil products, mg/kg	PAH, µg/kg															
		NFT	ACNFT	FLR	FEN	ANT	FRT	PIR	BZA	CHRZ	BZB	BZK	BENZA	DBAH	BENZGHI	IND123	SUM
3	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
18	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
25	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
26	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
27	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
28	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
29	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
32	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
33	<100	<1	<1	<1	<1	<1	4.4	4.4	2.0	2.0	5.7	1.9	2.7	<1	4.2	3.6	**30.9**
38	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
39	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
40	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
41	<100	<1	<1	<1	<1	<1	<1	1.0	<1	<1	1.7	<1	<1	<1	1.9	1.1	**5.7**
43	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
44	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
45	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
46	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
47	<100	<1	<1	<1	2.0	<1	2.2	1.9	<1	<1	<1	<1	<1	<1	<1	<1	**6.1**
101	<100	<1	<1	<1	4.2	<1	8.6	7.3	2.0	3.0	3.1	1.6	2.6	<1	1.7	1.4	**35.5**
102	<100	<1	<1	<1	1.7	<1	1.8	1.6	<1	<1	<1	<1	<1	<1	<1	<1	**5.1**
GES*	**100**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1,000**

Abbreviations: NFT – Naphthalene; ACNFT – Acenaphthene; FLR – Fluorene; FEN – Phenanthrene; ANT – Anthracene; FRT – Fluoranthene; PIR – Pyrene; BZA – Benz(a)anthracene; CHRZ – Chrysene; BZB – Benzo(b)fluoranthene; BZK – Benzo(k)fluoranthene; BENZA – Benzo(a)pyrene; DBAH – Dibenzo(a,h)anthracene; BENZGHI – Benzo(g,h,i)perylene; IND123 – Indeno(1,2,3-cd)pyrene; SUM – Sum of 15 PAH compounds.

* GES value – average annual concentration of pollutants in seabed sediments, mg/kg of dry weight. Results below the detection limit are marked with “<”.

Table 5.3.4. Results of Petroleum Hydrocarbons (C10–C40) and PAH Analysis in Seabed Sediments (*UAB "Vandens tyrimai", Research Protocol No.* 241106GC128)

Station	Oil products, mg/kg	PAH, µg/kg															
		NFT	ACNFT	FLR	FEN	ANT	FRT	PIR	BZA	CHRZ	BZB	BZK	BENZA	DBAH	BENZGHI	IND123	SUM
1	<100	2.8	1.6	1.2	4.5	<1	<1	3.4	<1	1.1	1.9	<1	1.5	<1	1.8	<1	**19.8**
2	<100	<1	1.7	1.1	11	<1	8.1	6.8	1.7	2.6	2.1	1.0	1.7	<1	1.5	1.4	**40.7**
4	<100	<1	12	8.7	40	5.6	23	21	9.0	9.0	6.9	3.5	8.3	1.1	4.9	8.3	**161.3**
9	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	**<1**
11	<100	<1	<1	<1	<1	<1	1.4	<1	<1	1.2	<1	<1	<1	<1	<1	<1	**2.6**
13	<100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	**<1**
14	<100	<1	6.0	3.9	28	1.8	28	24	7.1	8.0	6.1	3.2	6.4	<1	3.1	2.3	**127.9**
18	<100	<1	<1	<1	1.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	**1.4**
19	<100	<1	<1	<1	<1	<1	<1	1.1	3.0	3.6	2.3	1.6	2.1	<1	<1	<1	**13.7**
GES*	**100**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**1,000**

Abbreviations: NFT – Naphthalene; ACNFT – Acenaphthene; FLR – Fluorene; FEN – Phenanthrene; ANT – Anthracene; FRT – Fluoranthene; PIR – Pyrene; BZA – Benz(a)anthracene; CHRZ – Chrysene; BZB – Benzo(b)fluoranthene; BZK – Benzo(k)fluoranthene; BENZA – Benzo(a)pyrene; DBAH – Dibenzo(a,h)anthracene; BENZGHI – Benzo(g,h,i)perylene; IND123 – Indeno(1,2,3-cd)pyrene; SUM – Sum of 15 PAH compounds.

* GES value – average annual concentration of pollutants in seabed sediments, mg/kg of dry weight. Results below the detection limit are marked with “<”.

5.3.3.1.4. Geologic structure

The seabed of the Baltic Sea contains sediments of varying age, origin, and composition. In the Lithuanian marine area, the sedimentary rock sequence is approximately 2 km thick. Depending on the intensity of sedimentary processes, modern sediment formation is absent in some seabed regions, exposing deposits and rocks formed in earlier geological periods.

The upper part of the geological profile consists of Quaternary deposits. The thickness of the Quaternary layer varies considerably, ranging from 5–10 m on plateaus to more than 100 m in paleo-incisions. Beneath the Quaternary deposits lie formations of Middle and Upper Devonian (sandstone, siltstone, dolomite), Permian (dolomitic limestone), Lower Triassic (clay, clayey silt, and marl), Middle and Upper Jurassic (argillite), and Lower and Upper Cretaceous (terrigenous clay, silt, glauconitic-quartz sand).

In the Lithuanian Baltic Sea area, the Quaternary sequence is composed of three main lithostratigraphic complexes: Pleistocene glacial deposits (predominantly moraine loams and sandy loams), Post-glacial and Holocene sediments (clays and sands) formed during various stages of Baltic Sea evolution, Modern marine sediments (sand, silt, and mud).

The deposits of the first two lithostratigraphic complexes are also referred to as relict sediments (Gulbinskas, 1995). These are found in hydrodynamically active seabed areas where modern sediment accumulation does not occur or where seabed erosion takes place.

In the planned OWF area, Quaternary deposits are approximately 20–30 m thick. Beneath them, Triassic deposits are typically present, and in paleo-incised zones, Permian deposits may also be exposed (see Fig. 5.3.8).

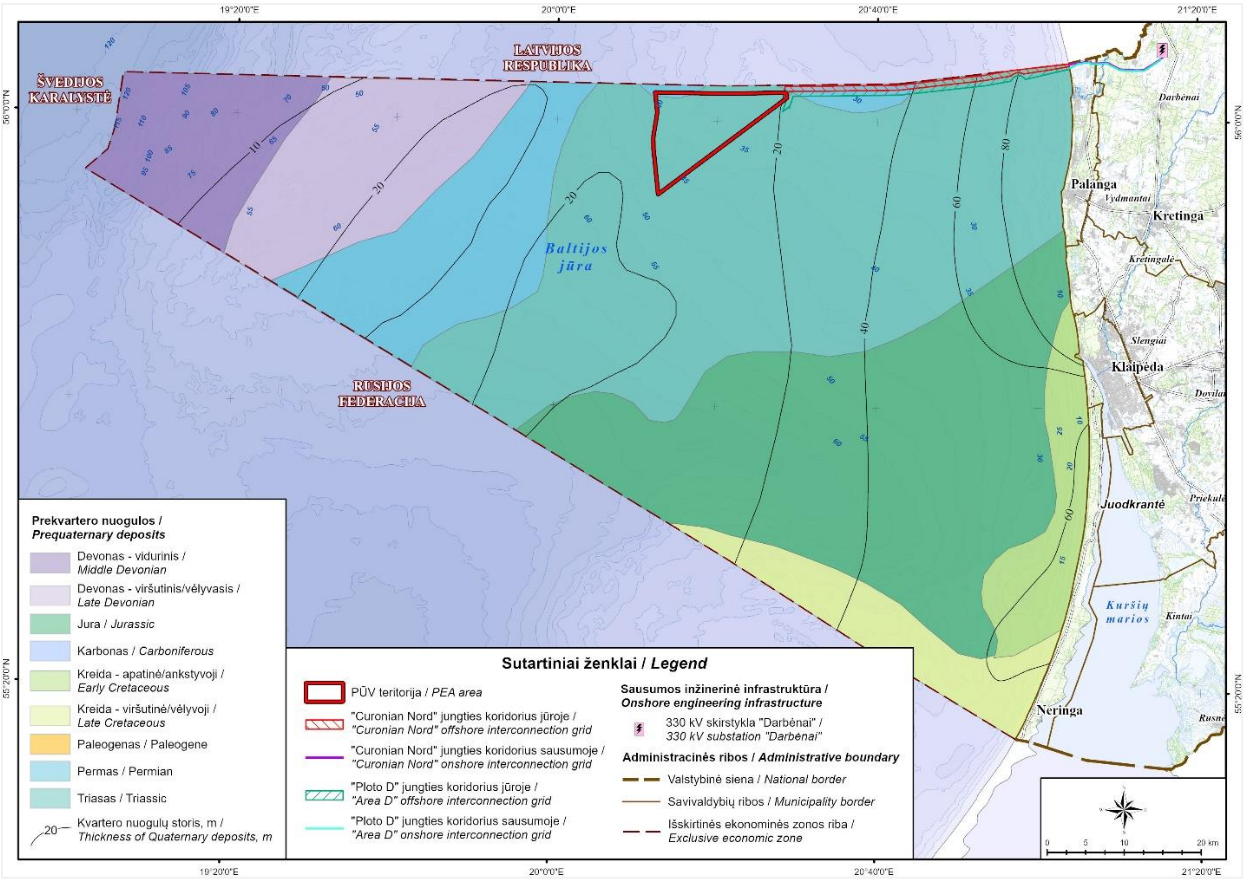


Fig. 5.3.8. Distribution of Pre-Quaternary deposits and thickness of the Quaternary layer.

5.3.3.1.5. Natural resources

Oil

According to information from the Lithuanian Geological Survey regarding prospective oil-bearing structures in Lithuania's marine area (see Fig. 5.3.9), approximately 40–80 million tons of oil may lie within Lithuania's EEZ.

Clause 465 of Section Eight, *"Resource Protection and Use, Development of the Bioproductive Economy,"* from the National Spatial Plan 2030 (NSP 2030), stipulates that regulation of oil resource development in the marine zone must be planned in coordination with other activities (such as wind energy, navigation, etc.). It also emphasizes the encouragement and strengthening of domestic, cross-sectoral, and international cooperation (*Lithuania 2030*, 2021).

Deep faults and limits of potential oil structures have been refined after the 2D seismic studies carried out in 2022 (UAB Geobaltic, 2022[29])The planned OWF area falls within the southern portion of the potential E2 oil-bearing structure (see Fig. 5.3.9). Therefore, should Lithuania decide in the future to initiate oil exploration and production in the EEZ, it may be necessary to coordinate possible drilling site locations with the OWF developer (depending on the future oil extraction regulations).

Although the European Directive concerning offshore oil and gas operations (2013/30/EU, adopted June 12, 2013) had to be transposed into Lithuanian national law (under the Ministry of Environment's 2021 action plan), it is still not fully implemented. As a result, offshore oil exploration and extraction remain unregulated, and thus no additional measures are currently required when establishing offshore wind energy infrastructure in the project area.

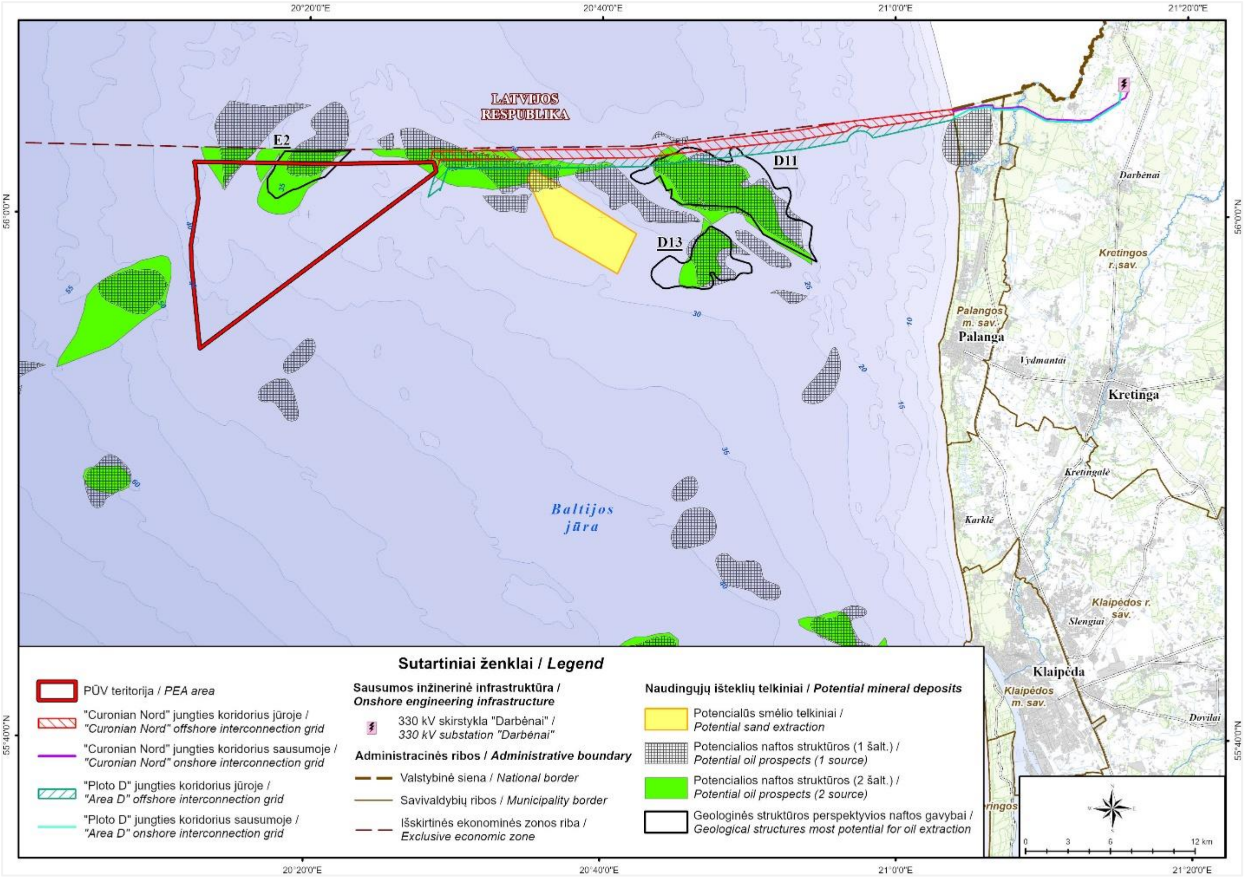


Fig. 5.3.9. Layout of the PEA in relation to mineral resource deposits.

Sand and gravel

The sand and gravel resources within Lithuania's EEZ have not been thoroughly explored and are not registered in the state geological resources database as exploitable mineral resources. However, potential accumulations of these resources were identified during seabed geological mapping.

The largest spread of sand was identified in the active hydrodynamic exchange zone up to 20 meters depth. However, sand in this zone maintains the dynamic balance of the coastline, nourishes beaches, and cannot be exploited due to environmental and coastal protection restrictions.

Another mineral sand resources were identified on the southeastern slope of the Liepaja Rise – on the Klaipėda-Ventspils Plateau and the Curonian-Sambian Plateau, including its northwestern slope. In these areas, the formation of sand and coarse-grained material is associated with nearshore formations created during Baltic Sea transgressions and regressions. Often, these older deposits are overlain by modern marine sands, with thicknesses potentially exceeding 5 m.

[29] Geobaltic, 2022. Sea floor (geophysical and geotechnical) investigations in the maritime territory of Lithuania to organize Competitions for the development and operation of wind power plants. Part i. Geophysical deep seismic survey.

Several areas in the marine territory have been identified as potential sand sources for coastal management:

- Southeastern slope of the Klaipėda-Ventspils Plateau: Depth of 25–30 meters; coastal formations from Baltic Sea transgressive-regressive phases. Sand is widely distributed on the plateau slopes, with layer thicknesses reaching or exceeding 1 meter.
- Surface of the Curonian-Sambian Plateau: Relict post-glacial or Baltic Sea evolutionary stage formations. Water depths of 20–30 m. This is the largest area of sand, with layer thicknesses exceeding 3 meters.
- Preila-Juodkrantė area: The most promising zone is located between 20–27-meter isobaths. Sand from this area has been used for the restoration of Palanga beaches under coastal management programs.

There are no confirmed mineral sand resources within the PEA area.

Amber

The largest amber deposits in the world are in the Sambian Peninsula, which is currently part of Russia's Kaliningrad region. The highest concentrations of amber have been found near the village of Yantarny, where it is extracted through open-pit mining. Despite the geographical proximity, Lithuania does not have significant amber deposits. Small amber deposits have been discovered near Priekulė, by the Wilhelm Canal, and in the areas of Preila, Juodkrantė, and Nida; however, these are of minimal industrial significance. There are no known amber deposits within the project area.

5.3.3.1.6. Tectonic activity and seismicity of the area

The Baltic Sea lies on the tectonically stable Eurasian lithospheric plateau. The sea itself is geologically very young, formed during the Quaternary, and its short geological history has been significantly influenced by continental glaciations and post-glacial processes. Based on its geological structure, morphology, and development history, the Baltic Sea basin is divided into two parts: the smaller southern-western part and the larger northern-eastern part. The southern-western section is young, shallow, and part of the Western European platform, while the northern-eastern part – including Lithuania's share of the Baltic Sea – belongs to the East European Craton, which experienced intense tectonic activity during the Late Pleistocene, resulting in the formation of major geomorphological and deep-seated structures (Šliaupa, 2004).

Compared to neighbouring countries, Lithuania has the lowest seismic activity. This is influenced by glacioisostatic processes occurring after glacial melt and minor seismic events triggered by earthquakes from more distant, seismically active zones. The strongest natural earthquakes recorded occurred in the Kaliningrad region along the Baltic coast in September 2004, measuring 4.8 and 5.2 on the Richter scale (source: Lithuanian Geological Survey – Seismology Bulletins).

Vertical glacioisostatic crustal movements may reach up to 2 mm per year. The horizontal compressive forces created as glaciers retreated have gradually diminished but may still activate older fault systems, especially in neighbouring Latvia and Estonia. In Lithuania, these processes are much weaker, making tectonic activity the lowest in the region (Šliaupa et al., 2004).

Tectonic faults are illustrated in Fig. 5.3.10 in orange and burgundy colours. Thinner orange lines indicate faults that were active during the Caledonian orogeny but not later than the Early Devonian. Thicker burgundy lines represent the youngest faults, which cut through nearly the entire sedimentary cover and terminate in Permian or even younger deposits (exact evaluation is limited by available data, as Triassic ridge reflections are not observed). These faults must be considered when evaluating the seismic risk of the area.

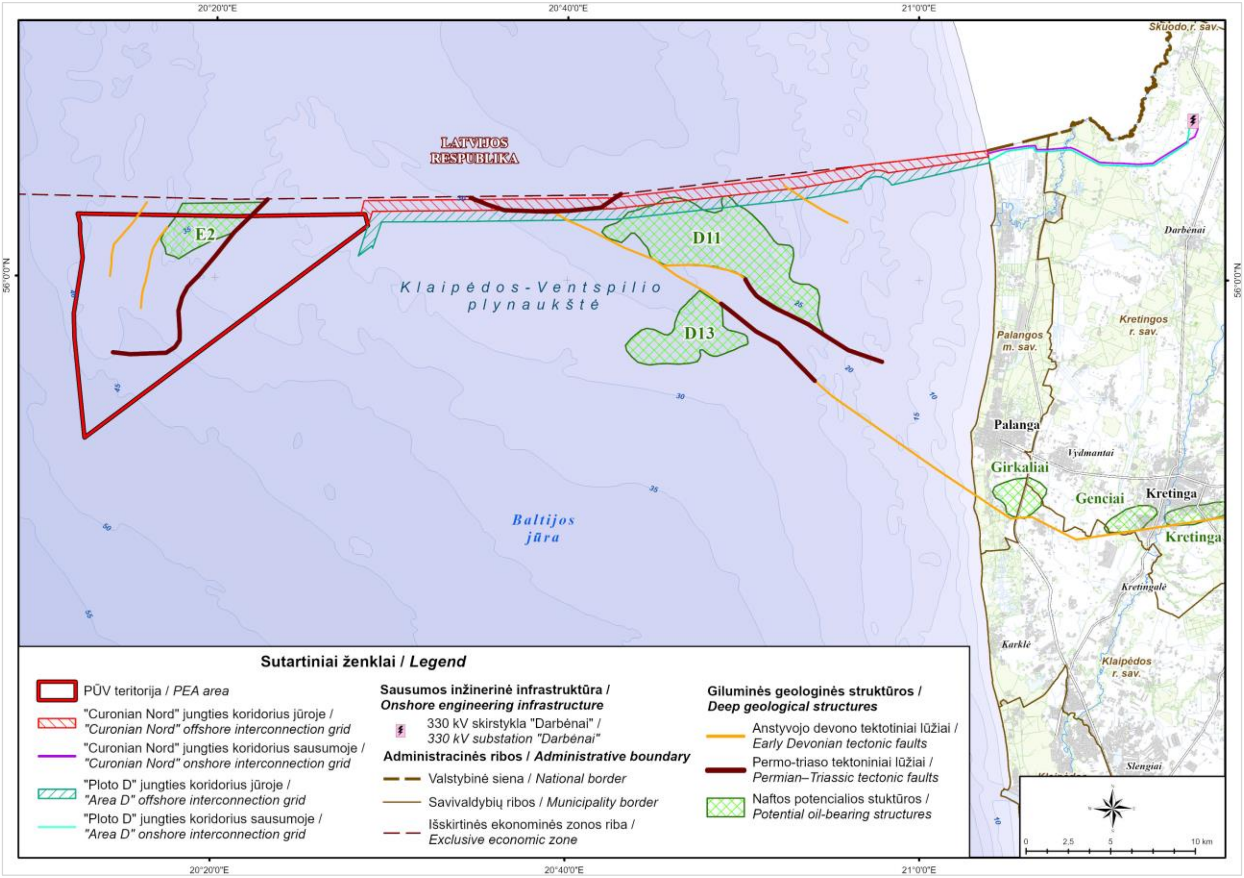


Fig. 5.3.10. Planned OWF Location in relation to deep geological structures.

5.3.3.2. Onshore

5.3.3.2.1. Distribution of surface sediments

In the study area, Pleistocene glacial and post-glacial deposits from the Baltic stage dominate, formed during the melting of glaciers. Most surface sediments consist of glacial and post-glacial origin formations. Holocene deposits are more localized – found in river valleys, swamps, and lake bottoms. Sandy and moraine sediments dominate in the Baltic stage layers from the end of the Ice Age, and glacial lake sediments are also present. The main lithocomplexes are:

- Moraine deposits – primary moraines composed of sediments of various sizes: clay, sand, gravel, and boulders. These formed during the advance and melting of glacier tongues. Moraine deposits often form a stable base but may include thicker clayey or loamy layers, which reduce water permeability.
- Marginal glacial formations – these types of sediments formed at glacier edges and typically consist of sands of various coarseness and moraine loam.
- Glaciofluvial deposits – formed during glacier melt, consisting of accumulations of sand, gravel, and pebbles.
- Glaciolacustrine deposits – typical of former glacial lake bottom areas, usually consisting of clayey sand.

All these glacial deposit types indicate the end of the last Ice Age, when the glacier retreated and left behind thick sediment layers (Fig. 5.3.11 a and b).

After the glacier's retreat, the region experienced significant geological changes related to lake, river, and wind activity. Therefore, the following are also widespread:

- Lake sediments – in areas where glacial lakes persisted for longer, clayey sand and sapropel settled. These sediments are usually found in lowlands or former swampy areas.
- Alluvial deposits – formed in present river valleys. These are accumulations of sand, silt, and clay transported by river flow.
- Swamp deposits – peat layers typical of depressed terrain areas, especially in places with limited water outflow.

- Eolian formations – these sand layers formed due to strong wind activity after glacier retreat. They are most common near the coast and are associated with modern dune formation.

In areas closer to the seashore, Litorina and Post-Litorina Sea sediments dominate – sand deposits formed in the ancient coastal and wave action zones. The terrain here is relatively flat and low, with sandy soils and localized swampy areas. Further east, toward Darbėnai, the landscape becomes more continental and features elevations – moraine forms with a greater spread of sandy and loamy deposits.

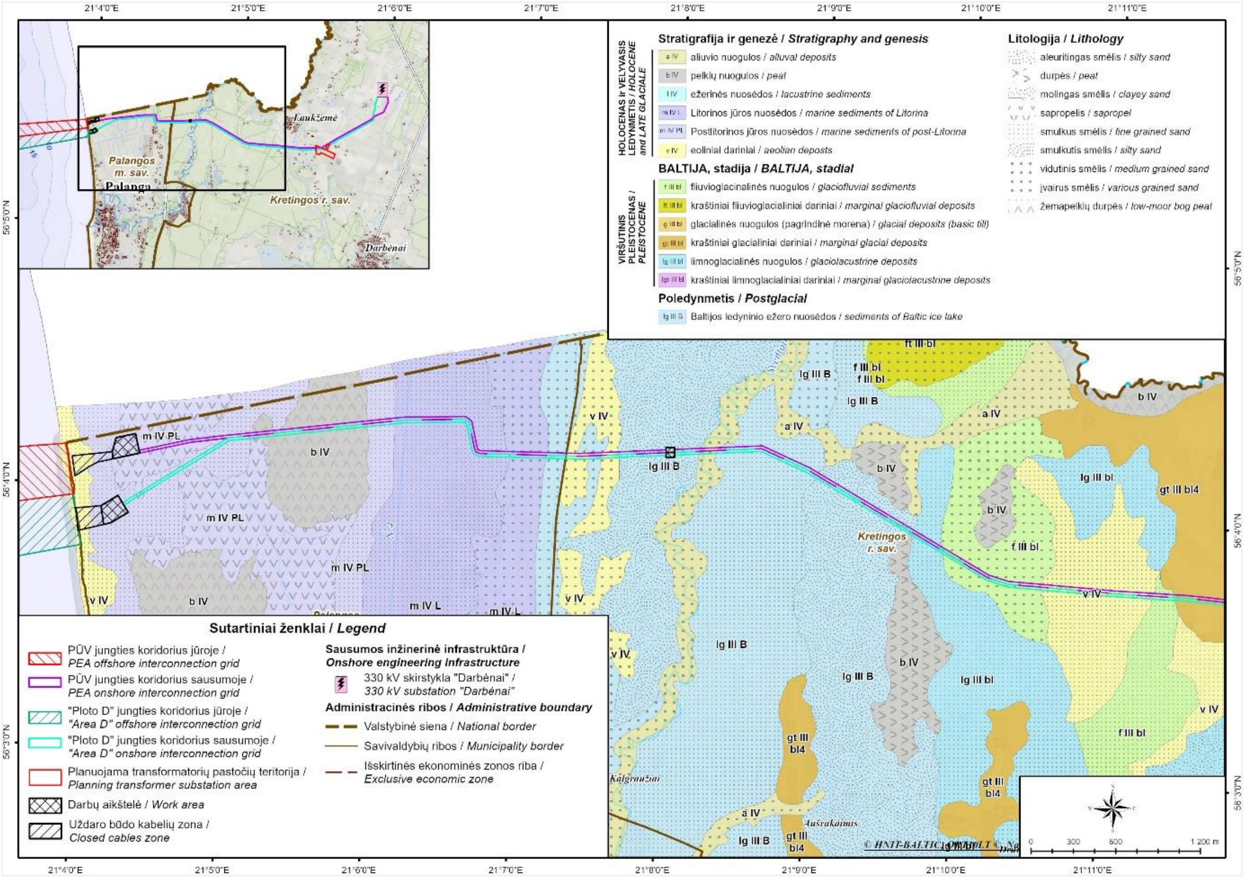


Fig. 5.3.11 a. Surface sediment distribution scheme (1 of 2).

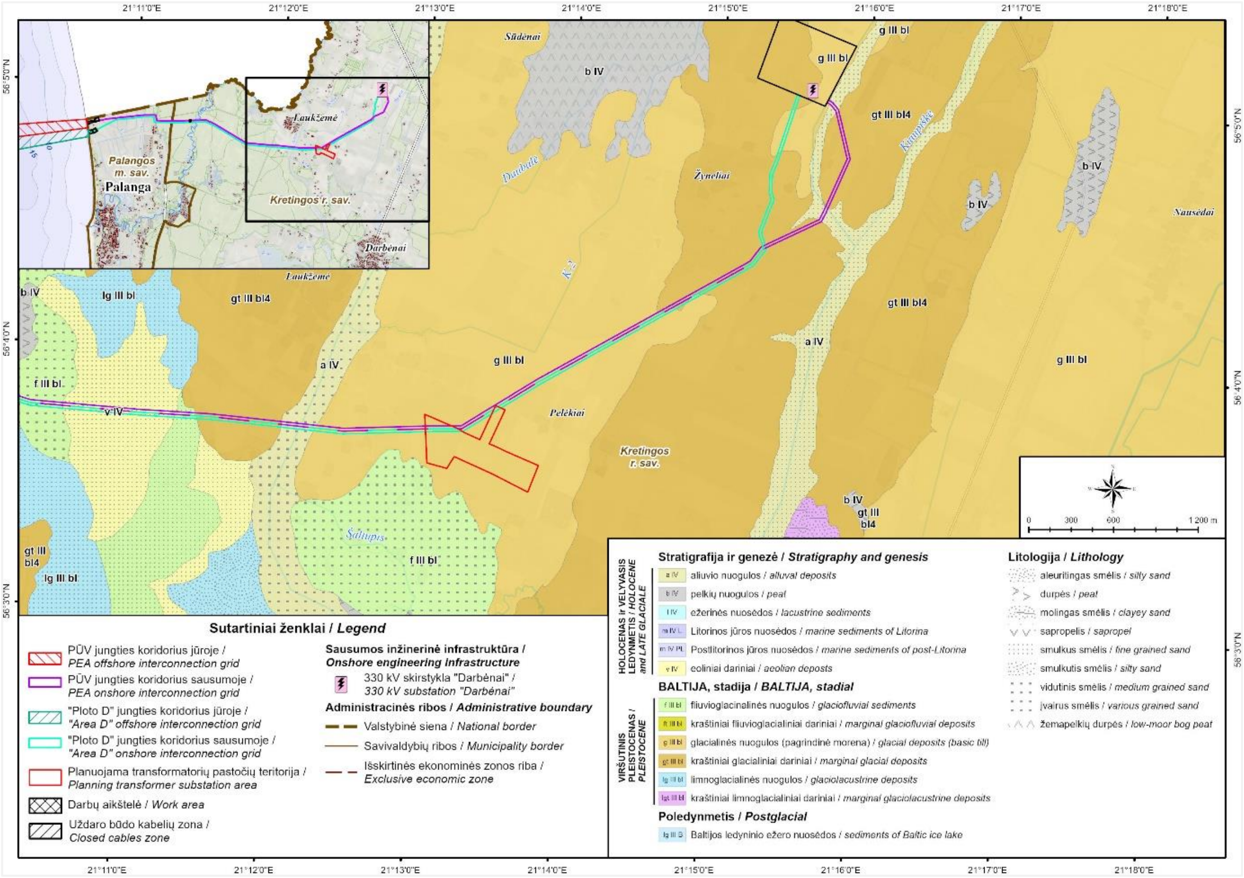


Fig. 5.3.11 b. Surface sediment distribution scheme (2 of 2).

5.3.3.2.2. Topsoil

In Lithuania, there are several topsoil groups considered the most valuable and whose protection is particularly important during excavation work, agricultural activities, or construction. These topsoil must be preserved or their disturbance minimized due to their high ecological, agronomic, and environmental significance. These include: Mollisols (chernozems), Podzols (sod-podzolic soils), Histosols (peaty and marshy soils), Arenosols (sandy and loamy sands), as well as clays and loams.

In the coastal zone crossed by the export cable route, including sandy beaches and the protective dune ridge, a closed-type technology (such as HDD or similar) will be used – thus, no direct disturbance or damage is expected. Further inland, within the continental part of the cable route corridor, various types of topsoil are found (Fig. 5.3.12 a and b). Closer to the sea, within the boundaries of the Palanga City Municipality, peat soils, podzolic soils, gleisoil, and sandy soils are found. As the distance from the sea increases, within the Kretinga District Municipality, eluviated soils dominate, with interspersed areas of albic soils, floodplain soils, and gleisoil.

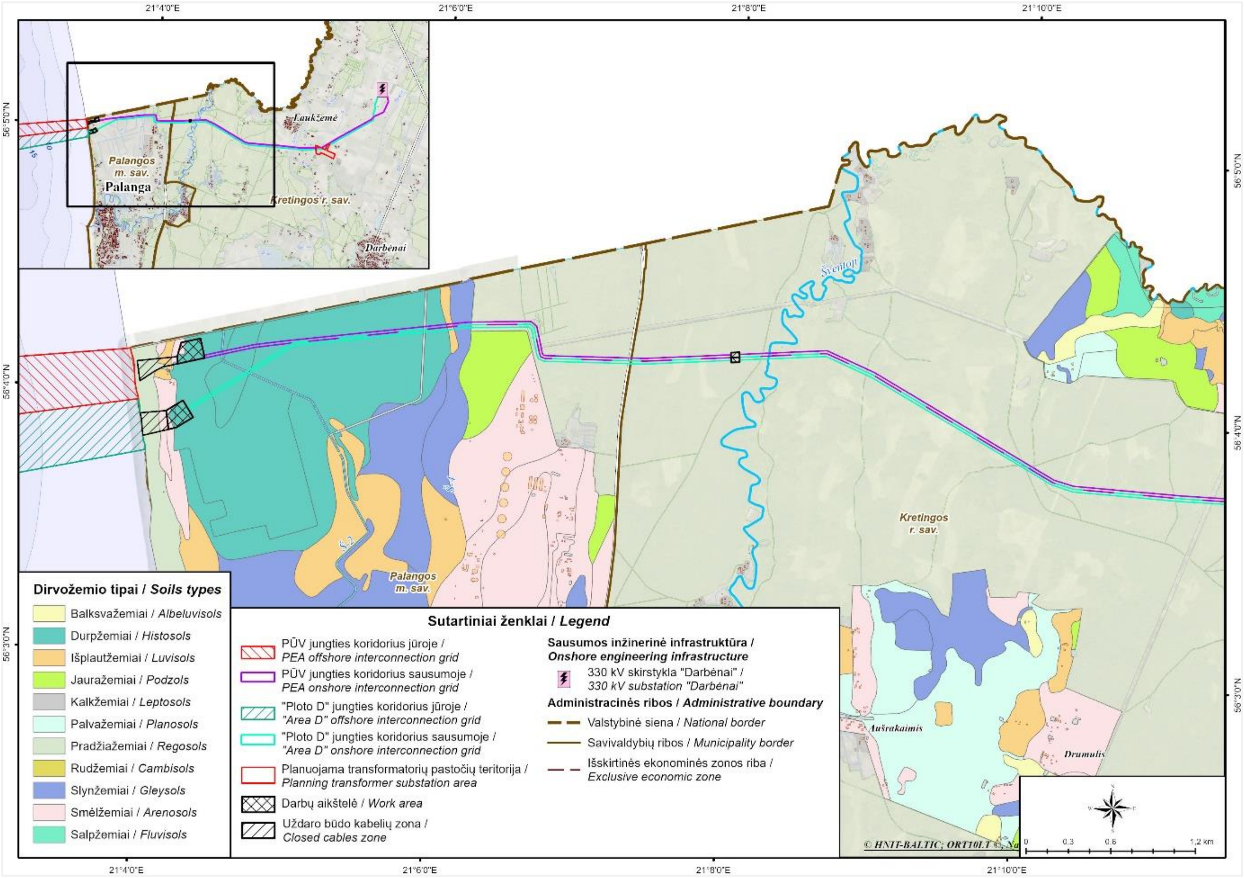


Fig. 5.3.12 a. Topsoil types in the onshore part of export cable corridor (1 of 2).

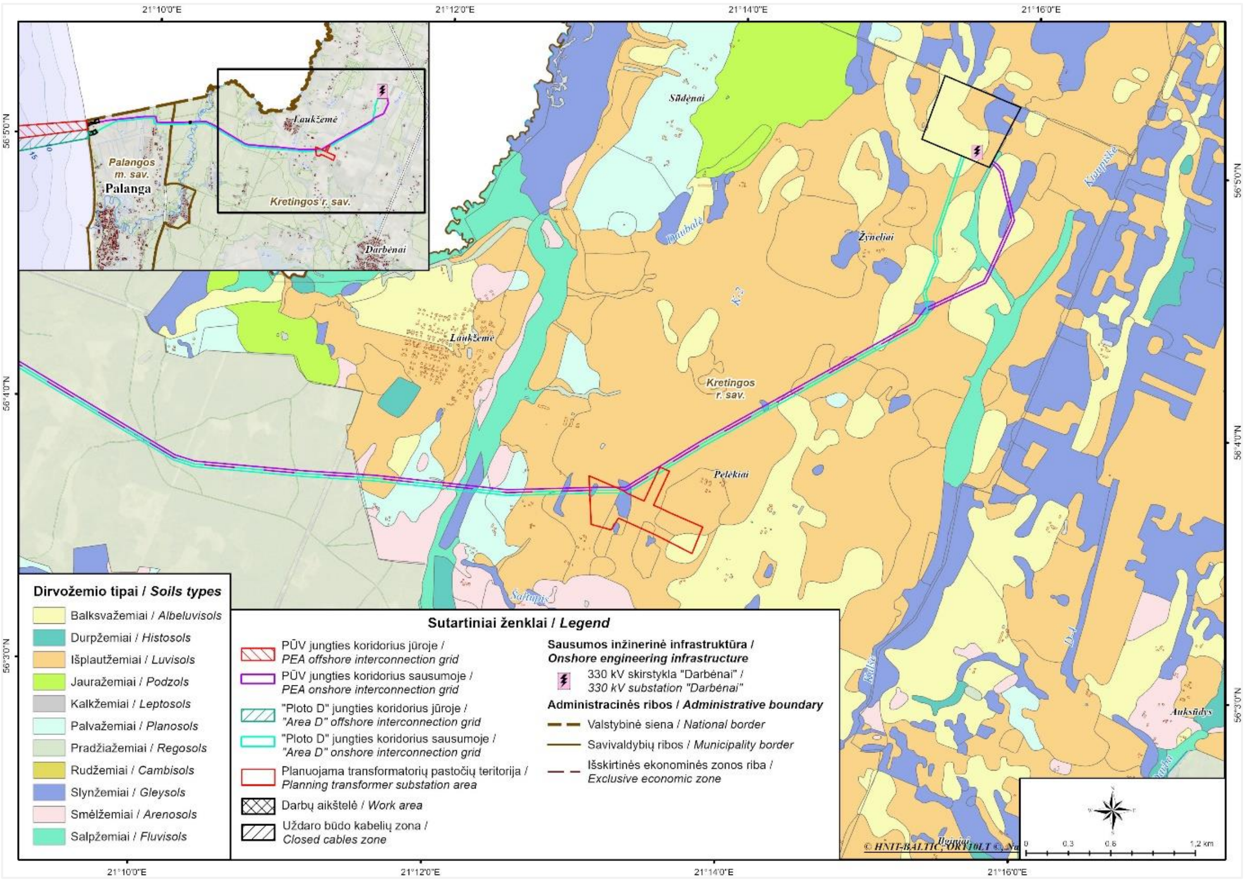


Fig. 5.3.12 b. Topsoil types in the onshore part of export cable corridor (2 of 2).

5.3.3.2.3. Deposits of mineral resources

Onshore, the export cable corridor may potentially cross the northern boundary of the Šventoji oil deposit (No. 2165, forecasted resources), but it will have no impact on oil extraction (Fig. 5.3.13). The nearest Vanagupė (Coastal) peat deposit (No. 954, forecasted resources) and a forecasted gravel deposit (No. 2299) are located approximately 5 km south of the planned export cable routes.

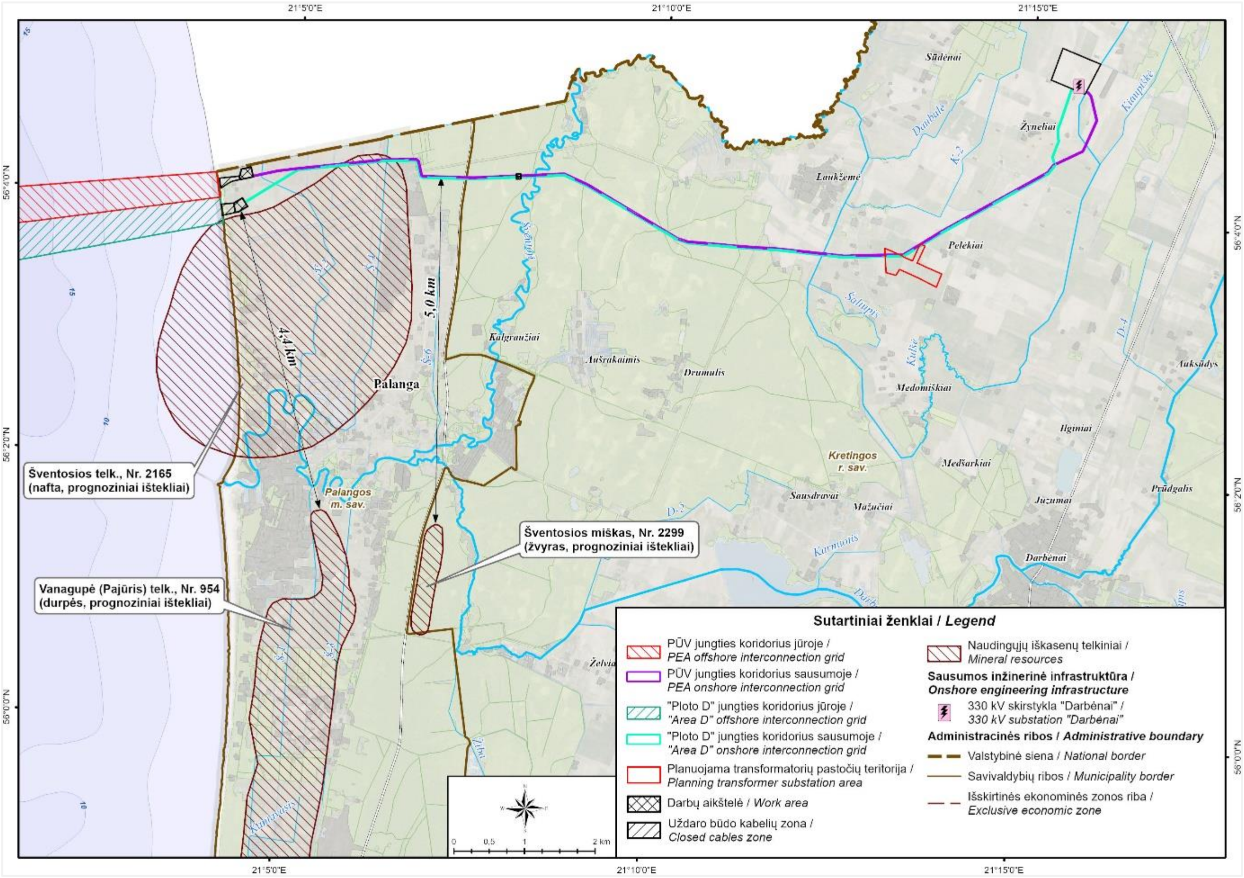


Fig. 5.3.13. Mineral resource deposits in the onshore section of export cable route.

5.3.4. Potential impact on the seabed

Seabed impacts are of two types:

- Impact on the seabed due to the installation of OWFs – during construction.
- Impact on the OWFs themselves and their associated infrastructure due to the geological conditions of the seabed.

Considering the structure of the seabed, the type and distribution of surface sediments, and the formation of valuable benthic communities, it can be concluded that impacts on the seabed will generally be local and relatively minor. The main negative impact is associated with partial disturbance of the seabed and secondary sedimentation at OWF foundation and cable installation sites. There may also be damage to valuable seabed habitats (see Section 5.4.2 on biodiversity/seabed habitats) if seabed-disturbing work is planned in such areas.

For OWF infrastructure, it is important to determine whether the geological structure of the seabed is stable enough for foundations, whether sediments are easily excavated for cable installation, and whether secondary erosion zones may develop that could negatively affect the stability of structures and the safety of engineering infrastructure. It is also essential to assess the potential danger of objects located on the seabed to installation safety and/or their influence on design (technological) decisions.

A study by British scientists (Cooper, Beiboer, 2002) evaluated the potential impact of OWFs on coastal zone processes, emphasizing changes in wave patterns, currents, and sediment transport regimes. Summarizing the modelling results, it was determined that the OWF's impact on wave activity, currents, and sediment transport is insignificant: wave speed decreases by less than one percent after encountering the OWF, direction changes by about 0.5°, and wave height decreases by approximately 0.5–1.5%. The placement of OWFs outside the main sediment transport corridors also has no significant impact on sediment transport direction. In Lithuania's nearshore zone, the main sediment flow occurs within a 1–1.5 km wide strip. Therefore, OWFs located in the project area (more than 36.8 km from shore) will not significantly affect shoreline stability or sediment transport.

Greater impact is possible in the northeastern part of the area, where washed glacial sediments prevail. The gravelly, coarse sand and boulder accumulations here provide favourable ground for the valuable *Mytilus crustacea* community. Seabed fauna studies have shown that dense populations of this bivalve mollusc are present in this substrate. When planning OWF foundations and cable routes, it is recommended to avoid damaging these sensitive seabed areas – either by moving WTGs away from the southwestern boundary of the protected area (the zone of abundant *Mytilus trossulus*), or by conducting additional seabed surveys before construction to precisely map the valuable habitat and avoid building in this area (see also Section 5.4.2 on biodiversity/seabed habitats).

The OWF area overlaps with one potential oil structure but does not border any areas of sand or other valuable mineral deposits. Since marine oil exploration and extraction are not yet regulated in Lithuania, the proximity of the OWF to the E2 potential oil structure does not create a potential sectoral conflict, as both activities (if oil exploration and extraction become viable) could be developed side by side. Therefore, no negative impact on natural resources is expected.

Scour formation in loose soils (sandy or clayey soils) is typical of pile foundation structures. The risk of scouring must be evaluated during OWF design, as it is more relevant to the stability of the OWF than to the geological environment. To prevent scouring, the seabed around the foundation could be reinforced with gravel or boulders. Due to active near-bottom currents, scour may also occur in cable trenches, which is why seabed monitoring at both foundation and cable sites is a standard procedure performed by the project operator after construction and during operation of the OWF.

Two main technologies are used for laying high-voltage cables on the seabed: trench excavation or laying cables directly on the seabed and covering them with heavy concrete mats or sand/gravel layers. Depending on geological conditions and soil properties, trenches can be excavated using specialised marine ploughs, high-pressure water jets, mechanical trenchers or other technologies.

In all cases, the impact on the seabed is local and minimal. Trenches are typically 0.8–2.5 meters deep and up to 2–3 meters wide (depending on the equipment used). If a cable-laying plough is used, the impact is very short-term, as the trench is backfilled simultaneously with the same excavated sediments, where possible. Cable covering technology is used only in specific conditions when trenching is impossible or prohibitively expensive.

5.3.5. Potential impact on topsoil during onshore cable installation

The most protected soils in Lithuania:

- Mollisols (Chernozems) – the most fertile, important for agriculture.
- Histosols (Peaty and Marshy Soils) – significant for climate regulation and ecosystems.
- Arenosols (Sandy and Loamy Sands) – highly prone to erosion.
- Podzols (Sod-Podzolic Soils) – important for forest stability.

Of these, only Mollisols are not found in the study area. Other soil types are present, and it is planned that the onshore section of export cable route will cross 1.9 km of peat soils and 0.11 km of sandy soils (Fig. 5.3.14 a and b). Podzols are also relatively widespread in the area, but the planned cable corridor will not cross them.

Podzols (Sod-Podzolic Soils) – important for forest ecosystems; mechanical disturbances in forests should be minimised, especially preserving forest litter, and avoiding activities that promote soil acidification.

Histosols (Peaty and Marshy Soils) – unique ecosystem soils found in swamps and wet meadows, high in organic matter, important for mitigating climate change. Drainage and excavation work should be avoided as they lead to peat decomposition and CO_2 emissions. Construction and peat exploitation should be limited.

Arenosols (Sandy and Loamy Sands) – erosion-prone, highly permeable to water, and quickly leach nutrients. Intensive tillage and disruption should be avoided to prevent desertification.

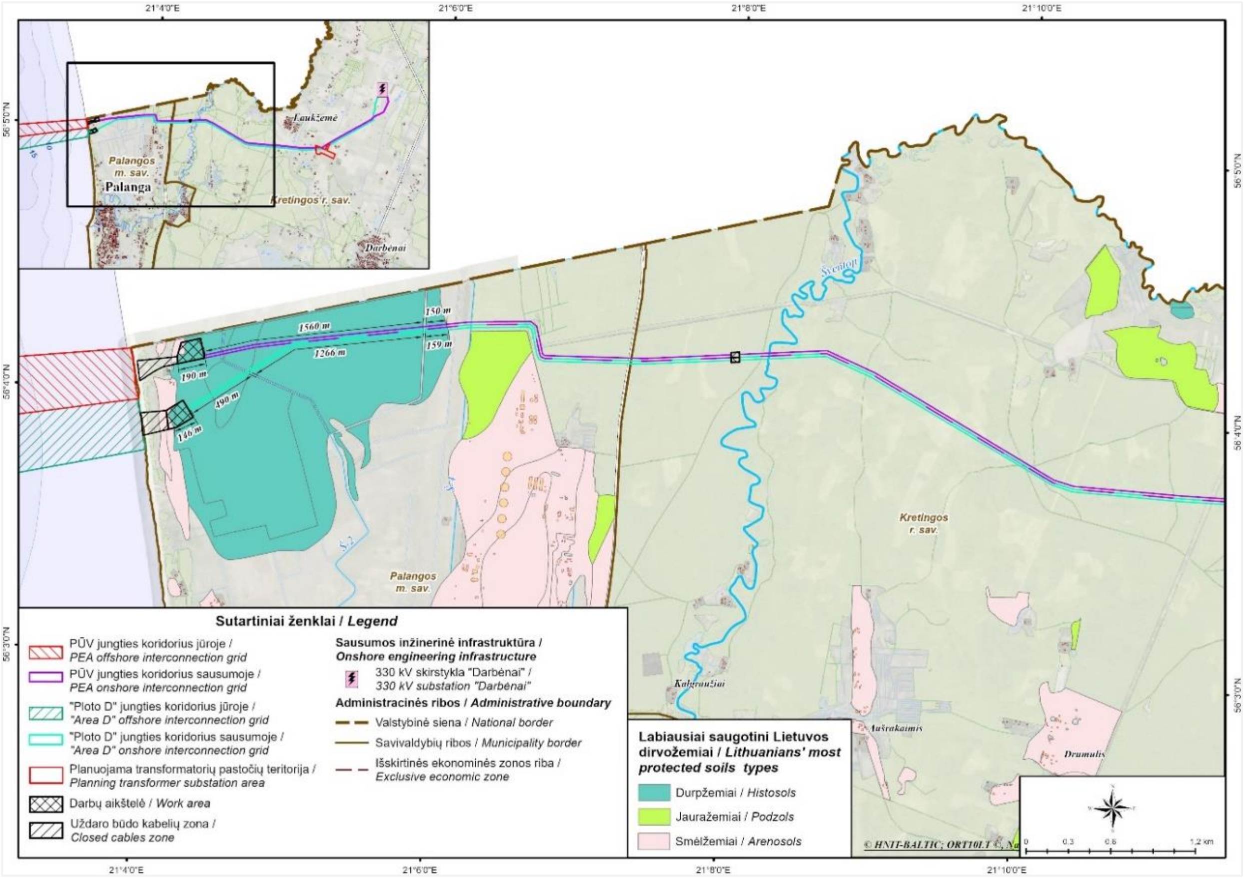


Fig. 5.3.14 a. Most valuable topsoil types in the onshore section of export cable corridor (1 of 2).

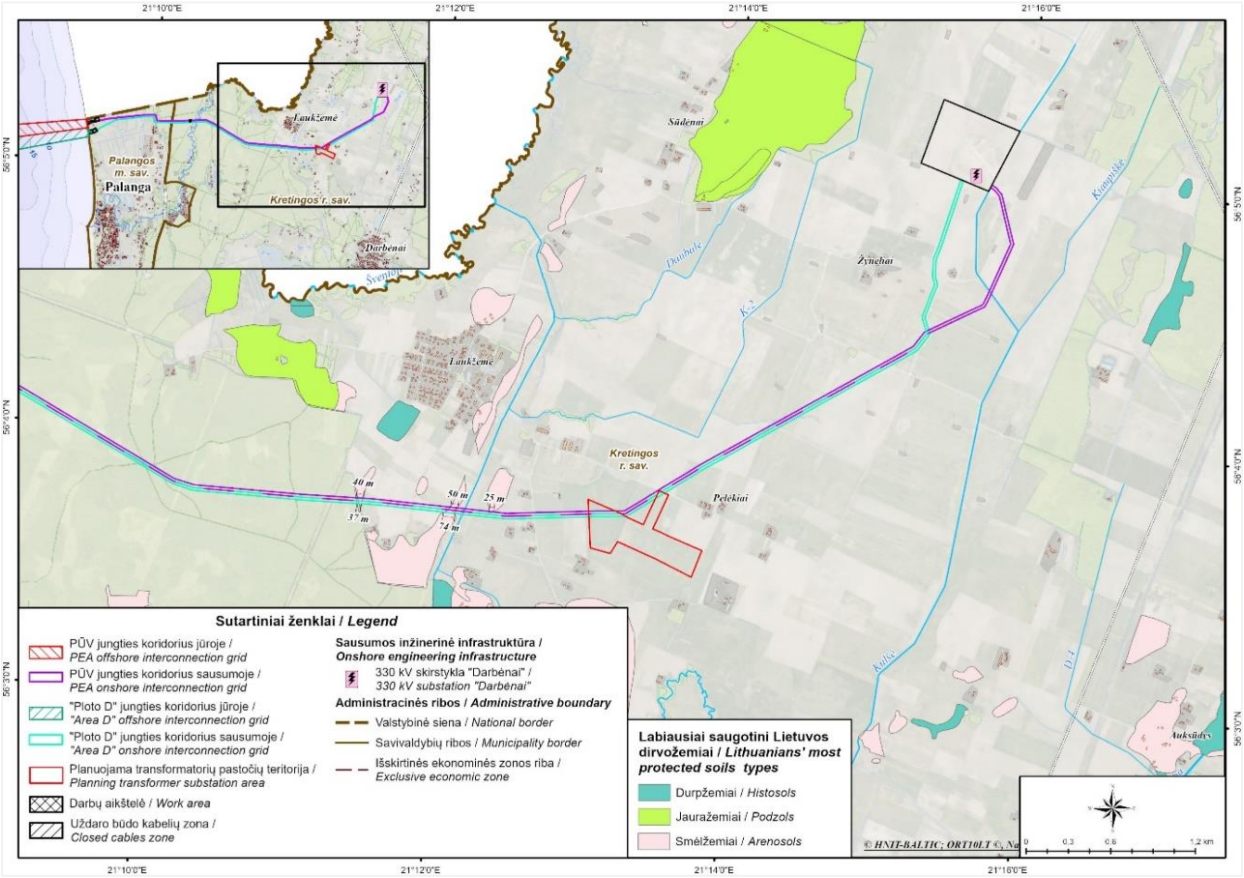


Fig. 5.3.14 b. Most valuable topsoil types in the onshore section of export cable corridor (2 of 2).

Soil protection in Lithuania is regulated by several key legal acts that establish measures and conditions aimed at preserving valuable soils and ensuring their sustainable use:

- The Law on Soil Protection of the Republic of Lithuania sets out the basic rights and obligations of legal and natural persons in using soil resources and preserving the naturally formed topsoil cover.
- The SLUC Law Article 110 establishes special land use conditions for agricultural land plots for the purpose of topsoil protection. These conditions include prohibitions on altering the land surface or topography or carrying out other activities that may damage topsoil fertility; requirements to apply anti-erosion measures in erosion-prone areas; and restrictions on using chemical substances that may contaminate the topsoil.

These legal acts form the basis for protecting valuable topsoil in Lithuania, setting requirements and restrictions aimed at preserving soil fertility, preventing erosion, pollution, and other adverse impacts.

Impact on topsoil and subsoil may occur during construction due to earthworks: during the installation of construction sites, ONSs, cables, and access roads topsoil movement activities will take place. During earthworks, it is prohibited to destroy the fertile topsoil. The removed topsoil will be stored within the construction site in a designated area specified in the technical project. Once construction is complete, the removed fertile topsoil will be used for land reclamation in the areas damaged during construction.

During construction, the contractor is obligated to use only technically sound machinery, ensuring that fuel or lubricants do not leak into the environment – this is aimed at preventing chemical pollution and protecting the topsoil and subsoil. To manage accidental oil spills, the contractor must keep oil-absorbing materials at the construction sites.

No significant negative impact on topsoil is expected during operation.

5.3.6. Potential impact on mineral resource deposits during export cable installation

Article 109 of the SLUC Law establishes restrictions on activities and special land use conditions in areas with approved mineral resource deposits extracted by open-pit mining. The planned export cable route does not intersect such deposits, therefore no restrictions or impacts on mineral resource deposits are foreseen.

5.3.7. Preventive, mitigation, and compensation measures for impact on the seabed, subsoil, and topsoil

Measures to reduce impacts on environmental components:

- Since OWF foundations are planned outside the main sediment transport corridors (which in Lithuania cover a 1–1.5 km nearshore zone), and the OWF area is located more than 36.8 km from the coast, it will not significantly affect shoreline stability or sediment transport. Additionally, export cables at the shoreline will be laid using closed HDD or similar technology, so no additional mitigation measures will be required.
- It is recommended where technically feasible and reasonably practicable, to avoid the installation of wind turbines within sensitive seabed zones and/or to minimize seabed disturbance by limiting the extent of cable trenching (see section 5.4.2.5 for more detail).
- To avoid excessive fragmentation of seabed sediments and the introduction of new lithological types due to secondary sedimentation, it is recommended that excavated material from cable trenches be reused for backfilling where construction technology allows.
- At construction sites onshore, export cable installation and ONS areas, the top fertile topsoil layer must be removed and stored separately before digging and used for land rehabilitation after work is completed.
- Once construction is completed, mechanically compacted (compressed) soil will be restored by shallow ploughing.
- All construction waste must be promptly removed to minimise potential chemical impact on topsoil.
- Only technically sound machinery should be used to ensure no fuel or lubricant leaks, preventing topsoil and subsoil contamination.

Measures to reduce potential impacts on OWF infrastructure:

- To mitigate the risk of seabed scour affecting foundations and cables, it is suggested to carefully assess the lithological conditions of surface sediments and, if needed, apply additional reinforcement around foundation piles during construction.
- Before commencing detailed OWF and cable design work, the developer will organise a survey for unexploded ordnance (hereinafter – UXO). This will also help identify any unknown historical cables and associated risks.

- It is recommended not to plan cable routes in areas with sharp seabed relief variations (e.g., steep slopes or deep incisions), or to apply partial seabed levelling in such areas to prevent potential damage to the transmission system.

Table 5.3.5. Potential impacts of the OWF on the seabed and summary of mitigation measures

Stage	Impact	Nature	Extent	Duration	Significance	Measures
Construction	Impact on seabed from installing WTG foundations, cables, and cable routes	Direct. The upper layer of seabed sediments and deposits is affected at the foundation construction depth. Possible damage to valuable seabed communities	Localised at turbine installation sites and cable routes	Only during construction	Minor impact	Recommended where technically feasible and reasonably practicable, to avoid the installation of wind turbines within sensitive zones and/or to minimize seabed disturbance by limiting the extent of cable trenching.
	Impact on coastal areas	Direct impact on valuable sand accumulations that shape the coast nearshore	Localised, only in cable trenching zones near the shore	Only during construction	Minor impact	HDD or similar technology planned for cable landfall.
Operation and Maintenance	Possible impact on seabed due to scouring around foundations and cable routes	Direct. The upper layer of loose seabed sediments and deposits is affected at the foundation and trench installation depth	Localised at foundation and cable trench installation sites	After construction, during operation	Minor impact	Additional seabed reinforcement at foundation locations.
Decommissioning	Possible seabed impact if foundations and cables are dismantled	Direct. Affects the upper layer of seabed sediments and deposits	Localised at WTG dismantling sites	Only during dismantling, if foundations are removed	Insignificant	Not applicable.

Colour code

(light green)	Positive impact
(light blue)	No impact or impact insignificant (not to be considered, no measures are applicable)
(blue)	Minor impact: decisions during design, preventive or mitigation measures
(light orange)	Moderate impact: addressed by mitigation measures
(orange)	Significant impact: mitigation and/or compensation measures are necessary.

Table 5.3.6. Potential impacts of the OWF on soil and summary of mitigation measures

Stage	Impact	Nature	Extent	Duration	Significance	Measures
Construction	Earthworks in the export cable route and Pelėkiai Transformer Substation area	Direct. Fertile topsoil is removed in the work zone	Local, at the export cable and Pelėkiai Transformer Substation installation site	During construction only	Minor impact	Topsoil is moved into piles and stored in a designated area. After work completion, the soil is used for site restoration.
Operation and Maintenance	Earthworks during export cable repair	Direct. Fertile topsoil is removed in the work zone	Local, at the export cable trench repair site	Post-construction, during operation	Insignificant	Topsoil is moved into piles and stored in a designated area. After work completion, the soil is used for site restoration.
Decommissioning	Earthworks in the export cable route and Pelėkiai Transformer Substation area if dismantled	Direct. Fertile topsoil is removed in the work zone	Local, at the export cable and Pelėkiai Transformer Substation installation site	During dismantling only	Insignificant	Topsoil is moved into piles and stored in a designated area. After work completion, the soil is used for site restoration.

Colour code

	Positive impact
	No impact or impact insignificant (not to be considered, no measures are applicable)
	Minor impact: decisions during design, preventive or mitigation measures
	Moderate impact: addressed by mitigation measures
	Significant impact: mitigation and/or compensation measures are necessary.

5.4 Biodiversity

5.4.1 State protected and "Natura 2000" areas

State protected areas and areas of the European ecological network "Natura 2000" have been designated in the Lithuanian waters of the Baltic Sea.

State protected areas are established and the territories of the European ecological network "Natura 2000" are designated in accordance with the procedure established by the Law on Protected Areas of the Republic of Lithuania[30]. The obligation to designate "Natura 2000" territories is provided in Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora [31]and in Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds[32].

5.4.1.1 Survey methods

Information on state protected and "Natura 2000" areas and the values protected therein, as well as the boundaries of protected territories, is provided using officially available data from the State Service for Protected under the Ministry of the Environment Areas (hereinafter – SSPA): the State Cadastre of Protected Areas[33].

5.4.1.2 Survey area

The survey area covers the geographical area of the PEA development, including both onshore and offshore planned and surrounding areas connected by natural links that are potentially affected by the PEA (see Fig. 5.4.1).

5.4.1.2.1 Offshore

In the marine part of the territory, the state protected and "Natura 2000" marine areas bordering the area intended for the development of the OWF are analysed, as well as the state protected, and "Natura 2000" areas crossed by the export cable corridor s.

5.4.1.2.2 Onshore

Onshore, state protected, and "Natura 2000" areas crossed by the export cable corridors are being analysed.

5.4.1.3 Current situation

5.4.1.3.1 State protected areas

The planned territory of the OWF borders the Klaipėda-Ventspils Plateau Biosphere Reserve on the eastern side. The export cable corridors at sea inevitably crosse the Klaipėda-Ventspils Plateau Biosphere Reserve. At sea and on the coast, the export cable corridors cross the Būtingė Geomorphological Reserve. (Fig. 5.4.1).

[30] https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.5627/asr

[31] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31992L0043

[32] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009L0147

[33] Website of Cadaster: https://stvk.lt/

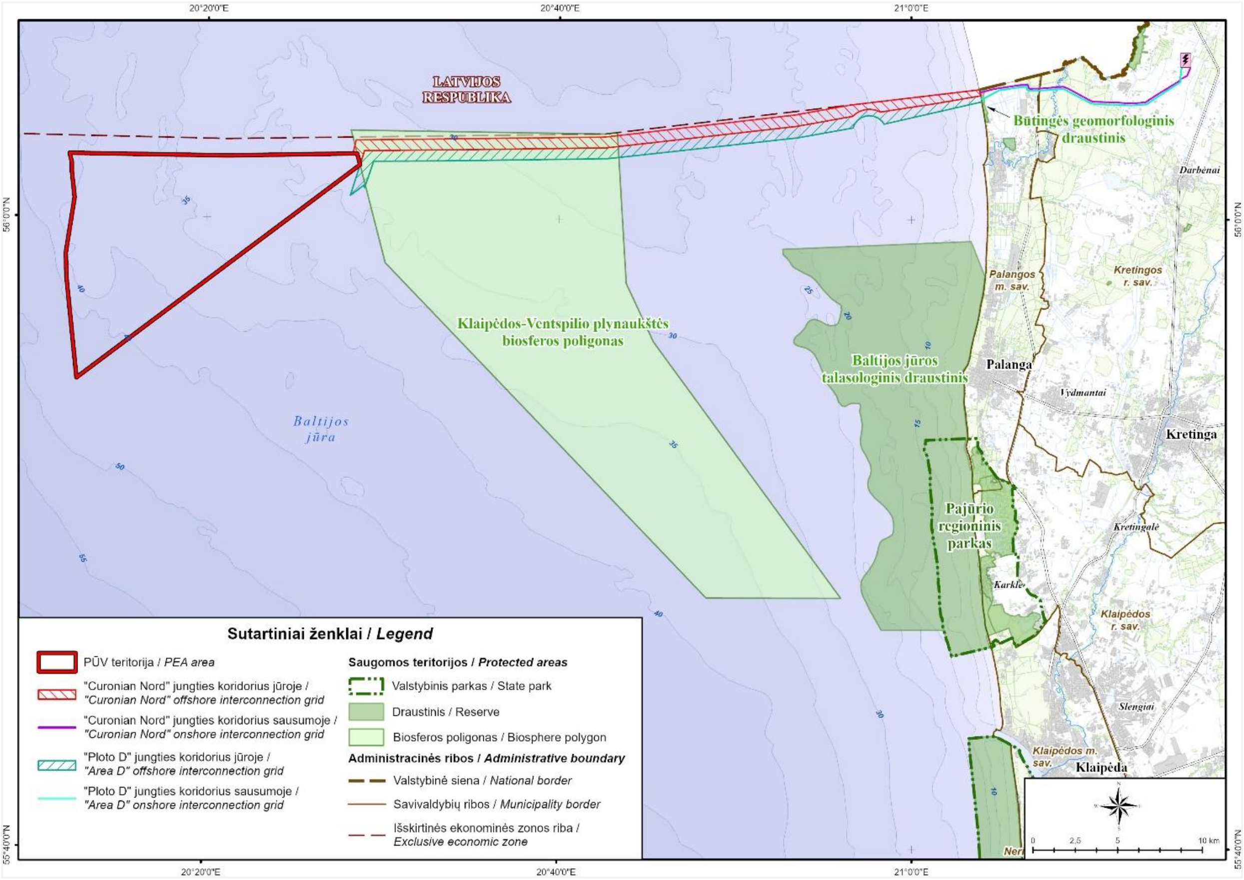


Fig. 5.4.1. State protected areas closest to the PEA territory.

Information about the state protected areas located in the vicinity of the OWF and crossed by the export cable corridors, the values protected therein, and the protection objectives is provided in Table 5.4.1.

Table 5.4.1. Information about the closest state protected areas (according to the data of the State Cadastre of Protected Areas of the Republic of Lithuania)

Protected area	Area, ha	Objectives of establishment, protected values	Distance from the boundary of the planned OWF
		Offshore	
Klaipėda-Ventspils Plateau Biosphere Reserve	31,949.31	To preserve a valuable part of the Baltic Sea ecosystem on the Klaipėda-Ventspils Plateau, especially: • ensure favourable conservation status of the natural marine habitats of the EC Importance (1170 Reefs). • ensure favourable conservation status of the areas of regular aggregations of protected wintering waterbirds of EC Importance – the velvet scoter (*Melanitta fusca*);. • ensure favourable conservation status of the areas of wintering and migration aggregations of razorbill (*Alca torda*) and long-	The OWF area borders a “Natura 2000” area stretch approximately 700 m long. The OWF export cable corridors cross the biosphere reserve in the northern part. The length of the crossing section is approximately 15.7 km for the CN and 16.1 km* for the “Area D” connection, respectively.

Protected area	Area, ha	Objectives of establishment, protected values	Distance from the boundary of the planned OWF
Offshore			
		tailed duck (*Clangula hyemalis*). • monitor natural habitats and protected species and to conduct scientific research related to the protection of protected values, to collect information on their condition. • analyse the impact of human activity on the marine ecosystem. • ensure that natural resources are used sustainably. • promote ideas and methods for preserving biodiversity.	
Onshore			
Būtingė Geomorphological Reserve	34.48	Preserve a stretch of coastal dunes.	The export cable corridor crosses. The length of the section at the CN is approximately 270 m, at the “Area D” – 160 m*.

* The length of the section is specified by measuring the central line of the northern cable.

Klaipėda-Ventspils Plateau Biosphere Reserve: the protected area was established in the territorial sea and EEZ of the Republic of Lithuania at sea by Order No. D1-333 of the Minister of the Environment of the Republic of Lithuania of 23 April 2015 “On the establishment of the Sambian Plateau and Klaipėda-Ventspils Plateau Biosphere Reserves, approval of their boundary plans and regulations”. According to the regulations of the Klaipėda-Ventspils Plateau Biosphere Reserve, economic and other activities carried out in the biosphere reserve may not deteriorate the favourable conservation status of the protected values specified in the purposes of establishment of the regulations. In the entire biosphere reserve, it is prohibited:

- To carry out economic or other activities if this would change the chemical composition of water, long-term hydrodynamic processes (except in cases where these processes are caused by vessels moving on waterways), the conditions of underwater habitats or otherwise significantly worsen the conservation status of wintering water bird populations or natural habitats.
- To manage and destroy the seabed, carry out dredging work or otherwise change habitats if this would significantly worsen the state of protection of protected values.
- To hunt water birds.
- To construct above-water and underwater structures if this would significantly worsen the condition of protected values.
- To fish in the part of the biosphere reserve located in the territorial sea of the Republic of Lithuania using:
  - bottom trawls
  - surface nets with a mesh size of 50 mm or more from November 1 to April 30.
  - bottom nets with a mesh size of 50 mm or more at depths greater than 20 metres from the water surface to the upper edge of the net. This restriction applies from 1 November to 30 April.

Special land use conditions apply to biosphere reserves specified in Article 88 of the SLUC Law, of which the following points of Part 2 apply to the Klaipėda-Ventspils Plateau Biosphere Reserve – a marine protected area:

- Paragraph 2, prohibiting the destruction or damage of landforms in the biosphere reserve.
- Paragraph 4, prohibiting the use of protected species in a biosphere reserve without a permit established by legal acts, or their intentional destruction or disturbance in such forms that may prevent the maintenance of a favourable conservation status of protected species, and the introduction or relocation of species that do not naturally inhabit the biosphere reserve without a permit established by legal acts.

In the section of the biosphere reserve within the EEZ of the Republic of Lithuania, it is mandatory to adhere to the restrictions on fishing or other economic activities as set by the EC, to protect the area's protected values.

According to the EU Council Directive 92/43/EEC [34] the aim is not only to avoid the deterioration of habitats, but also to achieve and maintain a favourable habitat condition and functions in its natural range.

Būtingė Geomorphological Reserve: a protected area in the territory of Palanga Municipality, along the Baltic Sea, starting behind Šventoji and extending all the way to the Latvian border. It was established by the Resolution of the Supreme Council of the Republic of Lithuania – the Reconstitute Seimas of 24th of September 1992 No. I-2913. The special land use conditions established in Article 69 of the SLUC Law apply to all reserves, therefore they are also valid for ensuring the protection of the Būtingė Geomorphological Reserve, and Article 71 of this Law establishes special land use conditions specifically applicable to geomorphological reserves, which prohibit:

- to change the natural boundaries of watersheds
- to clear-cut trees and shrubs on slopes with a slope of 15 degrees and on steeper slopes, as well as on hilltops, except: a) when eliminating the consequences of extreme events and (or) accidents; b) when the planning documents of protected areas allow the display of relief forms and (or) objects of natural or cultural heritage; c) to plant massifs of greenery, if this unifies the relief.

The Order of the Minister of the Environment of the Republic of Lithuania “On the Approval of the Coastal Zone Management Program for 2023–2032” (2023)[35] stipulates that the anthropogenic deflation ditches dividing the tops of the dunes of the reserve and their western slopes must be covered with branch formwork (2,600 m^2) every year, 2 new paths must be built and some of the paths must be renewed every year, 3 sand paths must be removed, and natural shoreline formation processes must be protected – typical and unique complexes of relief forms are preserved in the reserve.

5.4.1.3.2 Protected areas of the European ecological network "Natura 2000"

The offshore section of export cable corridors inevitably crosses the “Natura 2000” network of protected areas SAC Klaipėda-Ventspils Plateau (LTPAL0002) and SPA Klaipėda-Ventspils Plateau (LTPALB002). Onshore, the export cable corridors cross the Šventoji River – “Natura 2000” SAC Baltic Šventoji River (LTKRE0006) (Fig. 5.4.2).

[34] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. https://eur-lex.europa.eu/legal-content/LT/TXT/PDF/?uri=CELEX:31992L0043

[35] "On the approval of the Coastal Zone Management Program for 2023–2032". Order No. D1-117 of 21 April 2023. Ministry of the Environment of the Republic of Lithuania. https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/17dce601e07d11eda305cb3bdf2af4d8

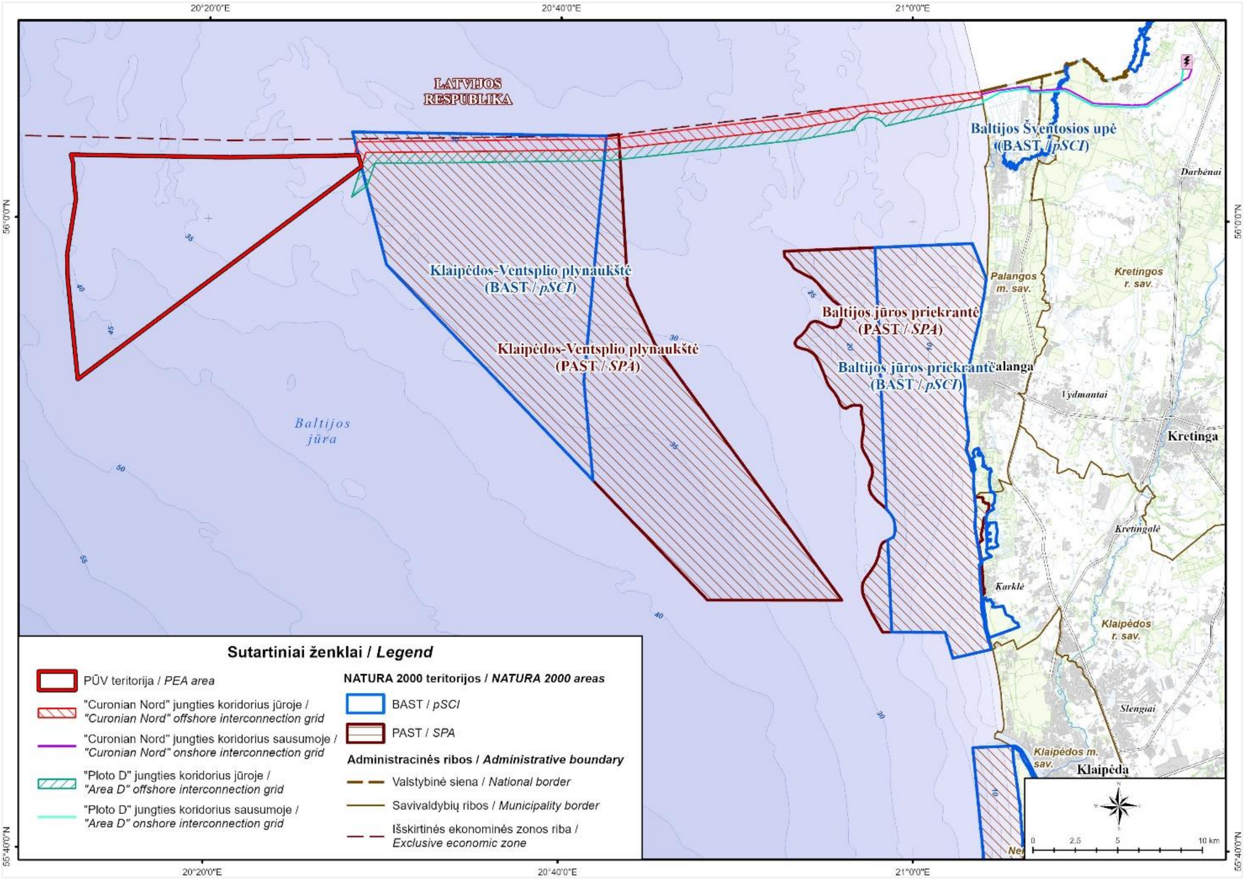


Fig. 5.4.2. "Natura 2000" areas closest to the PEA area.

Information about the "Natura 2000" protected areas located in the vicinity of the OWF and crossed by the export cable corridor s, the values protected therein, and the protection objectives is provided in Table 5.4.2.

Table 5.4.2. Information about the closest "Natura 2000" areas (according to the data of the State Cadastre of Protected Areas of the Republic of Lithuania)

Protected Area	Area, ha	Purpose of establishment, protected values	Established protection objectives [36,37]	Distance from the boundary of the planned area
		Offshore		
"Natura 2000" SPA Klaipėda-Ventspils Plateau	31,949.31	Velvet scoter (*Melanitta fusca*)	Not set	The OWF area is bordered by a stretch of about 700 m. The length of the section crossed by the export cable corridor is 15.7 km*. The length of the section crossed by the "Area D" export cable corridor is 16.1 km
"Natura 2000" SAC Klaipėda-Ventspils Plateau	17,948.50	1170 Reefs	The total area of habitat "1170, Reefs" under the conservation objective is 5,233 hectares, where a good conservation status of the habitat must be maintained	Borders with the area of the CN OWF. The length of the section crossed by the export cable corridor is approximately 14.9 km*. Borders with the "Area D" OWF. The length of the section crossed by the

[36] Order No. D1-281 of the Minister of the Environment of the Republic of Lithuania of 14 March 2014 "On the Identification of Areas Important for the Protection of Birds" (consolidated version valid from 7 December 2023); Order No. D1-245 of 19 July 2024 On the amendment of Order No. D1-281 of the Minister of the Environment of the Republic of Lithuania of 14 March 2014 "On the Identification of Areas Important for the Protection of Birds"

[37] Order No. D1-317 of the Minister of the Environment of the Republic of Lithuania of 19 April 2018 "On the Identification of Territories Important for Habitat Protection" (consolidated version valid from 28 April 2024).

Protected Area	Area, ha	Purpose of establishment, protected values	Established protection objectives [36,37]	Distance from the boundary of the planned area
				export cable corridor approximately 15.2 km*.
			Onshore	
"Natura 2000" SAC Baltic Šventoji River	27.14	European river lamprey (*Lampetra fluviatilis*)	The total area of the habitats suitable for European river lamprey is 22 ha, where good habitat condition must be maintained.	The CN OWF export cable corridor crosses. The length of the section is about 12 m. Export cable corridor of the "Area D" crosses. The length of the section is about 13 m.
		Thick shelled river mussel (*Unio crassus*).	The total area of the habitats suitable for the thick shelled river mussel is 22 ha, where good habitat condition must be maintained.	

* The length of the section is specified by measuring the central line of the northern cable.

The Klaipėda-Ventspils Plateau, an important "Natura 2000" area for bird protection (EU code LTPALB002). Established by Order No. D1-530 of the Minister of the Environment of the Republic of Lithuania of 8th of July 2015. The boundaries coincide with the boundaries of the Klaipėda-Ventspils Plateau Biosphere Reserve. The purpose of the designation of the protected area to the "Natura 2000" network is to protect the sites of wintering velvet scoter (*Melanitta fusca*).

General regulations for activities in the territory are established in accordance with Annex 2 to Resolution No. 276 of the Government of the Republic of Lithuania of 15 March 2004 "On the Approval of General Regulations for Territories Important for the Protection of Habitats or Birds":

- in areas where velvet scoter (*Melanitta fusca*) is present (Chapter III, paragraph 14):
  - fishing with set gillnets with mesh size of 50 mm and larger is prohibited in the Baltic Sea from December to April (this requirement does not apply when nets of the specified mesh size are lowered to such a depth in the Baltic Sea that the distance from the upper edge of the net to the water surface is at least 15 m, or in all cases when fishing with the specified nets is carried out under ice);
  - the seabed must not be managed, dredged (except for sand nourishment of beaches) or habitats must not be transformed in any other way if this would worsen their condition.

Klaipėda-Ventspils Plateau, a "Natura 2000" habitat protection area (EU code LTPAL0002). Established by Order No. D1-418 of the Minister of the Environment of the Republic of Lithuania of 3 June 2016. General regulations for activities in the territory are established in accordance with Annex 1 to Resolution No. 276 of the Government of the Republic of Lithuania of 15 March 2004 "On the Approval of General Provisions on Territories Important for the Protection of Habitats or Birds": the bottom relief of Reef habitats 1170 shall not be changed, and no other activities shall be carried out if this would violate the hydrological regime and chemical composition of water, change, pollute or otherwise worsen the condition of the habitats.

The conservation objectives set for the Klaipėda-Ventspils Plateau are listed in Table 5.4.2. These conservation objectives are subject to the target values of the set of criteria for good conservation status presented in Table 5.4.2 A.

Table 5.4.2 A. SAC Klaipėda-Ventspils Plateau Good Conservation Status (GCS) criteria for natural habitat of Community Interest 1170, Reefs, subtype 1170c, Circalittoral mussel reefs GCS criteria[33], with the territory-specific specification indicated in *italics*

No	Criterion code	Criterion	Unit of measure	Target value	Additional information
		Good Conservation Status criteria for 1170c, Reefs habitat			
1	1170.1	Total area occupied by the habitats	ha	Stable or increasing	

No	Criterion code	Criterion	Unit of measure	Target value	Additional information
2	1170.2	Area of habitats with good structure and functioning	ha	Stable or increasing	
3	1170.3	Change in the average projected cover of hard substrate (boulders, gravel) compared to the baseline level	%	<20	Determined by filming each monitoring grid cell using remotely operated video cameras. Given the high environmental heterogeneity, evaluations consider adjacent grid cells to confirm changes greater than 20% – such changes must also be observed in neighbouring cells. Changes beyond monitoring grid boundaries are interpolated based on available data. If the projected hard substrate cover in a grid cell is less than 20%, the reef's boundaries and an area are recalculated. If changes from the baseline exceed 20%, the criterion is not met, and the assessment of condition proceeds using other criteria.
4	1170c.6	Average projected mussel cover on hard substrate	%	*≥40*	Determined by filming the seabed using remotely operated video cameras.
5	1170c.7	Mussel size structure: median of the relative frequency of individuals in the >5 mm length group	%	≥30	Determined using dredge or frame samples that contain more than 100 individuals measuring at least ≥1 mm in length. When extrapolating to the habitat subtype area, it is essential to consider the conditions of mussel and hard substrate projected cover at similar depths or other ecologically relevant conditions.
6	1170c.8	Number of characteristic species	units	All species	Determined based on data from dredge samples collected from ecologically important substrate covered by reef-forming species at an appropriate depth. When extrapolating, it is necessary to consider hard substrate and mussel cover as well as depth. The list of characteristic species is provided in Table 5.4.2.B (*Mytilus edulis trossulus, Amphibalanus improvisus, Electra crustulenta, Jaera albifrons, Gammarus sp., Corophium volutator, Cordylophora caspia*).

The list of characteristic species of the habitat subtype '1170c, Circalittoral mussel reefs' is provided in Table 5.4.2 B.

Table 5.4.2 B. List of characteristic species of 1170c, Circalittoral mussel reefs

No.	Latin name of the specie
1	*Mytilus edulis trossulus*
2	*Amphibalanus improvisus*
3	*Electra crustulenta*
4	*Jaera albifrons*
5	*Gammarus sp.*
6	*Corophium volutator*
7	*Cordylophora caspia*

"Natura 2000" SAC Baltic Šventoji River (EU code LTKRE0006). General regulations for activities in the territory are established in accordance with Resolution No. 276 of the Government of the Republic of Lithuania of 15 March 2004 "On the Approval of General Regulations for Territories Important for the Protection of Habitats or Birds", Chapter XIII, paragraphs 43 and Chapter XIV, paragraphs 63:

- In the habitats of European river lamprey (*Lampetra fluviatilis*):
  - riverbeds cannot be straightened, drainage works cannot be carried out in water body protection zones
  - the river flow cannot be reduced by more than 20% of the average monthly flow
  - no artificial obstacles may be built on the migration routes of lampreys
  - lamprey juveniles may not be caught and used as bait for fishing
  - encouraging the installation of wastewater treatment plants in production centres and settlements
  - encouraging the planting of trees along the banks of water bodies
  - organic farming is encouraged in water body protection zones
  - encouraging the construction of fish culverts and removing obstacles in their migration routes
  - the implementation of other measures improving water quality to the requirements specified in Directive 2000/60/EC and the requirements for the protection of surface water bodies capable of supporting and breeding freshwater fish, approved by the Minister of the Environment, for salmonid and carp-type waters.
- In the habitats of thick shelled river mussel (*Unio crassus*):
  - rivers cannot be flooded
  - regulation of beaver abundance is encouraged
  - water tourism, establishment of campsites near habitats are restricted

The conservation objectives set for the Baltic Šventoji River SAC are provided in Table 5.4.2. These conservation objectives are subject to all target values of the GES criteria, which are set out in Table 5.4.3.

Table 5.4.3. SAC Baltic Šventoji River GES criteria for protected habitats of species of EC importance[33]

No	Criterion code	Criterion	Unit of measure	Target value	Additional information
GES criteria for European river lamprey (*Lampetra fluviatilis*)					
1	1099.1	Population. Number of spawning lamprey or number of spawning nests	ind./km	>10	Detection of spawners. Spawning nests (~20x15 cm areas of cleared gravel) are counted if spawners cannot be detected
2	1099.2	Population. Juvenile number	ind./m^2	>30	The survey is carried out only in typical habitats (coast, bays, where the depth is ≤0.6 m, current velocity <0.2 m/s, soil and sand with detritus admixture).
3	1099.3	Population. Number of young age classes	ind.	≥3	The number of age classes is determined by the length frequency groups of individuals.

No	Criterion code	Criterion	Unit of measure	Target value	Additional information
4	1099.4	Population. Frequency of detection of individuals in the territory	%	>65	Frequency of detection of individuals in the territory, if they counted in ≥2 locations.
5	1099.5	Habitat. Integration of spawning and nursery habitats	Expert evaluation	Integrated habitats are common	Spawning grounds are gravel-pebble stretches with current speed of 0.3–0.9 m/s. Breeding habitats are sand-detrital areas with current speed <0.2 m/s.
6	1099.6	Habitat. Water quality	Ecological status according to N, P and O_2 indicators	Very good according to the O_2 indicator, no worse than good according to other indicators	The status is determined based on state monitoring data in accordance with the procedure established by the Minister of the Environment. If monitoring data is not available, the status is determined based on the information on the ecological status of the reservoirs provided on the interactive map of the EPA website: 1 and 2 – very good or good, 3 – worse than good. Source – https://vanduo.gamta.lt/.
7	1099.7	Habitat. Riverbed morphology	Expert evaluation	Natural	The naturalness of the riverbed can be assessed using a geographic information system.
8	1099.8	Habitat. Hydrological regime	Expert evaluation	Hydrological regime natural	River sections whose hydrological regime has changed due to the activities of hydroelectric power plants are determined according to the information provided on the interactive map on the website of the EPA. Source – https://vanduo.gamta.lt/.
9	1099.9	Habitat. Riverbed integrity	Migration obstacles	No barriers to migration or barriers prevent <30% of spawning area	Migration barriers may be indicated in the Cadastre of Rivers, Lakes and Ponds of the Republic of Lithuania. Source – https://uetk.am.lt/.
		GES criteria for thick shelled river mussel (*Unio crassus*)			
1	1032.1	Population. Density of individuals ind./sq. m (average from research sites)	Ind. no./sq. m	≥10	Evaluated according to observation methodology.
2	1032.2	Population. Age structure	Number of age classes	3	According to the classification of three age classes: I – up to 3 years; II – from 3 to 6 years; III – individuals older than 6 years.
3	1032.3	Habitat. Riverbed regulation, anthropogenic changes		Natural riverbed	Expert evaluation.
4	1032.4	Habitat. Water quality class	Water quality class	Very good and good,	Source – https://vanduo.gamta.lt/

No	Criterion code	Criterion	Unit of measure	Target value	Additional information
			and nitrate content	and ≤2 mg/l NO_3-N	

5.4.1.4 Potential impact on values protected in protected areas and "Natura 2000" areas

5.4.1.4.1 Offshore

The area analysed for the construction of the OWF does not fall within the boundaries of "Natura 2000" and protected areas, however, on the eastern side, in a section of approximately 700 m in length, it borders the Klaipėda-Ventspils Plateau Biosphere Reserve and the Klaipėda-Ventspils Plateau, a designated "Natura 2000" area important for the protection of birds and habitats (Fig. 5.4.3).

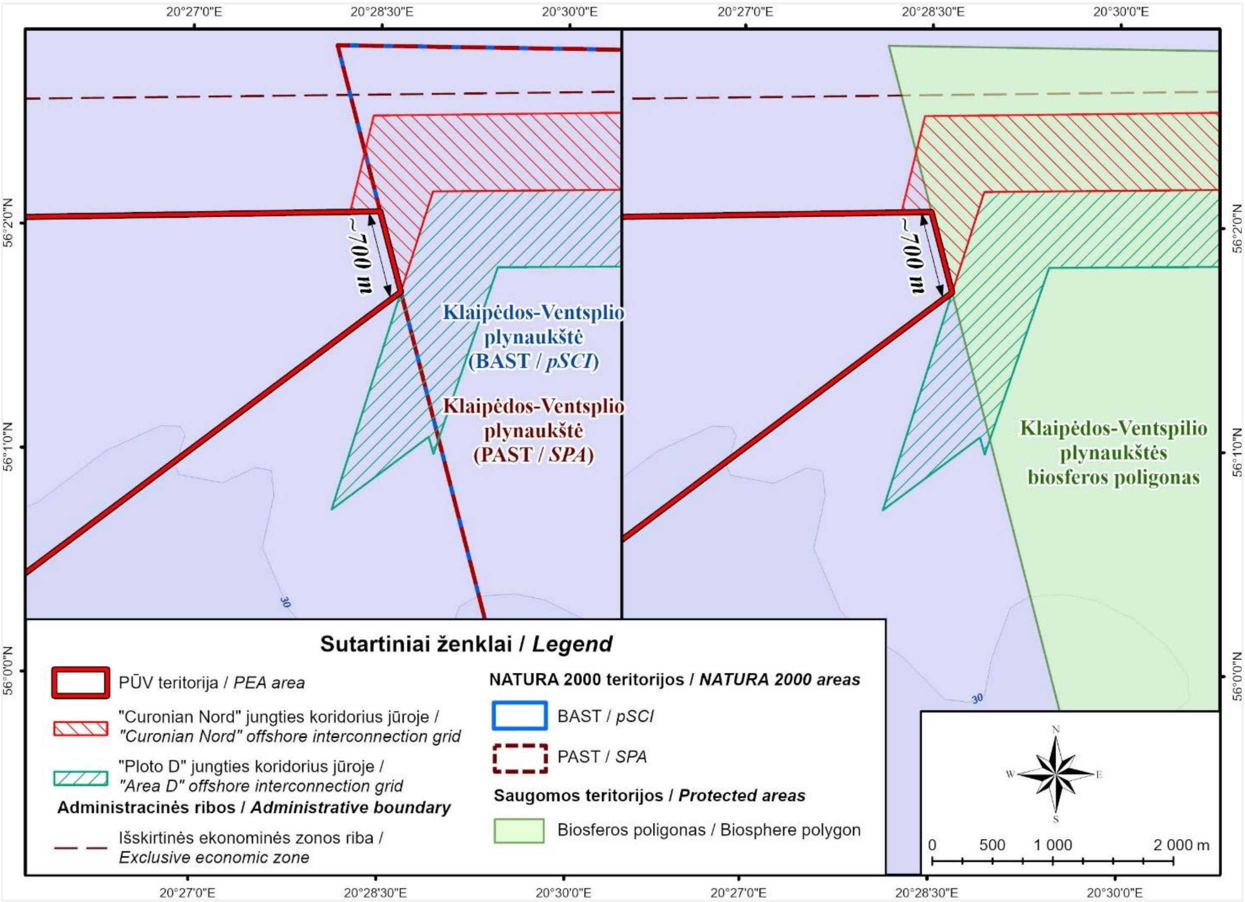


Fig. 5.4.3. The boundary of the analysed CN OWF area at the Klaipėda-Ventspils Plateau Biosphere Reserve and the "Natura 2000" territory important for the protection of birds and habitats Klaipėda-Ventspils Plateau.

The potential impact on wintering and aggregating birds during the installation of the OWF and the laying of export cable corridor is analysed in detail in subsection 5.4.3 of the EIA report. The potential impact on wintering bird species in the Klaipėda-Ventspils Plateau Biosphere Reserve and the SPA is mainly related to the potential disturbance during the construction, operation and dismantling stages of the OWF and due to the potential displacement from the habitat, which has suitable feeding areas.

The planned export cable corridor for the OWF crosses two significant protected areas: the Klaipėda-Ventspils Plateau Biosphere Reserve and the "Natura 2000" SPA Klaipėda-Ventspils Plateau. Since these protected areas overlap, the corridor's lengths within these zones are as follows:

- For the Klaipėda-Ventspils Plateau Biosphere Reserve and SPA:
  - CN OWF has a corridor approximately 15.7 km long.
  - "Area D" has a corridor approximately 16.1 km long.

Additionally, the corridor crosses the "Natura 2000" SAC Klaipėda-Ventspils Plateau:

- For the SAC:
  - CN OWF has a corridor approximately 14.9 km long.
  - "Area D" has a corridor approximately 15.2 km long.

Within the boundaries of the “Natura 2000” SAC Klaipėda-Ventspils Plateau, a habitat of the Reef (1170) of EC importance has been identified: a circumlittoral boulder field and a biogenic reef. The potential impact of the construction of the export cable corridor on these benthic habitats is analysed in detail in subsection 5.4.2 of the EIA report.

Due to the planned offshore export cable installation works, potential damage may occur in the work areas of the CN and “Area D” OWFs interconnection corridors. Depending on the width of the area, the estimated areas of negative impact on the seabed have been calculated, which, when installing two connection cables per WTG, may reach approximately 0.37 km^2 or 0.56% of the inventoried reef habitat area in the Klaipėda-Ventspils Plateau SAC area. This impact will not reach the established threshold of significant negative impact (1% of the habitat area).

Table 5.4.4. Information on potential impacts on protected areas and their values

Protected territory	Protected values that may be affected by the installation of an OWF	Potential impact
Klaipėda-Ventspils Plateau Biosphere Reserve	1170 Reefs	During the construction of the export cable corridors, local impacts on reefs are possible: movement of boulders forming the habitat, which may result in partial damage to reef-associated biota (the affected area of the habitat will not exceed the threshold value, see subsection 5.4.2).
	The regular wintering and migratory aggregation’s location aggregations of wintering birds – the location of velvet scoter (*Melanitta fusca*) populations of razorbill (*Alca torda*), long-tailed duck (*Clangula hyemalis*)	Potential impact on protected bird species due to disturbance and displacement from habitat with suitable feeding areas. It is predicted that habitat displacement and scaring effects are possible for benthic-feeding sea duck, such as velvet scoters and long-tailed duck. The scaring effect of birds during wintering is possible due to the increase in ship movement intensity during construction works or the regular movement of service personnel by ships or helicopters during the operational phase of the OWF.

Table 5.4.5. Information on potential impacts on protected values in “Natura 2000” areas

Protected territory	Protected values that may be affected by the installation of a wind farm	Potential impact
Natura 2000 SPA Klaipėda-Ventspils Plateau	Protection of wintering areas for the aggregations velvet scoters (*Melanitta fusca*)	Potential impact on protected bird species due to disturbance and displacement from habitat with suitable feeding areas. The scaring effect of birds during wintering is possible due to the increase in ship movement intensity during construction works or the regular movement of service personnel by ships or helicopters during the operational phase of the OWF.
Natura 2000 SAC Klaipėda-Ventspils Plateau	1170 Reefs	During the construction of the export cable corridors, local impacts on reefs are possible: movement of boulders forming the habitat, which may result in partial damage to reef-associated biota (the affected area of the habitat will not exceed the threshold value, see subsection 5.4.2).

Restoration of circumlittoral reef habitat after cable laying works

The export cable corridors are planned to be laid along the northern edge of the Klaipėda-Ventspils Plateau “Natura 2000” – the distance from the axis of the export cable corridor to the northern border of the “Natura 2000” is approximately 0.5 km.

As the trenches for laying the export cables inevitably cross the “Natura 2000”, it is important to assess the physical and biological potential of the habitat for natural recovery without the use of artificial compensation measures. The aim is to restore the damaged physical environment and biological structure of the habitat to their original natural state.

The physical environment of the reef is mainly formed by boulders and pebbles with a smaller part of sand, gravel or moraine. The biological or living main structure of the reef consists of mussels, bivalves, sessile filter feeders. Compared to the reefs of the Sambian Plateau and the circumlittoral of the Baltic Sea coast, the hard substrate coverage of *Mytilus edulis trossulus* in the Klaipėda-Ventspils circumlittoral is the highest amongst mentioned territories.

Baltic blue mussels are a hybrid of *Mytilus edulis* (Atlantic) and *Mytilus trossulus* (Pacific) *Mytilus trossulus* x *Mytilus edulis* hybrid genotype, where *Mytilus trossulus*-specific alleles predominate. These hybrid molluscs are better adapted to live in lower salinity conditions (about 7 ppm) (Väinölä, Strelkov, 2011; Gittenberger, Gittenberger, 2021; Knöbel et al., 2021). They are highly fertile dioecious invertebrates. Sperm formed in the testes of males enter the water through a siphon and then enter the mantle cavity of filter-feeding females, where fertilization of the eggs takes place. The eggs develop on the gills. At one time, the female releases up to 15 million larvae into the environment. It has been found that *Mytilus trossulus* larvae are abundant in their spawning areas, and their reproduction occurs throughout the year (Sokolowski et al., 2022).

The results of mussel aquaculture trials in different regions of the Baltic Sea (project BALTIC BLUE GROWTH, 2014–2020) showed that the colonization and growth of mussel larvae is quite rapid. The experiments established that the formation of a mussel colony takes up to 12 months. After the installation of cultivation ropes in the Gulf of Gdańsk, which is the closest natural environment to Lithuania, the highest density of small mussels (<2mm long) attached to the ropes for cultivation was observed after 8 months, and after 12 months a stable community of *Mytilus* and associated fauna was formed (Fig. 5.4.4) (Sokolowski et al., 2022).

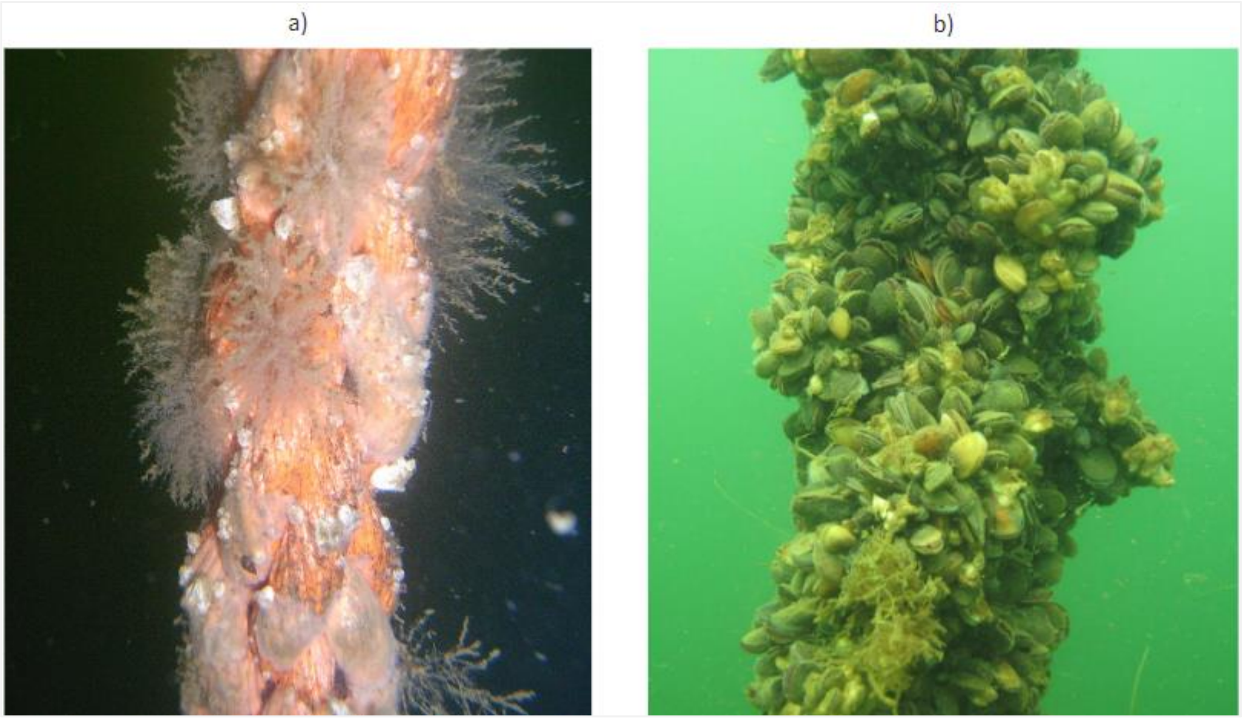


Fig. 5.4.4. *Mytilus* community growth on ropes after four (a) and twelve (b) months of exposure (according to Sokolowski et al., 2022).

Mytilus edulis trossulus and *Amphibalanus improvisus* (barnacle, less abundant in the circumlittoral than in the infralittoral) form the biogenic component of the circumlittoral reef habitat. These invertebrates are viviparous, with young larvae developing in the water column and being carried by currents to the surrounding area.

After reaching a certain biomass, the mussels sink to the bottom and attach themselves to the hard substrate and to each other with byssus filaments, while the head of the barnacle larva attaches itself to the hard substrate, live or empty shells of mussels and adult barnacles. In this way, colonies of sessile invertebrates are formed. The essential condition is the presence of a hard, stable substrate.

Other characteristic colonial species – hydrozoans (*Cordylophora caspia, Gonothyraea loveni*) and bryozoans (*Einhornia crustulenta*) – cover the hard substrate and mussels. In the spaces between the shells and in the empty shells of the barnacles, small and abundant sessile polychaete worms *Fabricia stellaris* settle. This becomes an attractive environment to mobile invertebrates (crustaceans, worms, leeches), because they find shelter and sufficient food.

Bioreef inhabitants feed by filtering water with small particles of organic matter, in this way substances from the water column are transformed, the water becomes clearer, and the pseudofeces of filtering organisms become suitable for further use by microorganisms for nutrition.

Circumlittoral reefs of Klaipėda-Ventspils SAC occupy about 6,626.8 ha or 33.2% of the reefs of the Klaipėda-Ventspils Plateau of the Republic of Lithuania (about 19,971.9 ha according to CORPI data) and extend into the territory of Latvia beyond the “Natura 2000”. The adjacent area occupied by the bioreef is large enough to be a donor area for mussel larvae and other invertebrates, therefore, in the areas of cable trenching/laying in the Klaipėda-Ventspils Plateau “Natura 2000” and beyond, mussel larvae will successfully colonise the damaged bottom areas, if the hard substrate is not removed from the environment, and the displaced boulders remain close to their original position.

Considering the above information, it is predicted that reef habitats will fully recover within approximately 12 months from cable laying.

5.4.1.4.2 Onshore

The export cable corridor cables will be installed utilising trenchless method, such as HDD or similar technology, without digging up the coastal dunes and the Būtingė Geomorphological Reserve. The cable laying construction site will be located outside the reserve. No significant impact on the Būtingė Geomorphological Reserve is expected.

Onshore, impact on the “Natura 2000” Baltic Šventoji River and the river lampreys and thick shelled river mussels are possible during the construction of the export cable corridors.

According to commercial fishing catches in the coastal waters and the Šventoji River, river lampreys actively migrate from the coastal waters to the Šventoji River in the autumn, from October to December. Here, in hiding places, they wait for suitable conditions for spawning until April–May, when the water temperature reaches 10–12°C. During this period, temporary scaring from occupied hiding places is possible during cable laying works.

River lampreys have good electroreception, so if the cables crossing the river are not sufficiently deepened (<3 m), an intense electromagnetic field (EMF) source can act as a physical barrier preventing migration to spawning grounds upstream.

Bivalve molluscs sensitive to physicochemical water quality and thermal pollution – thick shelled river mussels – are found in the Šventoji River.

To minimise the direct impact on protected values, at the intersection with the Šventoji River the cables will be laid in a trenchless way. The main risk posed by the installation of the export cable corridors in a trenchless way is the accidental leakage of drilling fluid (water with clay (bentonite)). During the construction of the interconnection cables, monitoring of the works will be carried out, therefore, possible leakage should cause only a short-term and very local impact on the aquatic habitat. The settled drilling fluid on the river bottom can be equated with natural processes, such as bank erosion or bank displacement. Large-scale uncontrolled leakage may have an impact on the spawning grounds of river lampreys and salmonids located 2–2.5 km downstream. These habitats often overlap with the habitats occupied by thick shelled river mussels. Their life cycle is often associated with rheophilic fish, as the larvae (glochidia) that hatch from the eggs parasitize the fish's gills for 20–50 days.

5.4.1.5 Preventive, mitigation and compensatory measures for impacts on protected areas

5.4.1.5.1 Offshore

The main measure for protecting the Reefs (1170) habitat is that boulders pushed or overturned at a short distance during the laying of the export cables (maximum trench width – 3 m) are left in the same environment, i.e. are not removed from the natural area of their formation, and other coarse-grained material (pebbles and pebbles), which also form the reef habitat, must be used when burying the laid cable in the trenches. Then the habitat area and natural hydrodynamic processes will remain unchanged (requirements for the protection of the Reefs (1170) habitat in “Natura 2000”). This impact is treated as physical habitat disturbance (MSFD descriptor D6 criterion C5).

The presence and density of benthic communities in the reef zone is not uniform (coverage percentage varies from 0 to 100, EPA, 2023). After the disturbance, spontaneous recovery of the zoobenthos community during the next vegetation season is highly likely. Disturbance of zoobenthos communities can be partially avoided if, during export cable laying/trenching, larger boulders with abundant mollusc colonies are simply pushed (not removed) away from the main trench route.

Plates, used to cover the connection cables, would act as artificial reefs and could improve the conditions for the recovery of zoobenthos communities. It is important that the size of the plates is at least 1x1 m, the porosity is 30–50%, the pore size is 2–5 mm, and the material is limestone or alternative characteristics with scientifically proved ecological performance, as porous structure and calcium-enriched medium attract mussel larvae, accelerate mussel colonization and growth.

The status of habitat restoration should be assessed according to following indicators:

- Physical environment – lithological structure of the substrate, percentage ratio between stable reef-specific (boulders, pebbles) and mobile substrate (sand, gravel).
- Living environment – *Mytilus edulis trossulus* colonies: size (age) of the shells; abundance of organisms; presence/absence of other species; number of other species.

In order to reduce potential impact on wintering and aggregating birds in the Klaipėda-Ventspils Plateau Biosphere Reserve and the “Natura 2000” SPA Klaipėda-Ventspils Plateau, mitigation and compensation measures are planned for both the OWF and export cable corridor installation works:

- OWF must not be designed and built at a distance of at least 2 km from the boundary of protected territory.
- During the construction and decommissioning phase to reduce the impact on wintering birds, it is recommended that the noisiest installation (pile driving) and decommissioning works of OWF are scheduled outside the main period of migratory and wintering bird aggregations (15 November–15 April). If pile driving cannot be postponed and must occur during the wintering period, to minimise the disturbance of wintering seabirds, the installation of foundations (or decommissioning works) should start at WTGs locations furthest from the SPA, while also applying appropriate noise mitigation measures (see section 5.4.5.4.1).
- During the construction, operation and decommissioning stages of the OWF to minimise disturbance to wintering birds, shipping routes must be planned to bypass protected areas if the works are carried out during the main period of migratory and wintering bird aggregations (15 November–15 April). Routes must be planned in the same way during the export cable laying and decommissioning phases. Restrictions do not apply for repair and maintenance works of cables.
- If a significant negative impact is identified during the operation phase, which was not foreseen during the EIA, additional mitigation measures shall be taken, selecting them depending on the impact. After the implementation of additional measures, their effectiveness shall be monitored until it is ensured that the additional measures applied to avoid significant impacts are effective. If the impact remains significant even with all tested mitigation measures, individual wind turbines or group of WTGs may not be operated during the period when they may have a significant impact on biodiversity. The impact (displacement from the protected area) is considered significant when the abundance of protected birds in the “Natura 2000” SPA – the number and/or density of individuals of protected bird species in the monitored area – decreases by more than 20% from the natural long-term (10-year) population fluctuation (according to long-term research data collected under the state environmental monitoring program).
- During the construction and decommissioning phases, cable laying or decommissioning activities within the offshore protected areas and a 2 km buffer zone around them must be avoided during the main period of migratory and wintering bird aggregations (15 November–15 April).

5.4.1.5.2 Onshore

For the export cable corridors from the sea to the shore and the crossing of the Šventoji River, a trenchless laying technology is planned, which eliminates the impact on the Būtingė Geomorphological Reserve and the Šventoji River and the integrity of the designated habitat and minimises the impact on target protected values and species.

Potential impacts on fish in the Šventoji River can only be caused by drilling fluid additives that have entered the water, some of which may be harmful to aquatic ecosystems, such as sodium hydroxide (for pH regulation), synthetic oils (for lubrication) or polyamine-based granulation inhibitors. Therefore, alternative or natural additives should be selected for the drilling fluid, the impact of which on protected areas would be minimal even in the event of a leak.

Some fish species and other aquatic organisms are sensitive to vibrations that may occur during HDD. To avoid a possible “migration barrier” effect, cable laying should not be carried out during the active migration or spawning period of salmonids and river lampreys, and the cables should be buried at least 3 m into the riverbed.

The export cables will cross the Kulšė River with an open trench. To reduce the entry of sediments into the Šventoji River, sediment dispersion reduction measures, such as sediment retention screens or other technologies that reduce sediment leaching and water turbidity, must be applied during the works.

The most sensitive periods for migratory fish in the Šventoji River and its tributaries, during which the construction of the export cables must not be carried out, are:

- for salmonid fish – from October 1 to January 15.
- for river lampreys – from April 1 to May 15.

Table 5.4.6. Potential impacts of the OWF and export cable corridors on marine protected areas and "Natura 2000" sites and summary of mitigation measures

Stages	Impact	Nature of impact	Scale	Duration	Impact	Mitigation measures
Construction	Resuspension of seabed sediments	Negative direct effects on the vital functions of some benthic organisms	Local (within the cable laying area and adjacent territories)	Short-term (only available during installation work)	Insignificant impact – abundance of benthic organisms will not change significantly	Not applicable
	Physical damage to seabed habitats	Negative direct impact on habitat – degradation, disturbance	Local (within the cable laying area and adjacent territories)	Short-term (habitat restoration will take about 12 months before benthic organisms recolonise)	Impact of minor significance – reduction in abundance of benthic animals	When preparing the seabed for cable laying, move stones to adjacent areas outside the preparation area.
	Noise and vibration	Negative direct impact – disturbance of birds	Local (in the OWF construction and cable laying areas)	Short-term (only available during works)	Impact of minor significance – temporary fluctuations in bird abundance	From November 15 to April 15, installation of foundations should start at WTGs locations furthest from the SPA. Cable laying activities within the offshore protected areas and a 2 km buffer zone around them must be avoided during the main period of migratory and wintering bird aggregations (15 November–15 April).
	Increased ship traffic and noise	Negative direct impact – disturbance of birds	Local (in the OWF construction and cable laying areas)	Short-term (only available during vessel's stay)	Impact of minor significance – temporary fluctuations in bird abundance	When planning shipping routes, avoid protected areas from November 15 to April 15 inclusive.
Operation and maintenance	Resuspension of seabed sediments	Negative direct effects on the vital functions of some benthic organisms	Local (in the cable repair area and adjacent territories)	Short-term (only available during troubleshooting)	Insignificant impact – abundance of benthic organisms will not change significantly	Not applicable.
	Physical damage to seabed habitats	Direct negative impact on the habitat (disturbance)	Local (in the cable repair area)	Short-term (habitat restoration will take until benthic organisms	Insignificant impact – abundance of benthic organisms will not change significantly	Not applicable.

Stages	Impact	Nature of impact	Scale	Duration	Impact	Mitigation measures
		Negative direct impact (vertical substrate may become a habitat for non-native species)		recolonise, about 12 months or less)	Insignificant impact, because natural reefs are found at similar depths relatively close to the OWF area	Not applicable.
	Increased movement and noise from ships and/or helicopters	Negative direct impact – disturbance of birds	Local (in OWF and surrounding areas)	Short-term (only available during vessel's stay)	Impact of minor significance – temporary fluctuations in bird abundance	When planning shipping routes, avoid protected areas from November 15 to April 15 inclusive. Restrictions do not apply for repair and maintenance works of cables.
	Displacement from habitat	Negative direct impact – reduction in abundance due to avoidance of OWF, thus losing part of the feeding habitat	Local (in OWF and surrounding areas)	Long-term (will last until the end of operation of the OWF)	Potential significant impact – on sea duck, auk birds and divers – birds will avoid OWF	OWF must be designed and built at least 2 km away from protected areas.
Decommissioning	Turbidity increase	Direct negative impact on the vital functions of benthic organisms	Local (in the cable removal area and adjacent areas)	Short-term (only available during dismantling work)	Insignificant impact – the abundance of benthic organisms will not change significantly	Not applicable.
	Physical destruction of seabed habitats	Negative direct impact on habitat (degradation, disturbance)	Local (in the cable removal area)	Long-term (the length of the period does not depend on the activity)	Impact of minor significance – abundance and biomass may decrease – reducing food source for birds and fish	Installation of artificial reefs.
	Increased ship traffic and noise	Negative direct impact – disturbance of birds	Local (in OWF and surrounding areas)	Short-term (only available during vessel's stay)	Impact of minor significance – temporary fluctuations in bird abundance	When planning shipping routes, avoid protected areas from November 15 to April 15 inclusive.

Colour code

	Positive impact
	No impact or impact insignificant (not to be considered, no measures are applicable)

	Minor impact: decisions during design, preventive or mitigation measures
	Moderate impact: addressed by mitigation measures
	Significant impact: mitigation and/or compensation measures are necessary.

Table 5.4.7. Potential impact of the export cable corridors on national protected areas and "Natura 2000" sites onshore and summary of mitigation measures

Stages	Works	Impact	Nature of impact	Scale	Duration	Importance	Mitigation measures
Construction	Installing of export cables across the Šventoji River	Turbidity increase	Negative direct impact on thick shelled river mussel habitat, fish feeding and respiration	Local. At the excavation site and downstream	Short-term (only during installation work)	Potential significant impact on protected species	At the intersection of the export cable corridors with the Šventoji River, a trenchless cable installation method is used without excavating the riverbed in an open trench.
		Physical destruction of seabed habitats	Negative direct impact on the habitat of the thick shelled river mussel	Local. At the excavation site	Short-term (due to the small area damaged, the habitat recovers quickly)	Potential significant impact on protected species	At the intersection of the export cable corridors with the Šventoji River, a trenchless cable installation method is used without excavating the riverbed in an open trench.
		Noise and vibration	Negative direct impact, fish will be scared away from the construction site or migration routes of passing fish will be changed	Local. At the excavation site	Short-term (only possible during installation work)	Impact of minor significance – temporary decrease in fish abundance	Not applicable.
Operation and maintenance	No effects are expected under normal operating conditions.					Insignificant impact	Not applicable.
Decommissioning	Removal of constructions	Turbidity increase	Negative direct impact on thick shelled river mussel habitat, fish feeding and respiration	Local (in the territory of the OWF)	Short-term (possible only during work)	Potential significant impact on protected species	Cable removal must be carried out without disturbing the riverbed, similarly to the installation.
		Physical destruction of seabed habitats	Negative direct impact on the habitat of the thick shelled river mussel	Local. At the excavation site	Short-term (due to the small area damaged, the habitat recovers quickly)	Potential significant impact on protected species	Cable removal must be carried out without disturbing the riverbed, similarly to the installation.
		Noise and vibration	Negative direct impact, as fish will be scared away from the site of the OWF being dismantled	Local (at the site of dismantling of the OWF)	Short-term (possible only during work)	Impact of minor significance – temporary	Not applicable

Stages	Works	Impact	Nature of impact	Scale	Duration	Importance	Mitigation measures
						decrease in fish abundance	

Colour code

	Positive impact
	No impact or impact insignificant (not to be considered, no measures are applicable)
	Minor impact: decisions during design, preventive or mitigation measures
	Moderate impact: addressed by mitigation measures
	Significant impact: mitigation and/or compensation measures are necessary.

5.4.2 Seabed habitats

5.4.2.1 Benthic invertebrate communities

Macrozoobenthos (macrofauna) are benthic invertebrates that live in the seabed habitat of the aquatic environment, bigger than 0.5–1 mm, most of which are highly fertile and have a planktonic stage of development that allows organisms to spread widely. Benthic invertebrates are among the most reliable biological indicators due to their low mobility, longer lifespans compared to other organisms, and their ability to accurately reflect environmental changes.

Benthic fauna habitats in the assessed area are formed by various species, including the bivalve molluscs *Macoma balthica* burrowing in loose bottom sediments, the bivalve molluscs *Mytilus edulis trossulus* and acorn barnacle *Amphibalanus improvisus*, forming colonies in boulders. Perennial algae contribute to biofouling in the photic zone.

Marenzelleria spp., forms a community along the coast in sandy bottom sediments at the depth of 3 to 45 metres. The community comprises 12 benthic fauna taxa, with *Bathyporeia pilosa* and *Hediste diversicolor* being common in the shallows and *Pygospio elegans* and *Oligochaeta* – in deeper waters.

The *Macoma balthica* community, widely distributed in the sandy and silty bottoms of the central Baltic Sea, encompassing all known infauna and mobile species for the area. Four forms of this community are identified depending on the depth. *M. balthica* dominates in all four forms typically exceeding 70–80% in biomass. The shallower part of the underwater slope (up to about 30 m) shows a more diverse benthic community, including species such as *Mya Arenaria and Cerastoderma glaucum.* In deeper waters, the community biomass is significantly greater and often exceeds 100 g m^{-2} and is dominated by large individuals of *M. balthica* and isopod crustacean *Saduria entomon*. However, the species composition is less diverse and the number of its permanent members, such as *Halicryptus spinulosus* or *Bylgides sarsi,* is low.

Pontoporeia communities form at the depth of around 50 m. *Monoporeia affinis* dominates in shallower areas, with an average of 8 species in the community. Deeper waters are dominated by *Pontoporeia femorata,* with a significantly smaller number of species (2–4). Both species are known to be dominant in deep muddy areas of the Baltic Sea. In all cases, the degree of dominance of amphipods is typically below 50% of the total benthic fauna biomass, indicating a dynamic community composition on the underwater slope which is usually composed of a random set of species that can survive in that environment[38].

5.4.2.2 Survey methods

5.4.2.2.1 Methods for assessing the current state

To assess the current environmental state, data from reef monitoring [39] conducted in 2021–2022 and 2022–2023, as well as benthic surveys carried out in 2024 in the CN OWF area and export cable corridors, were used.

The EU[40 41 42 43] and the Baltic Sea Region [44 45 46] guidelines on marine biodiversity protection and impact assessment were applied for the survey and assessment.

In 2021, in accordance with the state environmental monitoring program, the EPA along with the Marine Research Institute of Klaipėda University, started conducting research on seabed habitats – reefs (1170) belonging to the “Natura 2000” network. The suitability of the detailed monitoring plan for reef habitats presented in the report is based on the

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[45] Guidelines for the environmental impact studies on marine biodiversity for offshore, 2016.

[46] http://marmoni.balticseaportal.net/wp/wp-content/uploads/2011/03/Windfarm-EIA-Guidelines_March2016.pdf

assessment of the condition in accordance with the requirements of the EU MSFD[47], Council Directive 92/43/EEC (Habitats Directive)[48], Water Framework Directive 2000/60/EC[49], the indicators of the HELCOM related to the assessment of marine habitats and their impacts, and the criteria specified in the Lithuanian Environmental Monitoring Program 2018–2023.

In 2022 and 2023, reef (1170) habitat monitoring was carried out within the boundaries of the Sambian and Klaipėda-Ventspils Plateau Biosphere Polygon areas, covering the Lithuanian territorial sea and the EEZ. During the surveys, acoustic measurements were performed using side-scan sonar (SSS) and a multibeam echosounder (MBES). The underwater videos were collected by a drop-down video (hereinafter – DDV) system. The benthic samples were collected in 10 places using a dredge (internal opening dimensions: 93×33 cm; mesh size: 500 µm).

In each sample, the percentage coverage of mussels (*Mytilus edulis trossulus*) was evaluated along with the presence or absence of other macrozoobenthic species, the percentage coverage of different substrate types and the estimated area of the observed habitat (km²). Additionally, in several locations, semi-quantitative seabed samples were collected using a dredge.

Remote video surveys were conducted along transects in two depth zones: circalittoral zone a 1x1 nautical mile grid and infralittoral zone a 300x300 m grid. Each transect was filmed for 3–5 minutes at a vessel speed of 0.5 knots. The recorded footage was segmented into 10 m intervals, with each interval treated as a separate video sample.

For each video sample, the following parameters were evaluated:

- Percent coverage of blue mussels (*Mytilus edulis trossulus*).
- Presence/absence of other Macrozoobenthos species.
- Substrate type coverage (%) (e.g., sand, gravel, rock).
- Estimated habitat area (km²) of observed benthic communities.

In selected locations, semi-quantitative sediment samples were collected using a dredge to complement video data.

Underwater video surveys were conducted at 26 sampling stations within the OWF area and at 6 stations along the planned export cable corridor.

The video material was analysed by a qualified researcher with experience in identification of reef habitat structural and biological features, including:

- Key biogenic formations (e.g., mussel beds, epifaunal colonization).
- Substrate heterogeneity (e.g., bedrock, boulders, mixed sediments).
- Taxonomic proficiency in species characteristic of reef habitats.
- Sediment and substrate classification (e.g., grain size, lithological composition).
- Experience in visual interpretation of underwater footage, including identification of lithological types (e.g., till, glacial erratic boulders).[50] [51]

During the visual assessment of the video material, the substrate type and its composition, as well as the main biological features, were identified. Coverage was evaluated as a percentage with 10% accuracy (i.e., 0, 10, 20, 30, ..., 100% coverage). In cases where the coverage of a feature was less than 10%, it was estimated at 5% (scattered organisms) or 1% (a single organisms).

The coverage of seabed sediments or substrate was visually estimated as a percentage of the visible surface area, based on the granulometric classification of clastic deposits:

- Aleurites (mud) (<0.0625 mm; typically, dark grey or black in colour, may contain light greyish or yellowish fragments; usually lacks easily visible biological features; easily resuspends when the camera or its protective frame touches the seabed).

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[47] https://eur-lex.europa.eu/eli/dir/2008/56/oj/eng

[48] https://eur-lex.europa.eu/legal-content/LT/TXT/?uri=CELEX:31992L0043

[49] https://eur-lex.europa.eu/legal-content/LT/ALL/?uri=CELEX:32000L0060

[50] Šaškov, A., Dahlgren, T. G., Rzhanov, Y., & Schläppy, M. L. (2014). Comparing manual and semi-automatic underwater imagery analysis 1 approaches for hard bottom benthic macrofauna monitoring at offshore 2 renewable energy installations 3.

[51] Šiaulys, A., Vaičiukynas, E., Medelytė, S., Olenin, S., Šaškov, A., Buškus, K., & Verikas, A. (2021). A fully annotated imagery dataset of sublittoral benthic species in Svalbard, Arctic. *Data in brief*, *35*, 106823.

- Sand (0.0625–2 mm; yellowish sediments, often with clear biological (e.g., crawling, burrowing) or geomorphological (e.g., ripple marks) features on the sediment surface; resuspends minimally when the camera or its protective frame touches the seabed).
- Gravel (2–60 mm).
- Pebbles/Coarse Gravel (60–256 mm);
- Boulders (>256 mm)[52].

A visual assessment of biological characteristics was carried out. The coverage, presence/absence or number of individuals was determined:

- Blue mussels *Mytilus edulis trossulus* – coverage, percentage (infralitorall, cirkalitorall).
- Bay Barnacle *Amphibalanus improvises* – presence/absence (infralitorall, cirkalitorall).
- Hydroid *Cordylophora caspia* – presence/absence (infralitorall, cirkalitorall).
- Red algae *Furcellaria lumbricalis* – coverage, percentage (infralitorall).
- Red algae *Vertebrata fucoides* – coverage, percentage (infralitorall).
- Red algae *Coccotylus truncatus* – presence/absence (infralitorall).
- Green algae *Cladophora glomerata* – coverage, percentage (infralitorall).

On March 19–20 and 26, 2024, sediment and zoobenthos samples were collected at 49 stations. Sampling strategy targeted three distinct zones: the main OWF development area, the planned export cable corridor, and undisturbed reference locations. 37 locations were within the OWF area, 26 of which coincided with reef habitat (1170) monitoring sites, 10 locations were situated along the export cable corridor from the OWF area towards the shore and beyond its boundaries, 2 stations were located approximately one nautical mile west of the OWF area boundary.

A total of 91 seabed sediment samples were collected from 49 survey stations, with 1 to 3 replicates taken at each station. At 25 separate sites, samples were collected only with a grab sampler, at 8 sites – only with a dredge and at 16 sites – with both a grab sampler and a dredge (Table 5.4.8). To assess the Macrozoobenthos species composition, abundance and biomass, a combination of two methods was applied: quantitative and qualitative/semi-quantitative.

Quantitative method – seabed sediment samples were collected using two different sizes of Van Veen-type grabs with a sampling area of 0.1 m² or 0.06 m². Due to the complex morphological conditions of the seabed, grabs were used on a case-by-case basis to ensure sufficient data representativeness. Depending on the seabed topography and feasibility, one to three samples were taken at each site.

Semi-quantitative method – a dredge was used (internal opening dimensions: 15x38 cm; bag volume: 0.05 m³; mesh size: 500 µm). One to two samples were collected per site while the vessel moved at a speed of 0.5–1 nautical mile per hour. This method was applied in areas where morphological constraints made the use of a grab sampler unfeasible.

Using different sampling devices, the study also succeeded in retrieving individual boulders with biological growths from the seabed, which are important for assessing quantitative Macrozoobenthos colonization on boulders.

The samples were rinsed through a 500 µm mesh sieve. Invertebrates, along with the remaining sediment, were transferred into plastic containers and fixed in a 4% formaldehyde solution neutralized with sodium tetraborate, ensuring proper preservation for subsequent taxonomic identification in the laboratory. The study sites related to the PEA and monitoring locations for reefs (1170) are shown in Fig. 5.4.5

Table 5.4.8. Macrozoobenthos and sediment samples

Surface Seabed Sediment Type	Number of Study Sites	Number of Samples	
		Van Veen grab sampler	Dredge
Gravelly sand	19	29	7
Sand	4	8	-
Sandy gravel	25	29	17
Till (Moraine)	1	-	1
Total:	**49**	**66**	**25**

[52] Trimonis, E., Gulbinskas, S., & Kuzavinis, M. (2005). Sediment patterns of the underwater slope of the south-eastern Baltic Sea (Lithuanian sector). *Geologija*, *52*, 46-54.

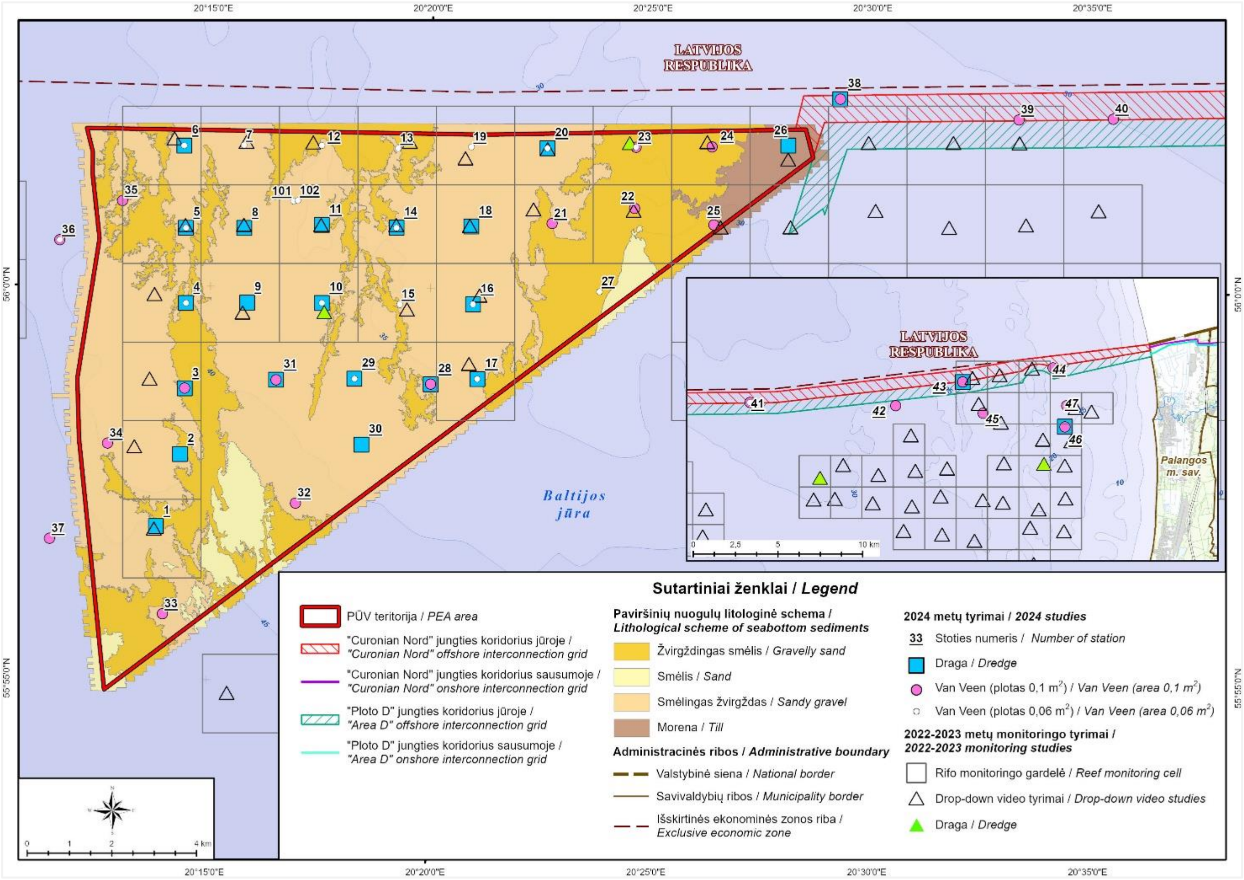


Fig. 5.4.5. Underwater videos and zoobenthos sampling stations.

The analysis of the taxonomic composition, abundance, and biomass of macroinvertebrates was carried out in accordance with the standard LST EN ISO 16665:2014.[53]

In the laboratory, a stereomicroscope (magnification range: 7–230 times) was used to identify and quantify the abundance of each macroinvertebrate species or taxon.

For the determination of formalin wet weight (FWW) of invertebrates, laboratory analytical balances (Class I precision; accuracy ± 0.0001 g) were used. The shell lengths (L, mm) of large specimens of *Macoma balthica* and *Mytilus edulis trossulus* (*Mytilus trossulus*)[54] were measured using a digital calliper with a precision of 0.01 mm, while smaller specimens were measured under a microscope.

Taxonomic identification was carried out to the lowest possible taxonomic level. Nomenclature was aligned with the European Register of Marine Species (ERMS)[55] and the World Register of Marine Species (WoRMS)[56], ensuring taxonomic consistency with international data sources.

For each quantitative sample collected using a Van Veen grab, the abundance and biomass of individuals identified per species/taxon were recalculated per unit area (m²), resulting in species or taxon-specific density (ind. m^{-2}) and biomass (g m^{-2}) estimates. Samples collected using the dredging method were processed semi-quantitatively: all individuals were counted, taxonomic composition was determined, dominant species were identified, and their relative abundance and biomass were estimated. At all dredging locations, the dredging distance was recorded to approximate and compare the quantity of organisms collected across sites.

[53] LST EN ISO 16665:2014. (ISO 16665:2014). Water quality – Guidelines for quantitative sampling and sample processing of marine soft-bottom macrofauna.

[54] Knöbel, L., Nascimento-Schulze, J. C., Sanders, T., Zeus, D., Hiebenthal, C., Barboza, F. R., ... & Melzner, F. (2021). Salinity driven selection and local adaptation in Baltic Sea mytilid mussels. Frontiers in Marine Science, 8, 692078.

[55] http://www.marbef.org/data/erms.php

[56] http://www.marinespecies.org

5.4.2.2.2 Methods for assessing potential impacts

The EC guidance document[57] on wind energy development and EU nature protection legislation provides recommendations to ensure that wind energy projects comply with EU environmental requirements. While the document does not specify detailed zoobenthos impact assessment methods, it emphasizes that EIA must include comprehensive studies of marine habitats and species, including zoobenthos. This involves collecting baseline data on current seabed conditions and biodiversity using best available methodologies**.**

The potential loss of seabed habitats and negative impacts associated with the installation of WTGs, OSS, export cables and inter-array cables were assessed based on relevant national and EU-level legal acts and guidelines.

The assessment of impacts on seabed habitats is conducted in accordance with applicable legal acts, methodologies and evaluation criteria at both national and EU levels.

The criteria for determining significant adverse effects on marine seabed habitats of the EC importance within “Natura 2000” SACs are established in Section 3.2.4 of the "Description of Criteria for Significant Adverse Effects on Birds and Bats from Wind Farms, Prevention and Mitigation Measures and Research Requirements," approved by Order No. D1-406 of the Minister of Environment of the Republic of Lithuania on 12 December 2023[58].

According to the Order No. D1-317 of the Minister of Environment of the Republic of Lithuania of 19 April 2018 ‘On the Designation of Sites of Community Importance’ (consolidated version in force as of 7 June 2025), the total conservation objective area of the habitat ‘1170, Reefs’ is 5,233 ha, within which the favourable conservation status of the habitat must be maintained.

The assessment applied the threshold values for GES as established in Communication from the European Commission No. C/2024/2078 "Commission Notice on the threshold values set under the Marine Strategy Framework Directive 2008/56/EC and Commission Decision (EU) 2017/848 (C/2024/2078)"[59].

The GES threshold values are applied when evaluating two D6 marine habitat status criteria:

- **D6C4** – habitat loss (quantitative area reduction), threshold value: <2% of the habitat destroyed.
- **D6C5** – habitat disturbance (adverse effects on habitat structure and function), threshold value for disturbance: ≤25% (including 2% under D6C4)

According to this document, the assessment of impacts on seabed habitats includes:

- Analysis of changes in benthic community status.
- Risk evaluation of habitat structure and function impairment.
- Assessment of natural recovery potential.
- The evaluation incorporates both quantitative and qualitative zoobenthos indicators.

The assessment aims to determine whether planned OWF infrastructure installation activities could lead to significant deterioration of these criteria compared to the established GES threshold limits. An impact is considered significant when it compromises the integrity of a habitat – its structure, function or capacity for recovery.

5.4.2.3 Study area

The reef (1170) monitoring study area included circalittoral and infralittoral reef habitats. Seabed video surveys were conducted both within protected areas and beyond their boundaries. The surveys conducted in 2024 covered the planned OWF area, the export cable corridor as well as adjacent areas beyond their boundaries (Fig. 5.4.6).

The study ensured sufficient spatial distribution of sampling stations to assess Macrozoobenthos community structure across:

- The OWF development area.
- Planned export cable corridor area.
- Reference sites outside the direct impact zone.

[57] European Commission, Directorate-General for Environment, Guidance document on wind energy development and EU nature protection legislation, Publications Office of the European Union, 2021, https://data.europa.eu/doi/10.2779/491

[58] https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/868f2ee2992e11eea70ce7cabd08f150/asr

[59] http://data.europa.eu/eli/C/2024/2078/oj

The collected data will enable future:

- Impact magnitude evaluation (pre- vs post-construction comparison).
- Structural analysis of community changes.
- Cumulative effect assessment across habitat types.

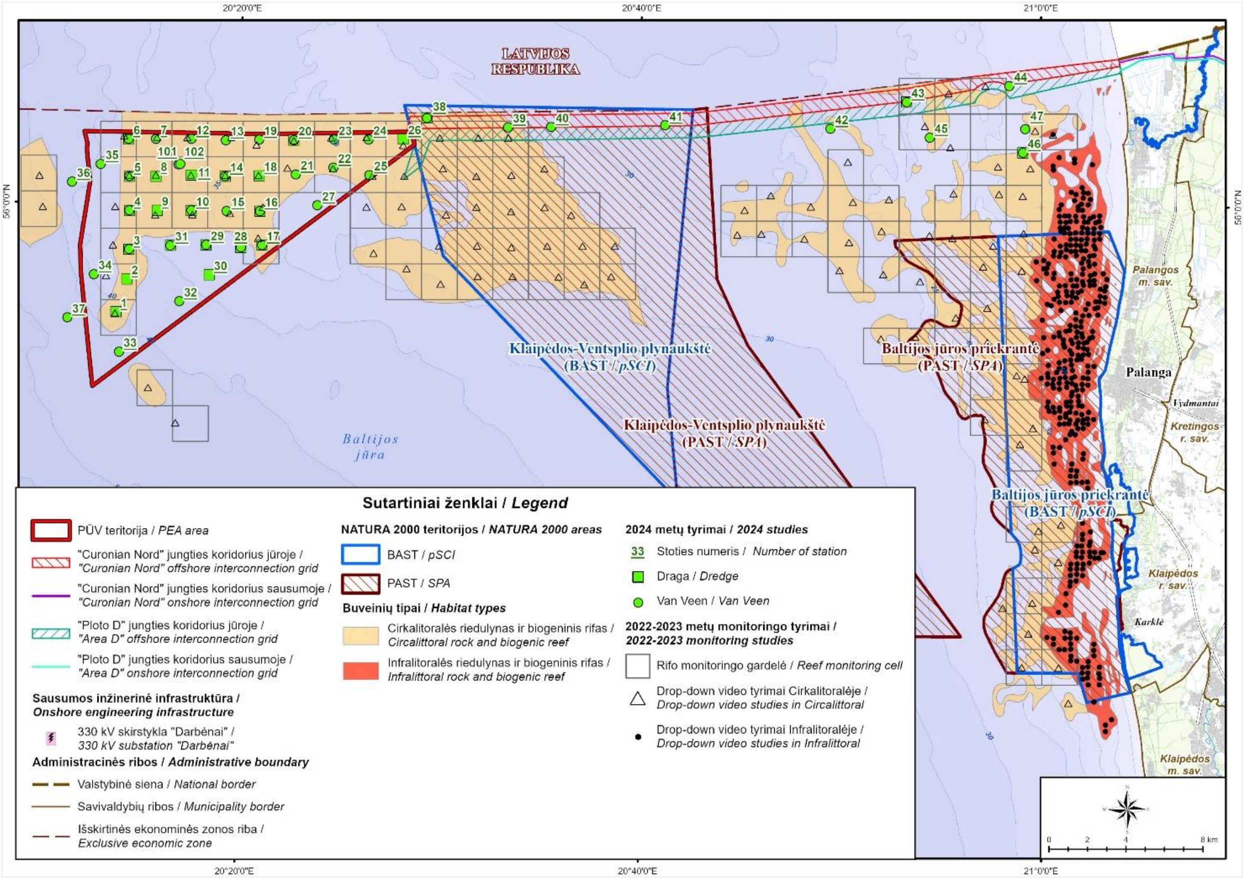


Fig. 5.4.6. Study area.

5.4.2.4 *Current situation*

5.4.2.4.1 Seabed habitats

According to the results of inventories conducted under "Renewal of the Lithuanian Baltic Sea Environmental Management Strengthening Documents (condition assessment)" in 2020[60], based on the recommendations of Evans et al.[61] and Condé et al.[62], the Lithuanian marine waters are classified into infralittoral, circalittoral and offshore (deep circalittoral) zones:

- Infralittoral zone – this is the euphotic zone where the amount of light reaching the seabed is sufficient for the formation of perennial macroalgae communities (e.g., the red alga *Furcellaria lumbricalis*). In the case of Lithuania, this refers to the nearshore area up to the depth of 15 meters.
- Circalittoral zone is the zone located deeper than the infralittoral, where the amount of light is no longer sufficient for the formation of macroalgal communities. Instead, the communities are formed by benthic invertebrates (e.g., bivalves *Mytilus edulis trossulus* or *Macoma balthica*). The circalittoral zone covers the area between the 15- and 70-meter isobaths.

[60] Environmental Protection Agency. (2020). Updating of the documents for strengthening the environmental protection management of the Lithuanian Baltic Sea (status assessment). Assessment of the ecological status and environmental protection objectives of the Lithuanian sea area. Final report. 2020-08-17. https://vanduo.old.gamta.lt/files/Galutine%20ataskaita%20(1%20dalis)1603107974586.pdf

[61] Evans, D., Aish, A., Boon, A., Condé, S., Connor, D., Gelabert, E. Michez, N., Parry, M., Richard, D., Salvati, E. & Tunesi, L. (2016). Revising the marine section of the EUNIS Habitat classification - Report of a workshop held at the European Topic Centre on Biological Diversity, 12 & 13 May 2016. *ETC/BD report to the EEA.*

[62] Condé, S., Royo Gelabert, E., Parry, M., Lillis, H., Evans, D., Mo, G., & Agnesi, S. (2018). Updated crosswalks between European marine habitat typologies-A contribution to the MAES marine assessment. *ETC/BD report for the EEA*.

- Deep circalittoral zone – an aphotic, open sea area deeper than 70 meters, where a halocline forms, oxygen deficiency phenomena are observed, and the physical, chemical, and biological characteristics of the seabed are influenced by inflows of North Atlantic water.

In total, the seabed habitats of Lithuanian marine waters are classified into 13 dominant or broad habitat types[63], corresponding to Level 2 of the European Nature Information System (hereinafter – EUNIS)[64] classification developed by the European Environment Agency (EEA). These habitat types largely have equivalents in the HELCOM HUB[65] classification at Level 3.

Habitat types are classified according to bottom sediments using the following principles:

- Boulder habitats are assigned to hard substrate seafloor dominated by >25 cm boulders.
- Coarse sediment habitats comprise sediments containing fractions from sand to boulders but dominated by pebbles and cobbles.
- Mixed sediment habitats include deposits containing all grain-size fractions, typically representing glacial till with clay, sand, pebble, and cobble fractions.
- Sand habitats encompass sediments predominantly composed of various sand fractions.
- Mud habitats are designated for sediments dominated by finest fractions: silt, mud, and clay.

The installation of the OWF and export cables will impact the following six dominant habitat types: circalittoral rock and biogenic reef, circalittoral coarse sediments, circalittoral sand, Infralittoral mud, Infralittoral sand, Infralittoral rock and biogenic reef.

Annex I of the Council Directive 92/43/EEC[66] (Habitats Directive) identifies reef habitats (1170) as the most vulnerable habitat type of Community importance for marine wind energy development.

In Lithuanian marine waters, approximately 194.13 km² (46.13%) of circalittoral reef habitats (1170) are located within three "Natura 2000" sites:

- the Baltijos Jūros Priekrantė (LTPAL0001) covering 7.1%.
- the Klaipėda-Ventspils Plateau (LTPAL0002) – 15.7%,
- the Sambian Plateau (LTNER0006) – 23.3%.[67]

The distribution of major large MSFD habitat types in the OWF area is presented in figure 5.4.7

[63] Environmental Protection Agency. (2020). Updating of the documents for strengthening the environmental protection management of the Lithuanian Baltic Sea (status assessment). Assessment of the ecological status and environmental protection objectives of the Lithuanian sea area. Final report. 2020-08-17. https://vanduo.old.gamta.lt/files/Galutine%20ataskaita%20(1%20dalis)1603107974586.pdf

[64] https://www.eea.europa.eu/data-and-maps/data/eunis-habitat-classification-1/folder_contents

[65] HELCOM, H. (2013). Technical Report on the HELCOM Underwater Biotope and habitat classification. In *Balt. Sea Environ. Proc* (Vol. 139, pp. 1075-1084).

[66] https://eur-lex.europa.eu/legal-content/LT/TXT/?uri=CELEX:31992L0043

[67] https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/636b6e40297b11e6a222b0cd86c2adfc

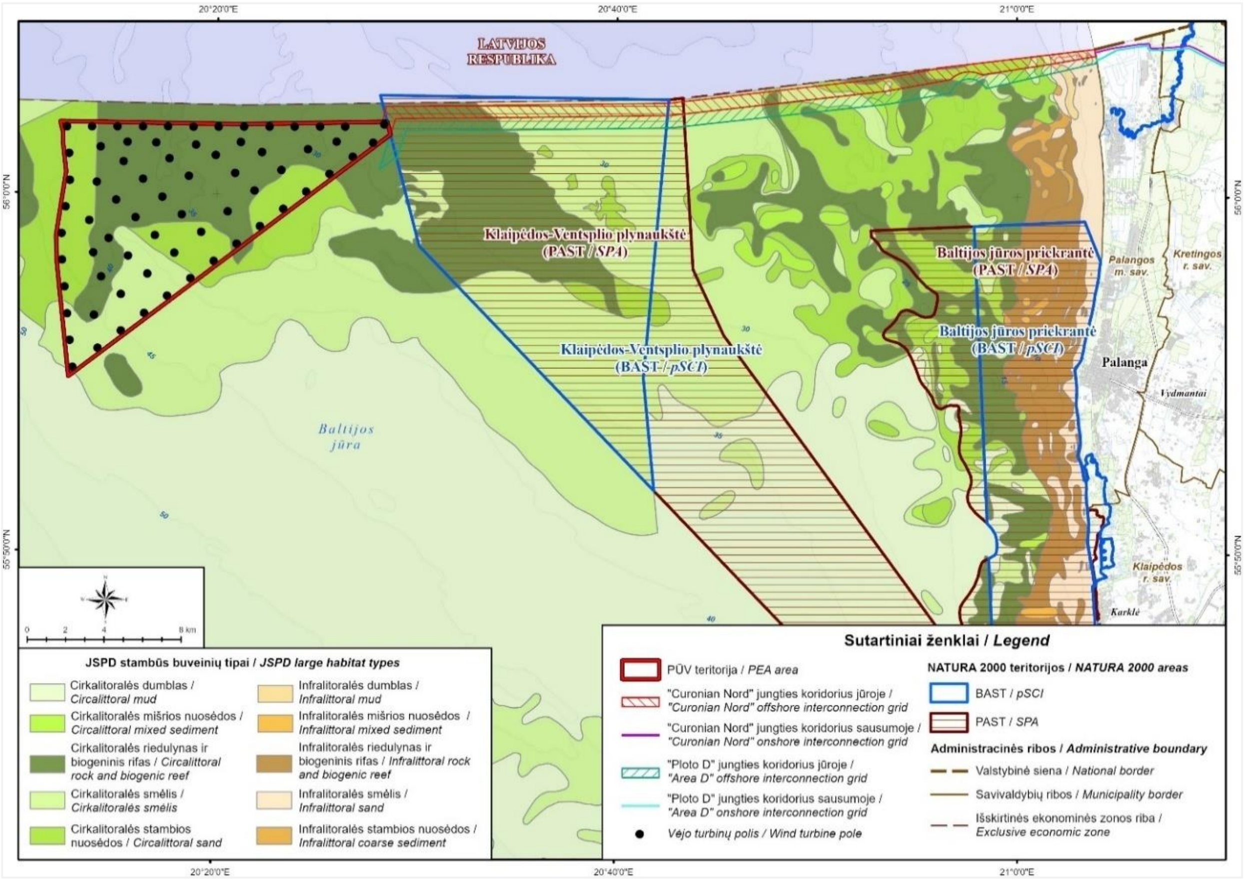


Fig. 5.4.7. Distribution of the main MSFD habitat types in Lithuanian marine waters (according to "Renewal of the Lithuanian Baltic Sea Environmental Management Strengthening Documents (condition assessment)"[68] and the preliminary locations of WTGs in an OWF.

5.4.2.4.2 Results of 2022–2023 monitoring for circalittoral reef habitats (1170)

Lithuania's circalittoral reef habitats (Annex I Code 1170) comprise three principal clusters: Sambian Plateau (southern EEZ), Klaipėda-Ventspils Plateau (northern EEZ), and eastern coastal transition zones below infralittoral depths.

Reef monitoring was conducted for the first time. Monitoring programme achieving 84.9% spatial coverage (357.4 km²) via standardised video transects (1 nautical miles grid resolution), excluding marginal areas.

The substrate type coverage percentages were determined as follows: boulders (Fig. 5.4.9), cobbles (Fig. 5.4.10), pebbles (Fig. 5.4.11), sand (Fig. 5.4.12), and till (Fig. 5.4.13), where reef habitat is expressed as the combined coverage of stable substrates (boulders and cobbles) (Fig. 5.4.8)[69].

[68] Environmental Protection Agency. (2020). Updating of the documents for strengthening the environmental protection management of the Lithuanian Baltic Sea (status assessment). Assessment of the ecological status and environmental protection objectives of the Lithuanian sea area. Final report. 2020-08-17.

[69] Environmental Protection Agency. (2023). Survey of marine reef (1170) habitats in the Baltic Sea and macrophytes in the Baltic Sea and the Curonian Lagoon belonging to the "Natura 2000" network in 2021 [contract No. 28t-2021-17/sut-21p-5, final report, 2023-01-31].

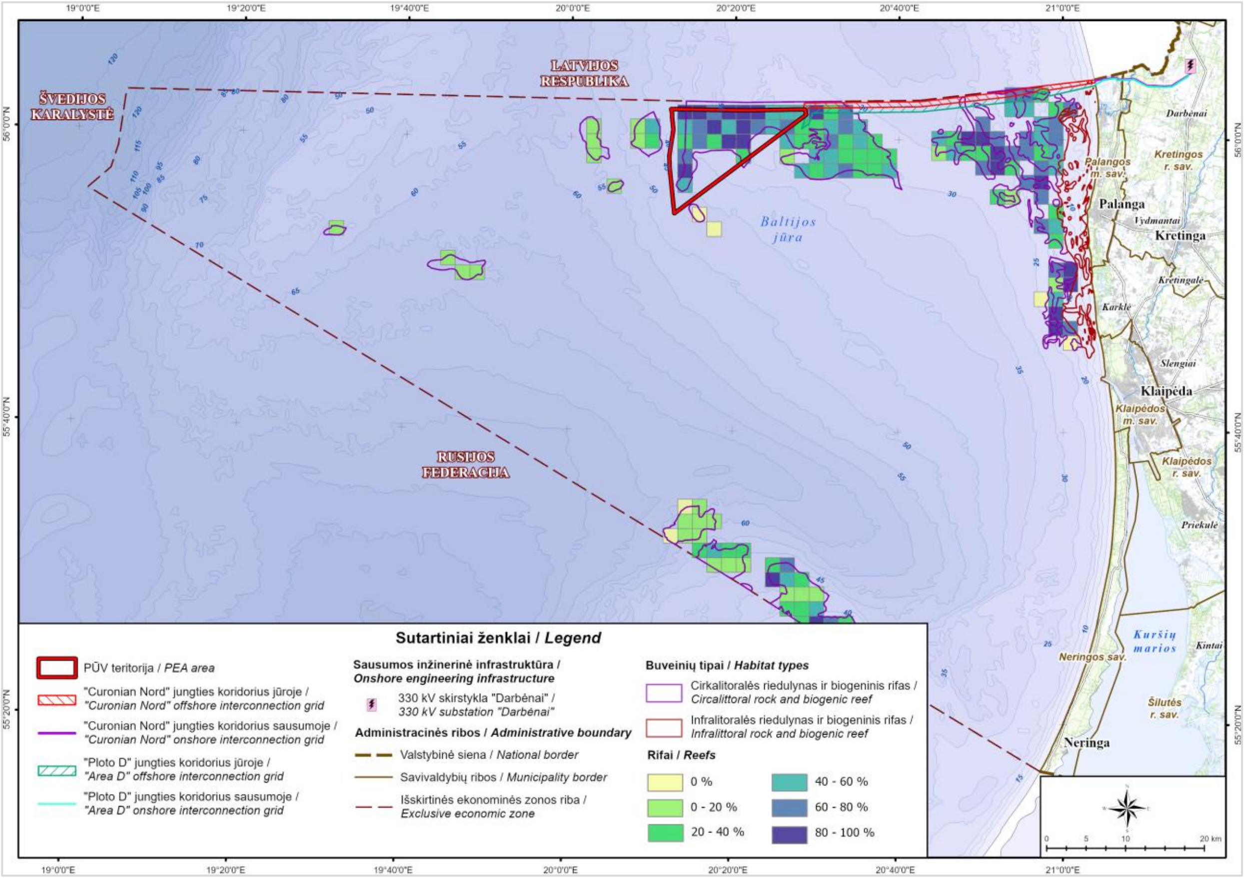


Fig. 5.4.8. Circalittoral reef habitat expressed as the combined coverage (%) of stable substrates percentage (boulders [>256 mm] and cobbles [64–256 mm]).

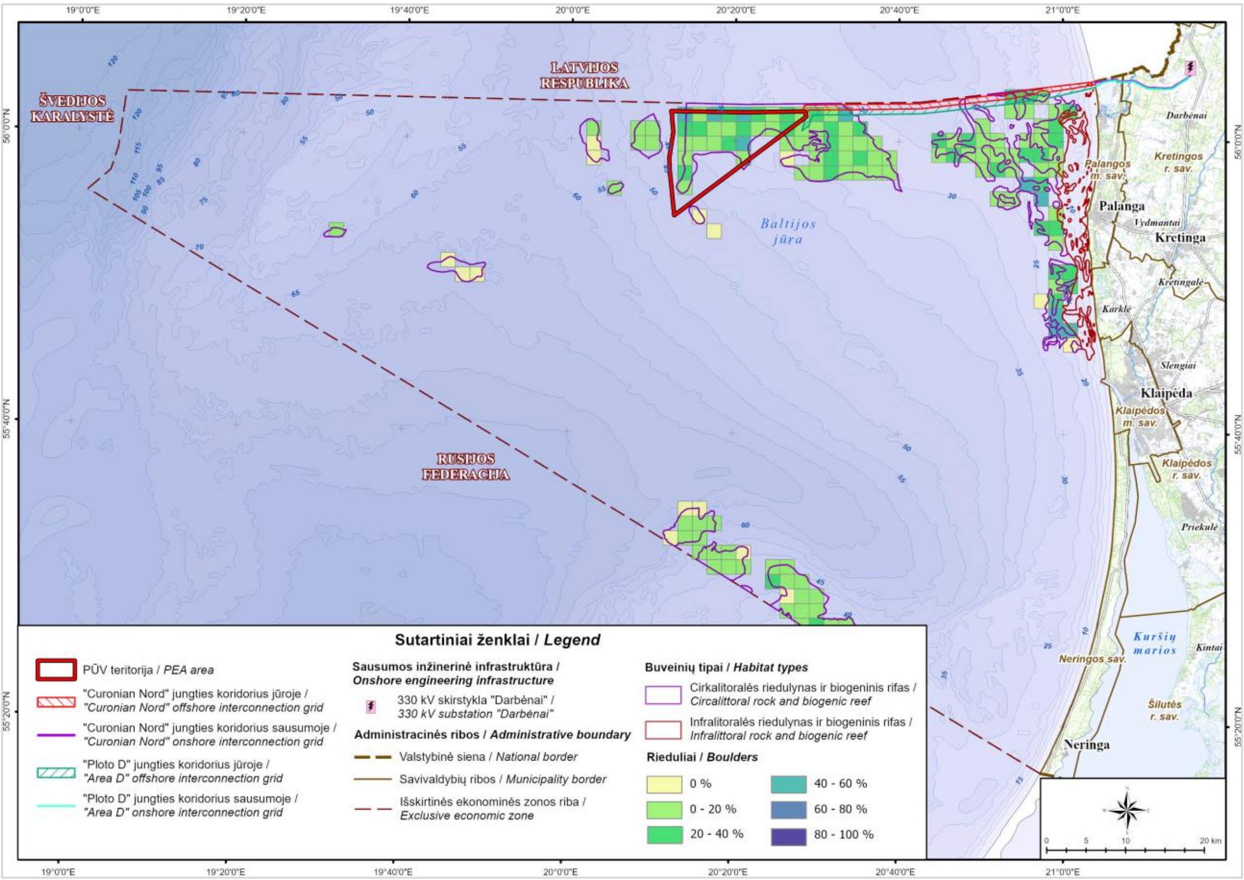


Fig. 5.4.9. Proportional coverage (%) of boulder-size fractions (>25 cm) in the circalittoral reef substrates.

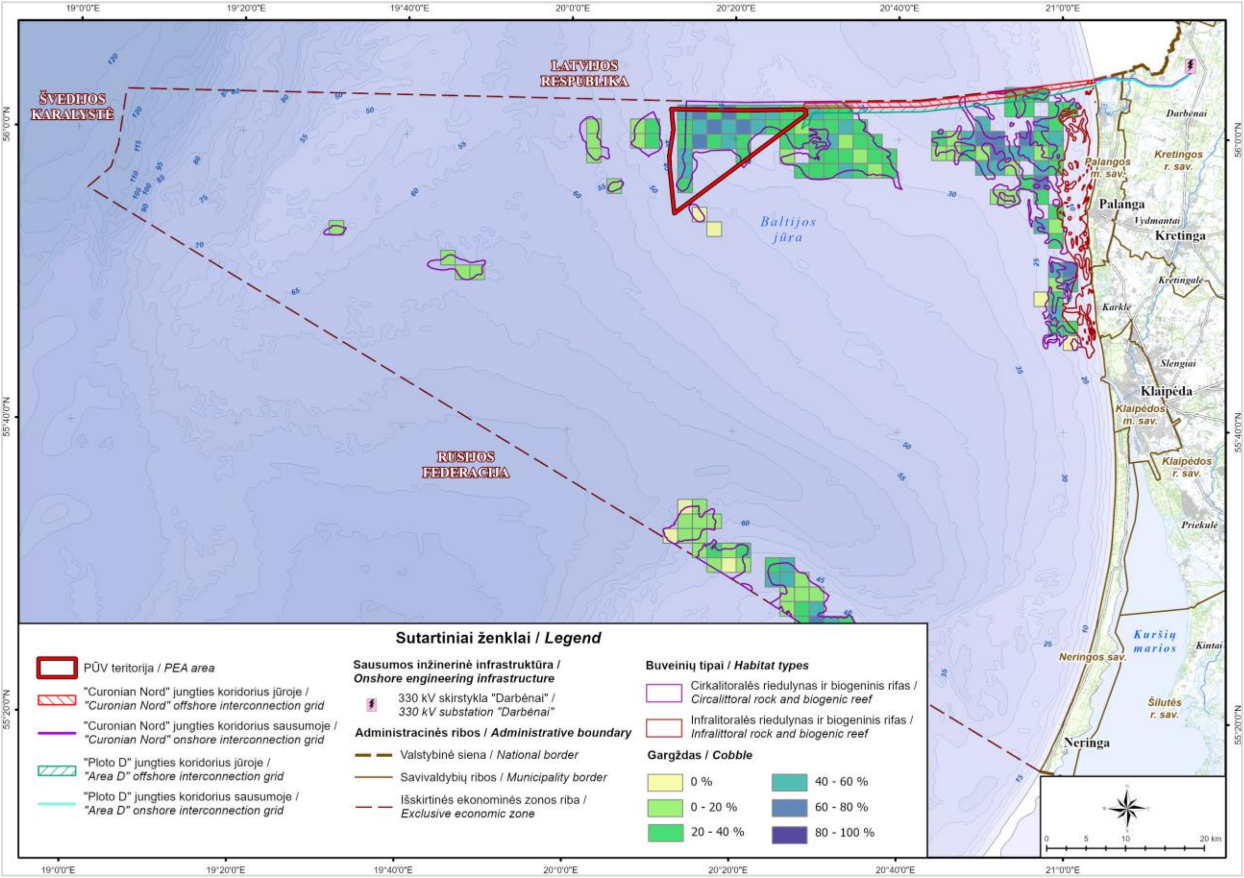


Fig. 5.4.10. Proportional coverage (%) of cobble-size fractions (6.4–25 cm) in the circalittoral reef substrates.

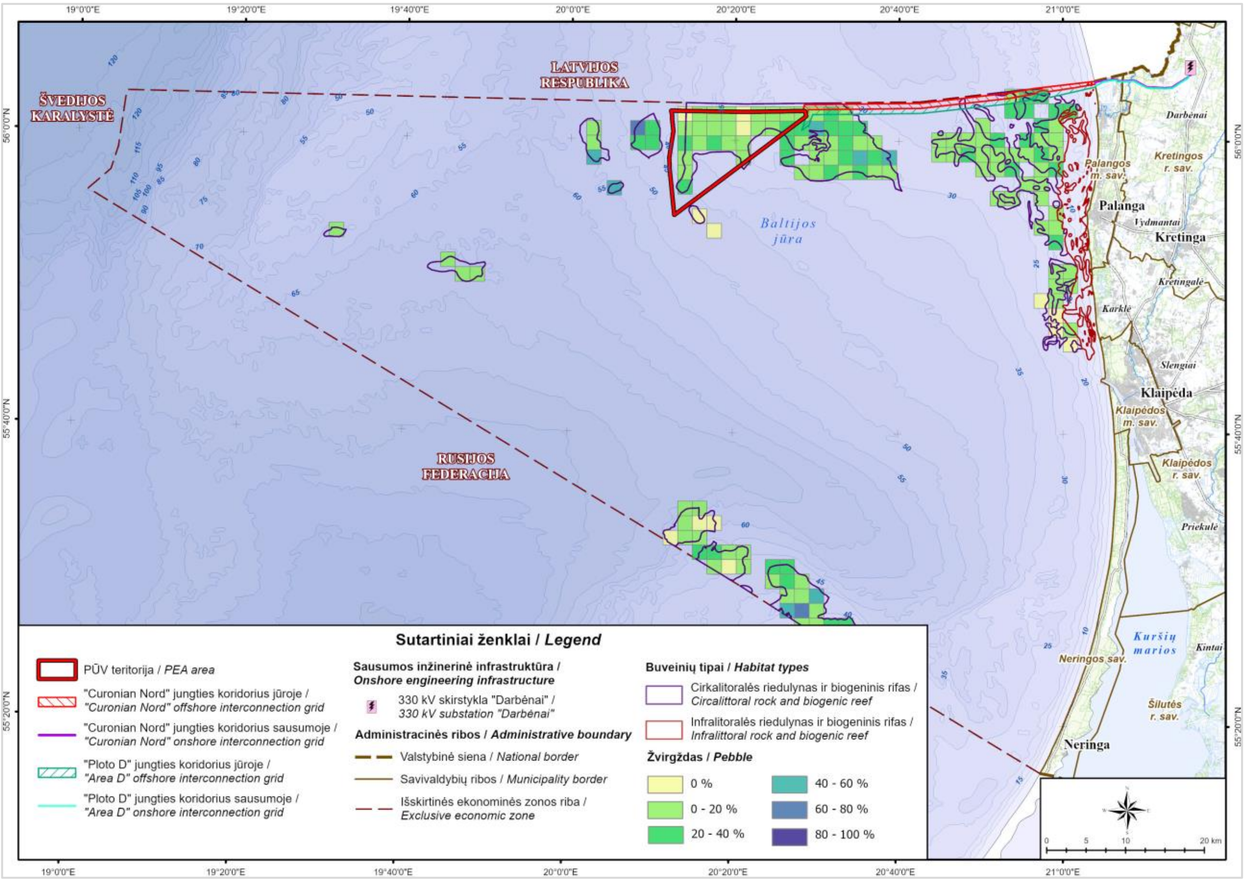


Fig. 5.4.11. Proportional coverage (%) of pebble-size fractions (4–64 mm) in the circalittoral reef substrates.

Circalittoral reef habitats are dominated by hard, stable substrates composed of boulders (>25 cm) and cobbles (6.4–25 cm). However, compared to infralittoral reefs, these habitats contain significantly higher proportions of sand fractions, which may become predominant along reef margins (Fig. 5.4.12).

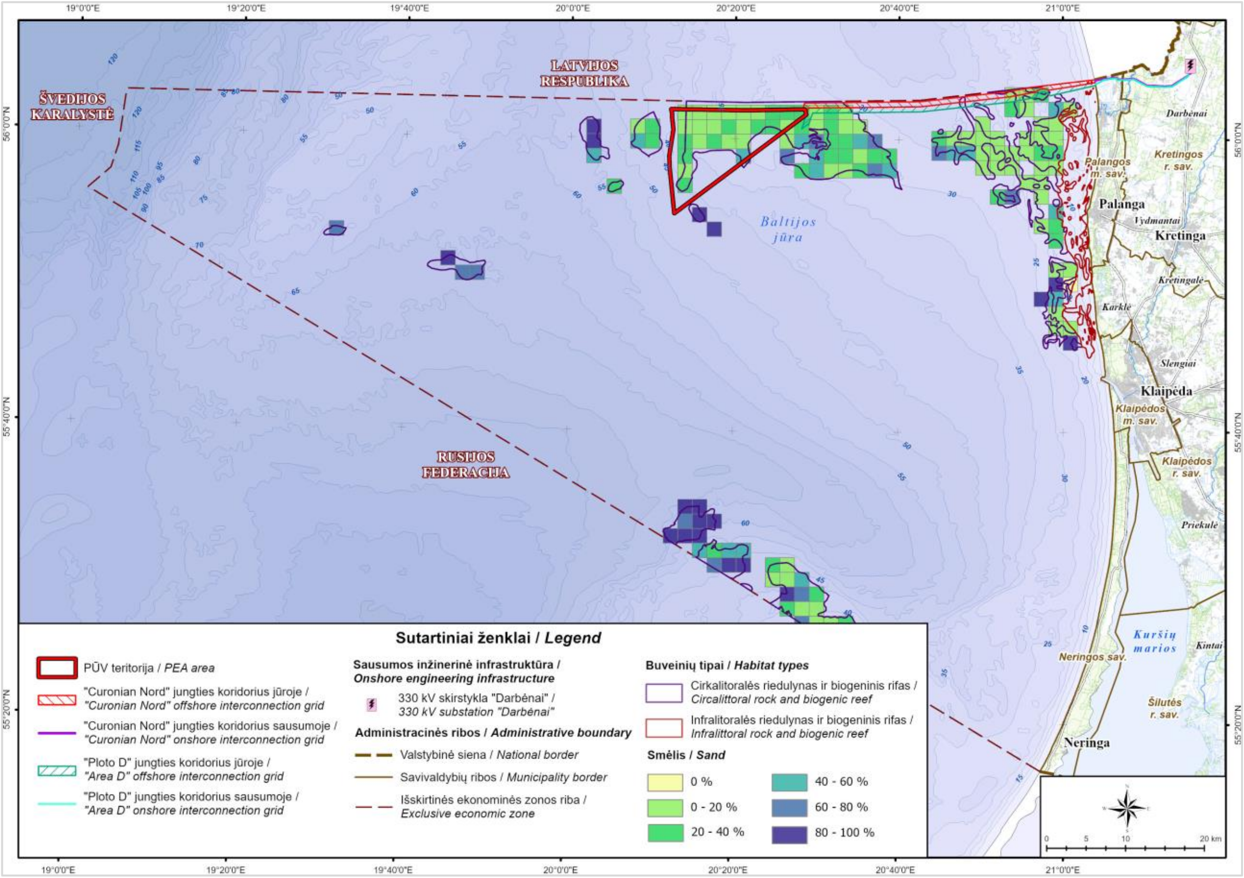


Fig. 5.4.12. Proportional coverage (%) of sand fractions (0.063-4 mm) in the circalittoral reef substrates.

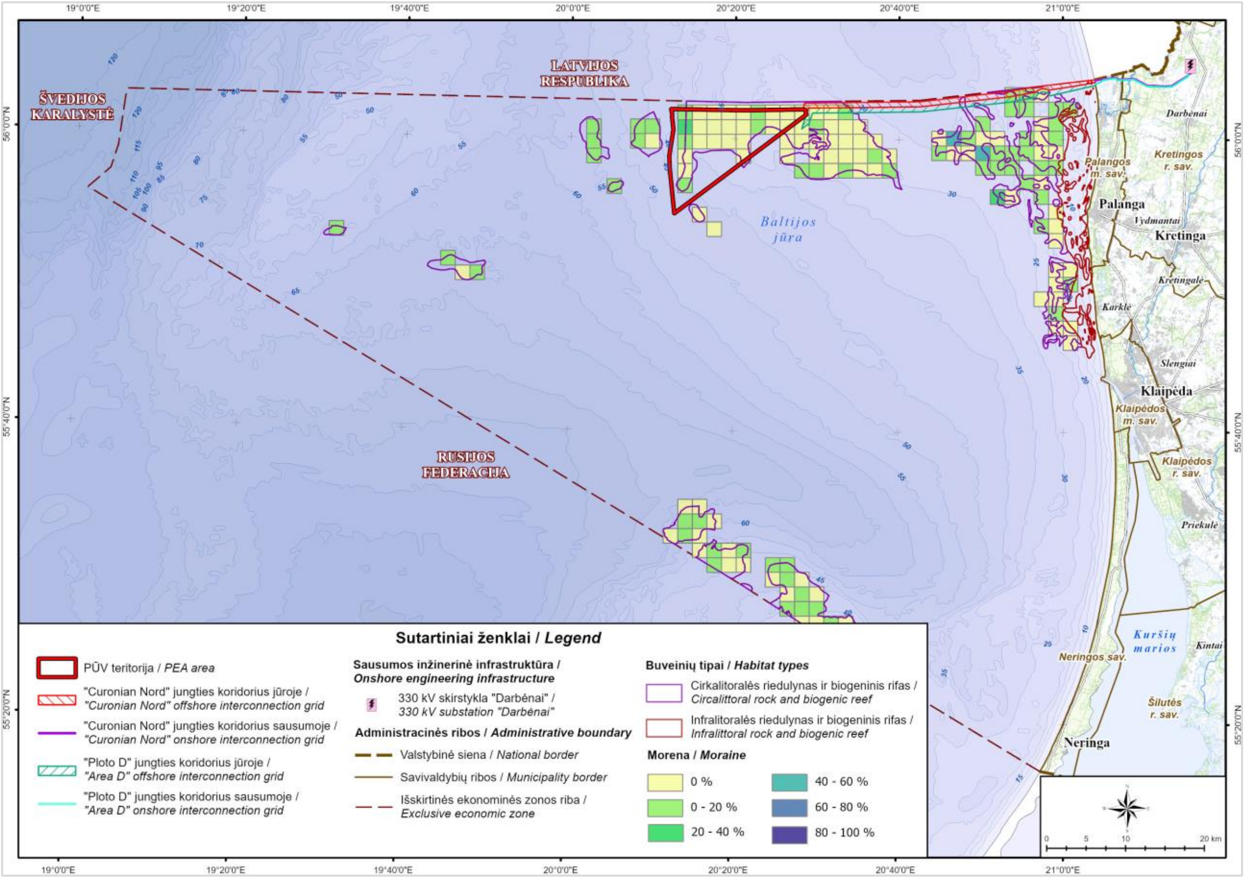


Fig. 5.4.13: Proportional coverage (%) of moraine (glacial till) substrates in the circalittoral reef habitats.

In the western Lithuanian marine area (Klaipėda Bank region), lithological data identify isolated reef formations with limited hard substrate coverage (<20%), predominantly composed of cobbles (64–256 mm). The remaining area is sand dominated. Similar conditions are recorded in the western and southwestern sectors of the Klaipėda-Ventspils Plateau.

Substrate composition directly governs epifaunal community development – higher proportions of reef-characteristic substrates (boulders >25 cm and cobbles 64–256 mm) correlate with increased epifaunal abundance, particularly of *Mytilus edulis trossulus*. Mussel dominance was quantified by percent cover, reaching up to 70% of total seabed coverage in some areas, with peak values recorded in eastern and northern circalittoral zones (Fig. 5.4.14).

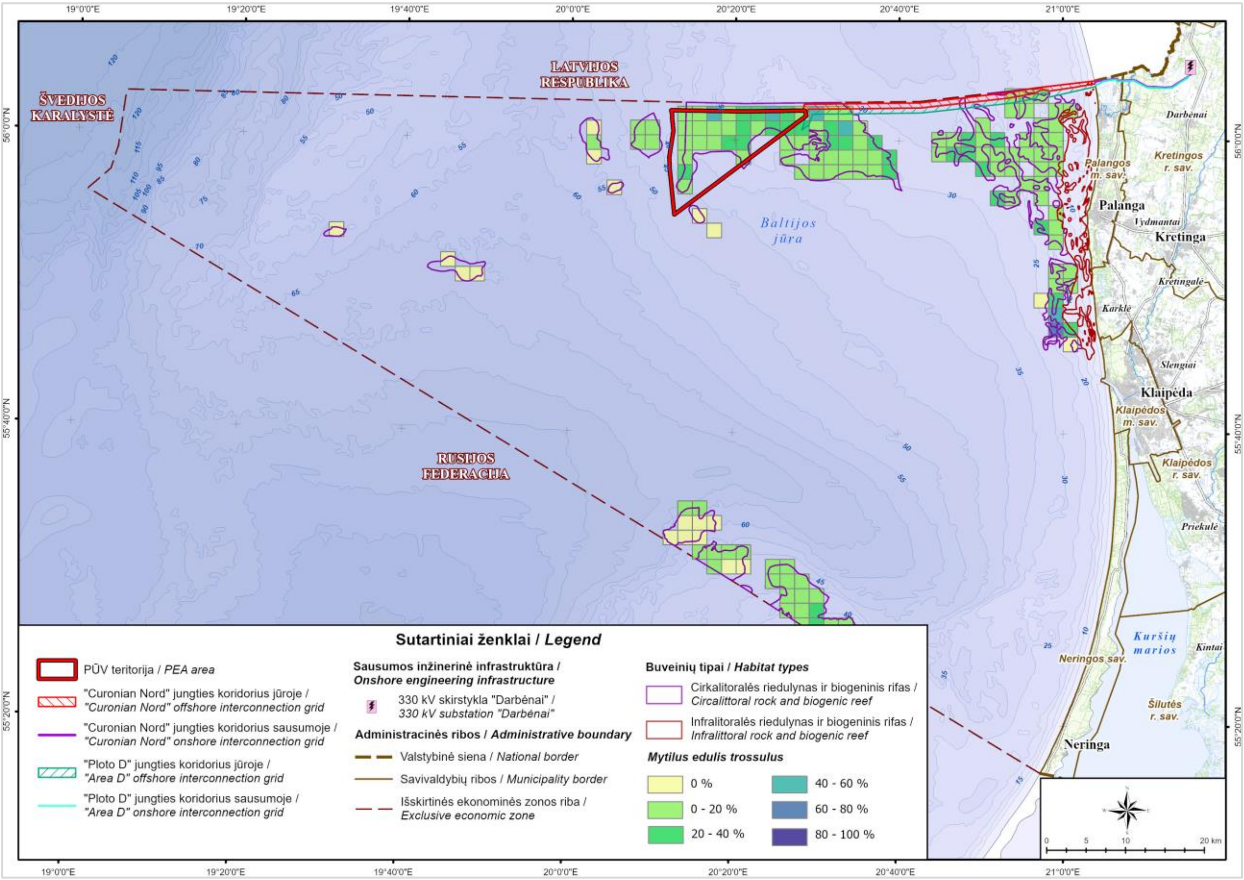


Fig. 5.4.14: Percentage cover of *Mytilus edulis trossulus* in the circalittoral reef habitats.

Standardising mussel coverage by suitable substrate availability reveals:

- Klaipėda-Ventspils Plateau has the highest mean coverage (30±22%).
- Eastern reef complex shows slightly lower values (27±20%).
- Sambian Plateau maintains minimal colonization (17±16%).
- Western deeper part lacks mussels entirely (0%).

Synthesis of 2021–2022 and 2022–2023 monitoring data reveals that detection/non-detection changes in reef-defining characteristics (both for reef habitats collectively and for boulder substrates specifically) did not exceed 1%. These results indicate that habitat status meets GES requirements under MSFD Descriptor 6C4 (seafloor integrity)[70].

5.4.2.4.3 Results of zoobenthos surveys in the PEA, 2024

The 2024 surveys identified 37 invertebrate species or higher taxonomic units, representing eight phyla: *Cnidaria, Cephalorhyncha, Nemertea, Platyhelminthes, Annelida, Arthropoda, Mollusca* and *Bryozoa*. Thirteen species or taxon showed an overall occurrence frequency exceeding 40% across the entire study area.

Throughout the study area, colonial invertebrates were consistently observed, including the hydrozoan *Gonothyraea loveni* and the bryozoan *Einhornia crustulenta*. For all identified species or taxon, qualitative indicators (species composition and occurrence frequency %) were determined from samples collected with Van Veen grabs and dredges, while quantitative parameters (individual abundance in ind. m⁻² and biomass in g m⁻²) were derived exclusively from Van Veen grab samples. The summarized research results are presented in Table 5.4.9.

[70] Environmental Protection Agency. (2023). Survey of marine reef (1170) habitats in the Baltic Sea and macrophytes in the Baltic Sea and the Curonian Lagoon belonging to the "Natura 2000" network in 2021 [contract No. 28t-2021-17/sut-21p-5, final report, 2023-01-31]

Table 5.4.9. Taxon/species list, mean frequency of occurrence % (mean ± SE), density and wet weight (mean ± SD) in 2024

Phylum	Taxon	Taxon/Species	OWF area (depth 28–46 m)			Outside the OWF					
						Western part (stations 36, 37; depth 42–45 m)			Export cables area (depth 15–34 m)		
			Frequency of occurrence ± SE, %	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}	Frequency of occurrence ± SE, %	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}	Frequency of occurrence ± SE, %	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}
Cnidaria	*Hydrozoa*	*Gonothyraea loveni* [3]	40.7 ± 6.4	-	-	50 ± 25	-	-	50 ± 11.2	-	-
		Cordylophora caspia [3]	1.7 ± 1.7	-	-	-	-	-	-	-	-
Cephalorhyncha	*Priapulida*	*Halicryptus spinulosus*	22 ± 5.4	107 ± 110	0.85 ± 0.98	50 ± 25	50 ± 20	0.25 ± 0.23	10 ± 6.7	18 ± 2	0.01 ± 0.01
Nemertea	*Nemertea*	*Nemertea gen. sp.*	35.6 ± 6.2	353 ± 398	0.05 ± 0.06	25 ± 21.7	270 ± 0	0.04 ± 0	35 ± 10.7	543 ± 334	0.06 ± 0.05
Platyhelminthes	*Tricladida*	*Planaria torva*	-	-	-	-	-	-	10 ± 6.7	10 ± 0	0.14 ± 0.003
Annelida	*Polychaeta*	*Bylgides sarsi* [4]	35.6 ± 6.2	39 ± 24	0.2 ± 0.22	75 ± 21.7	49 ± 16	0.3 ± 0.25	10 ± 6.7	10 ± 0	0.45 ± 0
		Hediste diversicolor	32.2 ± 6.1	55 ± 61	0.16 ± 0.16	-	-	-	60 ± 11	63 ± 55	0.49 ± 1.08
		Fabricia stellaris	3.4 ± 2.4	157 ± 97	0.02 ± 0.01	-	-	-	25 ± 9.7	253 ± 181	0.03 ± 0.02
		Marenzelleria spp.	64.4 ± 6.2	113 ± 103	1.55 ± 2.4	75 ± 21.7	403 ± 40	1.98 ± 1.51	55 ± 11.1	130 ± 138	1.53 ± 1.52
		Pygospio elegans	47.5 ± 6.5	100 ± 67	0.04 ± 0.03	75 ± 21.7	278 ± 65	0.11 ± 0.03	55 ± 11.1	92 ± 112	0.03 ± 0.04
		Boccardia proboscidea[6]	-	-	-	-	-	-	35 ± 10.7	136 ± 182	0.02 ± 0.29
	Oligochaeta	*Oligochaeta gen. spp.*	66.1 ± 6.2	517 ± 718	0.39 ± 0.65	75 ± 21.7	136 ± 150	0.07 ± 0.08	65 ± 10.7	243 ± 199	0.14 ± 0.1
	Hirudinea	*Piscicola geometra*[5]	10.2 ± 3.9	-	-	-	-	-	-	-	-

Phylum	Taxon	Taxon/Species	OWF area (depth 28–46 m)			Outside the OWF: Western part (stations 36, 37; depth 42–45 m)			Outside the OWF: Export cables area (depth 15–34 m)		
			Frequency of occurrence ± SE, %	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}	Frequency of occurrence ± SE, %	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}	Frequency of occurrence ± SE, %	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}
Arthropoda	*Crustacea*	*Ostracoda gen. spp.*[1]	8.5 ± 3.6	390 ± 240	0.06 ± 0.04	25 ± 21.7	30 ± 0	0.01 ± 0	-	-	-
	Mysida	*Praunus inermis* [2]	11.9 ± 4.2	-	-	-	-	-	-	-	-
		Neomysis integer [2]	28.8 ± 5.9	10 ± 0	0.13 ± 0	-	-	-	15 ± 8	190 ± 180	2.2 ± 2.02
	Isopoda	*Jaera (Jaera) albifrons*	39 ± 6.3	40 ± 35	0.06 ± 0.04	-	-	-	20 ± 8.9	15 ± 5	0.3 ± 0.01
		Saduria entomon	6.8 ± 3.3	20 ± 0	9.26 ± 0	50 ± 25	10 ± 0	0.51 ± 0.4	5 ± 4.9	16 ± 0	1.27 ± 0
	Cirripedia	*Amphibalanus improvisus*	35.6± 6 .2	81 ± 109	2.28 ± 5.24	-	-	-	55 ± 11.1	1143 ± 1,283	26.03 ± 31.72
	Amphipoda	*Corophium volutator*	10.2 ± 3.9	16 ± 0	0.06 ± 0	-	-	-	40 ± 11	170 ± 283	0.53 ± 1.03
		Leptocheirus pilosus	1.7 ± 1.7	-	-	-	-	-	25 ± 9.7	169 ± 194	0.12 ± 0.14
		Gammarus sp. (juvenile)	1.7 ± 1.7	25 ± 13	0.02 ± 0.01	-	-	-	40 ± 11	60 ± 57	0.38 ± 0.6
		Gammarus oceanicus	8.5 ± 3.6	-	-	-	-	-	-	-	-
		Gammarus salinus	57.6 ± 6.4	53 ± 43	1.11 ± 0	-	-	-	15 ± 8	32 ± 0	0.15 ± 0
		Monoporeia affinis	3.4 ± 2.4	-	-	-	-	-	-	-	-
		Pontoporeia femorata	5.1 ± 2.9	180 ± 148	0.37 ± 0.29	25 ± 21.7	10 ± 0	0.12 ± 0	-	-	-
		Bathyporeia pilosa	-	-	-	-	-	-	5 ± 4.9	30 ± 0	0.04 ± 0

Phylum	Taxon	Taxon/Species	OWF area (depth 28–46 m)			Outside the OWF: Western part (stations 36, 37; depth 42–45 m)			Outside the OWF: Export cables area (depth 15–34 m)		
			Frequency of occurrence ± SE, %	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}	Frequency of occurrence ± SE, %	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}	Frequency of occurrence ± SE, %	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}
	Cumacea	*Diastylis rathkei*	24.5 ± 5.7	15 ± 5	0.12 ± 0.05	75 ± 21.7	117 ± 130	0.25 ± 0.23	-	-	-
	Decapoda	*Crangon crangon*	30.5 ± 6.0	16 ± 0	1.73 ± 0	-	-	-	10 ± 6.7	100 ± 0	19.17 ± 0
		Palaemon elegans	-	-	-	-	-	-	5 ± 4.9	10 ± 0	0.42 ± 0
	Chelicerata	*Halacaridae gen. sp.*[2]	10.2 ± 3.9	20 ± 11	0.002 ± 0.001	-	-	-	5 ± 4.9	63 ± 0	0.01 ± 0
Mollusca	*Bivalvia*	*Macoma balthica*	52.5 ± 6.5	176 ± 64	48.5 ± 64.62	50 ± 25	295 ± 45	121.86 ± 26.21	50 ± 11.2	137 ± 170	43.57 ± 54.53
		Mya arenaria	1.7 ± 1.7	-	-	-	-	-	10 ± 6.7	20 ± 0	0.42 ± 0.38
		Mytilus edulis trossulus	91.5 ± 3.6	2364 ± 3006	134.67 ± 182.77	100 ± 0	248 ± 361	14.85 ± 20.46	70 ± 10.2	1350 ± 1611	58.07 ± 72.35
	Gastropoda	*Peringia ulvae*	8.5 ± 3.6	17 ± 5	0.04 ± 0.01	-	-	-	50 ± 11.2	43 ± 65	0.08 ± 0.12
		Theodoxus fluviatilis	3.4 ± 2.4	16 ± 0	0.02 ± 0	-	-	-	-	-	-
Bryozoa	*Bryozoa*	*Einhornia crustulenta* [3]	71.2 ± 5.9	-	-	100 ± 0	-	-	80 ± 8.9	-	-

Notes: 1 – nectobethic species; 2 – meiobenthos species (<1 mm); 3 – colony, fouling; 4 – semi pelagic; 5 – an ectoparasite; 6 – new species (unpublished by Solovjova)

Zoobenthic communities are associated with the seabed habitats. The main dominant species forming the zoobenthos communities in the OWF development zone is *Mytilus edulis trossulus*. In several circalittoral habitats, *Macoma balthica* and *Mytilus edulis trossulus* were also found coexisting in areas where the particle size of sandy gravel substrate is favourable for formation of *Mytilus edulis trossulus* clumps, where molluscs attach to each other using byssal threads, and for burrowing of *Macoma balthica*. Both species are characterized by long lifespan, which contributes significantly to habitat stability.

Macoma balthica has an average lifespan of about 3–6 years, with a maximum of 10–14 years[71]. In the study area, the maximum recorded size of *Macoma balthica* individuals reached 20 mm, while *Mytilus edulis trossulus* **–** 37 mm.

In the low-salinity conditions of the Baltic Sea, *Mytilus edulis trossulus* exhibits slower growth compared to the Atlantic Ocean, with an average lifespan of about 3–6 years and a maximum of around 10 years[72].

The size ratio of live organisms' shells among different size groups of *Mytilus edulis trossulus* – is larger than 10 mm (likely individuals older than 2 years) and smaller than 10 mm (approximately 1–2 years old) – presented in Fig. 5.4.15.

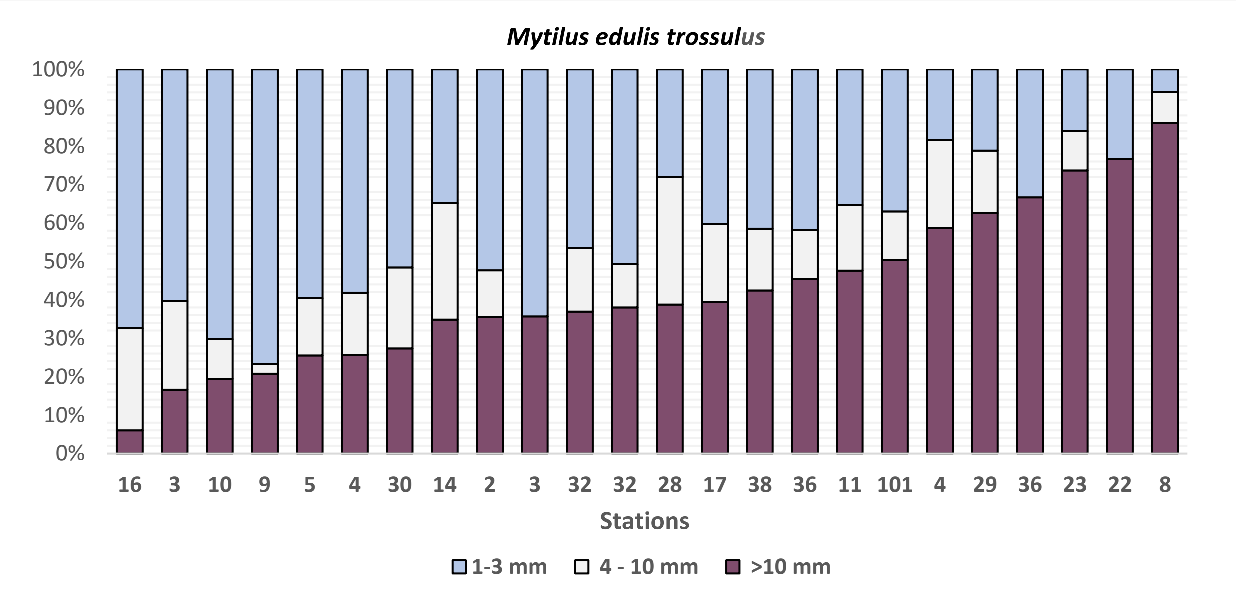


Fig. 5.4.15. Ratio of *Mytilus edulis trossulus* cohorts.

These species have high fecundity and planktotrophic larval development. This facilitates efficient dispersal at local and regional scales.

The *Macoma balthica* community predominates in areas with variably sorted sandy sediments at depths of 15–34 m, while *Mytilus edulis trossulus* dominates in coarser-grained substrates. Key findings presented in figures:

- Fig. 5.4.16: Total number of species/taxa in the *Macoma balthica* and *Mytilus edulis trossulus* communities.
- Fig. 5.4.17: Mean total density of benthic fauna species/taxon.
- Fig. 5.4.18: Total biomass of all species/taxon.

[71] Gusev, A. A., & Jurgens-Markina, E. M. (2012). Growth and production of the bivalve Macoma balthica (Linnaeus, 1758) (Cardiida: Tellinidae) in the southeastern part of the Baltic Sea. *Russian Journal of Marine Biology*, *38*, 56-63.

[72] Kautsky, N. (1981). On the trophic role of the blue mussel Mytilus edulis in a Baltic coastal ecosystem and the fate of organic matter. Marine Ecology Progress Series, 5, 249–256. https://doi.org/10.3354/meps005249

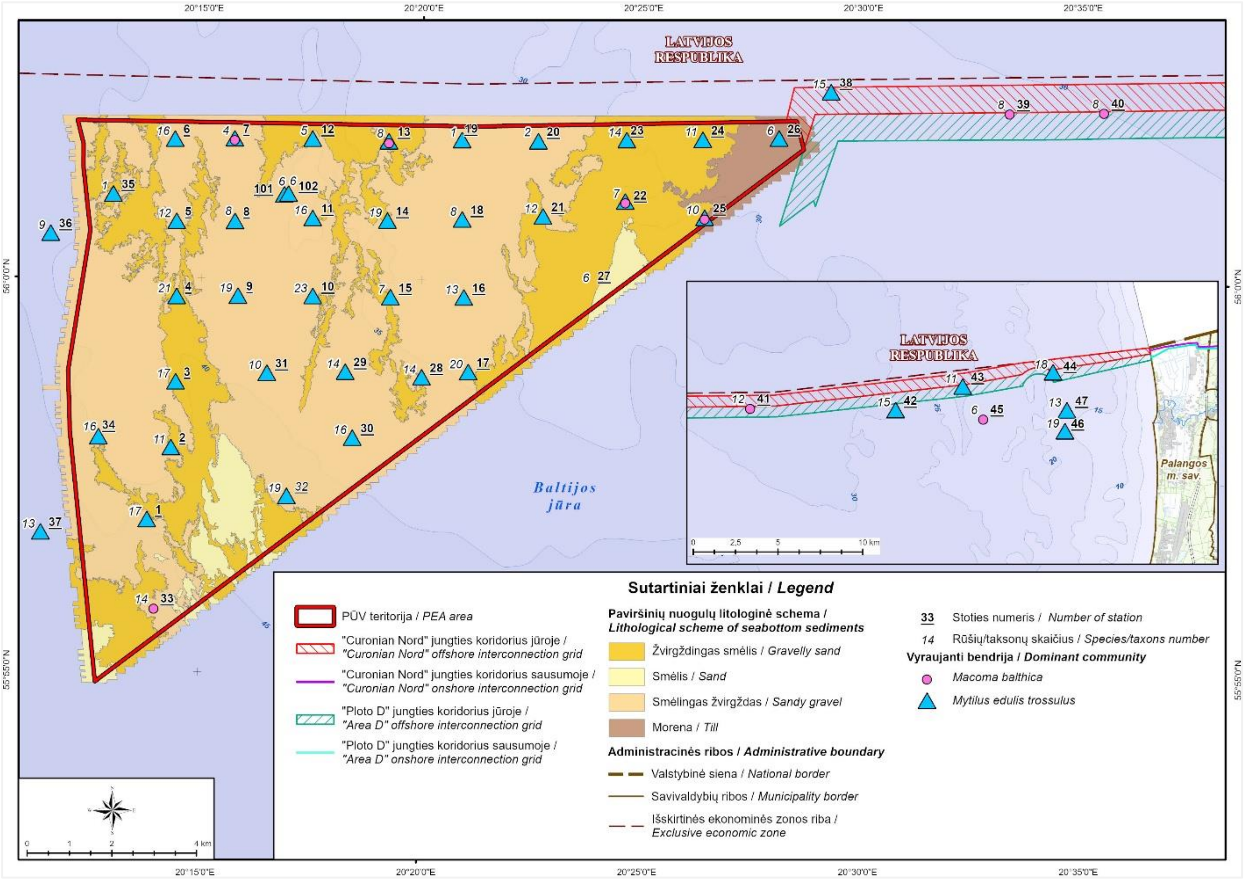


Fig. 5.4.16. Total number of species/taxa in the *Macoma balthica* and *Mytilus edulis trossulus* communities.

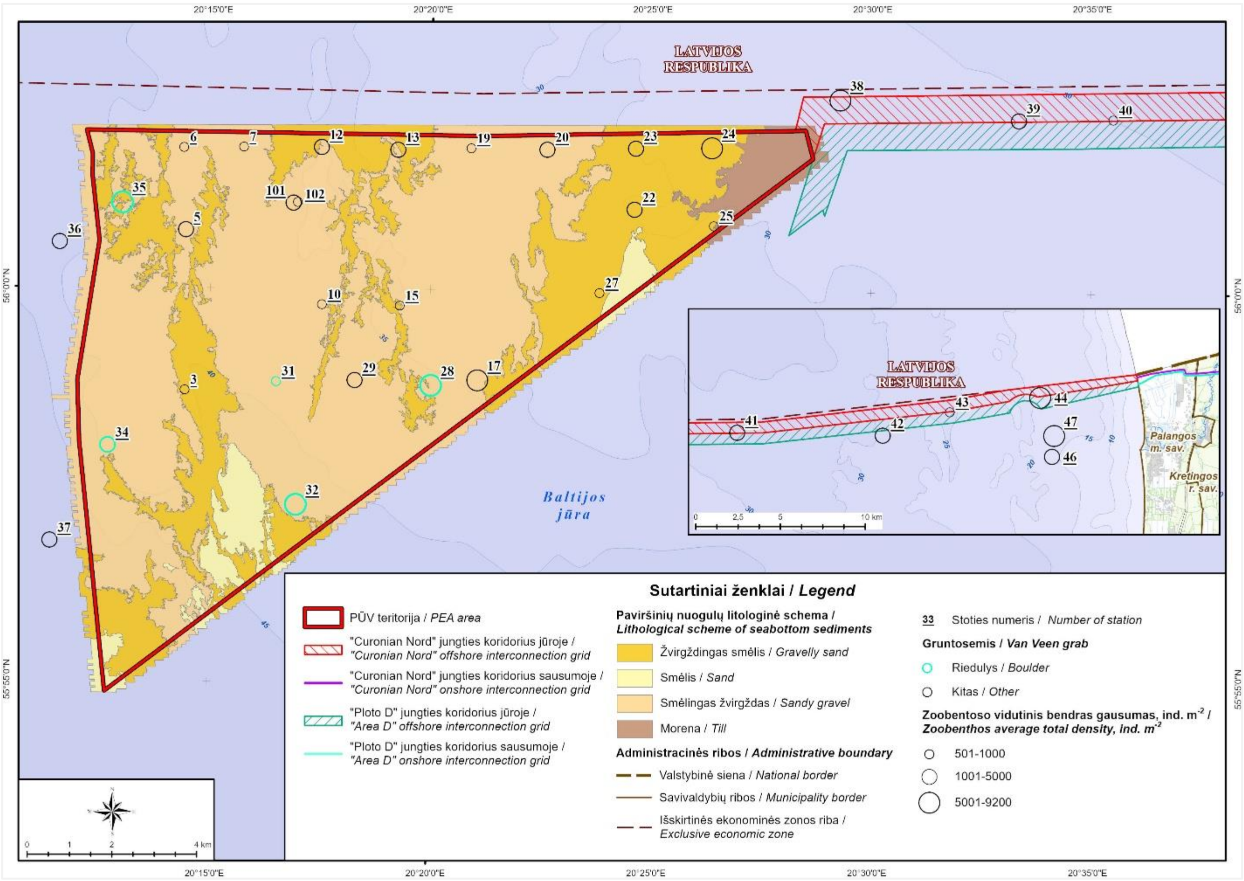


Fig. 5.4.17. Mean total density of benthic fauna species/taxon.

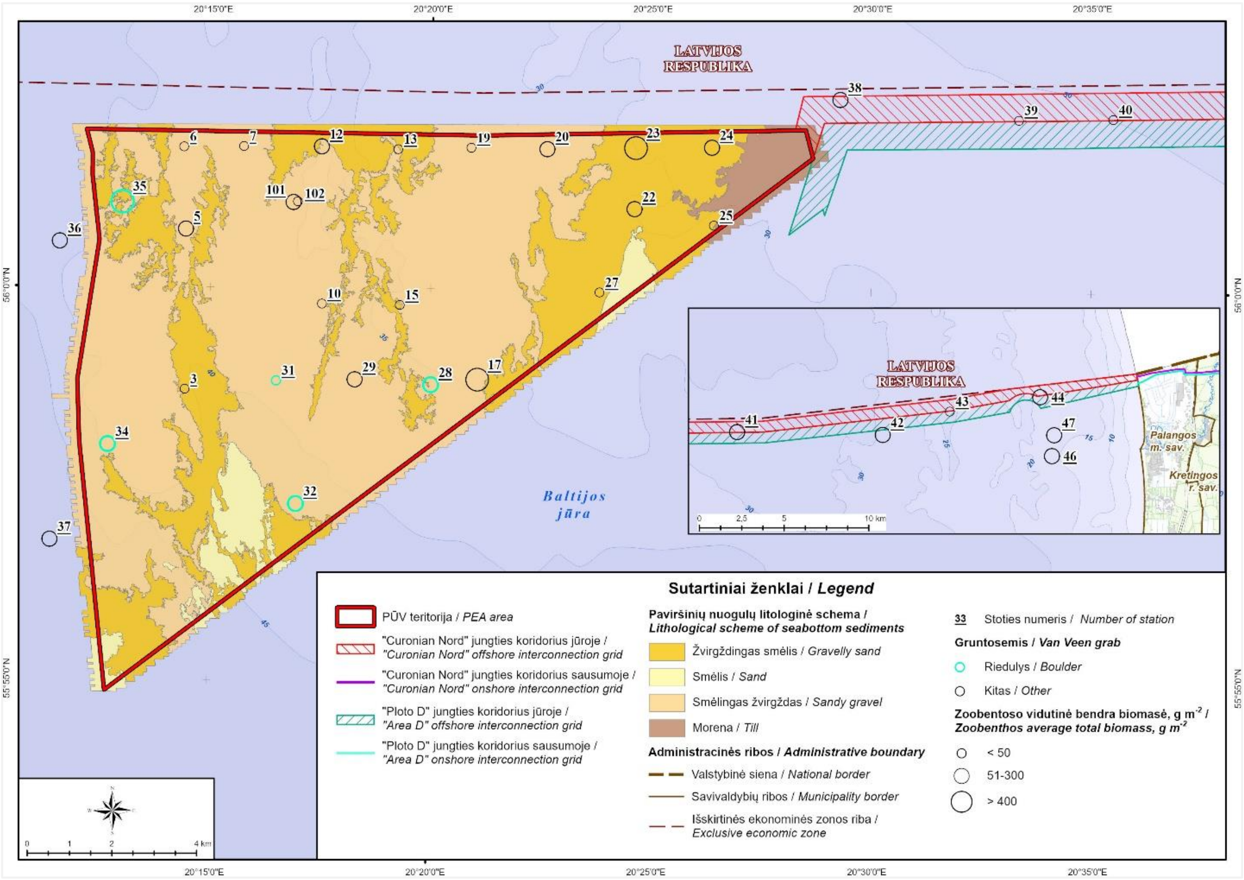


Fig. 5.4.18. Mean total biomass of benthic fauna species/taxon.

5.4.2.4.4 *Assessment of the ecological condition in circalittoral soft bottom habitats*

The condition of dominant benthic communities and seabed habitats in the sandy sediments of the Lithuanian Baltic Sea is assessed using the Benthic Quality Index (hereinafter – BQI), in accordance with the MSFD qualitative descriptor D5 (eutrophication), criterion D5C8 [73] [74].

The BQI evaluates the ecological status of marine water bodies based on the taxonomic composition, abundance, and sensitivity of macroinvertebrate taxon. The index is applied to seabed samples from infralittoral and circalittoral sandy bottoms, where communities are typically dominated by *Macoma balthica*, *Pygospio elegans*, or *Marenzelleria* spp.

The BQI is calculated according to the following formula:

$$BQI = \left(\sum_{i=1}^{n} \left(\frac{A_i}{A_{tot}} \times ES50_{0,05i} \right) \right) \times log\,(ES50 + 1) \times \left(1 - \frac{5}{5 + A_{tot}}\right),$$

Where: n – the number of species; A_i – the density of species i; A_{tot} – total density; $ES50_{0,05i}$ – the value of the sensitivity index for species i/taxon.

The ES50 – the Hurlbert Index. The Hurlbert Index (hereinafter – ES50) is the expected number of species/taxa at the 50 ind. m^{-2} bottom macroinvertebrates density. The index is calculated according to the following formula:

$$ES50 = \sum_{i=1}^{n} \frac{(A_{tot} - A_i)!\,(A_{tot} - 50)!}{(A_{tot} - A_i - 50)!\,A_{tot}!},$$

where: n – the number of species; A_{tot} – total density; A_i – the density of species i.

Target GES threshold value is not less than 2.9 per circalittoral area. BQI was calculated in specific areas where sediment grain size predominantly ranged 0.002–2 mm. Station 39 on the map falls under the SAC circalittoral reef-

[73] Methodology for determining the status of surface water bodies. Approved by the Order No. D1-210 of the Ministry of the Environment of the Republic of Lithuania of 12 April 2007 (as amended by Order No. D1-645 of the Minister of the Environment of the Republic of Lithuania of 4 November 2021).

[74] https://www.helcom.fi/wp-content/uploads/2019/08/State-of-the-soft-bottom-macrofauna-community-HELCOM-core-indicator-2018.pdf

type habitat, but BQI was still calculated because 91% of sediment particles measured 0.2–1 mm. At two stations, the BQI index did not reach the GES threshold. The average BQI value met GES criteria (3.0 ± 0.5; Fig. 5.4.2.15).

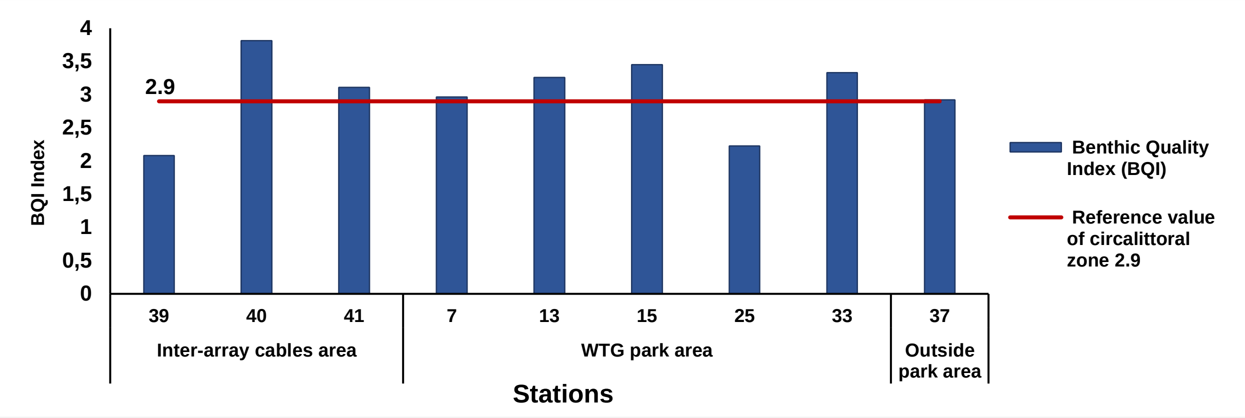


Fig. 5.4.19. BQI index values in circalittoral sandy habitats.

5.4.2.4.5 Results of zoobenthos studies in the Klaipėda-Ventspils "Natura 2000"

In the Klaipėda-Ventspils "Natura 2000" territory, video surveys were conducted along 21 transects, one per a 1x1 nautical mile grid. Video analysis results demonstrated that the coverage density of *Mytilus edulis trossulus* in these transects ranged from 5% to 60% (Fig. 5.4.14*).*

The results of grain size composition of sediments collected using Van Veen grab and dredge samplers presented in Table 5.4.10**.**

Table 5.4.10. Sediment and depth in the Klaipėda-Ventspils "Natura 2000" area

Station	Depth, m	Grain size composition, %								
		Gravel	Sand						Silt	Clay
		6.3-4 mm	4-2 mm	2-1 mm	1-0.63 mm	0.63-0.2 mm	0.2-0.125 mm	0.125-0.063 mm	0.063-0.002 mm	<0.002 mm
38	26.8	0	13.22	39.34	20.3	26.89	0.03	0.03	0.16	0.03
39	30.8	0.11	0.17	7.9	46.46	44.75	0.1	0.13	0.32	0.05
40	31.4	0	0	0	0	96.76	1.89	0.2	0.91	0.23
41	34.0	0	0	0	0	78.93	9.91	4.07	6.32	0.76

The greater presence of coarse sediment particles at station 38 resulted in a greater number of *Mytilus edulis trossulus* individuals at this site compared to stations 39, 40 and 41, where finer sediment particles were more prevalent. A total of 6 to 14 taxon were identified in the samples and their density and biomass are shown in Table 5.4.11.

Table 5.4.11. Zoobenthos taxon/species list, density and biomass identified in 2024

Broad habitat type			Circalittoral reef (1170)					Circalittoral sand			
Station Nr.			38			39		40		41	
Sampling equipment			Dredge	Van Veen		Van Veen		Van Veen		Van Veen	
Phylum	Taxon	Taxon/Species	Presence/ absence	Density ind. m^{-2}	Biomass g m^{-2}	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}
Cnidaria	*Hydrozoa*	*Gonothyraea loveni* [1]	X	-	-	-	-	-	-	-	-
Cephalorhyncha	*Priapulida*	*Halicryptus spinulosus*	-	-	-	-	-	-	-	18 ± 2	0.01 ± 0.01
Nemertea	*Nemertea*	*Nemertea gen. sp.*	X	-	-	725 ± 245	0.11 ± 0.04	-	-	-	-
Annelida	*Polychaeta*	*Bylgides sarsi* [2]	X	10	0.450	-	-	-	-	-	-
		Hediste diversicolor	X	-	-	70 ± 10	1.792 ± 1.74	145 ± 55	0.07 ± 0.01	72 ± 8	0.02 ± 0.002
		Marenzelleria spp.	X	-	-	315 ± 35	3.9535 ± 0,23	35 ± 15	0.37 ± 0.18	16 ± 0	0.15 ± 0
		Pygospio elegans	-	-	-	50 ± 0	0.02 ± 0	85 ± 65	0.03 ± 0.02	31 ± 1	0.01 ± 0
	Oligochaeta	*Oligochaeta gen. spp.*	X	-	-	270 ± 80	0.1625 ± 0.05	25 ± 5	0.02 ± 0.002	505 ± 35	0.23 ± 0.03
Arthropoda	*Isopoda*	*Jaera (Jaera) albifrons*	X	20	0.038	-	-	-	-	-	-
		Saduria entomon	-	-	-	-	-	-	-	16 ± 0	1.27 ± 0.0
	Cirripedia	*Amphibalanus improvisus*	X	160	12.000	-	-	-	-	-	-
	Amphipoda	*Corophium volutator*	X	-	-	-	-	-	-	-	-
		Gammarus salinus	X	30	0.621	-	-	-	-	32 ± 0	0.01 ± 0.0
Mollusca	*Bivalvia*	*Macoma balthica*	X	-	-	30 ± 0	27.1 ± 1.31	205 ± 25	40.17 ± 12.44	415 ± 145	129.26 ± 68.4

Broad habitat type			Circalittoral reef (1170)					Circalittoral sand			
Station Nr.			38			39		40		41	
Sampling equipment			Dredge	Van Veen		Van Veen		Van Veen		Van Veen	
Phylum	Taxon	Taxon/Species	Presence/ absence	Density ind. m^{-2}	Biomass g m^{-2}	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}	Mean density ± SD, ind. m^{-2}	Mean biomass ± SD, g m^{-2}
		Mya arenaria	-	-	-	-	-	20 ± 0	0.42 ± 0.39	20 ± 0	0.03 ± 0.0
		Mytilus edulis trossulus	X	5180	258.029	-	-	5 ± 0	0.01 ± 0.0	129 ± 109	0.35 ± 0.3
	Gastropoda	*Peringia ulvae*	X	10	0.022	35 ± 0	0.086 ± 0	185 ± 35	0.39 ± 0.0	18 ± 2	0.03 ± 0.01
Bryozoa	*Bryozoa*	*Einhornia crustulenta* [1]	X	-	-	X	X	X	X	X	X

Notes: 1 – colony, fouling; 2 – semi pelagic

5.4.2.4.6 Most valuable seabed habitats

Based on the results of the national monitoring of reef (1170) habitats conducted in 2022–2023, as well as additional studies carried out in 2024 within the planned project area, the most valuable seabed habitat zones (biomass > 400 g/m², abundance > 5,000 ind./m², number of species 11–20) have been identified within the boundaries of the planned CN OWF (see Figure 5.4.20). Although the impact values remain well below the established threshold limits, it is recommended where technically feasible and reasonably practicable, to avoid the installation of wind turbines within these zones and/or to minimize seabed disturbance by limiting the extent of cable trenching.

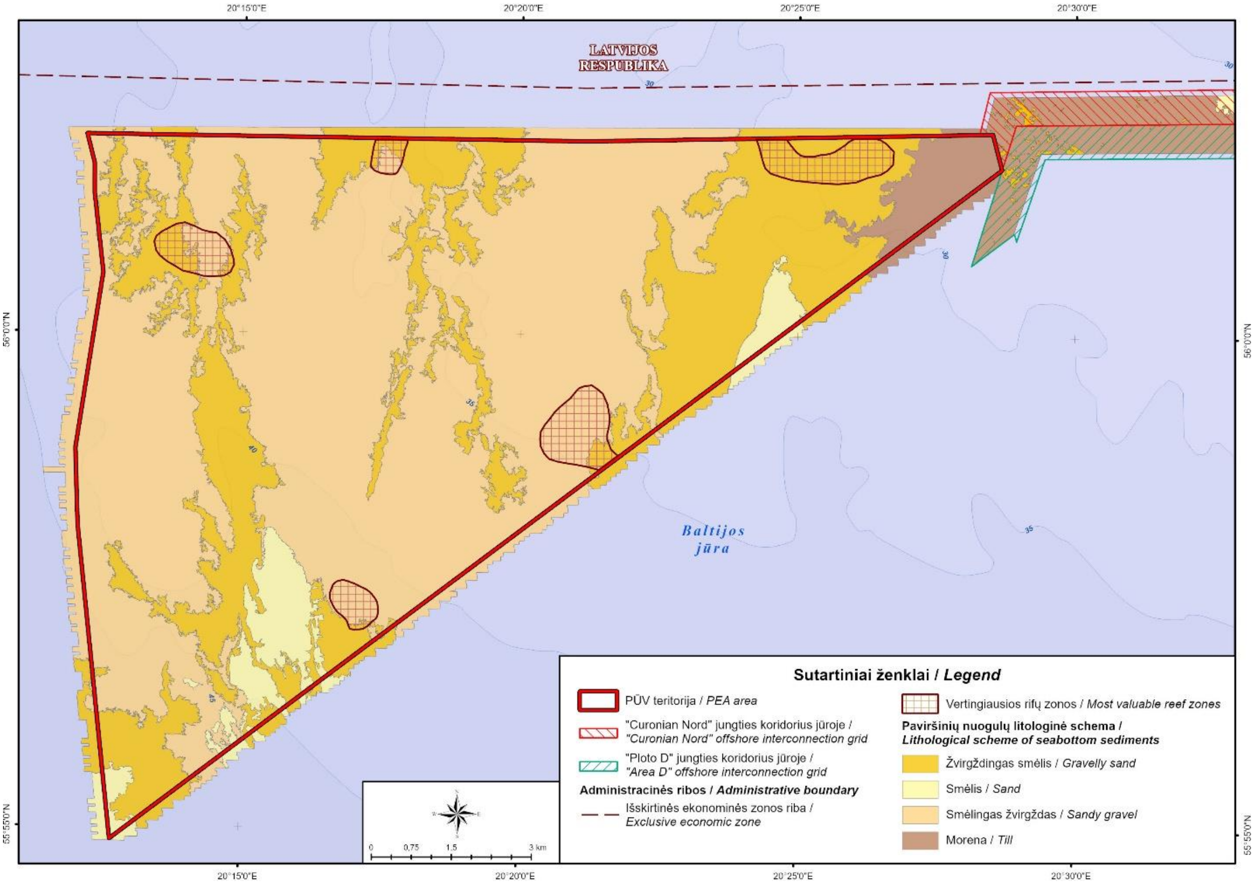


Fig. 5.4.20. Most valuable seabed habitats within the CN OWF area.

5.4.2.5 Potential impact on benthic habitats

Both the main directives (MSFD[75], WFD[76], Habitats Directive[77]) and the national environmental monitoring programme focus on two key aspects of reef habitats – the habitat area and the internal structure of the habitat (and the functions associated with it), or their combination. For example, habitat loss – the loss of species' living environment and the loss of function (D6C4).

For assessment purposes, ICES distinguishes two types of physical habitat loss: sealed physical loss and unsealed physical loss. Sealed physical loss occurs due to the installation of permanent structures in the marine environment (e.g., wind turbine foundations, scour protection systems) and the placement of seabed-sealing substrates in cable laying areas (e.g., concrete mattresses for cable covering).

Unsealed physical loss occurs due to physical habitat modifications due to human activities (e.g., uncovered cable laying), and indirect effects of artificial structures (e.g., WTG foundations acting as artificial reefs), ultimately leading to permanent alteration of EUNIS Level 2 habitat types.

[75] https://eur-lex.europa.eu/legal-content/LT/TXT/HTML/?uri=CELEX:32008L0056

[76] https://eur-lex.europa.eu/legal-content/LT/ALL/?uri=CELEX:32000L0060

[77] https://eur-lex.europa.eu/legal-content/LT/TXT/?uri=CELEX:31992L0043

Disturbance – a temporary physical, chemical, or biological impact caused by human activities or natural factors that does not alter the habitat type (e.g., EUNIS Level 2 classification) but may transiently affect habitat structure, ecosystem functions and biological community.

Depending on the nature of the impact, disturbances may include:

- physical habitat disruption (e.g., seabed disturbance, sediment resuspension)
- temporarily elevated turbidity
- mechanical impacts on organisms or their habitats (e.g., trawling, cable laying)
- noise, vibration, and/or chemical effects.

Disturbance, unlike physical loss, does not cause permanent habitat destruction or sealing, but may lead to short-term ecological instability or transient community composition changes[78] [79] [80] [81].

When assessing potential impacts on benthic habitats, it is important to consider two distinct components of the protected values:

- Impact on the reef as a benthic habitat.
- Impact on the fauna and flora associated with the reef (flora being relevant only in the infralittoral zone).

The impacts on benthic habitats and their associated fauna during project implementation will depend on the selected technical solutions, the type of foundation piles (monopile or jacket) and the applied scour protection requirements:

- in the case of monopile foundations, scour protection is typically required, which may result in a greater extent of habitat loss
- for jacket-type foundations, scour protection is usually unnecessary, therefore the extent of habitat loss is expected to be lower
- in the case of gravity-type foundations, protection against leaching is necessary, therefore a greater extent of bottom habitat loss is possible.

Additional impacts will depend on the specific cable installation technologies used, which will be selected based on:

- seafloor depth,
- proximity to the shoreline,
- seabed lithological characteristics.

Impact of cable laying on seabed. During cable installation, the cables will be laid in trenches and backfilled with the same natural excavated sediments, where possible. The hard substrate will not be destroyed. If boulders are encountered in the area, they will be locally relocated, while gravel and pebbles will be returned to the trench during cable burial. This approach will ensure that the seabed morphology and hydrodynamic conditions remain essentially unchanged post-installation.

Landfall of cables. In the coastal zone, the landfall of the subsea cables will be carried out using a trenchless method (HDD or similar). As a result, no impact on benthic habitats is expected to the shoreline.

Due to varying seabed conditions, different technological solutions will be applied for cable installation and protection. Depending on the selected method, the estimated seabed disturbance width per cable is as follows:

- Cable protection using gravel cover – up to 12 m
- Trench excavation – up to 15 m
- Seabed clearance from obstacles/boulders (e.g., through ploughing or dragging) – up to 35 m.

Preliminarily, based on seabed morphology and geological conditions, it is estimated that up to 20% of the total cable length – both within the OWF area and along the export cable route – may require protective covering, with a maximum

[78] ICES (2019a). Workshop on scoping of physical pressure layers causing loss of benthic habitats D6C1–methods to operational data products (WKBEDLOSS). ICES Scientific Reports, 1:15. 37 pp. https://doi.org/10.17895/ices.pub.5138

[79] ICES (2019b). Workshop to evaluate and test operational assessment of human activities causing physical disturbance and loss to seabed habitats (MSFD D6 C1, C2 and C4) (WKBEDPRES2). ICES Scientific Reports. 1:69. 87 pp. http://doi.org/10.17895/ices.pub.5611

[80] ICES (2019c). EU request to advise on a seafloor assessment process for physical loss (D6C1, D6C4) and physical disturbance (D6C2) on benthic habitats. In: Report of the ICES Advisory Committee, 2019. ICES Advice 2019, sr.2019.25, https://doi.org/10.17895/ices.advice.5742

[81] https://helcom.fi/wp-content/uploads/2021/11/Impacts-on-seabed-%E2%80%93approaches-for-assessment-as-step-towards-successful-measures.pdf

estimated width of up to 12 m. In these locations, habitats would be subject to irreversible loss (D6C4), while the remaining 80% would be subject to disturbance (D6C5).

5.4.2.6 Impact on circalittoral reef habitats and potential ecological consequences

The most vulnerable component of circalittoral reef habitats is the *Mytilus edulis trossulus* community, characterized by large, long-lived individuals (slow growth, age diversity) and associated rare species. During installation and decommissioning activities, significant physical loss of natural seabed habitats is expected, associated with irreversible changes to marine substrates (D6C4), as well as physical seabed disturbance (D6C5).

During installation and decommissioning activities, impacts on sandy seabed biotopes are unavoidable. The anticipated consequences include seabed disturbance, increased water turbidity, and secondary sediment deposition. These phenomena may negatively affect pelagic invertebrate larvae, particularly during their developmental and settlement stages.

During operation, a two-fold effect is very likely.

- **Positive impact** – the formation of the *Mytilus edulis trossulus* communities on underwater structures constitute artificial reef formation and development. This transformation in circalittoral reef (1170) and coarse sediment habitats will not alter the EUNIS level 2 habitat type. In sandy PEA areas, a secondary artificial reef habitat will emerge on OWF infrastructure creating an additional EUNIS level 2 habitat type. Biofouling on artificial reef will enhance biofiltration capacity and increase local productivity.
- **Negative impact** – the loss (1170) of natural environment and very likely spread of non-indigenous and invasive species (e.g. spread of the invasive Gammaridae crustacea *Dikerogammarus villosus* (criterion D2C2). In the upper layers of water, the salinity is lower than at the bottom and the temperature is higher. Therefore, the transfer (navigation, anchors, birds) of local and non-indigenous crustaceans (e.g. *Dikerogammarus villosus*) living in the mouth of the Curonian Lagoon (at the bottom, in the macrophyte growths of berths, water buoys and navigational buoys) and at the Palanga bridge (in the macrophyte growths of boulders and piles) and settling on the underwater structures is likely.

During the installation of the foundations for the WTGs and the OSS, the habitats at the pile driving locations and (potentially) under the scour protection (covering) will also be irreversibly destroyed. The impacts during seabed preparation works are classified as disturbance.

The impact areas of the main structures/activities are presented in Table 5.4.12.

Table 5.4.12. Impact areas of key structures/activities

Loss / Disturbance	Parameters	Value	Area per unit, km²
Loss	WTG MP-type scour protection	Ø 45 m (Ø 45 m; 1,590 m²)	0.00159
Disturbance	WTG MP-type seabed preparation	MP seabed preparation (Ø 400 m; 125,600 m²) – scour protection Ø 45 m (Ø 45 m; 1,590 m²) = 125,600 – 1,590 = 12,401 m²	0.12401
Loss	WTG jacket-type foundation	(Ø 2 m × 4; 12.56 m²)	0.00001256
Disturbance	WTG jacket-type seabed footprint	500 m²	0.0005
Loss	WTG jacket-type foundation	(Ø 4 m × 4; 50.24 m²)	0.00005024
Disturbance	WTG jacket-type seabed footprint	1,200 m²	0.0012
Loss	WTG gravity-type scour protection	Ø 60 m; 2,826 m²	0.002826
Disturbance	WTG gravity-type seabed preparation	Seabed preparation (Ø 400 m; 125,600 m²) – scour protection Ø 60 m (Ø 60 m; 2,826 m²) = 125,600 – 2,826 = 122,774 m²	0.122774
Loss	WTG gravity-type scour protection	75×75 m = 5,625 m²	0.005625

Loss / Disturbance	Parameters	Value	Area per unit, km²
Disturbance	WTG gravity-type seabed preparation	Seabed preparation (Ø 400 m; 125,600 m²) – scour protection (5,625 m²) = 125,600 – 5,625 = 119,975 m²	0.119975
Disturbance	Installation vessel	20,000 m²	0.02
Loss	Offshore substation MP-type scour protection	5,000 m²	0.005
Disturbance	Offshore substation MP-type seabed preparation	Seabed preparation (Ø 400 m; 125,600 m²) – scour protection (5,000 m²) = 125,600 – 5,000 = 120,600 m²	0.1206
Loss	Offshore substation jacket type	0.000675 km²	0.000675
Disturbance	Offshore substation jacket-type scour protection	None	0

5.4.2.7 Impact on "Natura 2000" SAC

According to subparagraph 3.2.4 of the "Description of criteria for significant negative impact on birds and bats from wind farms, measures for prevention and mitigation, and survey requirements", approved by Order No. D1-406 of the Minister of Environment of the Republic of Lithuania on 12 December 2023, the impact of WTGs or OWFs is considered to be significant negative if 1% or more of the inventoried marine seabed habitat area of Community importance within the SAC area is destroyed or degraded.

From the OSS to the landfall site, the CN and "Area D" export cable corridors cross two circalittoral habitats located within the Klaipėda-Ventspils Plateau SAC boundaries:

- Circalittoral rock and biogenic reef (1170) (the Community importance habitat).
- Circalittoral sand.

Maximum impact area of the two export cable corridors could reach approximately 0.37 km², accounting for 0.56% of the inventoried reef habitat area within the Klaipėda-Ventspils Plateau SAC (Table 5.4.13 A).

Table 5.4.13 A. Maximum potential seabed habitat loss and disturbance areas (km²) during the installation of CN OWF export cables, and proportion (%) of the habitat area within the SAC

Broad Habitat Type	Seabed loss/disturbance width (m)	Northern cable (5.200 km)		Southern cable (5.364 km)		Total cable length (10.564 km)	
		(km²)	(%)	(km²)	(%)	(km²)	(%)
Klaipėda-Ventspils Plateau SAC circalittoral reef (1170) (66.268 km²)	12	0.062	0.094	0.064	0.097	0.127	0.191
	15	0.078	0.118	0.080	0.121	0.158	0.239
	35	0.182	0.275	0.188	0.283	0.370	**0.558**

Note: the indicated widths (m) of the cable laying corridors are preliminary.

Accordingly, the estimated impact area of the "Area D" export cables may reach approximately 0.45 km², which represents 0.67% of the mapped reef habitat area within the Klaipėda-Ventspils Plateau SAC (see Table 5.4.13 B).

Table 5.4.13 B. Maximum potential seabed habitat loss and disturbance areas (km²) during the installation of export cables in "Area D", and their proportion (%) of the habitat area within the SAC

Broad Habitat Type	Seabed loss/disturbance width (m)	Northern cable (6.400 km)		Southern cable (6.360 km)		Total cable length (12.76 km)	
		(km²)	(%)	(km²)	(%)	(km²)	(%)
Klaipėda-Ventspils Plateau SAC circalittoral reef (1170) (66.268 km²)	12	0.077	0.116	0.076	0.115	0.153	0.231
	15	0.096	0.145	0.095	0.144	0.191	0.289
	35	0.224	0.338	0.223	0.336	0.447	**0.674**

Note: the indicated widths (m) of the cable laying corridors are preliminary.

The circalittoral sand habitat located within the Klaipėda-Ventspils Plateau SAC is not classified as a habitat type of European Community importance. However, to assess the potential impact on all seabed habitats, an evaluation was conducted regarding the scale of loss and adverse effects caused by the installation activities of both OWF export cable corridors.

It has been determined that the maximum impact area of the two cables installed in an export cable corridor within the CN OWF may reach approximately 0.61 km², which accounts for about 0.6% of the total circalittoral sand habitat area within the Klaipėda-Ventspils Plateau SAC (Table 5.4.14 A).

Table 5.4.14 A. Maximum potential seabed habitat loss and disturbance areas (km²) during the installation of CN OWF export cables, and proportion (%) of the habitat area within the SAC

Broad Habitat Type	Seabed loss/disturbance width (m)	Northern cable (9.679 km)		Southern cable (9.406 km)		Total cable length (19.085 km)	
		(km^2)	(%)	(km^2)	(%)	(km^2)	(%)
Klaipėda-Ventspils Plateau SAC circalittoral sand (101.72 km^2)	12	0.116	0.114	0.113	0.111	0.229	0.225
	15	0.145	0.143	0.141	0.139	0.286	0.281
	35	0.339	0.333	0.329	0.324	0.668	0.657

Note: the indicated widths (m) of the cable laying corridors are preliminary.

Accordingly, the maximum impact area from the installation of the two cables within “Area D” OWF’s export cable corridor may reach approximately 0.61 km², which accounts for about 0.6% of the total circalittoral sand habitat area within the Klaipėda-Ventspils Plateau SAC (Table 5.4.14 B).

Table 5.4.14 B. Maximum potential seabed habitat loss and disturbance areas (km²) during the installation of export cables in “Area D”, and proportion (%) of the habitat area within the SAC

Broad Habitat Type	Seabed loss/disturbance width (m)	Northern cable (8.700 km)		Southern cable (8.790 km)		Total cable length (17.490 km)	
		(km^2)	(%)	(km^2)	(%)	(km^2)	(%)
Klaipėda-Ventspils Plateau SAC circalittoral sand (101.72 km^2)	12	0.104	0.103	0.105	0.104	0.210	0.206
	15	0.131	0.128	0.132	0.130	0.262	0.258
	35	0.305	0.299	0.308	0.302	0.612	0.602

Note: the indicated widths (m) of the cable laying corridors are preliminary.

5.4.2.8 Impact assessment based on the characteristics of GES in the Baltic Sea region

According to the requirements for determining the GES characteristics[82] of the Baltic Sea region, applied under criterion D6C3, the following GES indicators and their target values have currently been established:

- The area of the habitat affected by dredging and sand extraction activities – threshold value: ≤1%.
- The area of the habitat affected by bottom trawling activities – threshold value: ≤ 10%.
- An indicator for assessing the impact of long-term structures (e.g., WTG foundations or other infrastructure elements) has not yet been established.

5.4.2.9 Impact assessment criteria based on the recommendations of the EU Communication

In accordance with Commission Communication No. C/2024/2078 “Commission Notice on the threshold values set under the Marine Strategy Framework Directive 2008/56/EC and Commission Decision (EU) 2017/848”[83], the GES threshold values are applied to the following criteria of Descriptor 6:

- **D6C4** (Habitat loss)**:** the largest portion of the dominant benthic habitat type that may be lost in the assessed area is 2% of its natural size (≤2%) (criterion D6C4).

[82] Order No. D1-675 by the Minister of Environment of the Republic of Lithuania dated November 9, 2020, regarding the amendment of Order No. D1-194 dated March 4, 2015, "On the approval of the characteristics of good environmental status of the marine area of the Republic of Lithuania." Access online: https://www.e-tar.lt/portal/legalAct.html?documentId=bf1b35a0231c11eb932eb1ed7f923910

[83] http://data.europa.eu/eli/C/2024/2078/oj

- **D6C5** (Adverse effects on habitats): the maximum proportion of a benthic broad habitat type in an assessment area that can be adversely affected is 25% of its natural extent (≤25%). This includes the proportion of the benthic broad habitat type that has been lost (D6C5). A benthic broad habitat type is adversely affected in an assessment area if it shows an unacceptable deviation from the reference state in its biotic and abiotic structure and functions (e.g. typical species composition, relative abundance and size structure, sensitive species or species providing key functions, recoverability and functioning of habitats and ecosystem processes). Adverse effects on habitats include the habitat disturbance.

5.4.2.10 Comparison of project alternatives based on their impact on benthic habitats

Alternative 1 (maximum) foresees the installation of 68 WTGs and one OSS. The potential impacts, their extent, and percentage expression are presented in Table 5.4.15.

Habitat loss due to cable installation is assessed as a physical loss of habitat resulting from cable scour protection measures, specifically covering with gravel. The area of such protection corresponds to a 12-meter-wide trench, of which 20% is considered permanently lost habitat.

Cable installation-induced disturbance is also assessed as a temporary impact within the 35-meter-wide cable installation corridor. This disturbance is not included in the loss area but is important for evaluating the overall extent of impact.

In the infralittoral mud habitat (area <2 km²), the potential negative impact during cable installation is estimated at 0.18% (loss) and 3.49% (disturbance). Considering the limited distribution of this habitat and the impact intensity (0.05 km²), the effect is regarded as local.

Assessment results indicate that the scale of loss or disturbance to circalittoral and infralittoral reef habitats (considered the most sensitive according to habitat typology) will not exceed the threshold values for adverse effects established in the European Commission Communication No. C/2024/2078 (Tables 5.4.15 and 5.4.16).

Although the direct impact of the CN OWF infrastructure does not exceed the permissible limits of adverse effects, the project's contribution must be considered in the context of cumulative impacts arising from existing and planned economic activities in the Baltic Sea.

Alternative 2 (optimal) envisages a reduced number of 55 WTGs and one OSS. Potential impacts, their extent, and percentage expressions are presented in Table 5.4.16. Changes will occur only in the circalittoral reef habitat (1170), where the number of WTGs will decrease by 13 units, representing 31.7% of all WTGs. The length and area of cable routes will be reduced in the following habitats:

- Circalittoral reef (1170) – 35.56 km (28%)
- Circalittoral coarse sediments – 1.81 km (4.3%)
- Sand – 1.05 km (2.0%).

The total reduction in cable length of 38.4 km will significantly contribute to minimizing the impact on reef habitats. A summarised comparison of the lengths and areas of loss and disturbance between the two alternatives, as well as their changes, is provided in Table 5.4.17.

The European Commission Communication No. C/2024/2078 emphasizes the obligation of Member States to ensure that the impacts of activities do not exceed the established threshold values for dominant habitat types. Although the intensity of impact under Alternative 1 does not exceed these threshold negative impact values, Alternative 2 appears more favourable. In the case of Alternative 2, the negative impact on the circalittoral reef habitat (1170) would be lower and would be in better alignment with the requirements for maintaining GES set out in the EU's environmental policy.

Table 5.4.15. Alternative 1 (Maximum scenario: 68 WTGs and 1 OSS): preliminary assessment of seabed physical loss and disturbance across broad habitat types by export cable corridor width scenarios

Broad habitat type		Circalittoral reef (1170)			Circalittoral coarse sediment			Circalittoral sand			Infralittoral mud			Infralittoral sand			Infralittoral reef (1170)		
Area (km²)			420.8			345			2,360			2			142			68.4	
Seabed impact width (m)		12	15	35	12	15	35	12	15	35	12	15	35	12	15	35	12	15	35
Inter-array cables from WTGs to the OSS	Length (km)		98.66			24.96			16.45										
	Area (km²)	1.18	1.48	3.45	0.30	0.37	0.87	0.20	0.25	0.58									
	Loss / disturbance (%)	0.28	0.35	0.82	0.09	0.11	0.25	0.01	0.01	0.02									
	Loss (km²)	0.24			0.06			0.04							No impact				
	(%)	0.06			0.02			0.00											
	Total disturbance (km²)		3.22			0.81			0.54										
	(%)		0.76			0.24			0.02										
Two cables from the offshore substation to the HDD site	Length (km)		28.95			17.36			35.72			1.53			1.36			0.02	
	Area (km²)	0.35	0.43	1.01	0.21	0.26	0.61	0.43	0.54	1.25	0.02	0.02	0.05	0.02	0.02	0.05	0.0002	0.0003	0.001
	Loss / disturbance (%)	0.08	0.10	0.24	0.06	0.08	0.18	0.02	0.02	0.05	0.92	1.15	2.68	0.01	0.01	0.03	0.0004	0.0004	0.001
	Loss (km²)	0.07			0.04			0.09			0.004			0.003			0.0000		
	(%)	0.02			0.01			0.004			0.18			0.002			0.0001		
	Total disturbance (km²)		0.94			0.57			1.16			0.05			0.04			0.001	
	(%)		0.22			0.16			0.05			2.49			0.03			0.001	
Total	Length (km)		127.61			42.32			52.17			1.53			1.36			0.02	
	Area (km²)	1.53	1.91	4.47	0.51	0.63	1.48	0.63	0.78	1.83	0.02	0.02	0.05	0.02	0.02	0.05	0.0002	0.00003	0.001
	Loss / disturbance (%)	0.36	0.45	1.06	0.15	0.18	0.43	0.03	0.03	0.08	0.92	1.15	2.68	0.01	0.01	0.03	0.0004	0.00004	0.001

Broad habitat type		Circalittoral reef (1170)	Circalittoral coarse sediment	Circalittoral sand	Infralittoral mud	Infralittoral sand	Infralittoral reef (1170)
	Loss (km^2)	0.31	0.10	0.13	0.004	0.003	0.00005
	(%)	0.07	0.03	0.01	0.18	0.002	0.0001
	Total disturbance (km^2)	4.16	1.38	1.70	0.05	0.04	0.001
	(%)	0.99	0.40	0.07	2.49	0.03	0.001
Number of WTGs		**41**	**16**	**11**			
Scour protection for MP-type (Ø 11 m) WTGs – Ø 45 m; scour protection for the offshore substation (Ø 14 m) – 5,000 m²; cable protection – 20%							
Loss	(km^2)	0.38	0.13	0.14	0.004	0.003	0.00005
	(%)	0.09	0.04	0.006	0.18	0.002	0.0001
Seabed preparation for MP-type WTGs and the offshore substation (Ø 400), seabed preparation along the cable route, installation vessel							
Disturbance	(km^2)	10.19	3.68	3.28	0.05	0.04	0.001
	(%)	2.42	1.07	0.14	2.49	0.03	0.001
Jacket-type WTG foundations (Ø 2 m × 4; 12.56 m²) and scour protection for the jacket-type offshore substation – 5,000 m²; cable protection – 20%							
Loss	(km^2)	0.31	0.10	0.13	0.004	0.003	0.00005
	(%)	0.07	0.03	0.005	0.18	0.002	0.0001
Jacket-type WTGs (Ø 2 m × 4; 12.56 m²) with a seabed footprint of 500 m², seabed preparation for the offshore substation and cable route, installation vessel							
Disturbance	(km^2)	5.12	1.71	1.93	0.05	0.04	0.001
	(%)	1.22	0.49	0.08	2.49	0.03	0.001
Jacket-type WTG foundations (Ø 4 m × 4; 50.24 m²) and scour protection for the jacket-type offshore substation – 5,000 m²; cable protection – 20%.							
Loss	(km^2)	0.31	0.10	0.13	0.004	0.003	0.00005
	(%)	0.07	0.03	0.005	0.18	0.002	0.0001
Jacket-type WTGs (Ø 4 m × 4; 50.24 m²) with a seabed footprint of 1,200 m², seabed preparation for the offshore substation and cable route, installation vessel							
Disturbance	(km^2)	5.15	1.72	1.93	0.05	0.04	0.001
	(%)	1.22	0.50	0.08	2.49	0.03	0.001
Gravity-type WTG (foundation Ø 45 m) and offshore substation scour protection; cable protection – 20%							
Loss	(km^2)	0.42	0.15	0.16	0.004	0.003	0.00005
	(%)	0.10	0.04	0.01	0.18	0.002	0.0001
Seabed preparation for gravity-type WTGs and the offshore substation (foundation Ø 45 m; Ø 400), cable route, installation vessel							

Broad habitat type		Circalittoral reef (1170)	Circalittoral coarse sediment	Circalittoral sand	Infralittoral mud	Infralittoral sand	Infralittoral reef (1170)
Disturbance	(km^2)	10.16	3.66	3.27	0.05	0.04	0.001
	(%)	2.41	1.06	0.14	2.49	0.03	0.001
Gravity-type WTG (foundation 75×75 m) and offshore substation scour protection; cable protection – 20%							
Loss	(km2)	0.54	0.19	0.19	0.004	0.003	0.00005
	(%)	0.13	0.06	0.008	0.18	0.002	0.0001
Seabed preparation for gravity-type WTGs and the offshore substation (Ø 400), seabed preparation along the cable route, installation vessel							
Disturbance	(km^2)	10.04	3.62	3.24	0.05	0.04	0.001
	(%)	2.39	1.05	0.14	2.49	0.03	0.001

Note: The area of the MP foundation is not considered for the physical loss assessment, as it overlaps with the larger (Ø 45 m) scour protection area.

Table 5.4.16. Alternative 2 (Optimal scenario: 55 WTGs and 1 OSS): preliminary assessment of seabed physical loss and disturbance across broad habitat types by cable corridor width scenarios

Broad habitat type		Circalittoral reef (1170)			Circalittoral coarse sediment			Circalittoral sand			Infralittoral mud			Infralittoral sand			Infralittoral reef (1170)		
Area (km^2)			420.8			345			2 360			2			142			68.4	
Seabed impact width (m)		12	15	35	12	15	35	12	15	35	12	15	35	12	15	35	12	15	35
Inter-array cables from WTGs to the OSS	Length (km)		63.1			23.15			15.4										
	Area (km^2)	0.76	0.95	2.21	0.28	0.35	0.81	0.18	0.23	0.54									
	Loss / disturbance (%)	0.18	0.22	0.52	0.08	0.10	0.23	0.01	0.01	0.02									
	Loss (km^2)	0.15			0.06			0.04							No effect				
	(%)	0.04			0.02			0.00											
	Total disturbance (km^2)		2.06			0.75			0.50										
	(%)		0.49			0.22			0.02										
Two cables from the offshore substation to the HDD site	Length (km)		28.95			17.36			35.72			1.53			1.36			0.02	
	Area (km^2)	0.35	0.43	1.01	0.21	0.26	0.61	0.43	0.54	1.25	0.02	0.02	0.05	0.02	0.02	0.05	0.0002	0.0003	0.001
	Loss / disturbance (%)	0.08	0.10	0.24	0.06	0.08	0.18	0.02	0.02	0.05	0.92	1.15	2.68	0.01	0.01	0.03	0.0004	0.0004	0.001
	Loss (km^2)	0.07			0.04			0.09			0.004			0.003			0.0000		
	(%)	0.02			0.01			0.004			0.18			0.002			0.0001		
	Total disturbance (km^2)		0.94			0.57			1.16			0.05			0.04			0.001	
	(%)		0.22			0.16			0.05			2.49			0.03			0.001	
Total	Length (km)		92.05			40.51			51.12			1.53			1.36			0.02	

Broad habitat type		Circalittoral reef (1170)			Circalittoral coarse sediment			Circalittoral sand			Infralittoral mud			Infralittoral sand			Infralittoral reef (1170)		
	Area (km²)	1.10	1.38	3.22	0.49	0.61	1.42	0.61	0.77	1.79	0.02	0.02	0.05	0.02	0.02	0.05	0.0002	0.0003	0.0007
	Loss / disturbance (%)	0.26	0.33	0.77	0.14	0.18	0.41	0.03	0.03	0.08	0.92	1.15	2.68	0.01	0.01	0.03	0.0004	0.0004	0.001
	Loss (km²)	0.22			0.10			0.12			0.004			0.003			0.00005		
	(%)	0.05			0.03			0.01			0.18			0.002			0.0001		
	Total disturbance (km²)		3.00			1.32			1.67			0.05			0.04			0.001	
	(%)		0.71			0.38			0.07			2.49			0.03			0.001	
Number of WTGs				**28**			**16**			**11**									
Scour protection for MP-type (Ø 11 m) WTGs – Ø 45 m; scour protection for the offshore substation (Ø 14 m) – 5,000 m²; cable protection – 20%																			
Loss	(km²)	0.27			0.12			0.14			0.004			0.003			0.00005		
	(%)	0.06			0.04			0.006			0.18			0.002			0.0001		
Seabed preparation for MP-type WTGs and the offshore substation (Ø 400), seabed preparation along the cable route, installation vessel																			
Disturbance	(km²)		7.15			3.62			3.25			0.05			0.04			0.001	
	(%)		1.70			1.05			0.14			2.49			0.03			0.001	
Jacket-type WTG foundations (Ø 2 m × 4; 12.56 m²) and scour protection for the jacket-type offshore substation – 5,000 m²; cable protection – 20%																			
Loss	(km²)	0.23			0.10			0.12			0.004			0.003			0.00005		
	(%)	0.05			0.03			0.005			0.18			0.002			0.0001		
Jacket-type WTGs (Ø 2 m × 4; 12.56 m²) with a seabed footprint of 500 m², seabed preparation for the offshore substation and cable route, installation vessel																			
Disturbance	(km²)		3.70			1.65			1.89			0.05			0.04			0.001	
	(%)		0.88			0.48			0.08			2.49			0.03			0.001	
Jacket-type WTG foundations (Ø 4 m × 4; 50.24 m²) and scour protection for the jacket-type offshore substation – 5,000 m²; cable protection – 20%.																			
Loss	(km²)	0.23			0.10			0.12			0.004			0.003			0.00005		
	(%)	0.05			0.03			0.005			0.18			0.002			0.0001		
Jacket-type WTGs (Ø 4 m × 4; 50.24 m²) with a seabed footprint of 1,200 m², seabed preparation for the offshore substation and cable route, installation vessel																			
Disturbance	(km²)		3.72			1.66			1.90			0.05			0.04			0.001	
	(%)		0.88			0.48			0.08			2.49			0.03			0.001	
Gravity-type WTG and offshore substation (foundation Ø 45 m) scour protection – Ø 60 m; cable protection – 20%																			

Broad habitat type		Circalittoral reef (1170)	Circalittoral coarse sediment	Circalittoral sand	Infralittoral mud	Infralittoral sand	Infralittoral reef (1170)
Loss	(km^2)	0.30	0.14	0.15	0.004	0.003	0.00005
	(%)	0.07	0.04	0.01	0.18	0.002	0.0001
Seabed preparation for gravity-type WTGs and the offshore substation (foundation Ø 45 m; Ø 400), cable route, installation vessel							
Disturbance	(km^2)	7.14	3.60	3.24	0.05	0.04	0.001
	(%)	1.70	1.04	0.14	2.49	0.03	0.001
Scour protection for gravity-type WTGs and the offshore substation – 75×75 m; cable protection – 20%							
Loss	(km2)	0.38	0.19	0.18	0.004	0.003	0.00005
	(%)	0.09	0.05	0.008	0.18	0.002	0.0001
Seabed preparation for gravity-type WTGs and the offshore substation (Ø 400), seabed preparation along the cable route, installation vessel							
Disturbance	(km^2)	7.06	3.56	3.21	0.05	0.04	0.001
	(%)	1.68	1.03	0.14	2.49	0.03	0.001

Note: The area of the MP foundation is not considered for the physical loss assessment, as it overlaps with the larger (Ø 45 m) scour protection area.

5.4.2.11 Cumulative impact

The potential cumulative impact is assessed from two main aspects:

1. Impact on the circalittoral sand habitat, as this habitat in the Lithuanian Baltic Sea is also affected by seabed excavation and dredging activities.
2. The cumulative impact of export cables on the “Natura 2000“ and protected reef habitats, since the export cable corridors of the CN and "Area D" offshore wind energy projects intersect the same habitats.

Impact on the circalittoral sand habitat. The main areas of seabed physical loss/disturbance due to seabed excavation and burial within the circalittoral sand habitat cover 21.31 km², amounting to 0.9% (Table 5.4.17).

According to the D6C3 criterion – "Seabed integrity ensures the conservation of ecosystem structure and functions and does not negatively affect benthic ecosystems" – the threshold for GES in Lithuania is ≤1%.

This indicates that currently, the extent of physical loss/disturbance in the circalittoral sand habitat does not exceed the GES criterion limit and thus complies with the requirements for GES under the D6C3 criterion.

Table 5.4.17. Areas of physical loss in habitats

Broad habitat type	Long-distance (offshore) dumping		Alternative dumping		Near dumping		Sand extraction		Total adverse effects	
	km²	%	km²	%	km²	%	km²	%	km²	%
Circalittoral sand (2,359.8 km²)	18.17	0.77	0.64	0.03	-	-	2.50	0.11	21.31 (21,45)[84]	0.90 (0.91)
Circalittoral mud (1,853.6 km²)	-	-	4.33	0.23	7.75	0.42	-	-	12.08	0.65

The implementation of the OWF project would result in a cumulative maximum physical loss of 0.92% in the circalittoral sand habitat, which would therefore not exceed the GES threshold value established in Lithuania under Criterion D6C3 – ≤1% (Table 5.4.18).

Table 5.4.18. Cumulative physical loss in the circalittoral sand habitat

Dominant habitat type: Circalittoral sand (area 2,360 km²)			
Area	**Source of habitat loss**	**km²**	**%**
CN (11 WTGs), cables	(1) Scour protection for monopile foundations, cables covering 20%	0.14	0.006
	(2) Jacket-type foundations (Ø 2 m × 4; 12.56 m²) cables covering 20%	0.12	0.005
	(3) Jacket-type foundations (Ø 4 m × 4; 50.24 m²) cables covering 20%	0.12	0.005
	(4) Scour protection for gravity-based foundations Ø 60 m, cables covering 20%	0.15	0.007
	(5) Scour protection for gravity-based foundations 75×75 m, cables covering 20%	0.18	0.008
“Area D”	(6) Export cables covering 20%	0.09	0.004
Damping and sand extraction	(7) Damping and sand extraction	21.45	0.91
Cumulative loss	(1), (6), (7)	21.68	0.92
	(2), (6), (7)	21.66	0.92
	(3), (6), (7)	21.66	0.92
	(4), (6), (7)	21.69	0.92

[84] AAA, 2025. Lietuvos jūros rajono aplinkos būklė 2018–2023 metais, geros aplinkos būklės savybės ir aplinkos apsaugos tikslai. https://aaa.lrv.lt/public/canonical/1744888274/3448/Lietuvos%20j%C5%ABros%20rajono%20aplinkos%20b%C5%ABkl%C4%97%202018-2023%20m.pdf

Dominant habitat type: Circalittoral sand (area 2,360 km²)			
Area	**Source of habitat loss**	**km²**	**%**
	(5), (6), (7)	21.72	0.92
Potential loss area for other economic activities (up to 1% threshold)		**1.88**	**0.08**

Cumulative impact of export cables from planned OWF. It has been assessed that the area of circalittoral reef habitat (1170) potentially affected by the export cable corridors installation within the “Natura 2000” area must not exceed 1% of the natural extent of this habitat, i.e., 0.663 km². To ensure this threshold is not exceeded, the width of the export cable corridor crossing this habitat should not exceed 27 meters (Table 5.4.19).

A significant cumulative impact on Circalittoral Sand Habitat is also recorded on the circalittoral sand habitat, as this habitat experiences adverse effects from dumping and sand extraction activities. The cumulative impact on this habitat in the Lithuanian Baltic Sea must not exceed 1% of its natural extent, i.e., 23.6 km² (Table 5.4.19).

Table 5.4.19. Impact of export cable corridors on circalittoral reef (1170) and circalittoral sand habitats within and outside the “Natura 2000” area

Territory	Impact (width of export cable corridor 27 m)	Klaipėda-Ventspils Plateau SAC			Entire habitat	
		Circalittoral reef (1170) (66.268 km²)	Circalittoral sand (101.72 km²)	Total (167.988 km²)	Circalittoral reef (1170) (420.8 km²)	Circalittoral sand (2,360 km²)
CN 2 cables: Northern and Southern	Length, km	10.564	19.085	29.649	28.95	35.72
	Impact area, km²	0.29	0.52	0.80	0.78	0.96
	Impact area, %	0.43	0.51	0.48	0.19	0.034
	Loss					
	km²	0.03	0.05	0.07	0.07	0.09
	%	**0.04**	0.05	0.04	**0.02**	0.004
	Disturbance					
	km²	0.26	0.47	0.73	0.71	0.88
	%	0.39	0.46	0.43	0.17	0.04
"Area D" 2 cables: Northern and Southern	Length, km	12.76	17.49	30.25	30.9	38.33
	Impact area, km²	0.34	0.47	0.82	0.83	1.03
	Impact area, %	0.52	0.46	0.49	0.20	0.04
	Loss					
	km²	0.03	0.04	0.07	0.07	0.09
	%	**0.05**	0.04	0.04	0.02	0.004
	Disturbance					
	km2	0.31	0.43	0.74	0.76	0.94
	%	0.47	0.42	0.44	0.18	0.04
Total	Length, km	23.32	36.575	59.90	59.85	74.05
	Impact area, km²	0.63	0.99	1.62	1.62	2.00
	Impact area, %	0.95	0.97	0.96	0.38	0.08
	Loss					
	km²	0.06	0.09	0.14	0.14	0.18
	%	**0.08**	0.09	0.09	0.03	0.01
	Disturbance					
	km²	0.57	0.90	1.47	1.47	1.82

Territory	Impact (width of export cable corridor 27 m)	Klaipėda-Ventspils Plateau SAC			Entire habitat	
		Circalittoral reef (1170) (66.268 km²)	Circalittoral sand (101.72 km²)	Total (167.988 km²)	Circalittoral reef (1170) (420.8 km²)	Circalittoral sand (2,360 km²)
	%	**0.87**	0.88	0.88	0.35	0.08
Loss/ Disturbance %		**0.95**	0.97	0.96	0.38	0.09

Other impacts (e.g., multi-purpose cables, military exercises) are non-cumulative and therefore excluded from the cumulative impact assessment of the OWF on circalittoral habitats.

5.4.2.12 Invasive and non-native species

The installation of OWF infrastructure introduces new hard substrates that serve as attachment surfaces for benthic invertebrates, potentially leading to artificial reef formation. While this can enhance local biodiversity under certain conditions, scientific studies highlight that such structures may also facilitate the establishment and spread of invasive species[85].

During the 2024 ecological surveys in the future OWF development area, no invasive species or new non-native species, including the invasive amphipod *Dikerogammarus villosus*,[86] were detected.

Concurrently, within the cable installation corridor, the occurrence sites of the rare polychaete *Boccardia proboscidea* in Lithuanian waters were verified and precisely mapped (unpublished data, Solovjova).

5.4.2.13 Measures for preventing, mitigating and compensating impacts on benthic habitats

During trench excavation, short-term and localised increases in water turbidity may occur. The magnitude will depend on:

- Seabed type (lower turbidity increase over hard substrates, higher over muddy or sandy bottoms).
- Local hydrodynamic conditions (currents and wave action).

If works are conducted only under favourable weather and sea conditions, turbidity increases will remain localised and short-term. Consequently, additional mitigation measures are not required.

As a compensatory measure within the designated "Natura 2000" area, artificial reef structures made from natural materials could be installed to promote benthic habitat restoration. Alternatively, the use of protective plates over cable crossings – designed to mimic the ecological functions of artificial reefs – could enhance recovery conditions for zoobenthic communities. To ensure ecological effectiveness, the protective plates should meet the following specifications: minimum dimensions of 1x1 m, porosity of 30–50%, pore size of 2–5 mm and be composed of limestone or alternative characteristics with scientifically proved ecological performance. The porous structure and calcium-enriched substrate attract mussel larvae, thereby accelerating mussel colonization and growth.[87] [88]

[85] Inger, R., Attrill, M. J., Bearhop, S., Broderick, A. C., James Grecian, W., Hodgson, D. J., ... & Godley, B. J. (2009). Marine renewable energy: potential benefits to biodiversity? An urgent call for research. *Journal of applied ecology*, *46*(6), 1145-1153.

[86] Šidagytė, E., Solovjova, S., Šniaukštaitė, V., Šiaulys, A., Olenin, S., & Arbačiauskas, K. (2017). The killer shrimp *Dikerogammarus villosus* (Crustacea, Amphipoda) invades Lithuanian waters, south-eastern Baltic Sea. *Oceanologia*, *59*(1), 85-91.

[87] Kraufvelin, P., Olsson, J., Bergström, U., Bryhn, A., & Bergström, L. (2021). Restoration measures for coastal habitats in the Baltic Sea: cost-efficiency and areas of highest significance and need.

[88] Swift, V. (2024). The effects of coastal artificial reefs on biodiversity, aquatic food security and ecosystem services.

Table 5.4.20. Summary of potential OWF impacts on benthic habitats and associated mitigation measures

Phase	Impact	Nature	Extent	Duration	Significance	Mitigation measures
Installation	Seabed sediment resuspension	Negative direct impact on vital functions of some benthic organisms	Local (installation site)	Short-term (only during installation works)	Negligible impact – the abundance of benthic organisms will not change significantly	Not applicable.
	Physical seabed habitat damage	Negative direct impact on habitat – loss or disturbance	Local (installation site)	Long-term (until decommissioning)	Minor significant impact – possible decrease in abundance of benthic fauna	Relocate boulders to adjacent areas outside the installation area.
Operation and maintenance	Seabed disturbance from anchoring	Negative direct impact (minor disturbance of existing habitats)	Local (small areas around individual WTGs)	Short-term (only during vessel presence)	Negligible – only a small portion of biotopes will be disturbed	Not applicable.
	Formation of secondary habitats	Positive direct impact (additional substrate increases habitat area, community diversity, and biomass)	Local (OWF area)	Long-term (until decommissioning)	Positive impact – new habitats will form on vertical substrates in the photic zone. In the aphotic zone, typical invertebrate communities will recover	Not applicable.
		Negative direct impact (vertical substrates may host non-native species)			Negligible impact – natural reefs exist at similar depths relatively close to the OWF area	Not applicable.
Decommissioning	Seabed sediment resuspension	Negative direct impact on vital functions of benthic organisms	Local (OWF area)	Short-term (only during decommissioning)	Negligible impact – the abundance of benthic organisms will not change significantly	Not applicable.
	Primary habitat recovery	Positive direct impact (conditions restored for original habitats recovery)	Local (small areas around individual WTGs)	Long-term (duration not dependent on the activity)	Negligible impact – abundance and biomass of benthic organisms will not significantly change	Not applicable.
	Loss of artificial habitats	Negative indirect impact	Local (OWF area)	Long-term (additional substrates removed)	Minor significant impact – may lead to a decrease in abundance and biomass, resulting in reduced food availability for birds and fish	Installation of artificial reefs.

Colour code

(green)	Positive impact
(light blue)	No impact or impact insignificant (not to be considered, no measures are applicable)
(blue)	Minor impact: decisions during design, preventive or mitigation measures

	Moderate impact: addressed by mitigation measures
	Significant impact: mitigation and/or compensation measures are necessary.

Table 5.4.21. Summary of potential impacts of offshore cable installation on benthic habitats and associated mitigation measures

Phase	Impact	Nature	Extent	Duration	Significance	Mitigation measures
Installation	Seabed sediment resuspension	Negative direct impact on some benthic organisms' vital functions	Local (export cable route and adjacent areas)	Short-term (only during installation woks)	Negligible impact – abundance of benthic organisms will not change significantly	Not applicable.
	Physical seabed habitat damage	Negative direct impact (habitat loss/ disturbance)	Local (export cable route area)	Short-term (up to 12 months for recolonization)	Minor significant impact – potential decrease in the abundance of benthic fauna	Relocate boulders to adjacent areas outside the installation area.
Operation and maintenance	Seabed sediment resuspension	Negative direct impact on some benthic organisms' vital functions	Local (repair zone and adjacent areas)	Short-term (only during fault repair works)	Negligible impact – abundance of benthic organisms will not change significantly	Not applicable.
	Physical seabed habitat disturbance	Negative direct impact (habitat disturbance)	Local (repair zone)	Short-term (up to 12 months for recolonization)	Negligible impact – no significant change in benthic organism abundance	Not applicable.
Decommissioning	Turbidity increase	Negative direct impact on benthic organisms' vital functions	Local (export cable removal zone and adjacent)	Short-term (only during decommissioning works)	Negligible impact – abundance of benthic organisms will not change significantly	Not applicable.
	Physical seabed habitat removal	Negative direct impact (habitat loss/ disturbance)	Local (export cable removal zone)	Long-term (recovery period independent of project activities)	Slightly significant impact – possible reduction in abundance and biomass – food availability for birds and fish may decline	Installation of artificial reefs.

Colour code

	Positive impact
	No impact or impact insignificant (not to be considered, no measures are applicable)
	Minor impact: decisions during design, preventive or mitigation measures
	Moderate impact: addressed by mitigation measures
	Significant impact: mitigation and/or compensation measures are necessary.

5.4.3 Birds offshore

More than 20 seabird species regularly occur in Lithuania's Baltic Sea region, with even more appearing during spring and autumn migrations. Geese, ducks, swans, herons, and various migratory passerines are commonly observed.

The area is particularly significant for wintering seabirds, with abundant concentrations of Velvet Scoters (*Melanitta fusca*), Long-tailed Ducks (*Clangula hyemalis*), Razorbills (*Alca torda*), Common Guillemots (*Uria aalge*), Red-throated Divers (*Gavia stellata*), Great Crested Grebes (*Podiceps cristatus*), and other species found in both coastal and open waters. Benthic feeders, such as diving sea ducks, typically forage at depths of 5–35 m, occasionally reaching 40–50 meters. Migratory birds like divers and auks can dive as deep as 50–60 m, with regular feeding occurring at around 20–30 meters. Consequently, seabird distribution is influenced by depth, food availability, and proximity to shore. Adjacent to the proposed PEA, “Natura 2000” areas serve to protect wintering bird populations.

The Baltic Sea is also a vital migration route for birds traveling to and from their wintering or breeding grounds. Wildfowl, cranes, divers, passerines, and other species migrate intensively over Lithuanian territorial waters, flying at varying altitudes – some close to the water and others several hundred meters above it.

During summer, only few bird species remain, including local breeders such as Great Cormorants (*Phalacrocorax carbo*) and Common Terns (*Sterna hirundo*), along with several gull species, including Herring Gulls (*Larus argentatus*), Common Gulls (*Larus canus*), Black-headed Gulls (*Chroicocephalus ridibundus*), and Great Black-backed Gulls (*Larus marinus*), which continue to utilise the coastal waters. In open sea, Common Guillemots and Little Gulls can be found (*Hydrocoloeus minutus)*.

5.4.3.1 Survey methods

5.4.3.1.1 Methods for assessing the current state

Birds at sea have been studied from two perspectives – evaluation of resting birds and evaluation of flying migrating birds. Resting birds in the context of seabirds refers to birds that are temporarily settled on the water's surface to rest often between foraging activities during migration or while wintering.

Methodological approach to studying resting birds:

- **Ship-based transect surveys**. Surveys were conducted according to a pre-planned transect plan and took place from May to October, at a frequency of one survey per month. The surveys adhered to the ESAS methodology (Garthe and Hüppop, 1996, 2000) and the German Federal Maritime and Hydrographic Agency (hereinafter – BSH) guidelines of German Standard Investigation of the Impacts of Offshore Wind Turbines on the Marine Environment (hereinafter – StUK4; BSH, 2013). While sailing the transect, all resting birds were registered within the transect.
- **Aerial digital transect surveys**. Surveys took place according to a pre-planned transect plan and were conducted from January to April and November to December, at a frequency of one survey per month. The recordings of resting birds were carried out using digital video technology developed by HiDef company, following the methodology outlined in the ESAS program (Garthe and Hüppop, 1996, 2000) and BSH guidelines of StUK4 (BSH, 2013). The methodology involved a digital video system mounted on a twin-engine, high-wing aircraft (OY-VPB Partenavia P68), which flew at approximately 220 km/h (120 knots) at altitudes above 500 m. The system was equipped with four high-resolution video cameras capturing footage at around 7 frames per second, with a resolution of 2 cm at sea level.

Methodological approach to studying flying migrating birds:

- **Visual monitoring of flying migrating birds**. Surveys were conducted from the vessel in stationary positions during spring (from late February to late April) and autumn migration (from late August to early December). Surveys done according to methodology, developed by a company BioConsult SH. Birds were observed from sunrise to sunset with two 15-minute efforts per hour with making not less than 5-minute breaks between efforts. All flying birds were recorded, registering the flight heights, direction and other parameters when possible.
- **Vertical radar monitoring of flying migrating birds**. Surveys were conducted from stationary positions during spring (from late February to late April) and autumn migration (from late August to early December). Surveys done according to methodology, developed by a company BioConsult SH. The radar was adjusted to stay perpendicular to the main migration flow, ensuring optimal bird detection within a 1,500-meter radius, both in height and distance from the ship. Specialised software captured radar screenshots every few minutes, recording all detected signals. The radar’s operation was continuously monitored, and if the ship changed

direction, the radar was realigned accordingly. Meteorological data was also collected to correct for weather conditions like precipitation or fog that could affect bird detection.

- **Nocturnal monitoring of migrating birds**. Surveys were conducted from a vessel, from stationary positions during spring (from late February to late April) and autumn migration (from late August to early December). The observations were made after sunset with stationary audio recording equipment or by listening twice every hour for 15 min. and doing 15 min. breaks during the night.

5.4.3.1.2 Methods for assessing potential impacts

The European Commission's guidance on wind energy development and EU nature protection legislation outlines that all wind energy projects must comply with the EU Birds Directive (2009/147/EC) and the Habitats Directive (92/43/EEC). While not prescribing specific methodologies for avian impact assessment, the guidance emphasizes that EIA procedures must include detailed evaluations of bird populations, particularly those using SPAs and sites important for migration, foraging, and overwintering.

The assessment of potential impacts on birds is carried out in accordance with applicable international and national legislation, methodologies, and a review of scientific literature. The criteria for determining significant adverse effects on birds are established in the document titled "*Description of Criteria for Significant Adverse Effects of Wind Turbines on Birds and Bats, Application of Prevention and Mitigation Measures, and Research Requirements*," approved by Order No. D1-406 of the Minister of Environment of the Republic of Lithuania on 12 December 2023.

To assess potential impacts on birds several factors were evaluated:

- Species composition and abundance – current situation both resting and migrating birds.
- Mean densities – individual density for all resting birds during all months of research was assessed.
- Spatial distribution – pinpoint and density maps were created to better understand resting bird distribution within research and the PEA areas.
- Flight altitudes – during visual observations from stationary position flight altitudes could be evaluated for every observed species, while with radar not only diurnal, but also nocturnal migration evaluated, and altitude distribution compared.
- Migration traffic rate – was modelled to every migration season and allows to evaluate whenever migration was most intense.
- Based on scientific literature and articles and following an analysis of the ecological behaviour of individual species, the main threats and their potential impacts have been identified.

5.4.3.2 Survey area

For transect surveys both ship-based and aerial, transect plans were prepared in advance. Designs were slightly different in 2023 and 2024 but covered most of the area of interest.

Ship-based transect surveys. The 2023 transect design consists of 6 parallel transects in total length of 155 km, covering an area of 533 km². The 2024 transect design consists of 8 parallel transects in total length of 170.1 km, covering an area of 616.5 km² (Fig. 5.4.21).

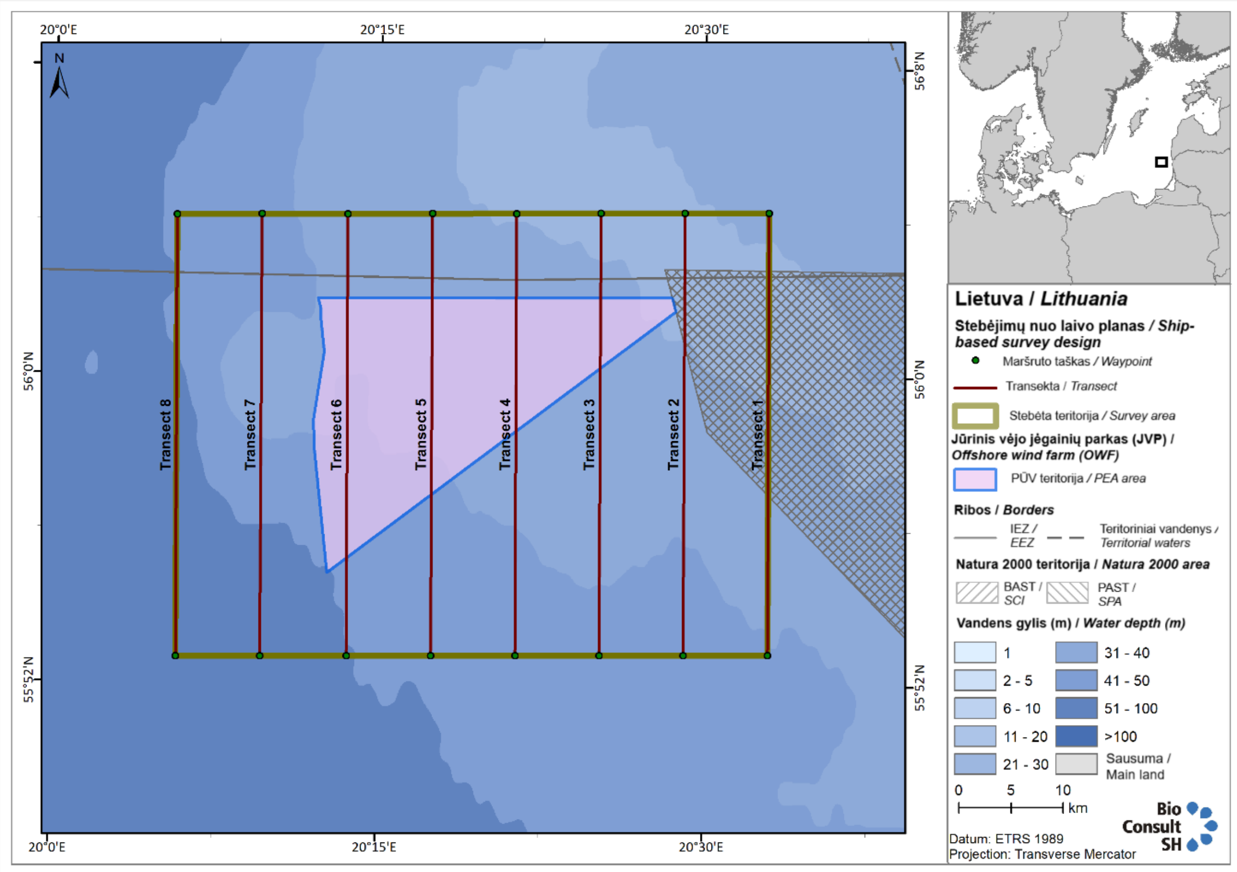


Fig. 5.4.21. Transect design for ship-based resting bird monitoring from May to October 2024.

Aerial digital transect surveys. Two transect designs were used between November 2022 and April 2023: the first for the flights in November 2022 and January 2023, and the second for the flights in February–April 2023. The initial design included 13 transects totalling 583.28 km and covering an area of 2,340 km². The transect design used from November 2023 to January 2025 covered 23,457 km², including the proposed OWF and adjacent areas, using 19 parallel transects (Fig. 5.4.22).

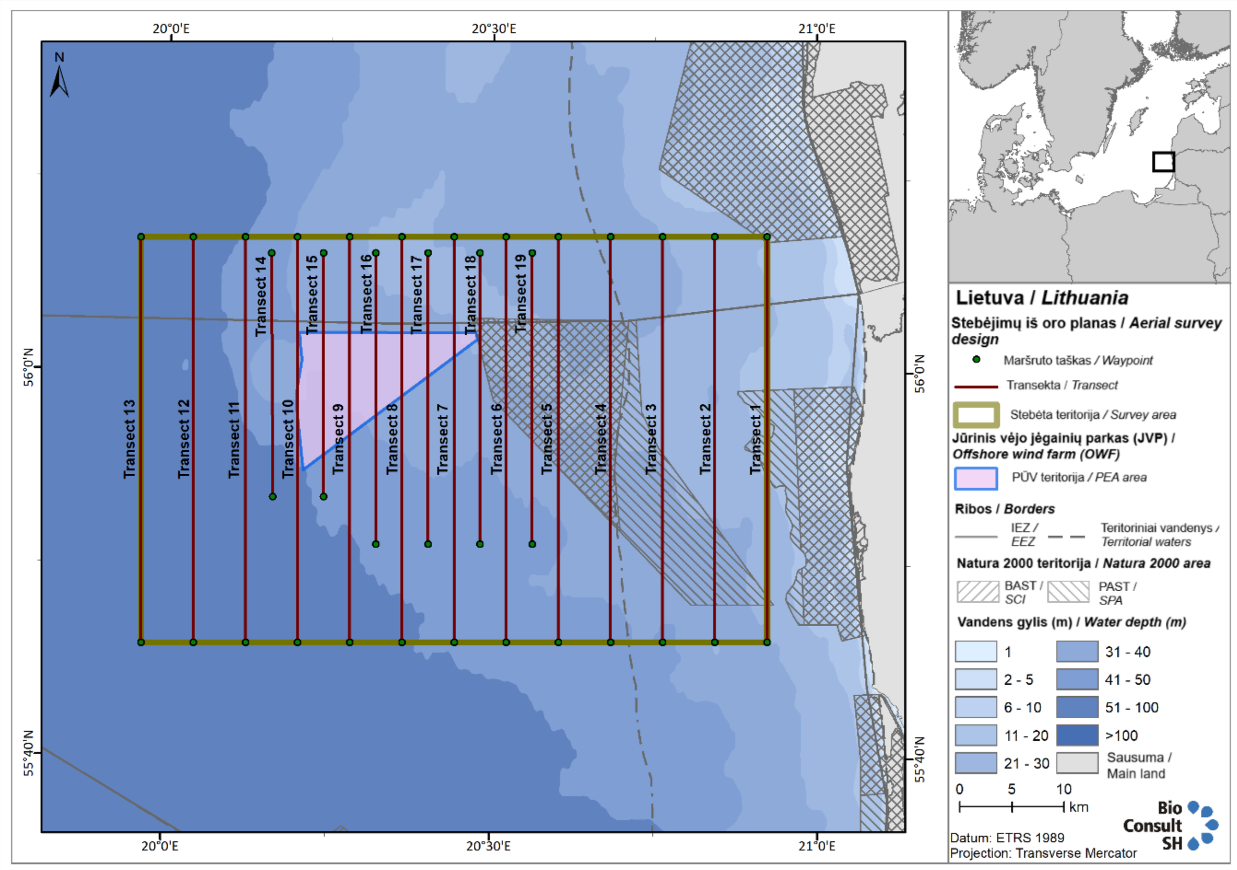


Fig. 5.4.22. Aerial survey transect design for the survey area November 2023–January 2025.

Stationary migration observations. All migration observations (visual, radar and nocturnal) were conducted from a stationary ship anchored in position. There were two locations: one for the spring migration observations in 2023, and another for the autumn migration observations in 2023, as well as for both migration observations in 2024 (see Fig. 5.4.23). The radar observation distance was 1,500 m radius from the position and the visual observation distance was up to 3,000 m (depending on the species) from the position.

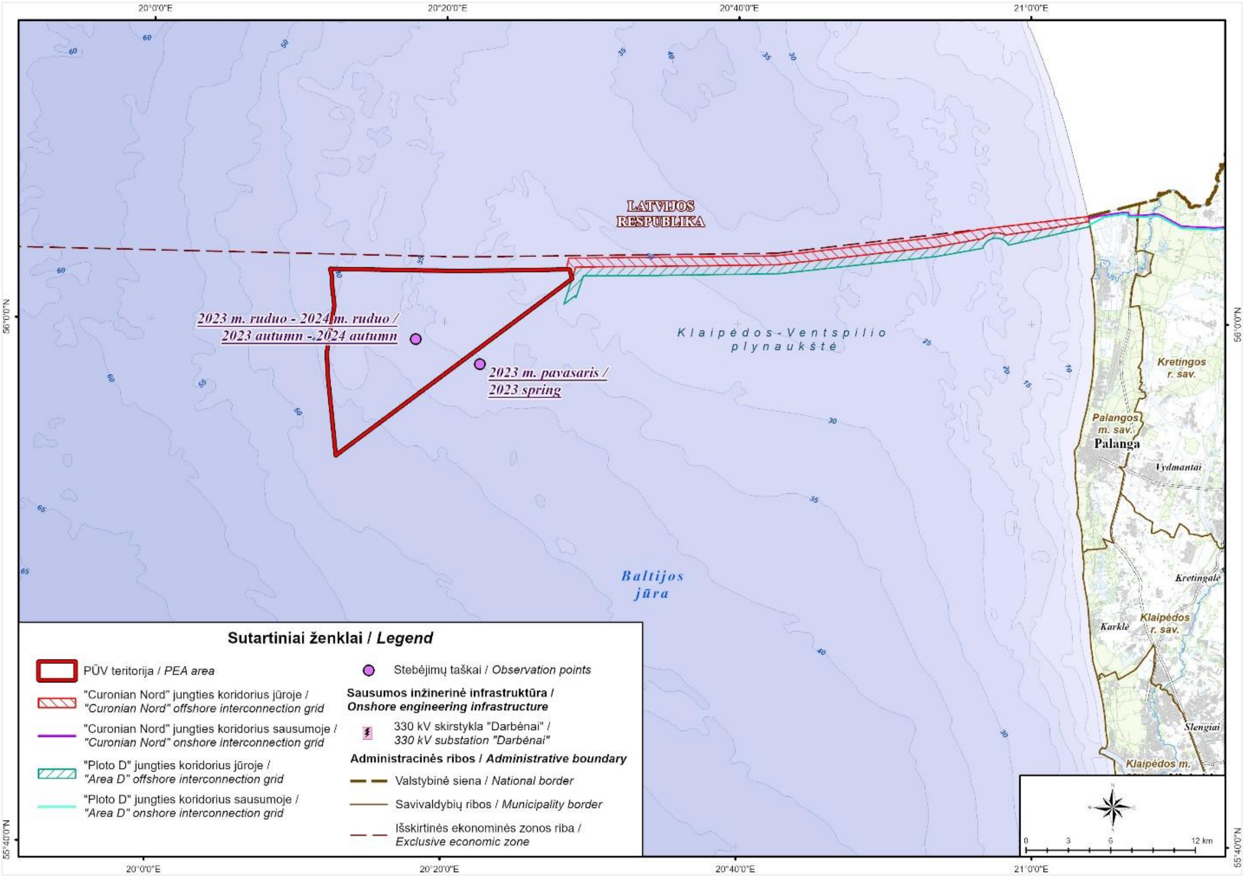


Fig. 5.4.23. Migration observation points.

5.4.3.3 Current state

5.4.3.3.1 Resting birds

Vessel-based transect surveys. Twelve ship-based surveys were conducted at a frequency of one per month in the area from May to October during the research in 2023 and 2024. A total of 2,644 birds from 38 species were recorded in 2023, and 3,014 birds from 44 species were recorded in 2024. Only resting birds (n = 2,008 in 2023 and n = 1,718 in 2024) within the transect area were included in the subsequent analysis (Table 5.4.3.1). Resting birds represented 15 species in 2023 and 18 species in 2024 within the transect areas.

Table 5.4.22. Bird abundance and percentage recorded during transect surveys conducted by ship (2023–2024)

English name	Scientific name	Vessel-based surveys, 2023		Vessel-based surveys, 2024	
		N° Ind.	%	N° Ind.	%
Red-throated Diver	*Gavia stellata*	1	<0.1	8	0.5
Black-throated Diver	*Gavia arctica*	88	4.4	79	4.6
Great Cormorant	*Phalacrocorax carbo*	21	1.0	51	3.0
Long-tailed Duck	*Clangula hyemalis*	11	0.5	2	0.1
Common Scoter	*Melanitta nigra*	0	0	13	0.8
Velvet Scoter	*Melanitta fusca*	5	0.2	32	1.9
Common Eider	*Somateria mollisima*	0	0	1	0.1
Arctic Skua	*Stercorarius parasiticus*	1	<0.1	7	0.4
Little Gull	*Hydrocoloeus minutus*	787	39.2	577	33.6
Black-headed Gull	*Chroicocephalus ridibundus*	0	0	6	0.3
Common Gull	*Larus canus*	122	6.1	107	6.2
Lesser Black-backed Gull	*Larus fuscus*	5	0.2	51	3.0

English name	Scientific name	Vessel-based surveys, 2023		Vessel-based surveys, 2024	
		N° Ind.	%	N° Ind.	%
European Herring Gull	*Larus argentatus*	445	22.2	306	17.8
Great Black-backed Gull	*Larus marinus*	2	0.1	2	0.1
Sandwich Tern	*Thalasseus sandvicensis*	1	<0.1	1	0.1
Common Tern	*Sterna hirundo*	2	0.1	1	0.1
Common Guillemot	*Uria aalge*	469	23.4	430	25.0
Razorbill	*Alca torda*	48	2.4	44	2.6
Total		**2,008**	**100**	**1,718**	**100**

During ship-based surveys, gulls and auks were the most abundant bird groups, accounting for 67.8% and 25.7% of all observations in 2023, and 61.1% and 27.6% in 2024, respectively. Divers (4.4% in 2023 and 5.1% in 2024), cormorants (1% in 2023 and 3% in 2024) and sea ducks (0.8% in 2023 and 1.8% in 2024), were recorded much less frequently (Fig. 5.4.24).

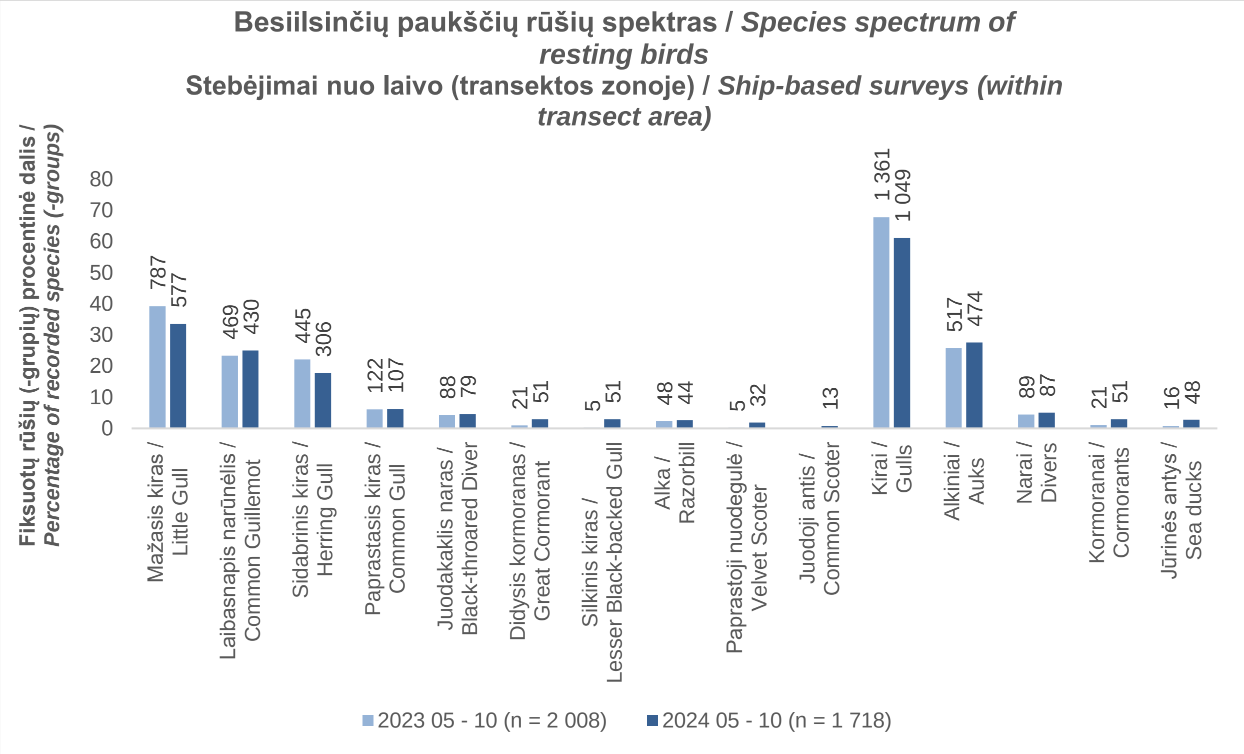


Fig. 5.4.24. Percentage of common species/groups (≥0.5% of resting birds) recorded in transect areas during ship-based surveys (2023–2024), with individual counts above bars.

Little Gull was the most abundant species during both years, accounting for 39.2% in 2023 and 33.6% in 2024 of all resting birds recorded across the surveys. Common Guillemot was second most numerous species - 23.4% in 2023 and 25.0% in 2024. Herring Gull (22.2% in 2023 and 17.8% in 2024) followed in dominance. Together, the top three species comprised 84.7% of all resting bird sightings within the transect in 2023 and 76.4% in 2024.

The number of resting individuals, recorded during the ship-based transect surveys, was adjusted to account for data collection errors. The monthly mean densities of the most frequently resting bird species (ind./km²) were then calculated (Table 5.4.3.2). This was achieved by dividing the total count of birds per species within the transect by the corresponding total survey area, incorporating correction factors for swimming and diving birds.

Once again, the Little Gull was the most abundant species, with the highest density recorded at 5.88 individuals per km² in 2023 and 6.65 individuals per km² in 2024. The species peaked in August in 2023 and in July in 2024. It was also numerous in July of 2023 - 5.51 ind./km². The species also was recorded in densities above 1 ind./km² in June of 2023 (2.00); in May (1.48) and August (2.19) of 2024.

The Common Guillemot was another species recorded at high densities, with 3.57 individuals per km² registered in August 2024. It was also abundant in September, May and October 2024, with densities of 2.8, 1.38 and 1.28 ind./km², respectively. The Common Guillemot was also numerous in September 2023; however, due to technical inaccuracies, its density was incorrectly estimated at 9.09 and it was not included in the subsequent analysis to avoid distorting the data.

Only two more species were recorded at densities above 1 ind./km²: the European Herring Gull in May (1.64), August (1.98) and October (1.60) of 2023 and in July (1.95), August (1.05) and September (1.08) of 2024, and the Black-throated Diver in May (1.28) of 2023 and May (1.12) of 2024.

Table 5.4.23. Monthly mean densities (ind./km²) of selected species from ship-based surveys (2023–2024) (*the average density of Common Guillemot in September 2023 is incorrectly estimated due to technical inaccuracies)

Survey Method	Vessel-based surveys													
Species	**2023 05**	**2023 06**	**2023 07**	**2023 08**	**2023 09**	**2023 10**	**Max**	**2024 05**	**2024 06**	**2024 07**	**2024 08**	**2024 09**	**2024 10**	**Max**
Red-throated Diver	0	0	0	0	0	**0.01**	**0.01**	**0.09**	0	0	0	0	0.01	**0.09**
Black-throated Diver	**1.28**	0	0	0	0	0.06	**1.28**	**1.12**	0	0	0	0.15	0.03	**1.12**
Great Cormorant	0	0.01	0	0.07	0	**0.14**	**0.14**	0.03	0	0	0	**0.52**	0	**0.52**
Long-tailed Duck	0.01	0	0	0	0	**0.10**	**0.10**	**0.02**	0	0	0	0	0	**0.02**
Common Scoter	0	0	0	0	0	0	**0**	0.01	0	0	0	0	**0.14**	**0.14**
Velvet Scoter	0	0	0	0	0	**0.05**	**0.05**	0.07	0	0	**0.17**	0	0.12	**0.17**
Common Eider	0	0	0	0	0	0	**0**	**0.01**	0	0	0	0	0	**0.01**
Black-headed Gull	0	0	0	0	0	0	**0**	0	**0.03**	0.01	0.02	0	0.01	**0.03**
Little Gull	0.15	2.00	5.51	**5.88**	0.05	0.37	**5.88**	1.48	0.04	**6.65**	2.19	0.03	0.12	**6.65**
Common Gull	0.18	0.07	0.25	0.22	0.08	**0.67**	**0.67**	0.06	0.04	**0.75**	0.15	0.18	0.35	**0.75**
Lesser Black-backed Gull	0	0.01	0	**0.03**	0.02	0	**0.03**	**0.58**	0	0	0.04	0.14	0	**0.58**
Great Black-backed Gull	0	0	0	**0.04**	0	0	**0.04**	0	0.01	**0.02**	0	0	0	**0.02**
European Herring Gull	1.64	0.14	0.47	**1.98**	0.51	1.60	**1.98**	0.14	0.34	**1.95**	1.05	1.08	0.37	**1.95**
Sandwich Tern	0	0	0	0	**0.01**	0	**0.01**	0	0	0	0	0	**0.01**	**0.01**
Common Tern	0	0	0	**0.02**	0	0	**0.02**	**0.01**	0	0	0	0	0	**0.01**
Common Guillemot	0	0.06	0.72	**0.83**	(9.09)*	0.75	**0.83**	1.38	0.12	0.39	**3.57**	2.8	1.28	**3.57**
Razorbill	0.09	0.01	0	0	0	**0.41**	**0.41**	**0.47**	0.01	0	0	0	0.25	**0.47**
No. of surveys	**1**	**1**	**1**	**1**	**1**	**1**		**1**	**1**	**1**	**1**	**1**	**1**	

*The average density of Common Guillemot in September 2023 was incorrectly assessed due to technical inaccuracies.

Aerial digital transect surveys. A total of five surveys were conducted between November 2022 and April 2023, six aerial surveys were carried out between November 2023 and April 2024 and a further three were conducted between November 2024 and January 2025. For better data representation in this report, will be named as aerial surveys 2023, aerial surveys 2024 and aerial surveys 2025 respectively.

A total of 9,941 birds belonging to 28 species were recorded during these surveys, including 9,478 resting birds in 2023, 7,049 birds belonging to 20 species (including 6,616 resting birds) in 2024, and 5,782 birds belonging to 24 species (including 5,661 resting birds) in 2025. Of these, 8.6% (817) in 2023, 15.7% (1043) in 2024 and 8.1% (461) in 2025 could not be identified at species level but could be identified at genus or family level. Only the resting birds (n = 9,478 in 2023; n = 6,616 in 2024; and n = 5,661 in 2025) were included in the further analysis (Table 5.4.24).

Table 5.4.24. Bird counts and percentages of resting bird species from aerial transect surveys (2023–2025). Species comprising at least 0.5% abundance are detailed in the results

English name	Scientific name	Aerial surveys					
		2023		2024		2025	
		N° Ind.	%	N° Ind.	%	N° Ind.	%
Red-throated Diver	*Gavia stellata*	684	7.22	599	9.05	178	3.14
Black-throated Diver	*Gavia arctica*	34	0.36	11	0.17	12	0.21
Unidentified diver	*Gavia sp.*	36	0.38	59	0.89	35	0.62
Great Crested Grebe	*Podiceps cristatus*	4	0.04	0	0	0	0
Red-necked/Great Crested Grebe	*Podiceps grisegena / Podiceps cristatus*	2	0.02	0	0	0	0
Unidentified grebe	*Podiceps sp.*	2	0.02	4	0.06	2	0.04
Great Cormorant	*Phalacrocorax carbo*	5	0.05	7	0.11	0	0
Long-tailed Duck	*Clangula hyemalis*	1,208	12.75	640	9.67	381	6.73
Common Scoter	*Melanitta nigra*	35	0.37	33	0.5	4	0.07
Velvet Scoter	*Melanitta fusca*	2,511	26.49	2,073	31.33	2,559	45.20
Common / Velvet Scoter	*Melanitta nigra / Melanitta fusca*	152	1.6	201	3.04	46	0.81
Common Eider	*Somateria mollissima*	0	0	5	0.08	0	0
Little Gull	*Hydrocoloeus minutus*	1,631	17.21	514	7.77	578	10.21
Black-headed Gull	*Chroicocephalus ridibundus*	30	0.32	2	0.03	0	0
Unidentified small gull		77	0.81	25	0.38	17	0.30
Common Gull	*Larus canus*	256	2.7	93	1.41	66	1.17
Herring Gull	*Larus argentatus*	387	4.08	317	4.79	301	5.32
Common / Herring Gull	*Larus canus / Larus argentatus*	15	0.16	42	0.63	7	0.12
Lesser Black-backed Gull	*Larus fuscus*	3	0.03	13	0.2	0	0
Great Black-backed Gull	*Larus marinus*	9	0.09	10	0.15	7	0.12
Lesser / Great Black-backed Gull	*Larus fuscus / Larus marinus*	0	0	1	0.02	0	0
Unidentified large gull	*Larus (magnus) sp.*	20	0.21	23	0.35	6	0.11
Black-legged Kittiwake	*Rissa tridactyla*	1	0.01	0	0	0	0
Unidentified gull	*Larus sp.*	6	0.06	18	0.27	1	0.02
Unidentified tern	*Sterna sp.*	1	0.01	0	0	0	0
Unidentified tern / gull		2	0.02	0	0	0	0
Common Guillemot	*Uria aalge*	1,085	11.45	736	11.12	880	15.54
Razorbill	*Alca torda*	773	8.16	520	7.86	249	4.40
Common Guillemot / Razorbill	*Uria aalge / Alca torda*	503	5.31	664	10.04	332	5.86

English name	Scientific name	Aerial surveys					
		2023		2024		2025	
		N° Ind.	%	N° Ind.	%	N° Ind.	%
Black Guillemot	*Cepphus grylle*	4	0.04	0	0	0	0
Unidentified auk	*Alcidae*	2	0.02	6	0.09	0	0
	Total	**9,478**	**100**	**6,616**	**100**	**5,661**	**100**

Sea ducks were the predominant group among resting birds, accounting for 41.2% of the total in 2023, 44.6% in 2024 and 52.8% in 2025. Gulls comprised 25.7% in 2023, 16.0% in 2024 and 17.6% in 2025; Auks 25.0% in 2023, 29.1% in 2024 and 25.8% in 2025, while divers, mainly Red-throated Divers, made up 8.0% in 2023, 10.1% in 2024 and only 3.9% in 2025 of the observed birds during the survey periods (Fig. 5.4.25).

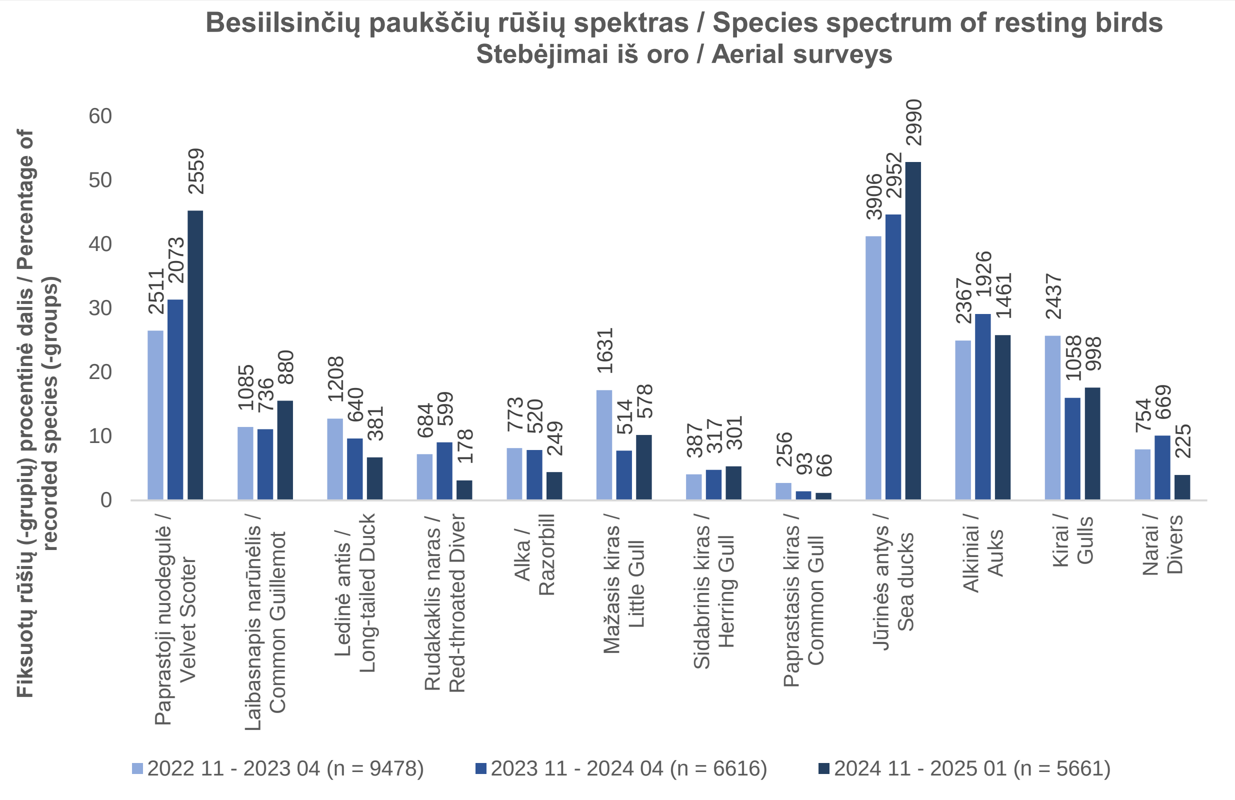


Fig. 5.4.25. Percentage of common species/groups (≥0.5% of resting birds) recorded in transect areas during digital aerial surveys (2022 11–2025 01), with individual counts above bars.

The Velvet Scoter was the most abundant species, representing 26.5% of all resting birds in 2023, 31.3% in 2024, and 45.2% in 2025. Other notable species included the Little Gull 17.2% in 2023, 7.8% in 2024 and 10.2% in 2025, Long-tailed Duck 12.7% in 2023, 9.7% in 2024 and 6.7% in 2025, Common Guillemot 11.4% in 2023, 11.1% in 2024 and 15.5% in 2025. Razorbills, Red-throated Divers, Herring Gulls, and Common Gulls each accounted for less than 10% of the total resting bird population during all years.

Densities (ind./km²) were calculated for all relevant resting bird species (Table 5.4.25). This was done by dividing the number of detected individuals per species in each survey by the transect area (“effort”). Since aircraft have minimal impact on bird flight behaviour, no correction factors were applied to species abundances in aerial surveys, assuming all individuals were captured in the images.

Four species were recorded in densities >1 ind./km² in 2023, two in 2024 and four in 2025. Velvet Scoter was most abundant in January of 2025 – 7.16 ind./km², also was abundant in January and February in 2023 and 2024 – 2.89 and 3.66 ind./km² respectively in 2023 and 2.08 and 2.3 ind./km² respectively in 2024, while in December of 2024, density reached 3.27 ind./km². Little Gull was most numerous in November 2022 – 4.06 ind./km²; Long-Tailed Duck was most numerous in January and February of 2023 (2.08 and 1.19 ind./km² respectively), also in January of 2025 – 1.04 ind./km²; Common Guillemot – 2.0 ind./km² in January 2025 and 1.43 ind./km² in November 2022; Red-throated

Diver was most abundant in March of 2024 – 1.06 ind./km²; and Herring Gull peaked in December 2024 with density of 1.05 ind./km².

Table 5.4.25. Monthly mean densities (ind./km²) of selected species from aerial surveys (2023–2025)

Survey Method	Digital aerial surveys															
Species/Dates	2022 11	2023 01	2023 02	2023 03	2023 04	Max.	2023 11	2023 12	2024 01	2024 02	2024 03	2024 04	Max.	2024 11	2024 12	2025 01	Max.
Red-throated Diver	0.38	0.27	0.61	**0.64**	0.16	**0.64**	0.04	0.11	0.1	0.47	**1.06**	0.16	**1.06**	**0.38**	<0.01	0.12	**0.38**
Black-throated Diver	**0.07**	0	0.02	0	0.02	**0.07**	0	0.01	0	<0.01	<0.01	**0.02**	**0.02**	**0.03**	0	0	**0.03**
Great Cormorant	0	0	0	**0.01**	0	**0.01**	0	0	0	<0.01	**0.02**	<0.01	**0.02**	0	0	0	**0**
Long-tailed Duck	0.03	**2.08**	1.19	0.42	0.01	**2.08**	0.33	0.16	0.4	0.33	**0.62**	0.24	**0.62**	0.06	0.61	**1.04**	**1.04**
Common Scoter	0	0	**0.09**	0.01	0	**0.09**	0	<0.01	0	0	0	**0.1**	**0.1**	**0.01**	0	0	**0.01**
Velvet Scoter	0.11	2.89	**3.66**	0.94	0.04	**3.66**	0.18	0.77	2.08	**2.3**	1.78	<0.01	**2.3**	0.37	3.27	**7.16**	**7.16**
Little Gull	**4.06**	0.84	0.46	0.15	0.06	**4.06**	0.37	**0.93**	0.12	0.03	0.16	0.36	**0.93**	**0.91**	0.37	0.35	**0.91**
Common Gull	**0.61**	0.04	0.09	0.1	0.02	**0.61**	0.11	**0.12**	0.01	0.02	0.04	0.03	**0.12**	0.09	**0.17**	0.05	**0.17**
Lesser Black-backed Gull	0	0	0	0	**0.01**	**0.01**	0	0	0	0	0	**0.04**	**0.04**	0	0	0	**0**
Great Black-backed Gull	0	0	**0.02**	0	0.01	**0.02**	0	**0.02**	<0.01	0	0.01	0.01	**0.02**	<0.01	0	**0.01**	**0.01**
European Herring Gull	**0.68**	0.24	0.16	0.15	0.03	**0.68**	0.27	**0.36**	0.12	0.09	0.22	0.06	**0.36**	0.43	**1.05**	0.29	**1.05**
Common Guillemot	**1.43**	0.51	0.55	0.68	0.26	**1.43**	0.46	0.45	0.18	**0.51**	0.37	0.47	**0.51**	**2**	0.32	0.5	**2**
Razorbill	**0.96**	0.48	0.51	0.49	0.02	**0.96**	0.23	0.22	0.03	0.41	**0.7**	0.1	**0.7**	0.22	0.31	**0.42**	**0.42**
No. of surveys	**1**	**1**	**1**	**1**	**1**		**1**	**1**	**1**	**1**	**1**	**1**		**1**	**1**	**1**	

5.4.3.3.2 Migrating, flying birds

Visual monitoring of flying migrating birds. A total of 48 surveys were conducted between March 2023 and late November 2024, during the autumn and spring seasons. A total of 14,400 migrating or passing birds were observed. 9,690 birds were recorded during the spring migration and 4,710 during the autumn migration. The bird species were divided into groups (see Table 5.4.26).

Table 5.4.26. Species groups registered during spring and autumn migrations (grouped by total abundance)

Species groups	Spring N° Ind.	%	Autumn N° Ind.	%	Total
Gulls	3,175	32.77	2,916	61.91	6,091
Ducks	2,411	24.88	655	13.91	3,066
Passerines	1,228	12.67	233	4.95	1,461
Auks	797	8.22	538	11.42	1,335
Geese	461	4.76	221	4.69	682
Pigeons	616	6.36	0	0	616
Cormorants	317	3.27	34	0.72	351
Waders	322	3.32	7	0.15	329
Divers	185	1.91	28	0.59	213
Swans	40	0.41	70	1.49	110
Cranes	91	0.94	0	0	91
Herons	21	0.22	0	0	21
Skuas	9	0.09	4	0.08	13
Birds of Prey	7	0.07	1	0.02	8
Owls	4	0.04	2	0.04	6
Terns	3	0.03	1	0.02	4
Grebes	3	0.03	0	0	3
Total	**9,690**	**100**	**4,710**	**100**	**14,400**

Gulls was the most abundant group of flying birds. It is nearly impossible to determine if the gull species observed were on migrations or just passing by. European Herring Gull was dominating in the group (n = 4,052) with 66.5% from all observed gull species. European Herring Gull was most numerous during autumn of 2023 (n = 1568). Another abundant species observed flying over – Lesser Black-backed Gull (n = 1,058). Migrating birds mostly observed during spring migration 98.4% of all species observations. Common Gull (n=720) was third gull species by abundance and was observed more in autumn (n = 449). In comparison, Little Gull being numerous both during ship-based and aerial surveys, has not been recorded often (n = 134) with 84 birds registered flying during autumn and 50 birds during spring migration.

Ducks was the second group by abundance of all registered flying birds. Sea ducks (Common Scoter, Velvet Scoter, Long-tailed Duck, Common Merganser and Red-breasted Merganser) were most numerous (n = 2,294) and compiled 74.8% of all registered ducks. Long-tailed Duck was the recorded the most (n = 1,029) with highest abundance during spring migration, especially in spring of 2024 (n = 732). Both scoter species, were observed in similar quantities with Velvet Scoter (n = 754) leading compared to Common Scoter (n = 452) and were more abundant during spring migration in 2024 (35.5% form all scoter observations). From the rest of duck species, only 3 species were recorded in abundances higher than 100 – Eurasian Wigeon (n = 291), Mallard (n = 174) and Greater Scaup (n = 146) with most registrations in spring for all 3 species.

Majority of passerines were observed during spring migration (84.1% from all recorded passerines). From the group, all thrush species combined were most abundant (n = 347) and compiled 23.7% from all the birds registered in passerine group. Other species or groups most frequently observed flying by tits (n = 266); Eurasian Skylark (n = 240); Common Starling (n = 226); finches (n = 170). There rest were recorded in numbers from 1 to 36 individuals.

Auks were also numerous during observations. Razorbill was the most dominant species (n = 894) and compiled 66.9% of all auks with 64.5% of registrations being in spring and more abundant in 2024 (n = 309). Common Guillemots were recorded more abundant in autumn seasons (n = 196) wile more abundant in 2024. Due to species similarity and observations in high distances, sometimes it was impossible to identify auks to species level, therefore some of the observations were registered as Razorbill / Common Guillemot (n = 117).

All the rest of the bird groups were recorded in abundances lower than 1,000 individuals, but it is worth mentioning some of the vulnerable species. Divers (n = 213) compiled only 1.5% of all migrating flying birds. Black-throated Diver was most abundant species from the group (51.2%) and was registered mainly during spring migration – 85.3% of species observations with majority in 2023. Red-throated Diver (n = 46) was also more abundant in spring with majority of registrations during spring migration in 2023. Due to species similarity and observations in high distances, sometimes it was impossible to identify divers to species level, therefore some of the observations were registered as Red-throated / Black-throated Diver (n = 58).

Common Cranes were scarce in the area (n = 91) and were registered only during spring migration in 2023 in 2 flocks of 5 and 51 birds in March and one flock of 35 birds in April. In comparison, during earlier counts in the area in adjacent territory, 81 Common Cranes were counted, also only during spring migration.

During daylight observations, altitudes were evaluated for all migrating flying birds. Later data was grouped in altitude classes for better analysis and representation (Fig. 5.4.26). According to the specifications of considered WTG models, safe and vulnerable altitude zones were established. Safe being from 1 to 25 m and from 271 m above and sensitive is considered from 26 to 270 meters. Sensitive zone considered as swept area.

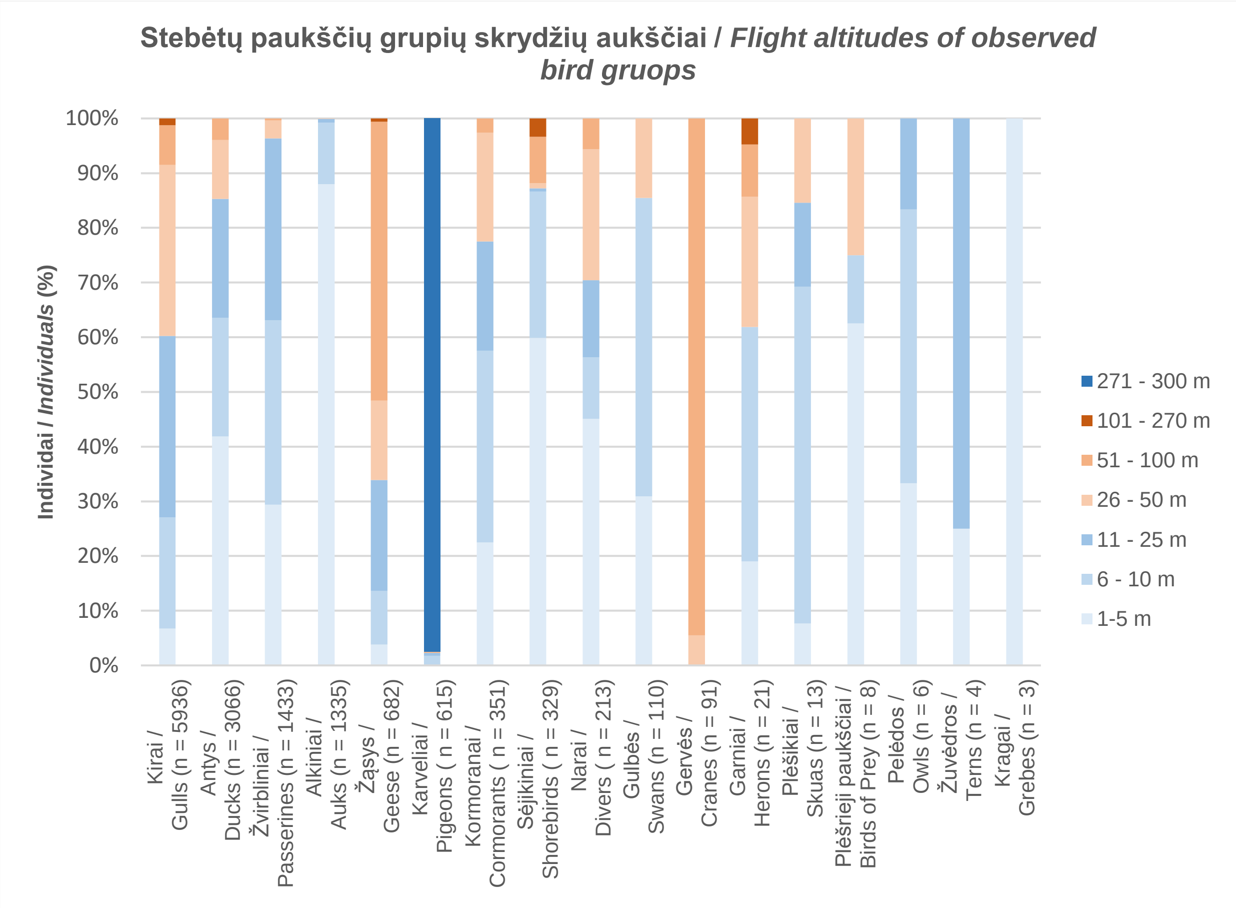


Fig. 5.4.26. Flight altitudes of birds observed in daylight hours.

Out of all bird groups observed, crane group was observed flying only in sensitive altitudes, though registrations were scarce and only 3 flocks of Common Cranes recorded and observed only during spring migration of 2023. Majority of migrating birds from geese group were also registered flying in sensitive heights – 66.1% of all recorded geese species and were more abundant during spring migration. Another 3 groups, with high percentage of flying birds in sensitive altitudes, were gulls (39.7%), herons (38.1%) and divers (29.6%). Only birds from owl, tern and grebe groups were observed flying only in safe altitudes even though there were only few records of last three groups. Only one individual from auk group (0.07% from all auk registrations) was recorded flying in sensitive altitude. Pigeons were observed in safe altitudes with majority of the group (n = 600) being a single observation of flock of Common Wood Pigeons migrating in 300 m altitude in March of 2023. Passerines were mostly recorded flying in safe altitudes (96.4%). Five more groups with highest percentage of birds flying in safe altitudes – waders (87.2%), swans (85.4%), ducks (85.3%), skuas (84.6%) and cormorants (77.5%).

Vertical radar monitoring of flying migrating birds. The vertical radar method was employed, with the radar adjusted to remain perpendicular to the primary migration flow. Even though the migration direction is species-specific, the main direction was considered towards northeast in spring ant towards southwest in autumn. Radar detected all bird signals within a 1,500-meter radius. Specialised software captured screenshots of the radar screen and recorded all detected signals at regular intervals. The radar's operation was continuously monitored, and if the ship's course changed, the radar was realigned to maintain its perpendicular position relative to bird migration. Additionally, meteorological data was collected to account for potential interference from precipitation, fog, or other atmospheric conditions.

Normally, one vertical radar unit was used for flying migrating bird monitoring, but due to technical issues, and involvement of additional vessel, second radar unit was engaged on several occasions in autumn of 2023 and spring and autumn of 2024. However, both radar units had identical technical parameters and calibrated to gather equivalent data. To assess the reliability of signal distances recorded by either vertical radar, several models of expected values were developed. By comparing expected values with the observed data, it was confirmed that the radar accurately recorded the signals.

During the spring migration of 2023, 3,828 bird flight signals were recorded by the radar, while during spring of 2024 – 3,509. During autumn migration of 2023, there were only 1,850 bird flight signals recorded and during autumn migration of 2024 – 1,721. All recorded signals presented in figures from 5.4.27 to 5.4.33. Overall, these are very low numbers of migratory birds recorded in the area. The main direction of spring migration is north, north-east, while in autumn – migration is south, south-west and south-east. This corresponds to the direction of the eastern Baltic Sea coast, so most birds use the mainland route and fly along the coast above the land or close to the sea. During the bird surveys carried out by the Lithuanian Ornithological Society and Klaipėda University on a narrow stretch of coastline about 1–2 km from the sea to the mainland near Klaipėda, during the peak of the migration in October, between 170,000 and 250,000 birds, mainly passerines, pass over the coastline in half a day (from 7 a.m. till midday). Based on the radar surveys held by other countries in other parts of the Baltic and North Seas, it can be assumed that the migration is not too intense in this Lithuanian part of the Baltic Sea (pers. comm. Jorg Welcker, Andres Kalamees).

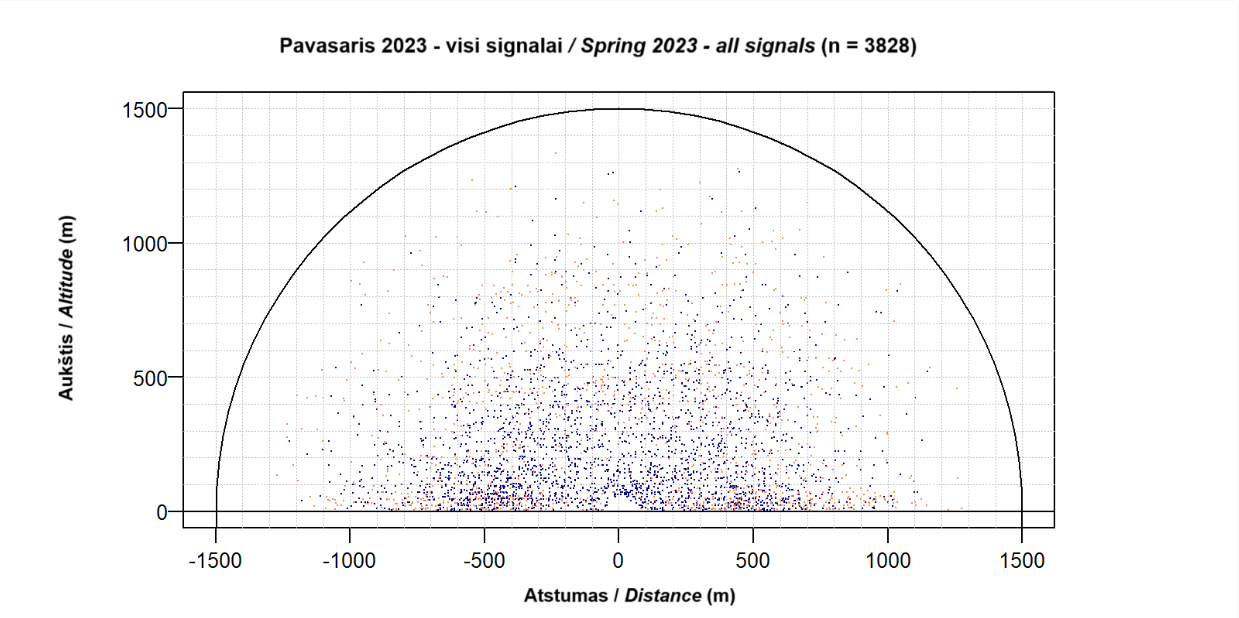


Fig. 5.4.27. All bird flight signals recorded by radar "VisionMaster" in spring of 2023.

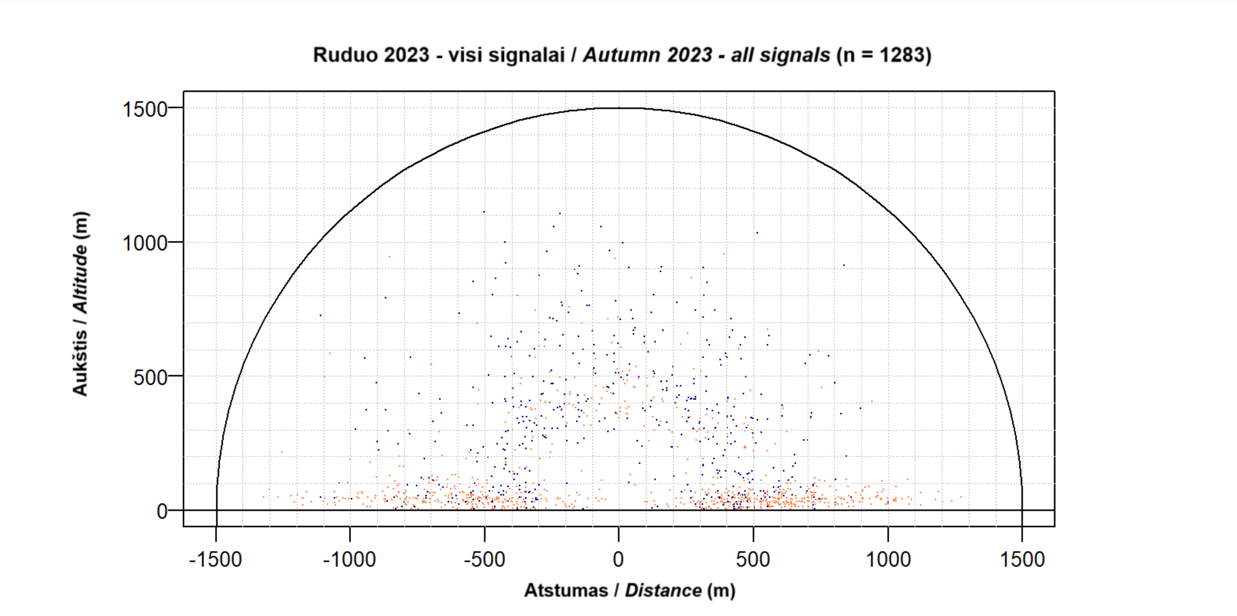


Fig. 5.4.28. All bird flight signals recorded by radar “VisionMaster” in autumn of 2023.

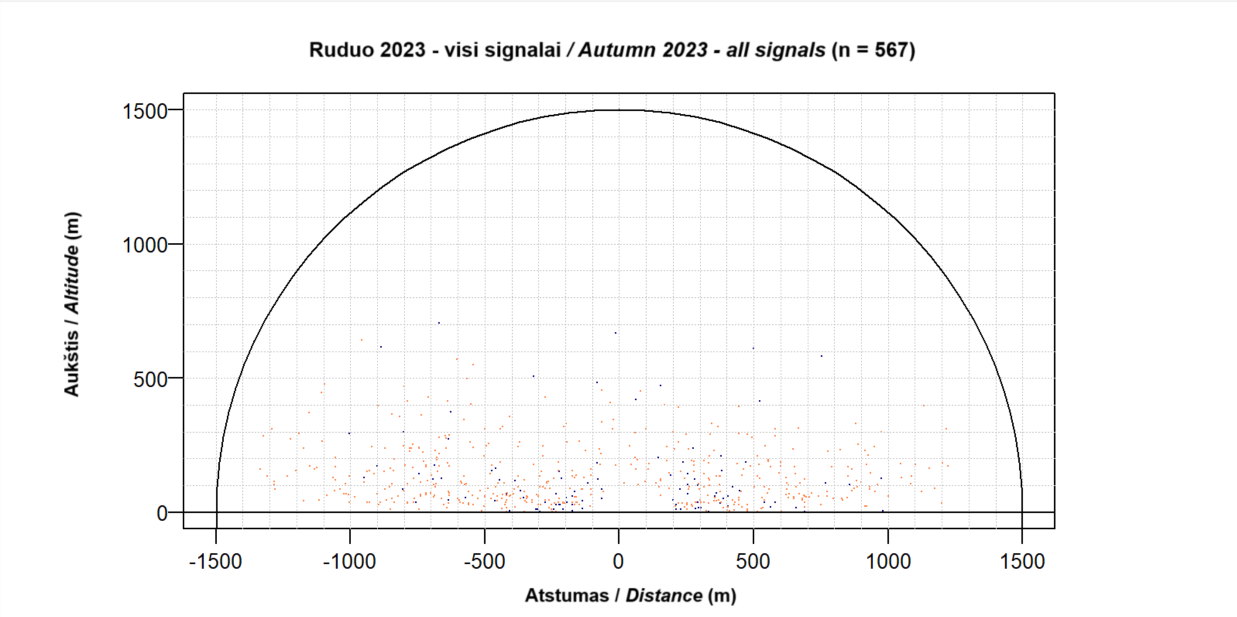


Fig. 5.4.29. All bird flight signals recorded by radar “Furuno” in autumn of 2023.

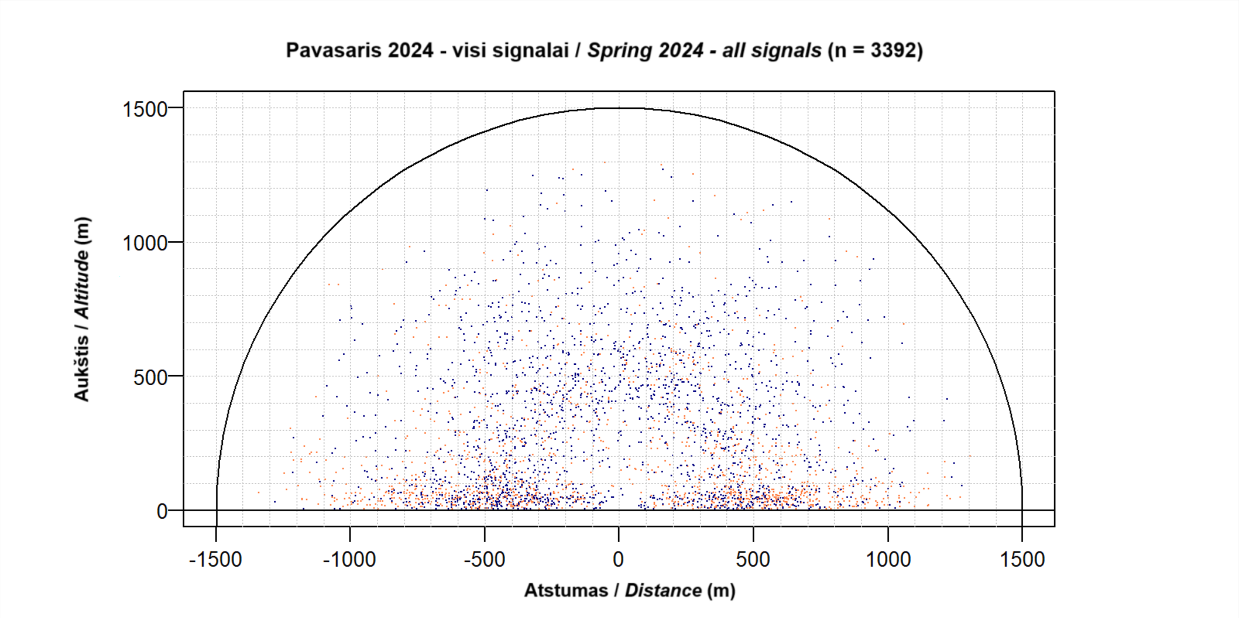


Fig. 5.4.30. All bird flight signals recorded by radar “VisionMaster” in spring of 2024.

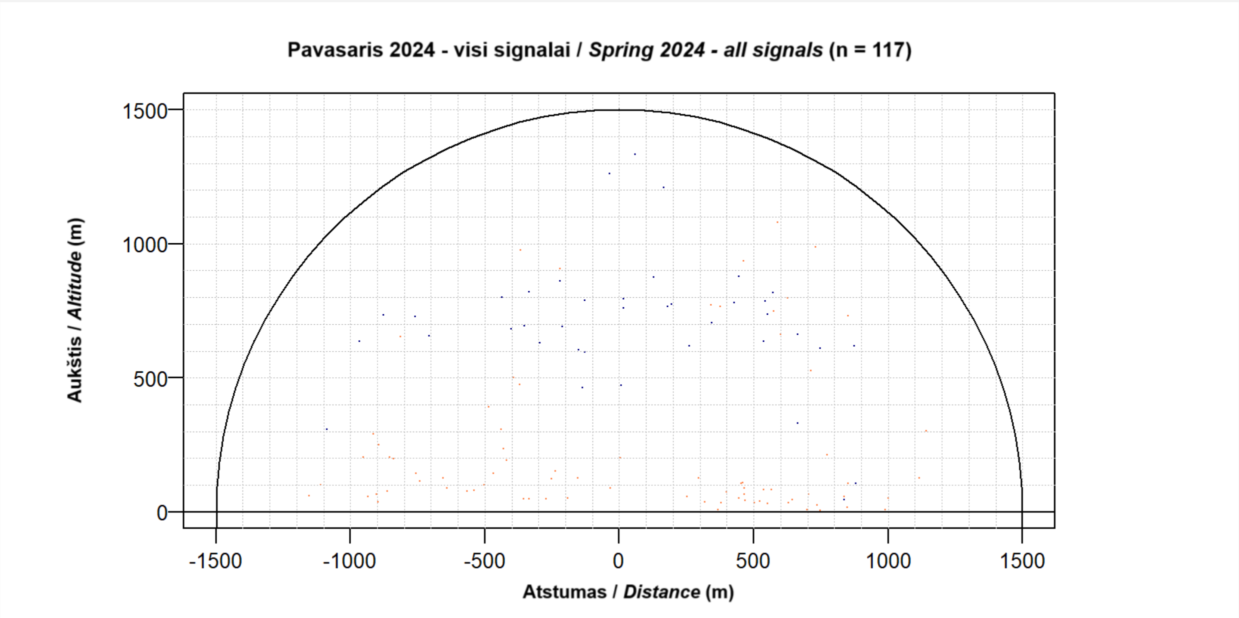


Fig. 5.4.31. All bird flight signals recorded by radar “Furuno” in spring of 2024.

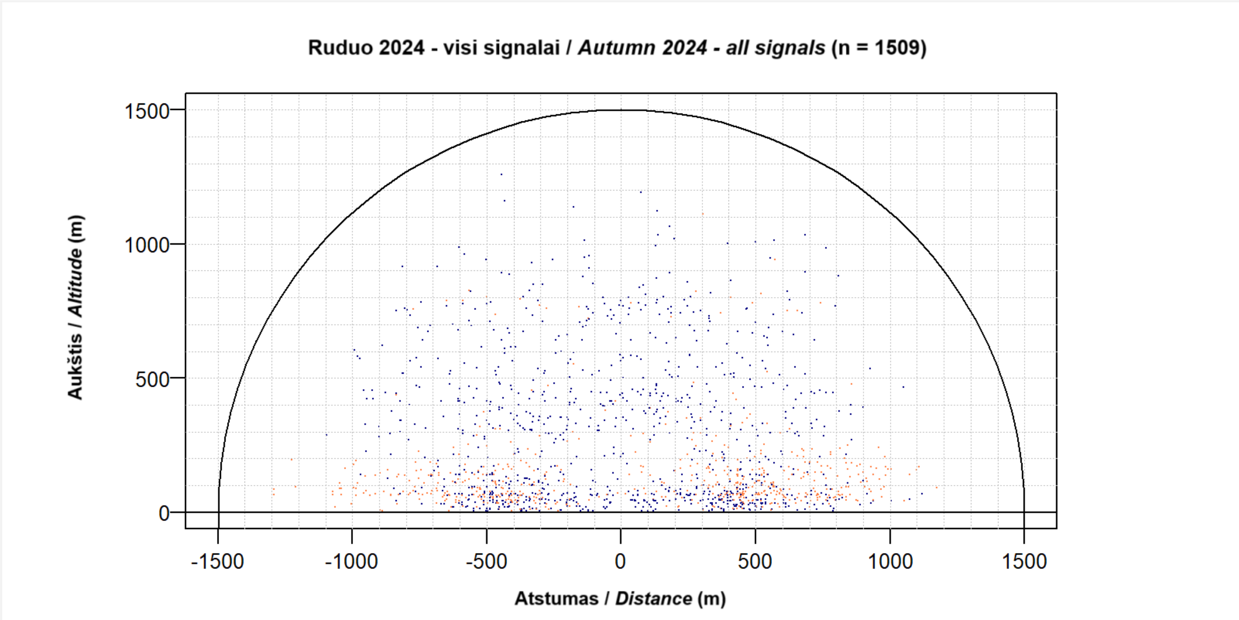


Fig. 5.4.32. All bird flight signals recorded by radar “VisionMaster” in autumn of 2024.

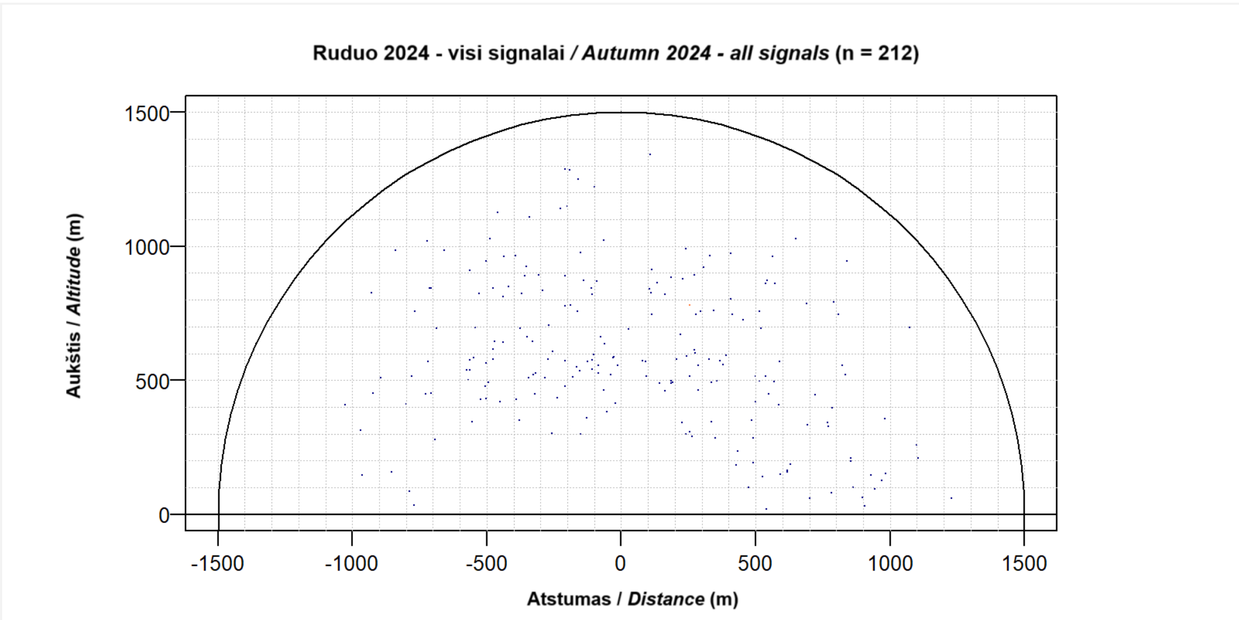


Fig. 5.4.33. All bird flight signals recorded by radar “Furuno” in autumn of 2024.

After analysing the intensity of all recorded signals, it was determined that the majority were detected within 1,000 meters of the radar, with the highest concentration of bird activity occurring 300–700 m from the ship over the water surface (Fig. 5.4.34 to 5.4.40). Migratory bird signals were primarily recorded at altitudes up to 100 meters, but quite some were recorded up to 400–500 meters above sea level, mostly in spring. Birds that were commonly associated with the ship, such as gulls circling around during the day or passerines attracted by the ship's lights at night, were excluded from the radar signal evaluation.

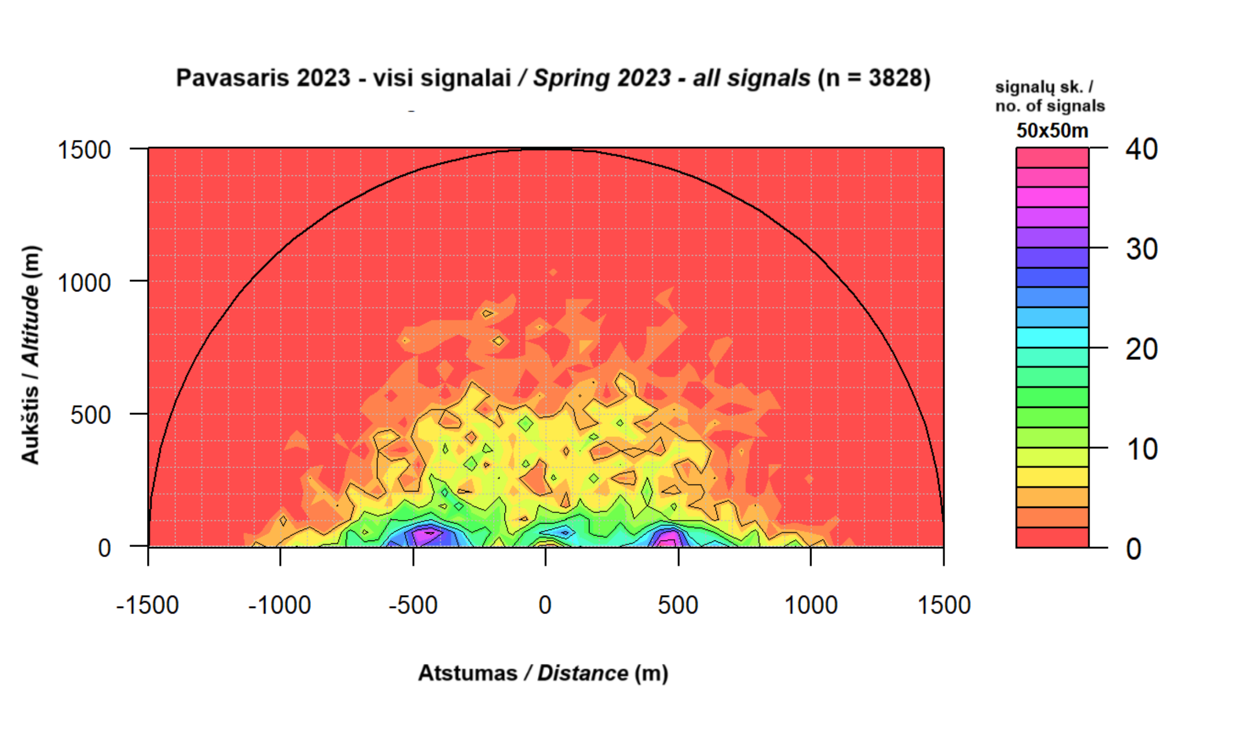


Fig. 5.4.34. Signal distance intensity in spring of 2023 recorded by “VisionMaster” radar.

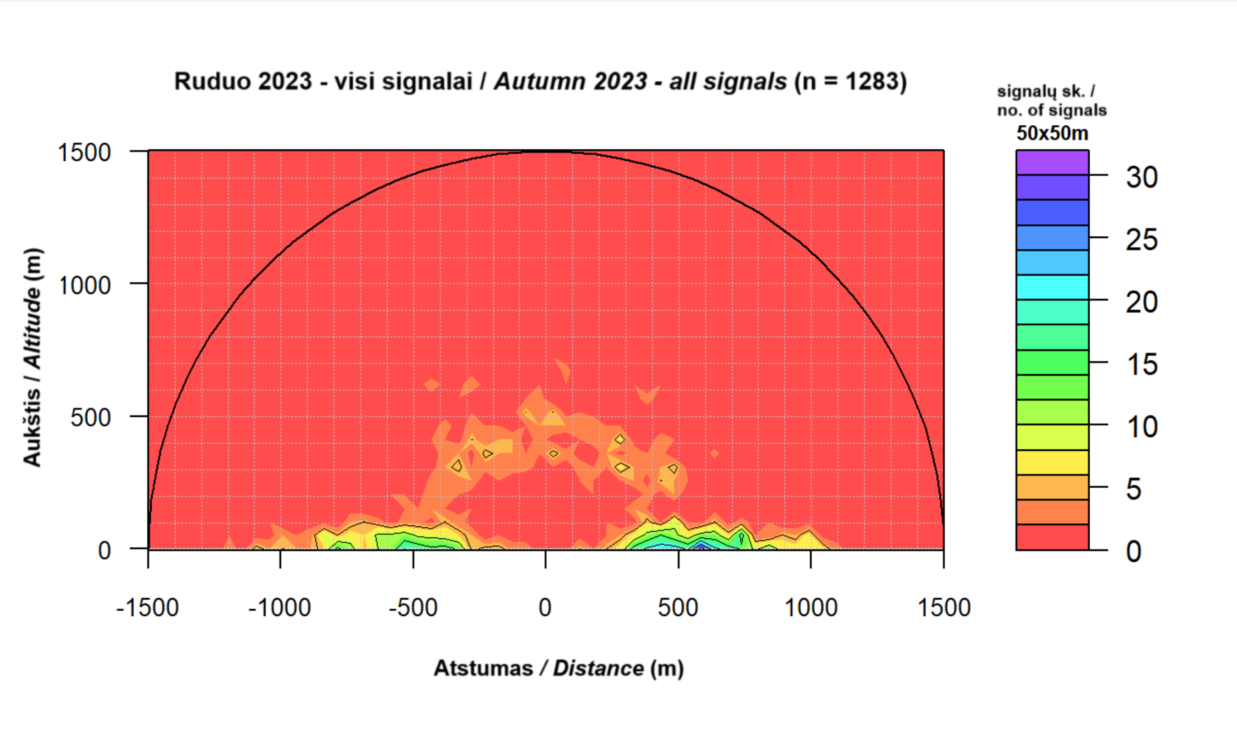


Fig. 5.4.35. Signal distance intensity in autumn of 2023 recorded by “VisionMaster” radar.

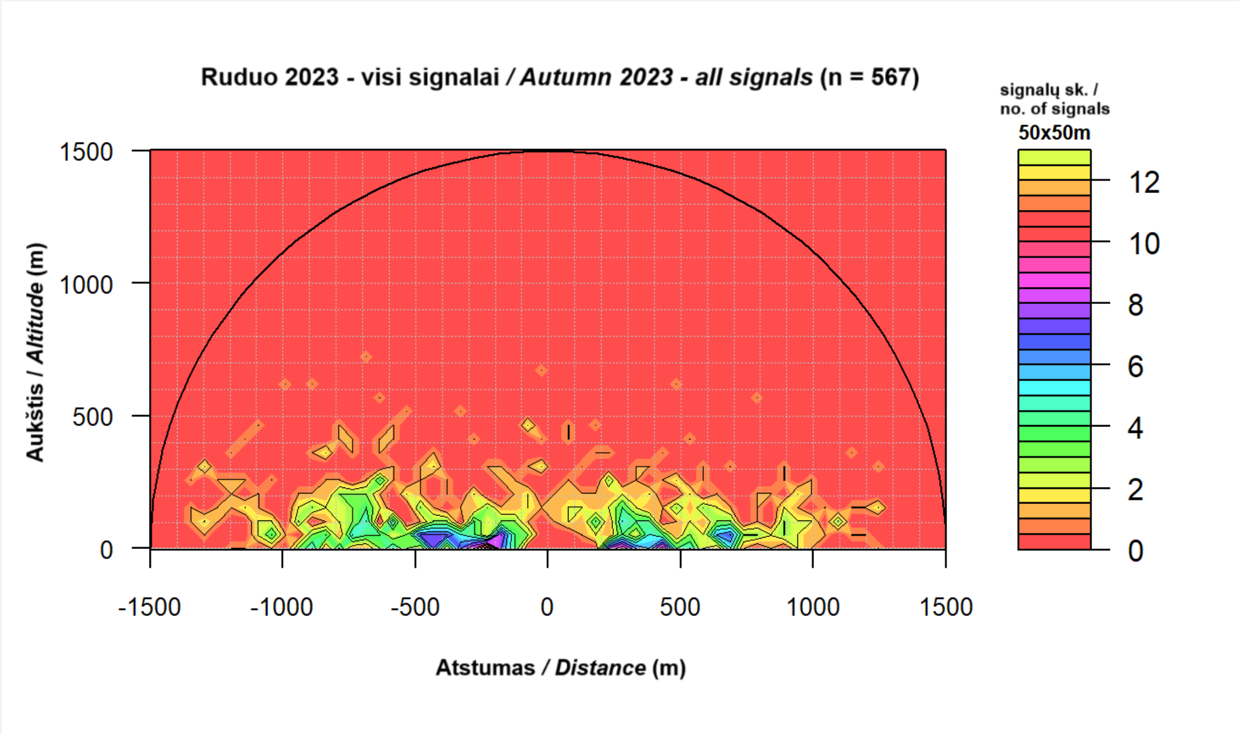


Fig. 5.4.36. Signal distance intensity in autumn of 2023 recorded by “Furuno” radar.

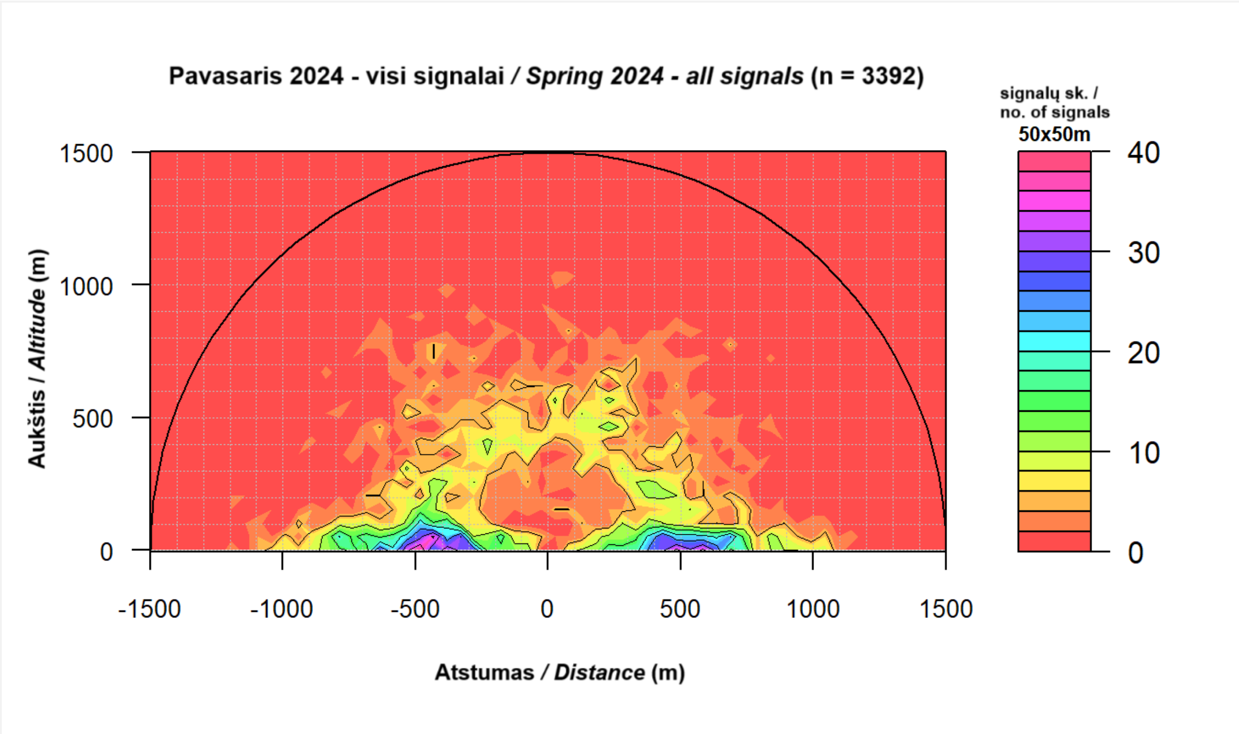


Fig. 5.4.37. Signal distance intensity in spring of 2024 recorded by “VisionMaster” radar.

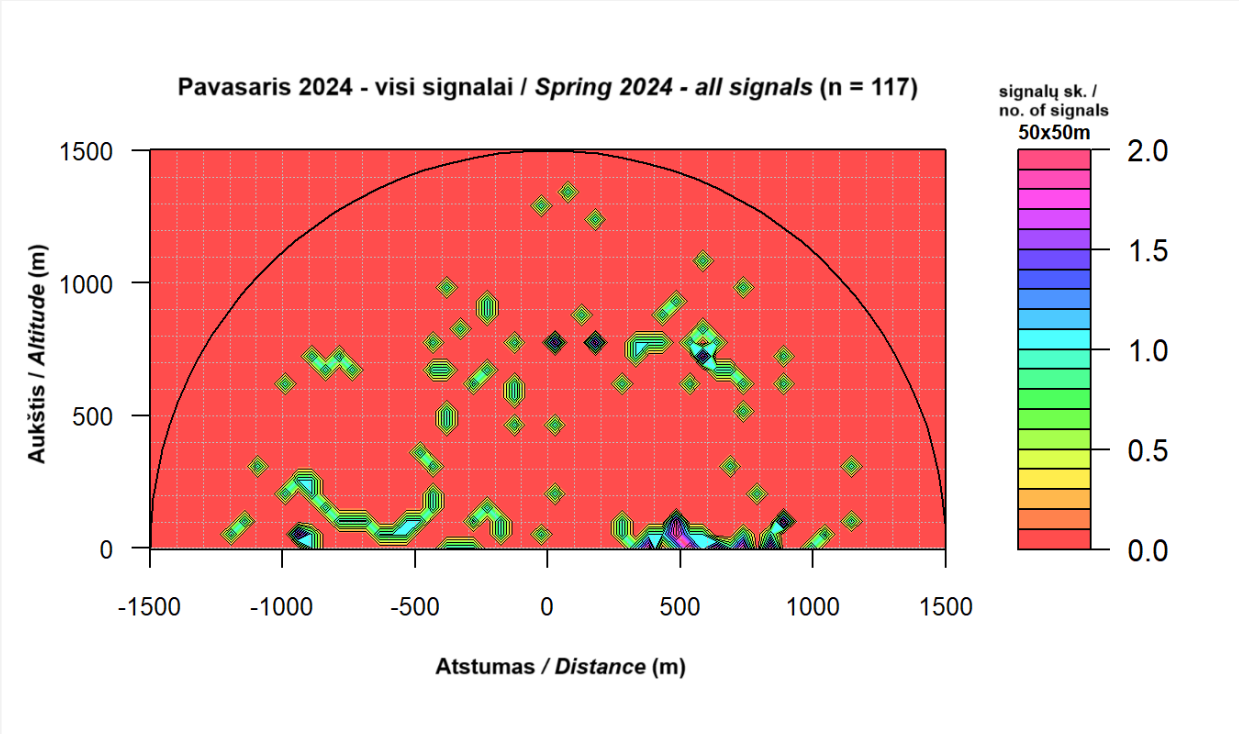


Fig. 5.4.38. Signal distance intensity in spring of 2024 recorded by “Furuno” radar.

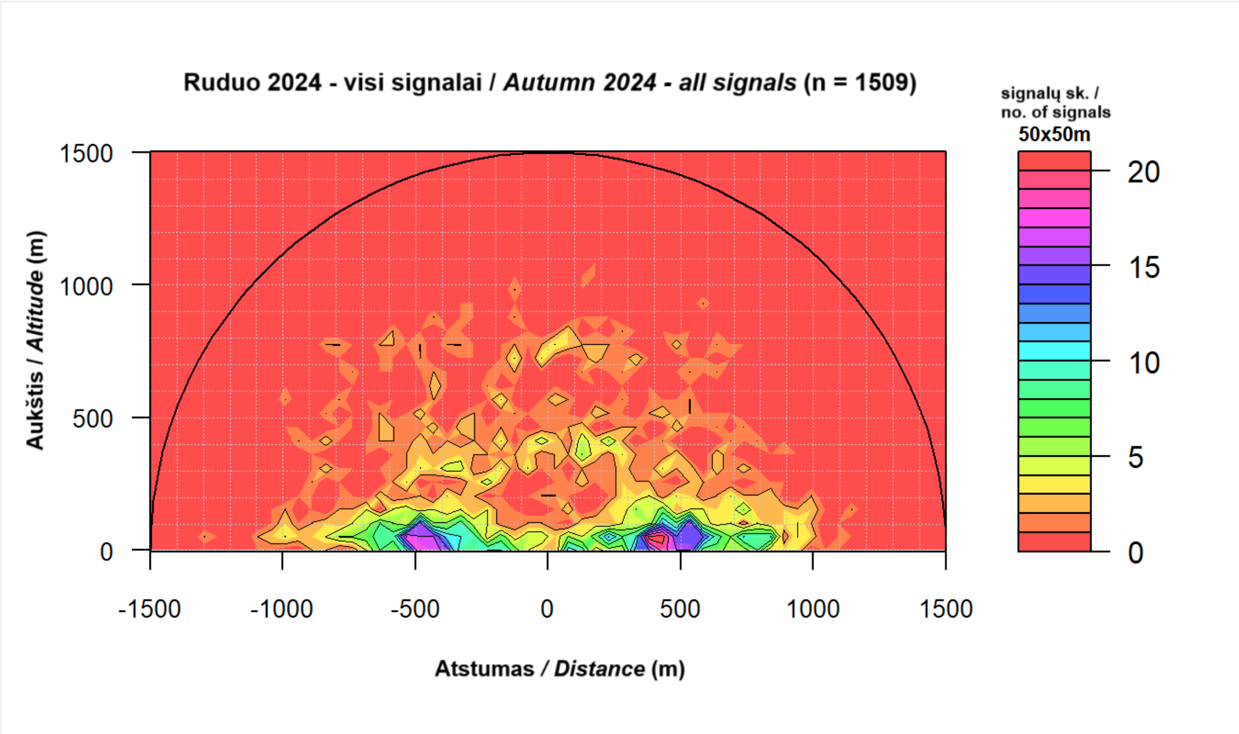


Fig. 5.4.39. Signal distance intensity in autumn of 2024 recorded by “VisionMaster” radar.

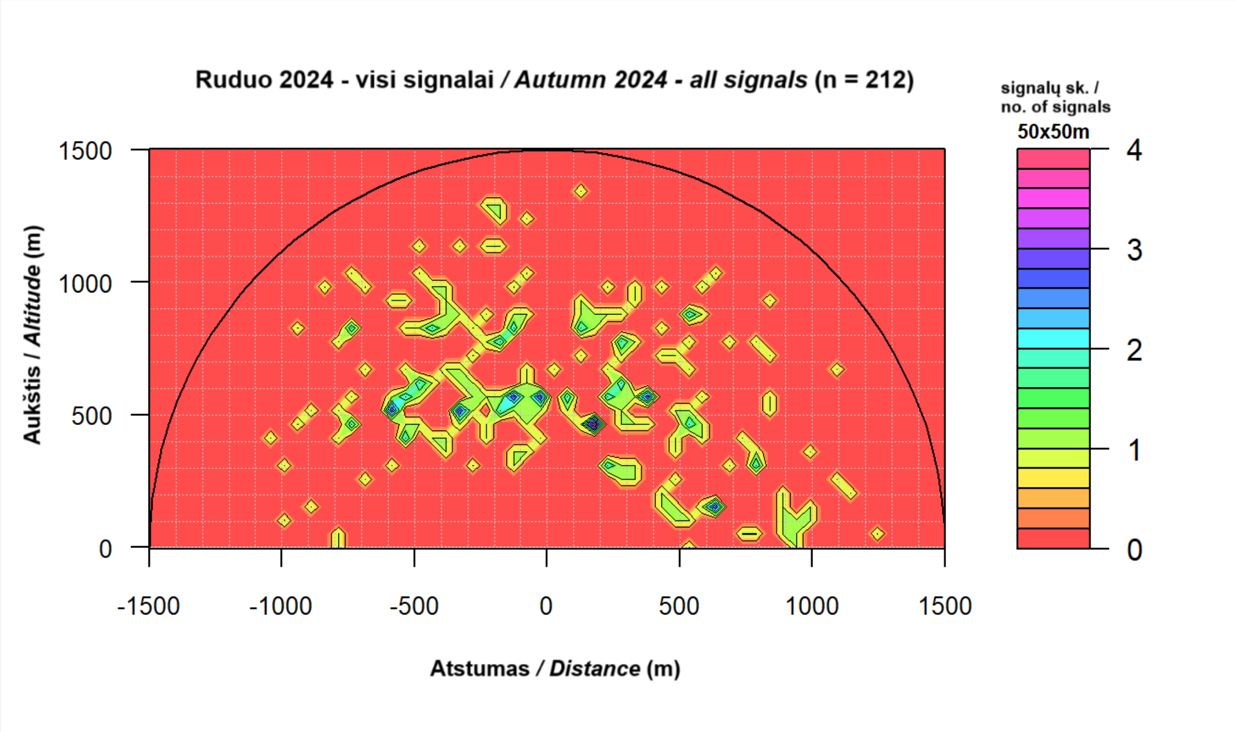


Fig. 5.4.40. Signal distance intensity in autumn of 2024 recorded by “Furuno” radar.

When comparing the altitudes of radar-recorded signals, during both day and night migrations, it was observed that birds tend to fly at lower altitudes up to 200 m above the water both during diurnal and nocturnal migrations, especially during diurnal autumn migration. Birds frequently associated with the ship, such as gulls circling around during the day or passerines attracted to the ship's lights at night, were excluded from the radar signal evaluation. The distribution of all altitudes of radar-recorded migrating bird signals are shown below in Fig. 5.4.41 to 5.4.44.

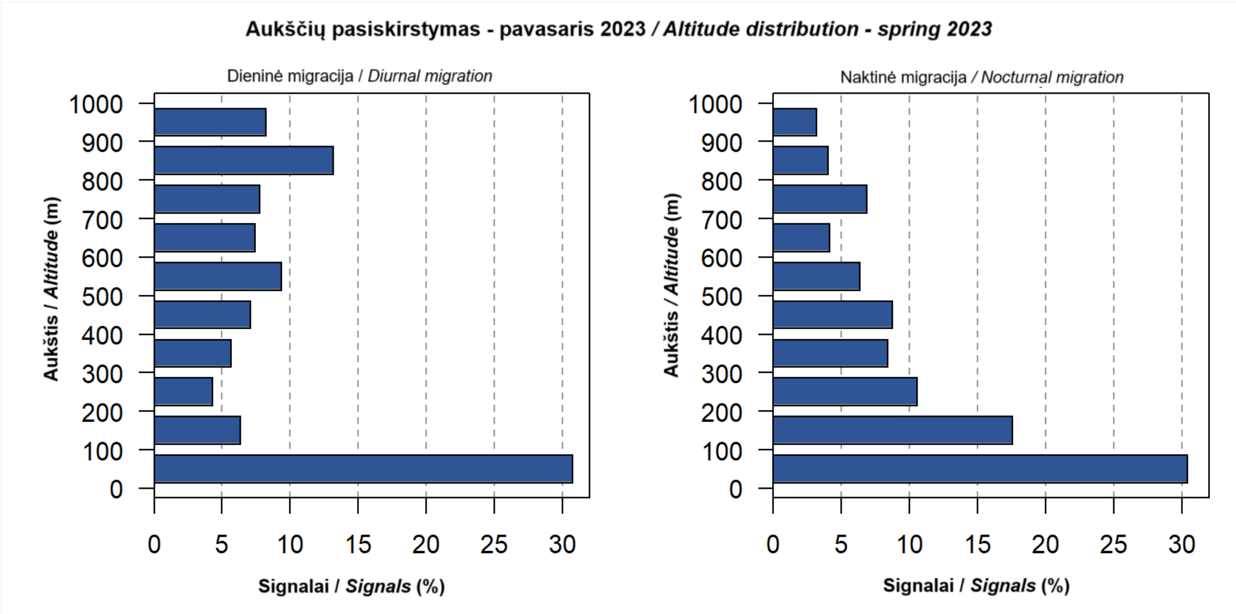


Fig. 5.4.41. Diurnal and nocturnal bird migration altitude distribution in spring 2023.

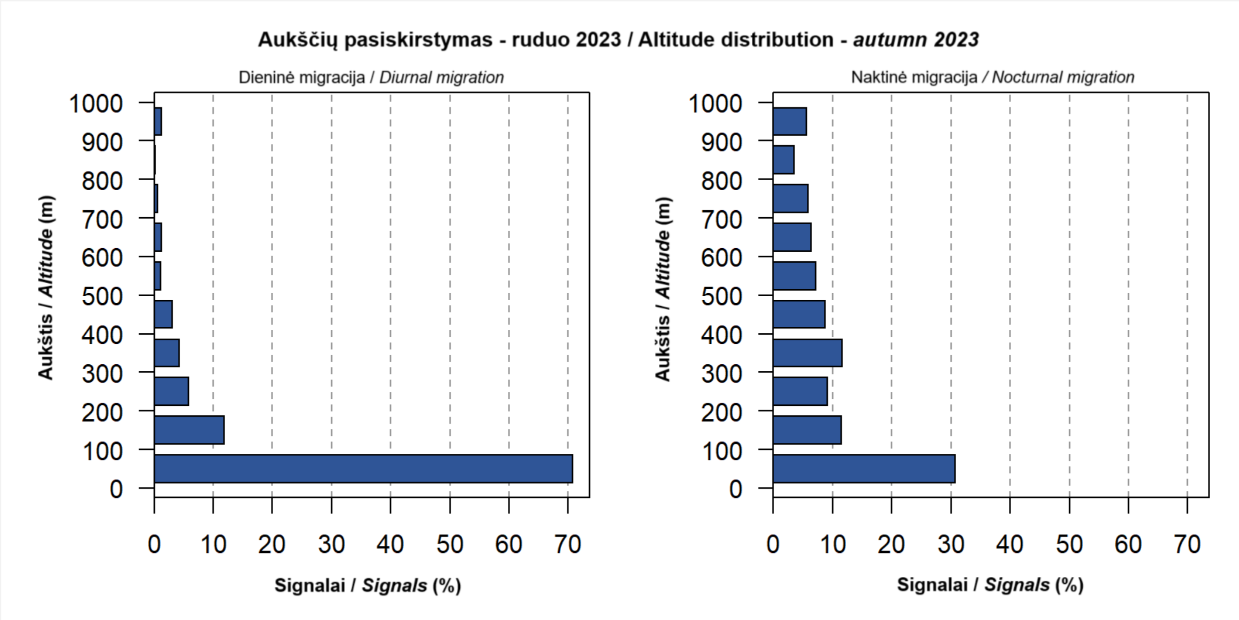


Fig. 5.4.42. Diurnal and nocturnal bird migration altitude distribution in autumn 2023.

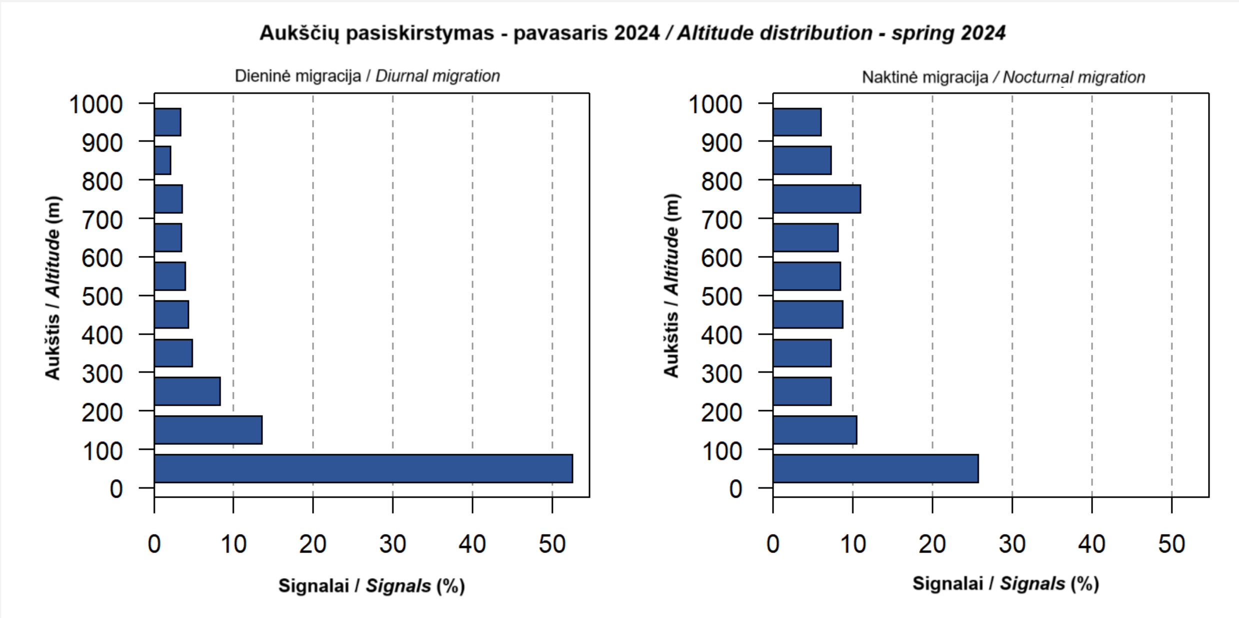


Fig. 5.4.43. Diurnal and nocturnal bird migration altitude distribution in spring 2024.

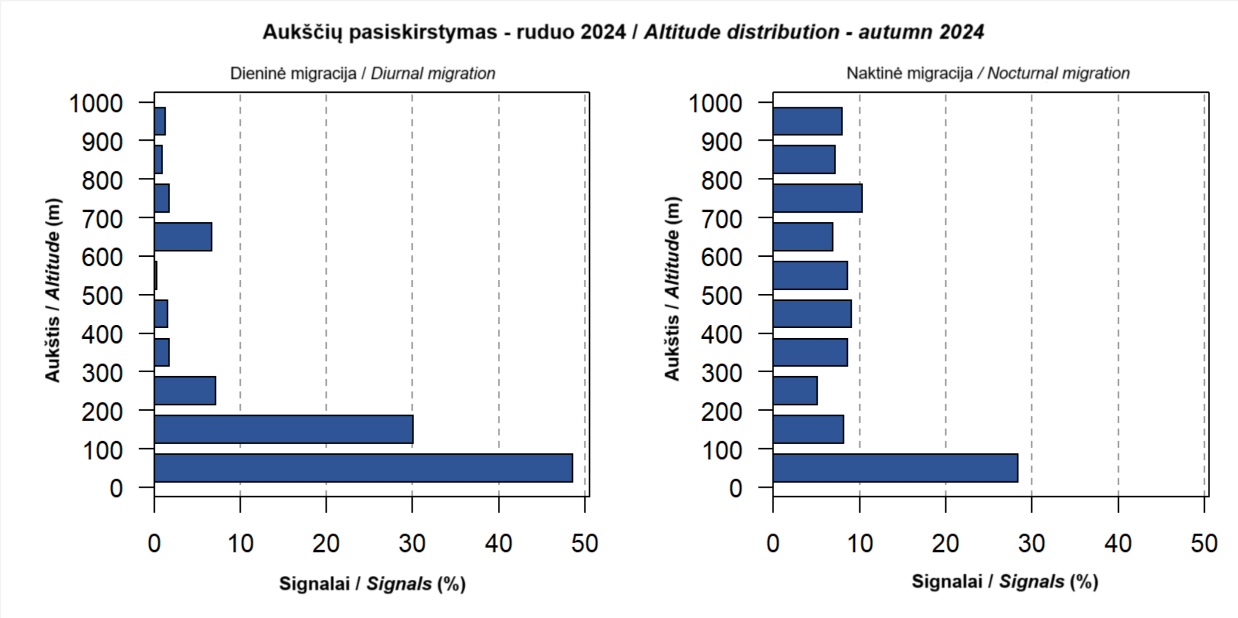


Fig. 5.4.44. Diurnal and nocturnal bird migration altitude distribution in autumn 2024.

Additionally, migration traffic rate (hereinafter – MTR) was assessed for the individual season of spring and autumn of 2023 and 2024 (Fig. 5.4.45). Nocturnal migration was more intense during the spring, while in autumn it was uniform with some peaks in the beginning of the night. During daylight hours of spring migration intensity was observed in decreasing progression and rising again from the first hours of night-time and peaking in midnight. Passerines, such as thrushes and skylarks, primarily migrate at night. The peak of migration occurred in the middle of the night, when migrants from the shore would reach the observation point in the PEA territory.

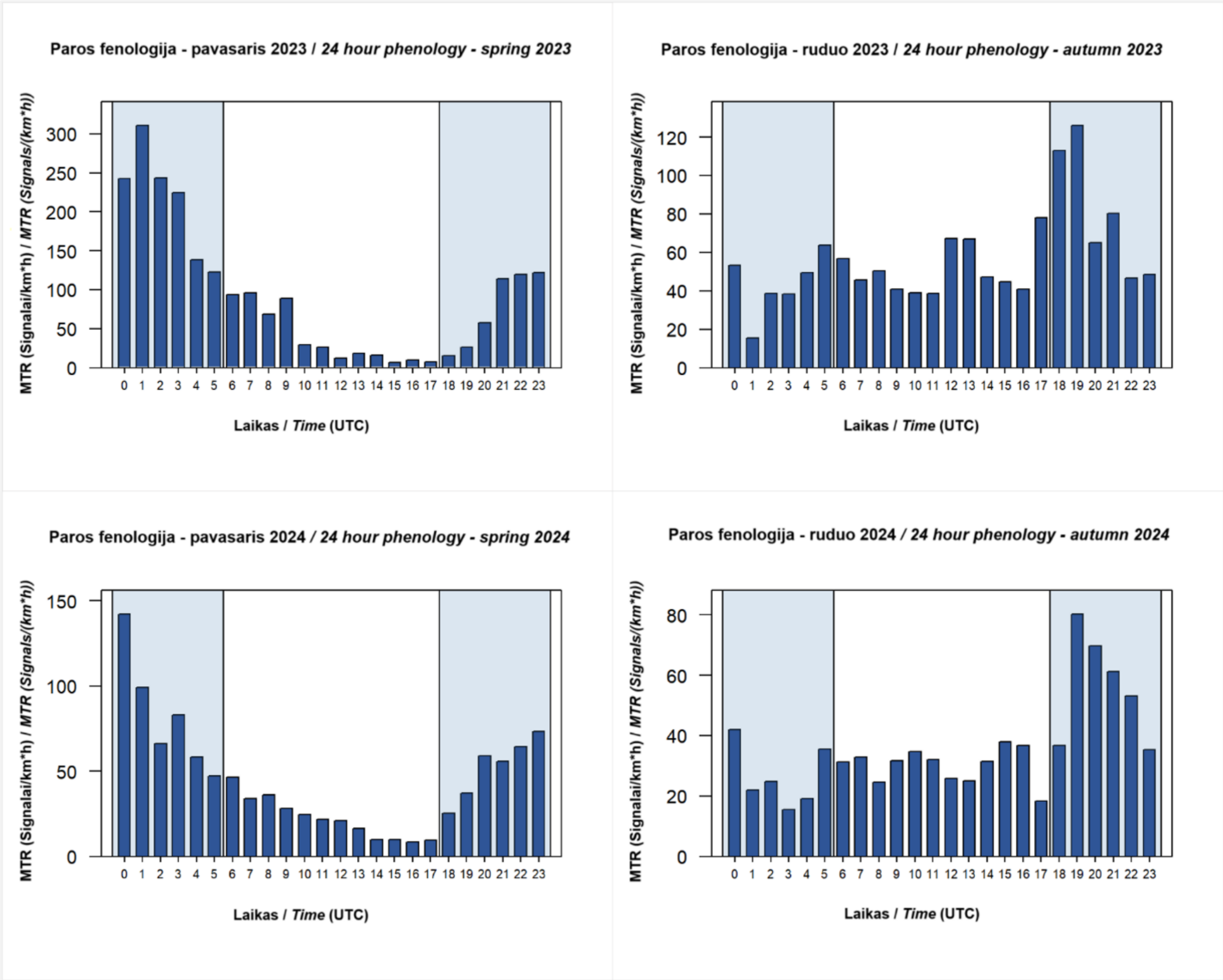


Fig. 5.4.45. Migration traffic rates.

5.4.3.3.3 Nocturnal monitoring of migrating birds

Surveys were carried out from fixed positions during the spring (late February to late April) and autumn (late August to early December) migrations. Observations took place after sunset, using stationary audio recording equipment or by listening for 15 minutes twice per hour, with 15-minute breaks throughout the night.

Due to the lights present on board for safety reasons, it was impossible to assess the abundance of species during nocturnal migrations. Artificial lights from ships have been shown to attract nocturnal migratory birds, meaning that some of the migrants were circling around the ship. However, it was possible to determine the species composition of the migrants, which consisted only of passerines (Table 5.4.27).

Table 5.4.27. Species composition of nocturnal migrants

English name	Scientific name
Eurasian Skylark	*Alauda arvensis*
Woodlark	*Lullula arborea*
Dunnock	*Prunella modularis*
Song Thrush	*Turdus philomelos*
Redwing	*Turdus iliacus*
Mistle Thrush	*Turdus viscivorus*
Fieldfare	*Turdus pilaris*
Common Blackbird	*Turdus merula*
European Robin	*Erithacus rubecula*
Common Chaffinch	*Fringilla coelebs*

English name	Scientific name
Brambling	*Fringilla montifringilla*
Goldcrest	*Regulus regulus*
Great Tit	*Parus major*
Eurasian Blue Tit	*Cyanistes caeruleus*
Common Starling	*Sturnus vulgaris*

Overall, the migration of passerines was not particularly intense with most birds being heard during the spring migration in both 2023 and 2024.

5.4.3.3.4 PEA territory analysis by sensitive bird groups or species

The study area partially encompassed the SPA Klaipėda-Ventspils plateau which extends east of the proposed OWF site (European Environment Agency, 2015). This SPA was designated to protect reef habitats and serves as a regular wintering site for Long-tailed Ducks, Velvet Scoters, and Razorbills. Additionally, the standard data form lists the Red-throated Diver and Common Guillemot as evaluated species within the site.

A total of 42,830 birds were recorded across all counts during the two years of observations. The highest number of birds was recorded during the aerial surveys - 22,772 (n = 21,775), followed by 14,400 birds observed from a stationary point on the boat while the radar was active and 5,658 (n = 3,726) birds recorded during the ship-based transect surveys. Sea ducks and auks, as well as gulls, were the most observed bird groups. As digital aerial transect counts were also conducted in January 2025, the results from these were added to those from 2024 for further analysis.

Sea ducks

The most abundant sea duck species recorded in the area was the Velvet Scoter, with 7,934 individuals observed (n = 2,861 in 2023 and n = 5,073 in 2024). Long-tailed ducks were also numerous, with 3,271 individuals recorded (n = 1,442 in 2023 and n = 1,829 in 2024). Most of these birds were detected during aerial surveys, accounting for 7,143 velvet scoters and 2,229 long-tailed ducks. These high numbers reflect the wintering period of sea ducks, when they congregate in the Baltic Sea. Notably, the majority of Common Scoters (84.2%) were observed during stationary migrating bird surveys. Fig. 5.4.3.26 illustrates the abundance of sea ducks.

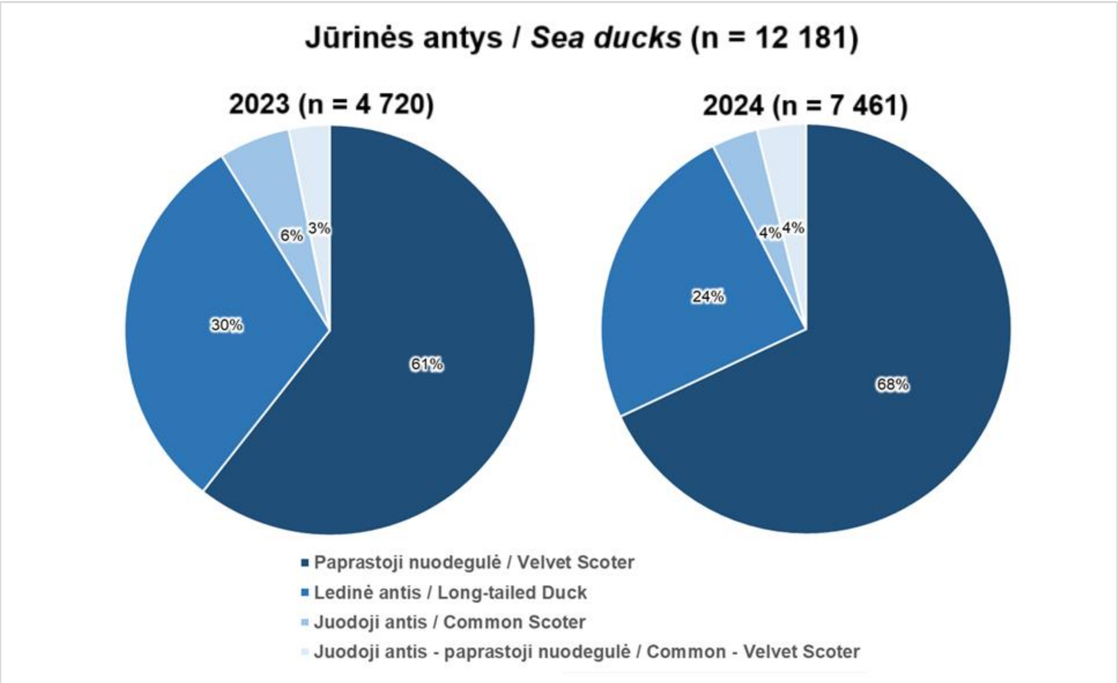


Fig. 5.4.46. Abundance distribution of sea ducks.

The highest densities and abundances of Velvet Scoters and Long-tailed Ducks were recorded during aerial surveys in the winter months (Figs. 5.4.47 and 5.4.48).

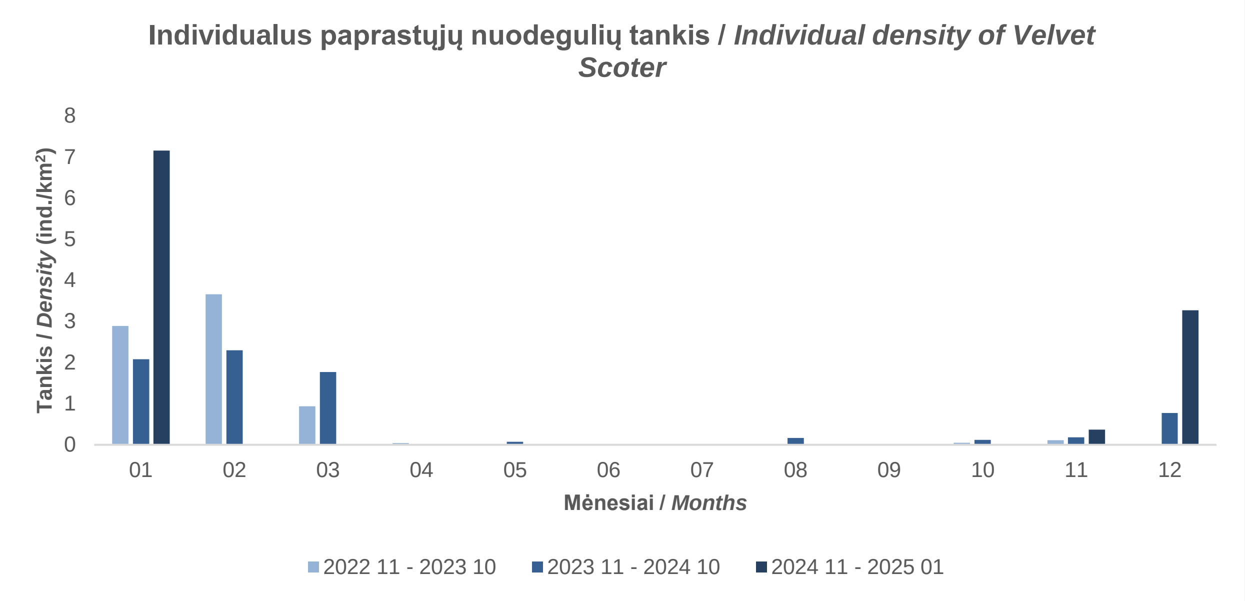


Fig. 5.4.47. Monthly densities of Velvet Scoters in the area (*there was no aerial survey 2022 12*).

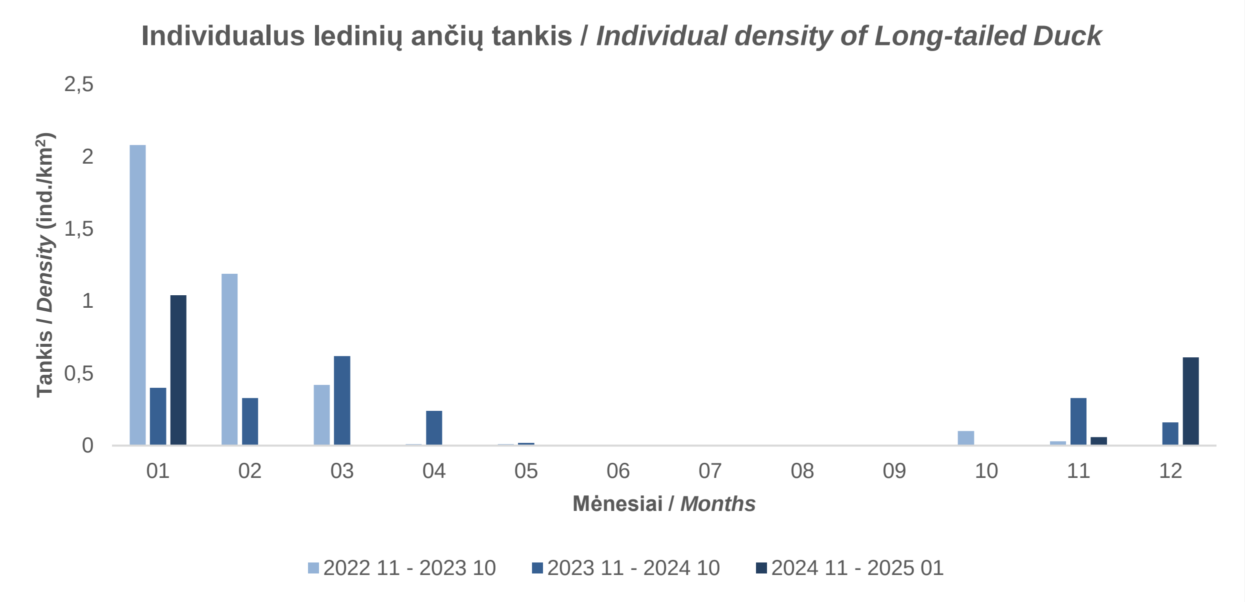


Fig. 5.4.48. Monthly densities of Long-tailed Ducks in the area (*there was no aerial survey 2022 12*).

Velvet Scoters primarily winter in the Baltic Sea (Durinck et al., 1994), utilizing various water depths on the availability of food. In Lithuanian coastal waters, they are most found at depths of up to 20 m (Morkūnas et al., 2022), but they can also feed at depths of 30–40 m (Mendel et al., 2008). Lithuania hosts approximately 4% of the European wintering population of this species (Staneva & Burfield, 2017). Lithuanian coastal waters are crucial wintering grounds for both, Velvet Scoters and Long-tailed Ducks though their highest densities occur in other Baltic Sea regions (Skov et al., 2011). Within the Baltic region, Velvet Scoter is classified as Vulnerable in its breeding grounds and Endangered in its wintering grounds (HELCOM, 2019b). Velvet Scoter diet mainly consists of bivalve molluscs and crustaceans, sourced from both sandy and solid sea bottoms. The species experience high mortality rates due to bycatch in fishing nets, with an estimated 500-1000 individuals lost annually in Lithuania (Morkūnas et al., 2022).

In terms of location, Velvet Scoters were mostly recorded in near-coastal waters and within the Special Protection Area (SPA), as well as within the PEA territory. They were more abundant during the 2024 surveys than in 2023. Their abundance peaked in January and February of both years, with the highest numbers recorded in January 2025. They were also rather abundant in March and December 2024. Velvet scoters were present in large numbers in the area of the planned cable installation within the SPA throughout the winter months, with higher numbers in 2024 (see Annex 6. Ornithological research reports: Survey Report Lithuania_2023_V3.0 and Survey Report Lithuania_2025_V2.0).

The impact of OWF on Velvet Scoters remains uncertain, though low levels of OWF avoidance have been observed, similar to Common Scoters, which are known to avoid high-traffic shipping lanes (Dierschke et al., 2016; Fliessbach et al., 2019). Following the installation of the wind turbines, Common Scoters exhibited increased avoidance of the wind farm area, including zones extending 2 to 4 km from its boundaries in Denmark (Fox & Petersen, 2006).

Long-tailed Duck was the second most abundant sea duck species recorded. Approximately 90% of the wintering population in Europe resides in the Baltic Sea during winter (Durinck et al., 1994). Lithuanian coastal waters are crucial wintering grounds for both, Long-tailed Ducks and Velvet Scoters though their highest densities occur in other Baltic Sea regions (Skov et al., 2011). Up to 7% of the wintering Long-tailed Duck population is recorded In Lithuanian territorial Baltic Sea waters (Morkūnas et al., 2022). These ducks prefer waters 10-35 m deep (Skov et al., 2011; Morkūnas et al., 2022), feeding primarily on mussels and crustaceans found on the solid sea bottom. Individuals closer to shore may also consume small fish (Skabeikis et al., 2019). Similar to Velvet Scoters, Long-tailed Ducks suffer high mortality from bycatch, with up to 1000 birds lost annually in Lithuania (Morkūnas et al., 2022).

Spatially, Long-tailed Ducks were recorded mostly within SPA but also within PEA territory. More during surveys in 2024 compared to 2023. Abundance peaked in January and February in 2023 and it was rather abundant in January of 2025 and March of 2024. Long-tailed Ducks were abundant and in the area of planned cable installation within the SPA during all winter months while more numerous in 2023 (Annex 6. Ornithological research reports: Survey Report Lithuania_2023_V3.0 and Survey Report Lithuania_2025_V2.0).

Unlike Velvet Scoters, Long-tailed Ducks actively avoid OWF and intensive shipping lanes (Durinck et al., 1994; Dierschke et al., 2016; Fliessbach et al., 2019) therefore could be displaced from its feeding habitats. During the baseline study at the Nysted site (Denmark), Long-tailed Ducks showed a preference for the wind farm area; however, following construction, they exhibited a significant avoidance of both the wind farm itself and up to 2 km from it (Petersen et al., 2006).

In summary, the OWF could displace wintering sea ducks within the SPA, resulting in density declines and distribution shifts as the birds move away from the disturbance. Furthermore, the installation of cables during winter could temporarily displace most sea ducks from the installation area.

While exact avoidance distances for Long-tailed Ducks and Velvet Scoters remain uncertain, studies on similar species indicate that avoidance might be within 2 km from an OWF. Given the OWF proximity to the SPA, it is likely to disrupt foraging grounds and displace protected species. To reduce potential impacts, relocating the OWF at least 2 km away from the SPA is mandatory to minimize disturbances to critical wintering and foraging habitats. Furthermore, cable installation works within the SPA and 2 km from it should not be performed during vulnerable phase of sea duck aggregation while on migration or overwintering - from November 15 to April 15, inclusive.

Auks

A total of 3,924 Common Guillemots (n = 1.651 in 2023 and n = 2,273 in 2024) and 2,528 Razorbills (n = 1,252 in 2023 and n = 1,276 in 2024) were recorded in the study area. The majority of Common Guillemots and Razorbills were registered during aerial surveys (n = 2,701 and n = 1,542 respectively). Additionally, four Black Guillemots were identified in the aerial survey data in 2023. Due to the similarity in appearance and behaviour among auk species, quite large number of individuals could not be identified to the species level (n = 1,624) and were therefore categorized as Common Guillemot / Razorbill. In most cases, it was not possible to identify the species during digital transect surveys conducted by aircraft. The overall abundance of auks is illustrated in Fig. 5.4.3.29.

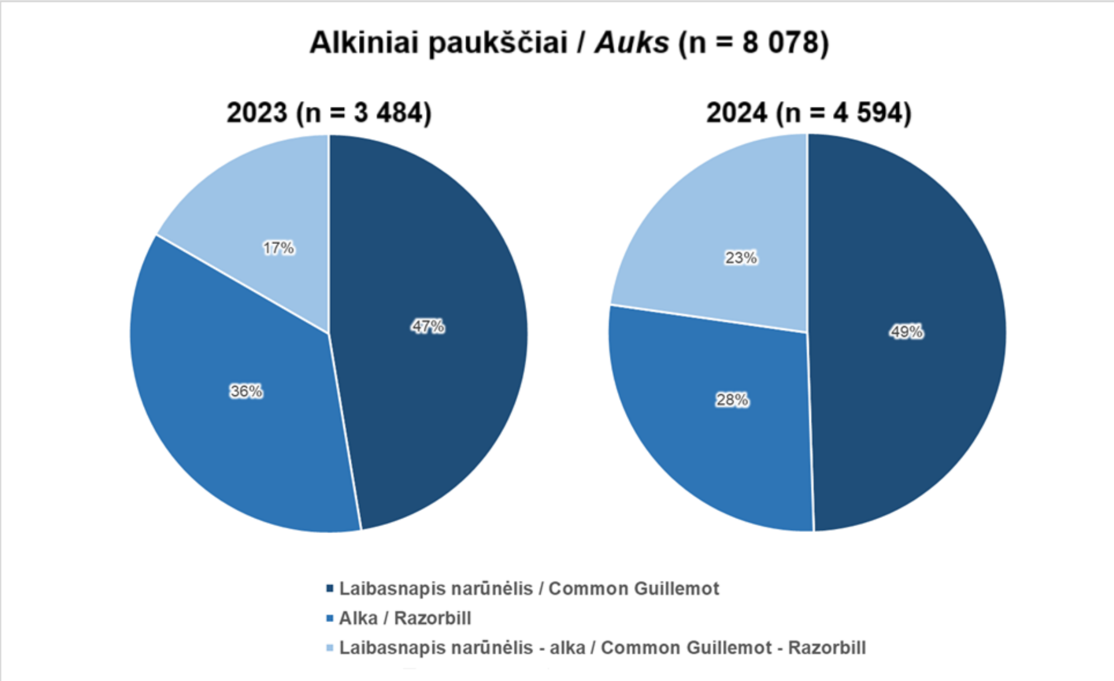


Fig. 5.4.49. Abundance distribution of auks.

Previous studies identified the Lithuanian coast as important for Razorbills but not for Common Guillemots, with densities ranging from 0.10 to 0.99 individuals per km² for Razorbills (Durinck et al., 1994).

Young auks spend the first few years of their lives exclusively in open water, so auks, especially the Common Guillemots, can be found at sea in all seasons, not just during wintering or migration.

The highest densities and abundances of Common Guillemots were recorded during ship-based surveys and were most abundant in late summer and autumn, when a significant increase in the number of adult and juvenile Common Guillemots was recorded, and the species was also quite abundant in early May of 2024 during migration while Razorbills were more abundant in late autumn, winter and early spring, therefore highest densities were recorded during aerial surveys and quite abundant during migration in May of 2024 (Figs. 5.4.50 and 5.4.51).

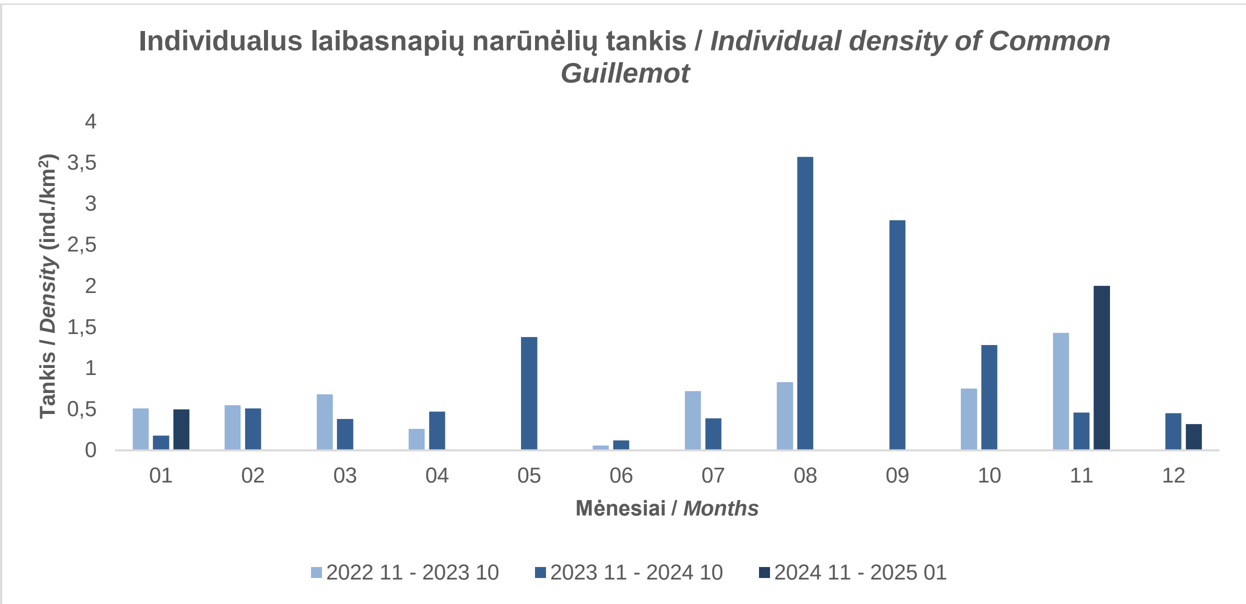


Fig. 5.4.50. Monthly densities of Common Guillemots in the area (*there was no aerial survey 2022 12 and data from ship-based survey in 2023 09 not evaluated*).

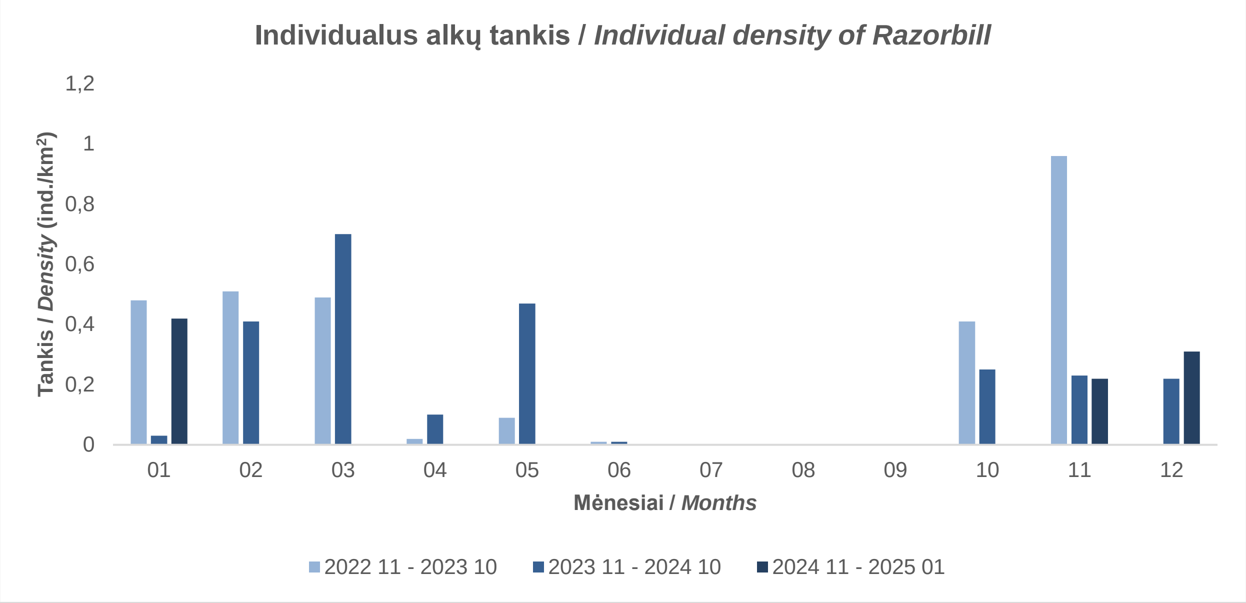


Fig. 5.4.51. Monthly densities of Razorbills in the area (*there was no aerial survey 2022 12*).

Common Guillemot is a pelagic fish hunter, breeding on islands in the Baltic Sea, particularly in Sweden and Finland. The estimated Baltic Sea population is around 50000 birds, with the majority wintering in southern Baltic waters, including Denmark and Sweden (Mendel et al., 2008). The primary breeding colony in the Baltic Sea is situated on Stora Karlsö, Sweden (Sarzo et al., 2019), approximately 200 km north-west of the proposed OWF.

Spatially, Common Guillemots were broadly distributed throughout the study area (Annex 6. Ornithological research reports: Survey Report Lithuania_2023_V3.0 and Survey Report Lithuania_2025_V2.0). The highest densities were primarily observed farther from the coast in deeper waters, with notable concentrations also recorded within the planned OWF area. During the ship survey in September, the highest overall densities were found within the OWF boundaries, whereas aerial surveys indicated peak densities closer to shore or south of the OWF. Common Guillemots were abundant and in the area of planned cable installation within the SPA during all winter months while more numerous during summer.

Common Guillemots have been observed to avoid OWF, with responses ranging from weak to strong avoidance (Dierschke et al., 2016; Peschko et al., 2020). However, recent studies have confirmed a significant decline of 65-76% in the presence of this species within 1 km of OWF (Szostek et al., 2024). Current distribution models for the German North Sea, which account for the cumulative effects of OWF, predict a reduction in the species winter distribution area at sea due to OWF impacts, adding further pressure on the population (Peschko et al., 2024).

Razorbill is a northern bird species, with the subspecies *Alca torda torda* inhabiting the Baltic Sea and breeding in Sweden, Finland, and Estonia (Mendel et al., 2008). These birds primarily feed on pelagic small fish, which they hunt in deep waters.

Spatially, Razorbills were broadly distributed throughout the study area (Annex 6. Ornithological research reports: Survey Report Lithuania_2023_V3.0 and Survey Report Lithuania_2025_V2.0). The highest densities were primarily observed near the coast, but the birds were also present in deeper waters, with notable concentrations also recorded within the planned OWF area. Razorbills were abundant and in the area of planned cable installation within the SPA during all winter months.

Similar to Common Guillemots, Razorbills have been observed to avoid OWF, although the degree of avoidance varies (Dierschke et al., 2016). In the Belgian North Sea, a significant reduction in their presence was recorded six years after the construction of OWF, with a 75-80% decline in numbers compared to pre-construction levels (Degraer et al., 2019). In the German Exclusive Economic Zone in North Sea, Razorbill abundance decreased by approximately 50% within buffer zones of 1 to 5 kilometers from OWF, with notably lower densities observed at distances of 0 to 3 kilometers from the OWF (Peschko et al., 2020; Szostek et al., 2024). However, in the northern Baltic Sea, Razorbills have not exhibited clear avoidance patterns following OWF construction, and their breeding populations have remained stable (Tanskanen 2012; Tanskanen et al., 2022).

In summary, the proposed OWF may displace wintering auks, particularly Razorbills within the SPA, leading to density declines and distribution shifts as birds move away from the disturbance. Additionally, cable installation during winter could cause temporary displacement of most auks from the installation area.

Due to its proximity to the SPA, where Razorbills are a focal species, the OWF is likely to disrupt foraging grounds and displace protected species. To reduce potential impacts, it is mandatory to relocate the OWF at least 2 km away from the SPA, minimizing disturbances to critical wintering and foraging habitats. In addition, cable installation works within the SPA and 2 km from it should not be performed during vulnerable phase of auk aggregation while on migration or overwintering – from November 15 to April 15, inclusive.

Divers

A total of 1516 Red-throated Divers (n = 722 in 2023 and n = 794 in 2024) and 333 Black-throated Divers (n = 199 in 2023 and n = 134 in 2024) were registered in the study area. The majority of Red-throated Divers were recorded during aerial surveys (n = 1.461), while most of Black-throated Divers were observed during ship-based surveys (n = 167). Due to the similarity in appearance and behaviour among diver species, quite large number of individuals could not be identified to the species level (n = 188) and were therefore categorized as Unidentified Divers. Mostly during analysis of aerial surveys. The overall abundance of divers is illustrated in Fig. 5.4.52.

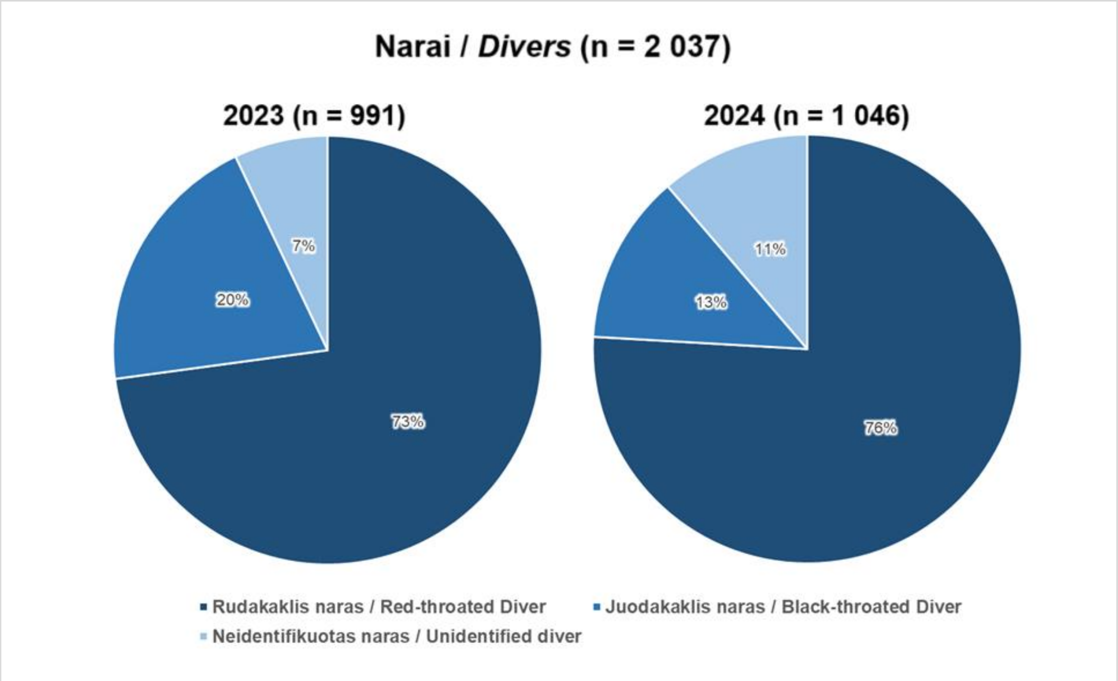


Fig. 5.4.52. Abundance distribution of divers.

The highest densities and abundances of Red-throated Divers were recorded during aerial surveys while Black-throated Divers were more abundant in early May during migration, therefore highest densities of Black-throated divers were recorded during ship-based surveys (Figs. 5.4.3.33 and 5.4.3.34). However, due to the well-documented high sensitivity of divers to marine traffic (Jarrett et al., 2021), the densities observed using ship-based method are likely slightly underestimated.

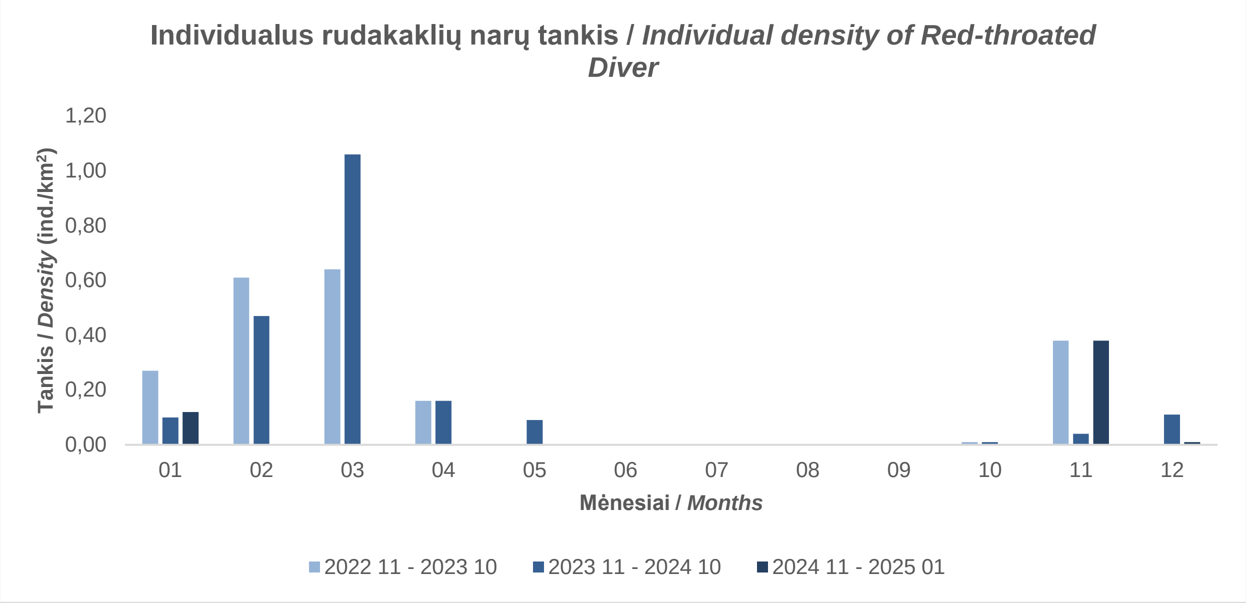


Fig. 5.4.53. Monthly densities of Red-throated Divers in the area (*there was no aerial survey 2022 12*).

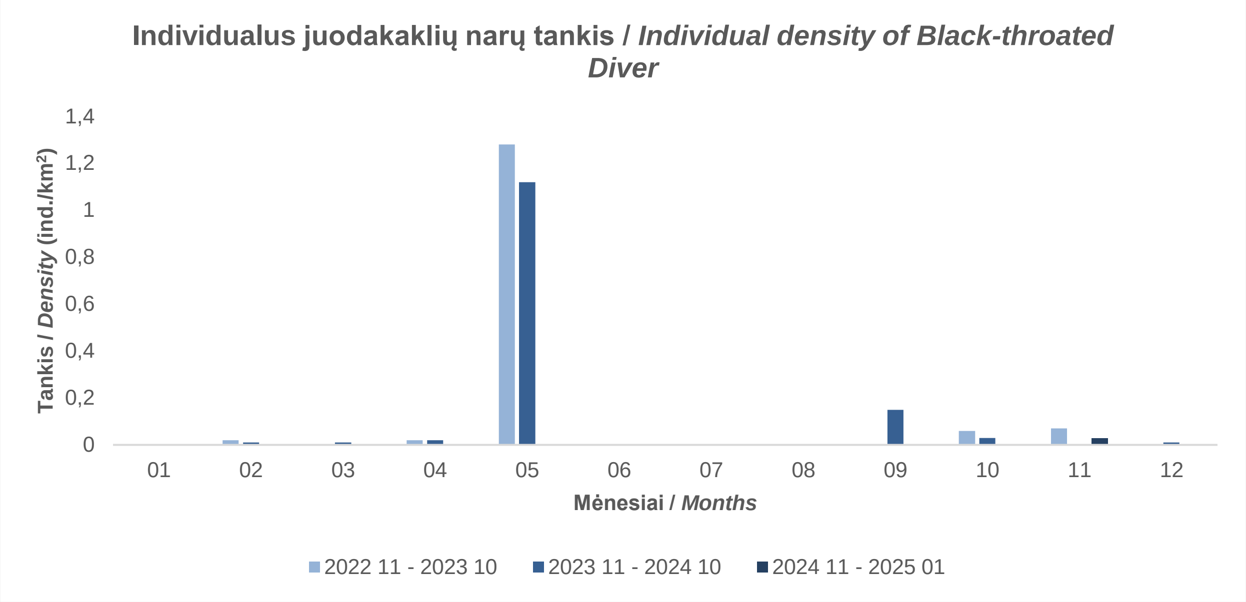


Fig. 5.4.54. Monthly densities of Black-throated Divers in the area (*there was no aerial survey 2022 12*).

Two species of divers are regularly found in the Lithuanian part of the Baltic Sea**: Black-throated Diver** and the **Red-throated Diver**. Two key wintering areas for divers are the Irbe Strait and the Gulf of Riga. Skov et al. (2011) reported that the highest concentrations of both diver species are found in a region stretching from the Irbe Strait along the Lithuanian, Latvian, and Estonian coasts up to the Pomeranian Bay. **Red-throated Divers** are more commonly observed, particularly during the wintering period. Shore-based winter bird surveys (conducted in January) indicate that Red-throated Divers make up approximately 90% of all recorded divers (BirdLife Lithuania). In contrast, **Black-throated Divers** are primarily seen during migration, with only a few individuals remaining for wintering.

Their spatial distribution of Red-throated Divers was throughout all research area in 2023, while in 2024 it showed higher distribution towards East and Northeast from PEA area, nevertheless the species was quite abundant in both PEA and SPA both years. Black-throated Divers were scarce during aerial surveys but were recorded within PEA and SPA areas in low densities. While during ship-based surveys, the highest abundance was observed in eastern part of PEA and within SPA during May of 2024 during migration. Red-throated Divers were abundant and in the area of planned cable installation within the SPA during all winter months, more abundant in 2023 (Annex 6. Ornithological research reports: Survey Report Lithuania_2023_V3.0 and Survey Report Lithuania_2025_V2.0).

The primary threats to divers include oil spills, bycatch in fishing nets, and habitat degradation (Mendel et al., 2008). Additionally, ship traffic and OWF negatively impact divers, as they exhibit a strong avoidance response to OWF with displacement distances reaching 10-15 km in some studies (Dierschke et al., 2016; Mendel et al., 2019; Heinänen et al., 2020), even individuals resting within the nearby SPA are likely to be affected by the planned OWF.

In summary, the study area does not appear to be a key habitat for Red-throated or Black-throated Divers, as the highest recorded density was recorded during migration of Black-throated Divers in early May – 1.28 in 2023 and 1.12 individuals per km² in 2024. However, given their high sensitivity to disturbances such as ship traffic and OWF, the proposed OWF could displace wintering divers within the SPA, leading to density declines and distribution shifts as birds move away from the disturbance.

Although none of the diver species are among the target species of the designated SPA, Red-throated Divers have been recorded abundant there. The OWF area is likely to disturb and displace diver species. To minimise potential impacts, WTGs should not be designed and constructed within 2 km of the SPA to minimise disturbance to diver wintering and feeding habitats.

Little Gull

To the east of the study area, near the coast of the Baltic Sea, there is a Natura 2000 Important Bird Area "Baltijos jūros priekrantė", which, in addition to protecting the wintering grounds of the Steller's Eider, the Common Goldeneye and the Common Merganser, has been designated to protect the migratory concentration sites of the Little Gulls.

A total of 4,221 Little Gulls (n = 2,466 in 2023 and n = 1,755 in 2024) were registered in the study area. The majority of Little Gulls were recorded during aerial surveys (n = 2,723). The birds were abundant during ship-based transect surveys as well – 787 birds in 2023 and 557 in 2024. In comparison, during earlier surveys from September 2021 to September 2022, there were 3,307 Little Gulls observed during one-year ship-based surveys and 625 recorded during aerial surveys.

Highest densities of Little Gulls were observed in July and August both years during ship-based surveys and also peaked in November of 2023 in aerial surveys. Overall, the species was observed every month of the two-year surveys (Fig. 5.4.55).

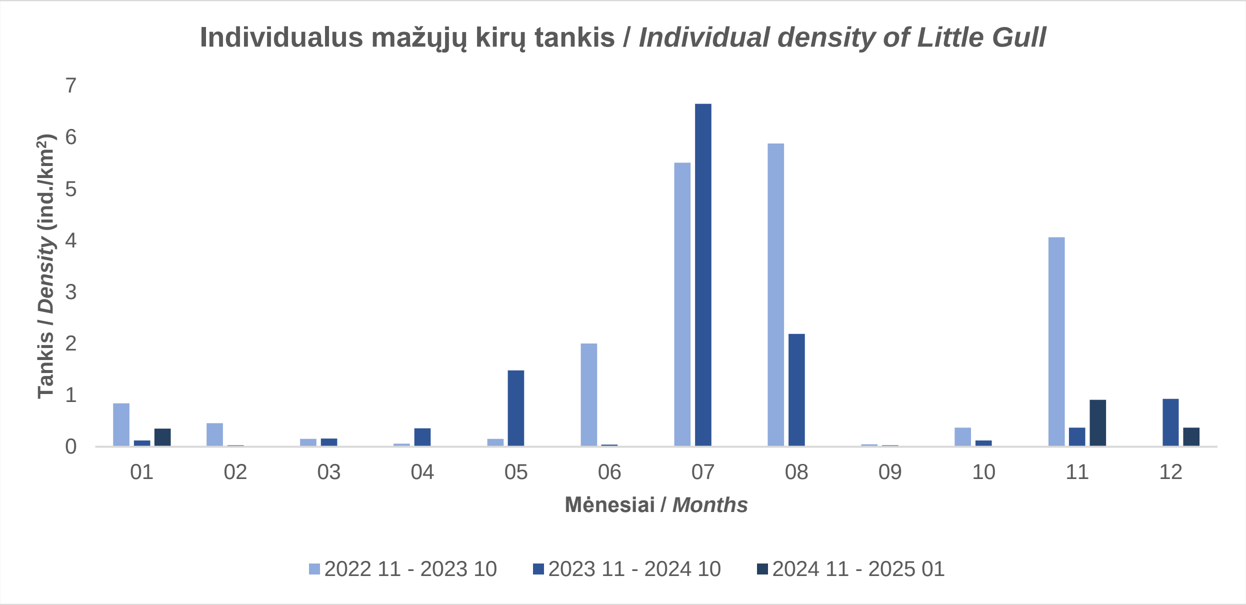


Fig. 5.4.55. Monthly densities of Little Gulls in the area (*there was no aerial survey 2022 12*).

In late July and August, Little Gulls migrate from their breeding grounds to the coasts of Lithuania, Latvia, and Poland for moulting (Durinck et al., 1994). They are primarily found in waters 20-50 m deep but can also occur at depths of up to 100 m (Durinck et al., 1994). Their diet consists mainly of insects and small fish.

Spatially, Little Gulls were broadly distributed throughout the study area, with lowest densities in September during both years and species was rare during winter of 2024 (Annex 6. Ornithological research reports: Survey Report Lithuania_2023_V3.0 and Survey Report Lithuania_2025_V2.0).

Little Gulls exhibit a non-significant reaction to OWF (Leemans & Collier, 2022) or are weakly affected, displaying some avoidance behaviour (Dierschke et al., 2016) due to a high collision risk (Piggott et al., 2021). It is estimated that approximately 5.5% of Little Gulls fly at sensitive to swept area altitudes WT (Cook et al., 2013).

In summary, the proposed OWF is unlikely to displace Little Gulls from the area but may present a collision threat. Additionally, cable installation during winter is not expected to affect Little Gulls within installation zone.

5.4.3.4 Potential impact on birds

5.4.3.4.1 Potential impact of the planned OWF

It has been determined that OWF can have various impacts on birds, including the disturbance of permanent wintering, and the foraging grounds as well as the disruptions to migration routes. Due to displacement, birds may be forced to seek new foraging areas, which may not provide the same quality of resources as their original habitat, or they may expend additional energy navigating around newly introduced obstacles.

Key effects of OWF on birds include:

- Direct collision: birds flying within the vicinity of WTGs face the risk of being struck by the blades, potentially resulting in fatalities.
- Displacement: some bird species actively avoid areas with OWF, leading to habitat loss and a reduction in available foraging sites.
- Barrier effect: OWF can obstruct traditional migration routes, forcing birds to fly around them or alter their paths, leading to increased energy expenditure.
- Disturbance: the presence of OWF, particularly during construction and maintenance, increases shipping traffic, and noise, temporarily driving birds away from their foraging and resting grounds.

Although high migration intensity over the proposed OWF was not observed, and most recorded species flew at low altitudes, the OWF still presents a potential collision risk for certain species, including gulls, cranes and nocturnal migrating passerines. This risk is particularly heightened during adverse weather conditions, such as fog. Additionally, despite their low occurrence within the study area, the OWF could act as a barrier for Common Cranes.

Seabirds in the research area were observed to be widely dispersed. Some species exhibit strong avoidance of the OWF, which may lead to their displacement from PEA and adjacent areas. Most Velvet Scoters were recorded from November to March wintering with highest densities varying from 0.77 to 7.16 ind./km^2 during winter months December to February. Meanwhile, Long-tailed Ducks were most abundant in the territory from December to April, with densities ranging from 0.33 to 2.08 ind./km^2. The highest density of Long-tailed Ducks was recorded in January 2023 and reached 2.08 ind./km^2. Razorbills were most abundant from January to March (0.03–0.7 ind./km^2) and were particularly abundant in November 2023 – 0.96 ind./km^2, and relatively high densities were also recorded during migration in early May 2024 (0.47 ind./km^2), although in previous years they reached only 0.09 ind./km^2.

After assessing individual species of seabirds, the greatest impact was found to be on wintering and migratory seabirds that form aggregations at sea and was identified as displacement from feeding or resting habitats and avoidance of these habitats. It is predicted that the displacement effect could extend up to 2 km from the OWF. Given that the planned OWF borders SPA, displacement could significantly reduce the population of protected seabirds wintering in the SPA.

During the construction and maintenance of the proposed OWF, the area will experience increased shipping traffic and noise, potentially causing some disturbance to seabirds. However, this impact is expected to be temporary and localised. Nonetheless, activities should be carefully planned during the vulnerable phase of seabird aggregation while on migration or wintering, when their abundance is at its peak (from 15 of November to 15 of April).

Within the PEA territory, foundation installation of WTG could lead to the partial loss of benthic habitats that serve as feeding grounds for birds. Additionally, noise generated by underwater pile driving may affect diving birds. During the construction and decommissioning phase to reduce the impact on wintering birds, it is recommended that the noisiest installation (pile driving) and decommissioning works of OWF are scheduled outside the main period of migratory and wintering bird aggregations (15 November–15 April). If pile driving cannot be postponed and must occur during the wintering period, to minimise the disturbance of wintering seabirds, the installation of foundations (or decommissioning works) should start at WTGs locations furthest from the SPA, while also applying appropriate noise mitigation measures (see section 5.4.5.4.1). Furthermore, during this sensitive period, for pile driving activities “soft-start” method should be applied, when work begins at minimum power, and gradually increasing it creates a gradual rise in sound level avoiding sudden noise shockwaves.

5.4.3.4.2 Potential impact of the export cable corridors installation offshore

The main effects predicted for birds during the cable installation are disturbance and displacement. These effects should be temporary and should not impact the wintering populations of seabirds.

The primary impacts on seabirds will occur during the construction phase. Key sources of disturbance include vessel traffic, noise and vibration, which could deter fish populations (a food source for piscivorous birds), and resuspension of seabed sediments, which increases water turbidity and hinders foraging for piscivorous species. Displacement could also be caused by the destruction of benthic communities along the transmission cable route, which could potentially reduce feeding areas for benthivores birds.

Installation or disassembly of the export cable might temporarily displace seabirds from the construction area. However, this effect is expected to be localized and short-term, ceasing once the work is completed.

The impact significance is assessed as low for Long-tailed Ducks, Velvet Scoters, Razorbills, Common Guillemots and both diver species. Nonetheless, activities should be carefully planned during vulnerable phase of seabird aggregation while on migration or overwintering (November 15 to April 15) when their abundance is at its peak.

5.4.3.4.3 Potential cumulative impact of various ongoing and planned activities (e.g., fishing, shipping) in the analysed area and its surroundings

Seabirds are adversely impacted by various human activities, including fishing, plastic pollution, shipping, and the effects of invasive species.

Fishing has a particularly strong negative effect on seabirds. Annually, between 1,000 and 3,000 seabirds perish along the Lithuanian coast due to coastal fishing (Morkūnas et al., 2022), with the highest mortality occurring in winter when birds become entangled in gillnets. Recent studies of seabirds retrieved from fishing nets indicate that Long-tailed Ducks and Red-throated Divers had ingested various debris. Among them, 5% of Long-tailed Ducks contained plastic and metal fragments in their stomachs (Morkūnas et al., 2021).

Shipping activity also disturbs seabirds, as birds avoid feeding near busy shipping lanes. The movement of vessels disrupts sea ducks, divers, and auks while they forage. During both the construction and maintenance of the OWF, increased vessel traffic in the area is expected to heighten disturbance levels for birds.

Invasive species further contribute to habitat degradation. The Round Goby (*Neogobius melanostomus*) preys on coastal mollusc communities, reducing food availability for seabirds like Long-tailed Ducks, which depend on mussels for sustenance. In response, these ducks have started altering their diet by catching fish instead (Skabeikis et al., 2019; Forni et al., 2022).

Although seabirds have partially adapted to these challenges by modifying their wintering grounds, diet, and behaviour, these adjustments require additional energy expenditure. The planned OWF may introduce cumulative impacts, combining with existing pressures in the marine environment. This cumulative effect is expected to be more significant for benthic-feeding sea ducks, such as Velvet Scoters and Long-tailed Ducks, while no substantial cumulative effects are anticipated for other bird species.

5.4.3.4.4 Potential cumulative impact of similar activities and transboundary effects

The wintering grounds of the Velvet Scoters and Long-tailed Ducks in the Baltic Sea are located from Slupsk (Poland) to Cape Kolka (Latvia), i.e. there is a large amount of suitable foraging habitat in the south-eastern Baltic Sea for these bird species. The planned OWF together with OWF in adjacent territory and “AVEC” OWF does not encroach on the most important habitats for these species, however, might displace some species due to avoidance.

On the Latvian side, on OWF is planned in close proximity meaning that cumulative impacts could resemble those identified for this OWF. However, due to a lack of sufficient data on seabird wintering sites in Latvian waters, it is currently challenging to assess the potential impacts on wintering birds. Regarding bird migration, the combined effect of the planned OWF in both Lithuania and Latvia is not expected to cause significant cumulative impacts on migratory birds. However, benthic-feeding species, which rely heavily on specific habitats, are likely to be more affected. In particular, impacts could be significant for Velvet Scoters and Long-tailed Ducks if similar numbers of this species winter on the Latvian side as they do in Lithuania.

5.4.3.5 Impact reduction, mitigation and compensatory measures

To reduce the potential impact on birds, mitigation and compensation measures are planned for the OWF and the installation of the export cables.

5.4.3.5.1 Mitigation measures

- No WTGs should be planned and built in the area closer than at least 2 km from SPA.
- During the construction and decommissioning phase to minimise the disturbance of wintering seabirds during the main period of migratory and wintering bird aggregations (15 November–15 April), the installation of foundations (or decommissioning works) should start at WTGs locations furthest from the SPA, while also applying appropriate noise mitigation measures (see section 5.4.5.4.1). Throughout this sensitive period, for pile driving activities “soft-start” method should be applied, when work begins at minimum power and gradually increasing it creates a gradual rise in sound level avoiding sudden noise shockwaves.
- Operation phase: radar and/or video surveillance systems must be installed in the northern and south-western parts of the OWF, capable of accurately capturing and archiving data during bird migration periods.
- During the construction, operation and decommissioning stages of the OWF to minimise disturbance to wintering birds, shipping routes must be planned to bypass protected areas if the works are carried out during the main period of migratory and wintering bird aggregations (15 November–15 April). Routes must be planned in the same way during the export cable laying and decommissioning phases. Restrictions do not apply for repair and maintenance works of cables.
- During the construction and decommissioning phases, cable laying or decommissioning activities within the offshore protected areas and a 2 km buffer zone around them must be avoided during the main period of migratory and wintering bird aggregations (15 November–15 April).
- Construction and operation phase: reducing unnecessary artificial lighting can help prevent collisions by minimising the attraction of certain bird species, which may be disoriented by artificial light. Effective measures include lowering illumination levels and intensity, adjusting the light spectrum, using deflectors, and modifying lighting patterns and lightning control systems to reduce interference with bird natural orientation mechanisms.

5.4.3.5.2 Compensatory measures

Before construction, during construction and operation stage: to enhance the understanding and analysis of seabird movements within the planned OWF and SPA, equip seabirds with GPS/GSM transmitters (trackers) – 40 seabirds before construction phase, 40 during construction phase and 40 after construction phase. Tagging should be conducted in the first months of seabird wintering season to collect the maximum amount of data. This will allow for a comparative analysis of bird behaviour before, during and post-construction phases of the OWF.

The OWF could have significant negative impacts on sea ducks and other bird species. Additionally, seabirds may face further risks due to the cumulative effects of the planned OWF combined with other offshore activities. To mitigate these cumulative impacts, it is recommended to offset the negative effects of other activities, particularly in fisheries, by reducing seabird bycatch. This can be achieved through measures such as: selecting safer fishing gear to minimise bird entanglement, providing financial support for the adoption of seabird-friendly fishing practices, funding safer fishing initiatives to promote sustainable methods, implementing temporary fishing bans in critical seabird habitats.

Another compensatory approach involves enhancing conservation efforts in protected areas and supporting scientific research on seabird wintering and breeding grounds.

5.4.3.5.3. Other measures

Bird monitoring should be conducted 2 years before construction, during construction phase and for 3 years post-construction. After this period, monitoring should be repeated every 5 years for a duration of 2 years.

If a significant negative impact is identified during the operation phase, which was not foreseen during the EIA, additional mitigation measures shall be taken, selecting them depending on the impact. After the implementation of additional measures, their effectiveness shall be monitored until it is ensured that the additional measures applied to avoid significant impacts are effective. If the impact remains significant even with all tested mitigation measures, individual wind turbines or group of WTGs may not be operated during the period when they may have a significant impact on biodiversity. The impact (displacement from the protected area) is considered significant when the abundance of protected birds in the “Natura 2000” SPA – the number and/or density of individuals of protected bird species in the monitored area – decreases by more than 20% from the natural long-term (10-year) population fluctuation (according to long-term research data collected under the state environmental monitoring program).

Summaries of potential impacts to birds during OWF and offshore export cables installation management and corresponding mitigation measures are presented in tables 5.4.28 and 5.4.29.

Table 5.4.28. Summary of potential impact of the CN OWF on seabirds and summary of mitigation measures

Stages	Impact	Nature	Scale	Duration	Significance	Mitigation measures
Construction	Work noise and vibrations	Negative direct effects – disturbance of birds	Local (within the OWF and surrounding areas)	Short-term (only available during installation works)	Potential minor effects – temporary fluctuations in bird abundance	WTGs must be designed and built at least 2 km away from SPA. From November 15 to April 15, the noisiest activities (pile driving) shall be started in the areas furthest away from the SPA. Underwater noise mitigation measures shall be used when driving piles. For driving piles "soft-start" method should be used, when works begin at minimum power and gradually increasing it creates a gradual rise in sound level avoiding sudden noise shockwaves.
	Physical destruction of benthic habitats	Negative effects due to possible reduced abundance of foraging areas	Local (within the OWF and surrounding areas)	Short-term (only available during installation works)	Negligible impact – only a small area destroyed compared to potential feeding areas	Not applicable.
	Increased vessel movements and noise	Negative direct effects – disturbance of birds	Local (within the OWF and surrounding areas)	Short-term (only available during vessel presence)	Potential minor effects – temporary fluctuations in bird abundance	When planning shipping routes, avoid protected areas from November 15 to April 15 inclusive.
Operation	Increased vessel or helicopter movements and noise	Negative direct effects – disturbance of birds	Local (within the OWF and surrounding areas)	Short-term (only available during vessel presence)	Potential minor effects – temporary fluctuations in bird abundance	When planning shipping routes, avoid protected areas from November 15 to April 15 inclusive. Restrictions do not apply for repair and maintenance works of cables.
	Displacement from habitat	Negative direct impact – reduction in abundance due to avoidance of OWF, resulting in	Local (within the OWF and surrounding areas)	Long-term (lasting until the end of the lifetime of OWF)	Potentially significant impacts – sea ducks, auks and divers will avoid the OWF	WTGs must be designed and built at least 2 km away from SPA.

Stages	Impact	Nature	Scale	Duration	Significance	Mitigation measures
		loss of part of the feeding habitat				
	Direct collision	Negative direct impacts – bird collision with OWF	Local (within the OWF)	Long-term (lasting until the end of the lifetime of OWF)	Possible minor impact – low mortality of birds will not affect the state of the populations	Reduce unnecessary artificial lighting.
	Barrier effect	Negative direct impact on bird migration due to the additional energy costs of flying around obstacles	Local (within the OWF)	Long-term (lasting until the end of the lifetime of OWF)	Potentially low significant effects – low impact on bird migration	Not applicable.
	Occurrence of secondary habitats	Positive indirect effects due to the potential increased abundance of foraging areas	Local (within the OWF)	Long-term (lasting until the end of the lifetime of OWF)	Positive impact	Not applicable.
Decommissioning	Work noise and vibrations	Negative direct effects – disturbance of birds	Local (within the OWF and surrounding areas)	Short-term (only available during disassembly works)	Potential minor effects – temporary fluctuations in bird abundance	When carrying out works, noise mitigation measures should be applied e.g. DBBCs, which help reduce underwater noise. From November 15 to April 15, the noisiest activities shall be started in the areas furthest away from the SPA.
	Increased vessel movements and noise	Negative direct effects – disturbance of birds	Local (within the OWF and surrounding areas)	Short-term (only available during vessel presence)	Potential minor effects – temporary fluctuations in bird abundance	When planning shipping routes, avoid protected areas from November 15 to April 15 inclusive.
	Destruction of secondary habitats	Negative effects due to possible reduced	Local (separate WTGs)	Long-term	Negligible impact – only a small area destroyed	Not applicable.

Stages	Impact	Nature	Scale	Duration	Significance	Mitigation measures
		abundance of foraging areas			compared to potential feeding areas	

Colour code

(green)	Positive impact
(light blue)	No impact or impact insignificant (not to be considered, no measures are applicable)
(blue)	Minor impact: decisions during design, preventive or mitigation measures
(light orange)	Moderate impact: addressed by mitigation measures
(orange)	Significant impact: mitigation and/or compensation measures are necessary.

Table 5.4.29. Summary of potential impact of the export cables installation on seabirds and summary of mitigation measures

Stages	Impact	Nature	Scale	Duration	Significance	Mitigation measures
Construction	Work noise and vibrations	Negative direct effects – disturbance of birds, deterring fish populations, which are a food source for piscivorous birds	Local (along the export cable laying zone and surrounding areas)	Short-term (only available during installation works)	Potential minor effects – temporary fluctuations in bird abundance	Avoid activities in the area from November 15 to April 15, inclusive.
	Increased vessel movements and noise	Negative direct effects – disturbance of birds	Local (along the export cable laying zone and surrounding areas)	Short-term (only available during vessel presence)	Potential minor effects – temporary fluctuations in bird abundance	When planning shipping routes, avoid protected areas from November 15 to April 15 inclusive.
	Physical destruction of benthic habitats	Negative effects due to possible reduced abundance of foraging areas	Local (along the export cable laying zone and surrounding areas)	Short-term (only available during installation works)	Negligible impact – only a small area destroyed compared to potential feeding areas	Not applicable.
	Resuspension of seabed sediments	Negative effects due to possible reduced visibility and abundance of foraging areas	Local (along the export cable laying zone and surrounding areas)	Short-term (only available during installation works)	Potential minor effects – temporary fluctuations in bird abundance	Avoid activities in the area from November 15 to April 15, inclusive.
Operation and maintenance	No effects are expected under normal operating conditions				Insignificant	Not applicable.
Decommissioning	Work noise and vibrations	Negative direct effects – disturbance of birds	Local (along the export cable disassembly zone and surrounding areas)	Short-term (only available during decommissioning works)	Potential minor effects – temporary fluctuations in bird abundance	Avoid the activities in the area from November 15 to April 15, inclusive.
	Increased vessel movements and noise	Negative direct effects – disturbance of birds	Local (along the export cable disassembly zone and surrounding areas)	Short-term (only available during vessel presence)	Potential minor effects – temporary fluctuations in bird abundance	When planning shipping routes, avoid protected areas from November 15 to April 15 inclusive.

Stages	Impact	Nature	Scale	Duration	Significance	Mitigation measures

Colour code

(green)	Positive impact
(light blue)	No impact or impact insignificant (not to be considered, no measures are applicable)
(blue)	Minor impact: decisions during design, preventive or mitigation measures
(light orange)	Moderate impact: addressed by mitigation measures
(orange)	Significant impact: mitigation and/or compensation measures are necessary.

5.4.4 Bats

5.4.4.1 Survey methods

5.4.4.1.1 Methods for assessing the current state

Recording bat migrations and flight intensity with an ultrasound detector is important for assessing bat activity. According to current legislation, bat surveys are not mandatory when planning OWFs located more than 15 km from the shore; however, they are recommended. To further assess potential risks, this evaluation utilised both existing and newly collected information on bat activity in the Baltic Sea and along its coast during the bat migration period. In the forested section of the cable's onshore route, trees were visually inspected for potential bat breeding sites.

Spring bat surveys in May of both 2022 and 2024 were conducted from a vessel monitoring bat migration in the middle of the PEA territory. Autumn migratory bat surveys were carried out during the autumn migration periods of 2022 and 2024. In autumn 2022, detectors recorded bat activity at three locations:

a) On the Palanga bridge (PALANGA), approximately 0.3 km from the shore, recorded from July 28 to October 15.

b) From a vessel near Būtingė (SL Tengiz, Fig. 5.4.56), about 5–7 km from the coast, recorded from August 18 to October 15.

c) In the open sea on a hydrometeorological parameters measurement platform, approximately 30–35 km from the coast, recorded from early July to October 15 (Fig. 5.4.57).

In May–June 2023, inspection of the forest onshore in the area of the planned cable zone was carried out. No suitable tree holes were spotted for bat reproducing.

In the autumn of 2024, detectors recorded bat activity at two points:

a) On the Palanga bridge (PALANGA2), about 0.3 km from the shore, recorded from July 28 to October 15.

b) At the Palanga lifeguard station (PALANGA1), on the beach near the sea line, recorded from July 28 to October 15.

Fig. 5.4.56. Vessel on which a bat detector was mounted in 2022.

Fig. 5.4.57. The buoy on which the bat detector was mounted in 2022.

Data were collected using stationary bat detectors SM4BAT FS (Wildlife Acoustics) equipped with U2 type microphones (Wildlife Acoustics). The microphone coverage range is 50–100 m, depending on the bat species. The detectors were programmed to automatically activate 30 minutes before sunset, record and store ultrasonic signals in internal memory, and deactivate 30 minutes after sunrise. All data collected at stationary recording points were analysed, and the detector recordings onboard were used for those made while the ship was at sea. The analysis of detector records was conducted using Kaleidoscope Pro software (Wildlife Acoustics), with auto-identification verification applied. Rstudio and Microsoft Excel were used for statistical analysis.

5.4.4.1.2 Methods for assessing potential impacts

To assess the potential impact on bats, several factors were assessed:

- Species composition – during breeding and migration periods.
- Evaluation of migration intensity over the year and day to determine periods of most intense migration.

5.4.4.2 Survey area

The survey locations were strategically selected to ensure observations covered the coast, the coastal zone, and the open sea – areas where the OWF is planned to be installed (see Fig. 5.4.58).

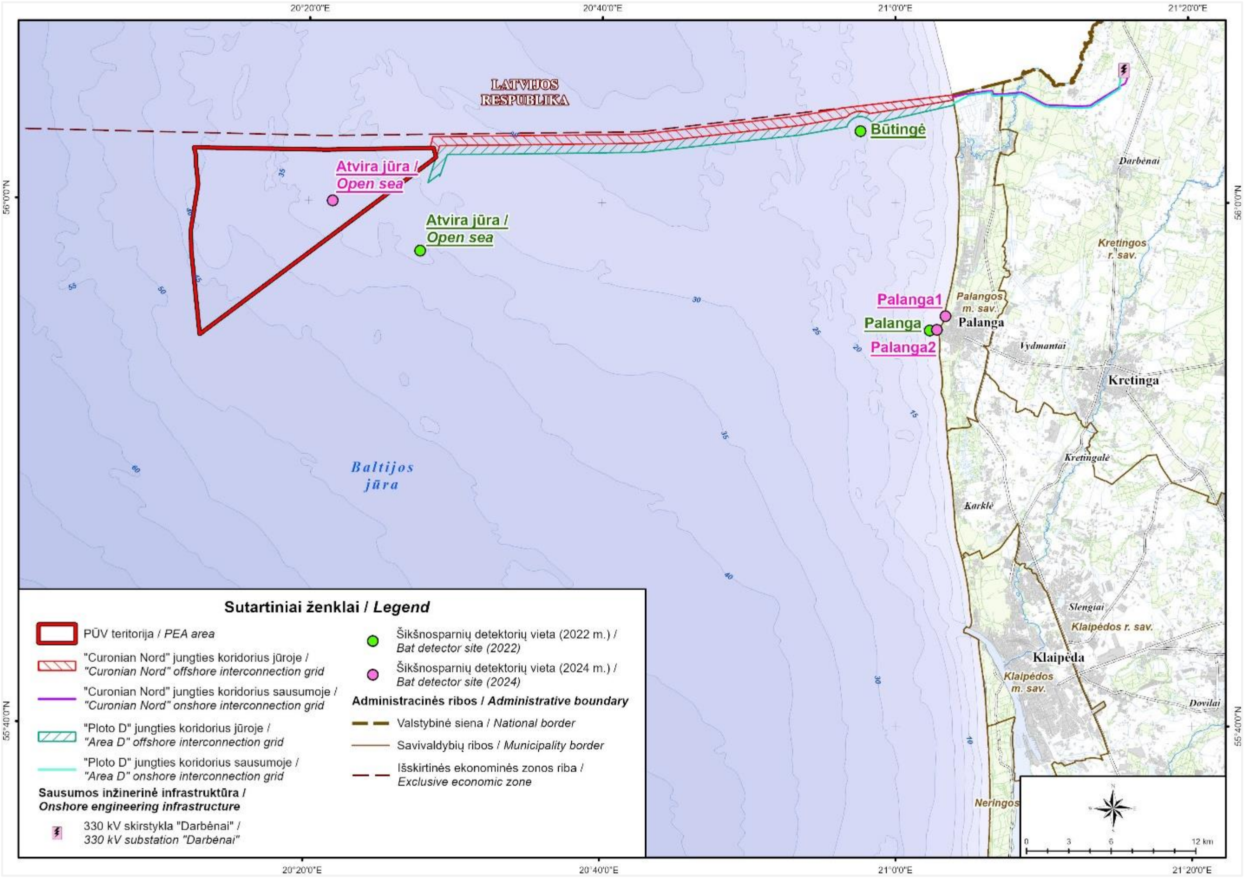


Fig. 5.4.58. Locations of migrating bat surveys and the area under impact assessment.

5.4.4.3 Current state

Bats are terrestrial animals, and in the temperate climate zone, which includes Lithuania, their habitats and behaviours vary between warm and cold periods of the year. Greater bat activity is recorded during the warm season; during this time, bats feed, breed, nurse their young, mate, and migrate (Stefanovič V. et al., 2011, *Let's Discover Bats Together*). Peak bat activity occurs in August, when juveniles become independent and hunt alongside adults before migrating to wintering sites in southern European countries (Barataud M., 2020, *Acoustic Ecology of European Bats: Species Identification, Study of their Habitats and Foraging Behaviour*).

During the cold season in Lithuania, only 9 of the 14 officially registered bat species remain (Baranauskas K., 2008, *Bats in Lithuania and Their Protection*). In the autumn migration period, these bats also migrate through Lithuania to regions further north (Gaultier SP et al., 2020, *Bats and Wind Farms: The Role and Importance of the Baltic Sea Countries in the European Context of Power Transition and Biodiversity Conservation*). Before 2022, there was no data on bat migration over the sea or along the coast in Lithuania. However, episodic observations have revealed that, on suitable nights, thousands of bats may fly over coastal areas or along the Curonian Spit in a single night (Morkūnas J., 2018, *Bat Inventories in the Territory of the Curonian Spit National Park*).

It is known that Nathusius's bats ringed in Lithuania have been found wintering in the UK. To reach the UK, these bats must fly over the North Sea (Bat Conservation Trust[89]). Additionally, some bats migrate to the UK from the Netherlands and Belgium, suggesting a high probability that bats may migrate to wintering grounds over the Baltic Sea near Lithuania's coast under suitable natural conditions. In Europe, Nathusius's bat migrates along a very wide front, covering coastal areas and flying over the sea from continental Europe to England (see Fig. 5.4.59).

According to EUROBATS, bats can be classified into three groups based on the impact of wind energy/WTG:

a. High risk of mortality due to WTG operations – species that migrate long distances or forage in open areas high above the ground and may reach the height of WTG rotors: Parti-coloured bat (*Vespertilio murinus*), Common noctule (*Nyctalus noctula*), Leisler's bat (*Nyctalus leisleri*), Nathusius' pipistrelle (*Pipistrellus nathusii*).

[89] https://www.bats.org.uk/our-work/national-bat-monitoring-programme/surveys/national-nathusius-pipistrelle-survey

b. Medium risk of mortality due to WTG operations – species that migrate over shorter distances and forage above or near trees; they may occasionally reach the height of WTG blades: Common pipistrelle (*Pipistrellus pipistrellus*), Soprano pipistrelle (*Pipistrellus pygmaeus*), Northern bat (*Eptesicus nilssonii*), Serotine bat (*Eptesicus serotinus*).

c. Low risk of mortality due to WTG operations – non-migratory species that forage in specific habitats or close to water surfaces, do not reach the height of WTG rotors, and are sedentary: Brandt's / whiskered bat (*Myotis brandtii / Myotis mystacinus*), Barbastelle (*Barbastella barbastellus*), Daubenton's bat (*Myotis daubentonii*), Pond bat (*Myotis dasycneme*), Natterer's bat (*Myotis nattereri*), Brown long-eared bat (*Plecotus auritus*).

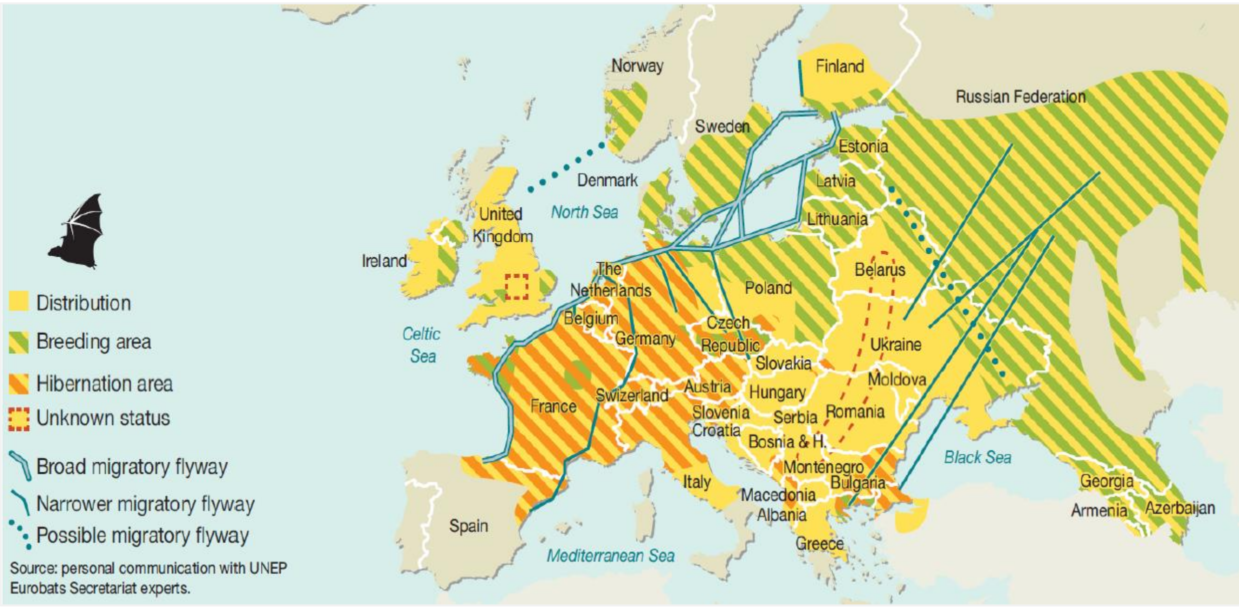


Fig. 5.4.59. Distribution and migration of Nathusius's' pipistrelle in Europe. Source: Riccardo Pravettoni, UNEP/GRID-Arendal (https://www.grida.no/resources/7643).

5.4.4.3.1 Observation results

During the spring migration of bats, the detector on the ship within the PEA territory did not record any ultrasonic signals attributed to bats.

In the 2022 surveys, 11,838 bat detections were recorded on the Palanga bridge, attributed to 12 species, while in Būtingė, 515 detections were recorded, attributed to 8 species (see Table 5.4.30). In the open sea, only 12 bat detections were recorded, attributed to 3 species. At the coastal monitoring point in Palanga, there were 22 times more bat recordings than at the Būtingė point located 5 km inland from the shoreline, and nearly 1,000 times more than in the open sea. This indicates that the farther the registration point is from the coast, the fewer bats were detected.

The most intensive bat registrations in Palanga occurred in August, with 10,581 recordings. In September, the intensity decreased tenfold to 1,053 registrations. In Būtingė, there were 427 ultrasound recordings in the first half of August, and only 72 in September, which is about 11 times fewer than in August. In the open sea, 7 bat registrations were recorded in August 2022, and 5 in September.

Table 5.4.30. Number of bat ultrasounds recorded during the surveys conducted in 2022 and 2024

Location and species	July	August	September	October	Total
	2022				
BŪTINGĖ	*****	**427**	**72**	**16**	**515**
Parti-coloured bat		21	2	1	24
Pond bat		2	4	1	7
Lesser noctule		203	16	4	223
Nathusius's pipistrelle		54	31	5	90
Common noctule		62	10	4	76
Northern bat		10			10

Location and species	July	August	September	October	Total
Common pipistrelle		1			1
Serotine bat		61	7	1	69
NoID		13	2		15
PALANGA	**180**	**10,581**	**1,053**	**24**	**11,838**
Parti-coloured bat		323	90		413
Western barbastelle	3	2			5
Pond bat		52	5		57
Lesser noctule	21	2,418	292	7	2,738
Nathusius's pipistrelle	10	996	254	14	1,274
Brown long-eared bat		5			5
Common noctule		541	60		601
Northern bat	107	5,691	303		6,101
Soprano pipistrelle	10	135	13		158
Common pipistrelle	3	35		3	41
Daubenton's bat	23	229	13		265
Serotine bat	3	111	11		125
NoID		43	12		55
Meteostation at sea 2022	**0**	**7**	**5**	**0**	**12**
Common noctule		1	2		
Nathusius's pipistrelle		3			
Northern bat		1	1		
NoID		2	2		
Total	**180**	**11,008**	**1,125**	**40**	**12,353**
	2024				
PALANGA1-2024 (lifeguard station)	**1,337**	**15,791**	**8,875**	**224**	**26,227**
Western barbastelle		4	7	1	12
Northern bat	1,031	867	69		1,967
Serotine bat	56	521	185	33	795
Brandt's bat		2			2
Pond bat		3	18		21
Daubenton's bat	4	19	98	12	133
Natterer's bat		4	6	5	15
Lesser noctule	156	1,636	1,570	34	3,396
Common noctule	30	647	273	11	961
Nathusius's pipistrelle	10	9,179	5,549	87	14,825
Soprano pipistrelle	44	1,836	842	38	2,760
Common pipistrelle	6	1,042	200	2	1,250
Brown long-eared bat		1	4		5
Parti-coloured bat		30	54	1	85
PALANGA2 2024 (bridge)		**181**	**2,356**	**441**	**2,978**
Western barbastelle			3		3
Northern bat		129	340	1	470
Serotine bat		4	37	7	48
Pond bat			17		17
Daubenton's bat		13	1,049	368	1,430
Lesser noctule		4	375	15	394
Common noctule		2	86	8	96

Location and species		July	August	September	October	Total
Nathusius's pipistrelle			20	218	37	275
Soprano pipistrelle			1	204		205
Common pipistrelle			7	8	2	17
Brown long-eared bat				2		2
Parti-coloured bat			1	17	3	21
	Total	**1,337**	**15,972**	**11,231**	**665**	**29,205**

The 2022 migration period survey revealed distinct differences in bat species composition between Palanga and Būtingė. In Palanga, the Northern bat was dominant, accounting for over 52% of all registrations, followed by the Lesser noctule at 23%, Nathusius' pipistrelle at 11%, and the Common noctule at 5%. In contrast, Būtingė saw the Lesser noctule as the most frequently recorded species, comprising 43% of the registrations, with Nathusius' pipistrelle at 18%, the Common noctule at 15%, and the Serotine bat at 13%.

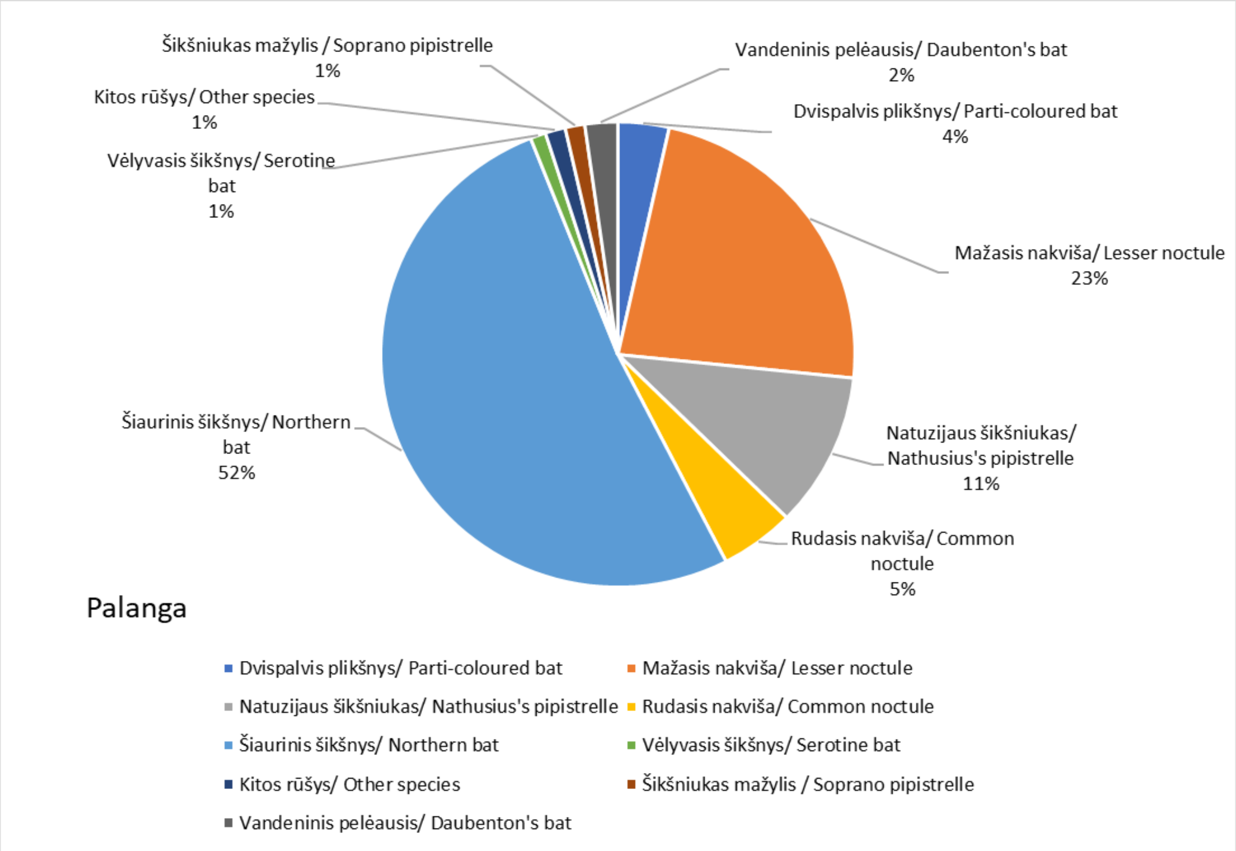


Fig. 5.4.60. Bats species composition in Palanga in 2022.

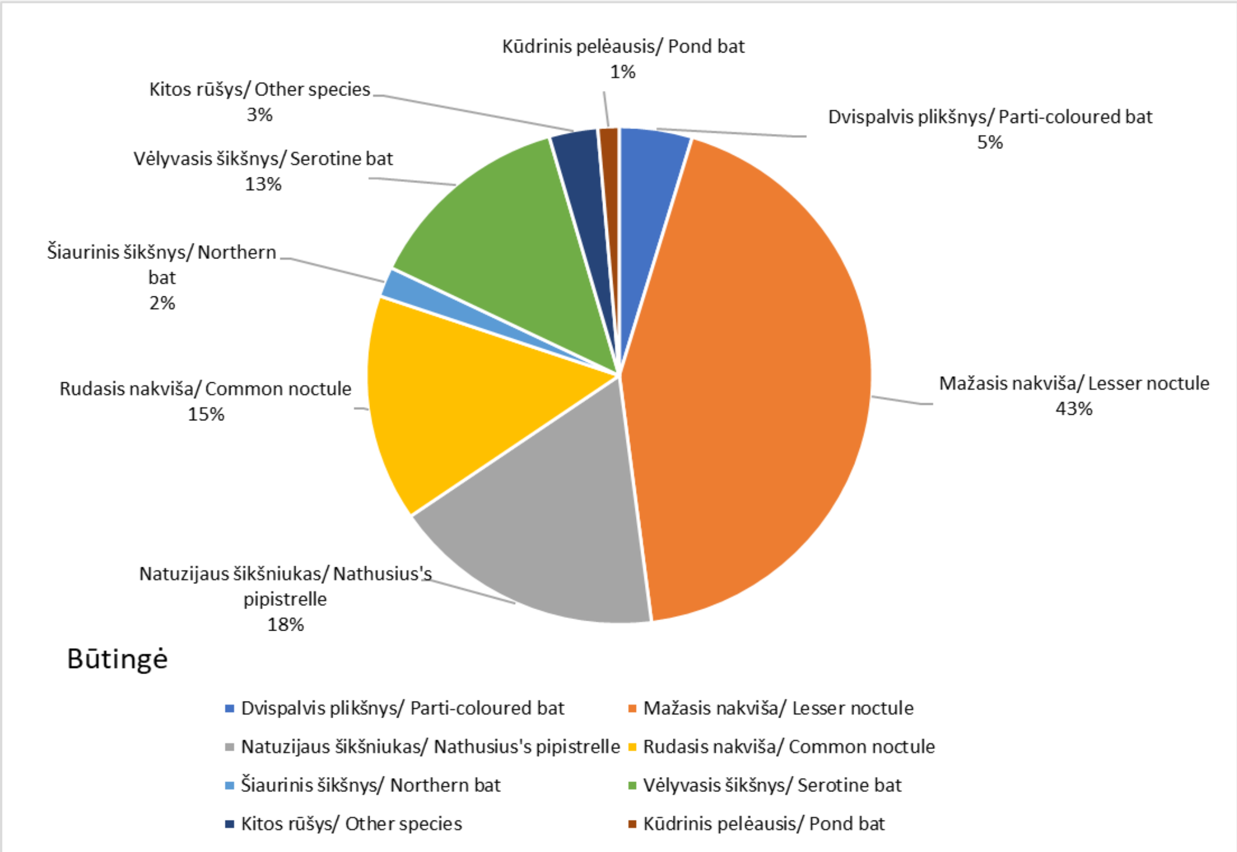


Fig. 5.4.61. Species composition of bats near Būtingė in 2022.

The peak of bat migration in 2022 at the Palanga bridge observation point was observed from August 10 to August 29, during which 300 to 1,093 ultrasonic registrations of bats per night were recorded. Meanwhile, at sea near Būtingė, located 5–7 km from the coast, much lower bat activity was recorded, typically ranging from 23 to 75 bat registrations per night, with a maximum of 138. This indicates intense migration along the coast and in the nearshore marine environment, whereas further offshore, bat migration is weakly expressed. The migration peak lasts about two weeks, from early to mid-August, and corresponds to the period identified at the Palanga bridge.

In the open sea, between July 19 and November 15, 2022, only 13 bat passes were recorded, all on August 14, 15, 16, and 26–27. Observation times suggest the presence of 7–9 individual bats, including one Nathusius' pipistrelle that may have stayed near a platform for three days, and repeated flights of the Serotine bat observed within minutes, possibly attracted to the platform itself. All bats were recorded between midnight and 1:00 AM, suggesting that bats could have reached the platform from the coast shortly after sunset, given their flight speeds of 20 to 50 km/h.

These incidental observations offshore demonstrate that detections are possible, particularly if an attractant is present, but such events do not represent systematic or directional migration. Bats observed at sea have no opportunity to land and must return to land by morning, or they risk dying due to the absence of roosting sites and increased predation risk from gulls during daylight. The study recorded instances where gulls easily caught migrating passerines, indicating that bats lost at sea could face similar threats.

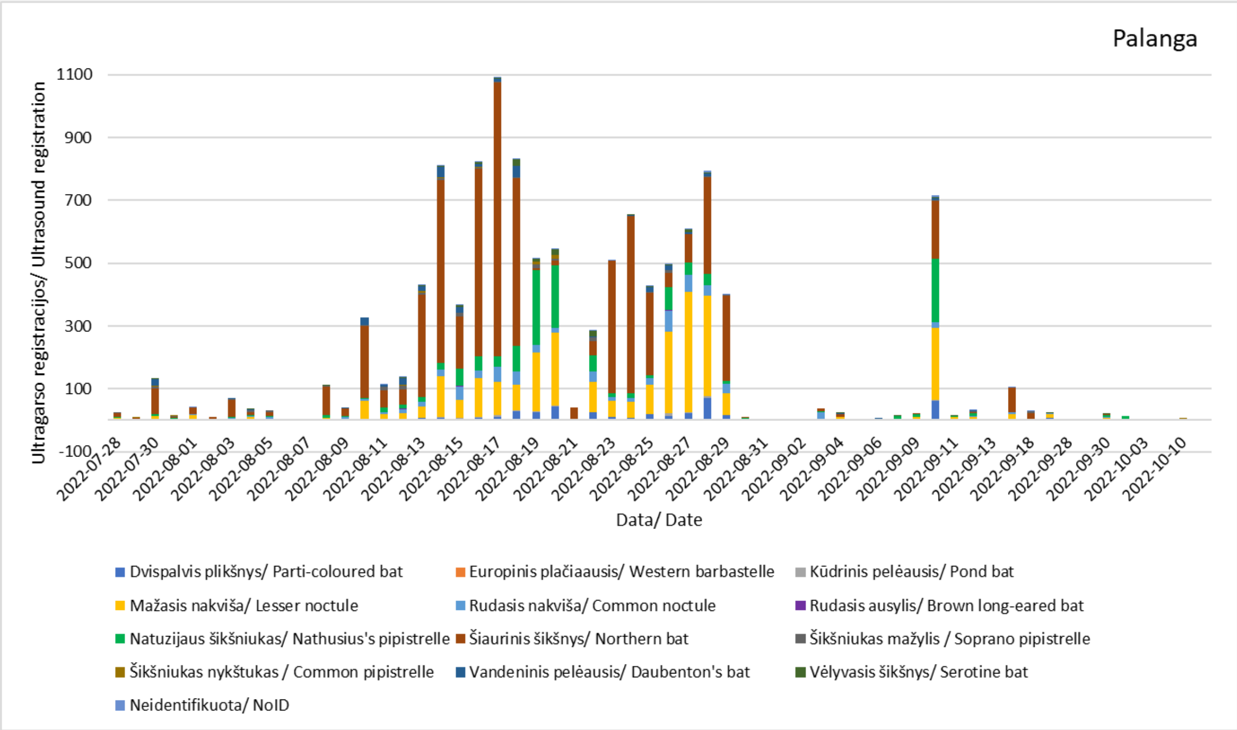


Fig. 5.4.62. Bat migration phonology in Palanga on the end of the bridge in 2022.

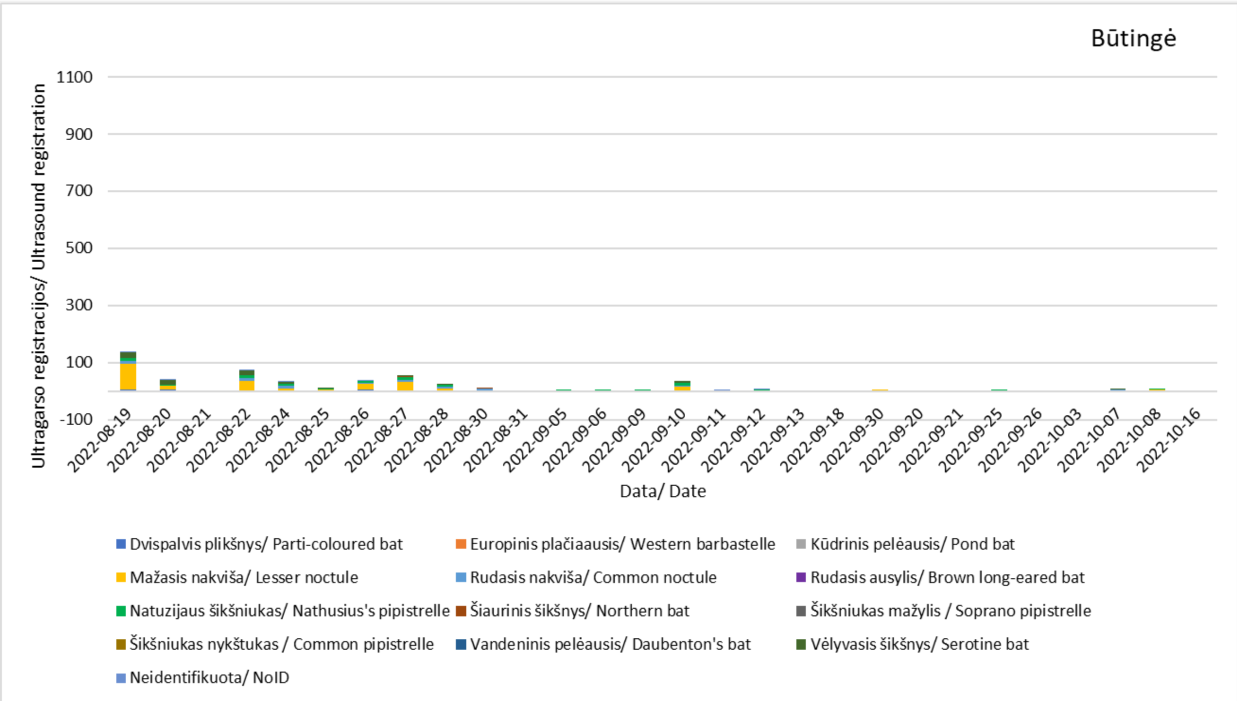


Fig. 5.4.63. Bat migration phonology near Būtingė, monitored from the vessel; 2022.

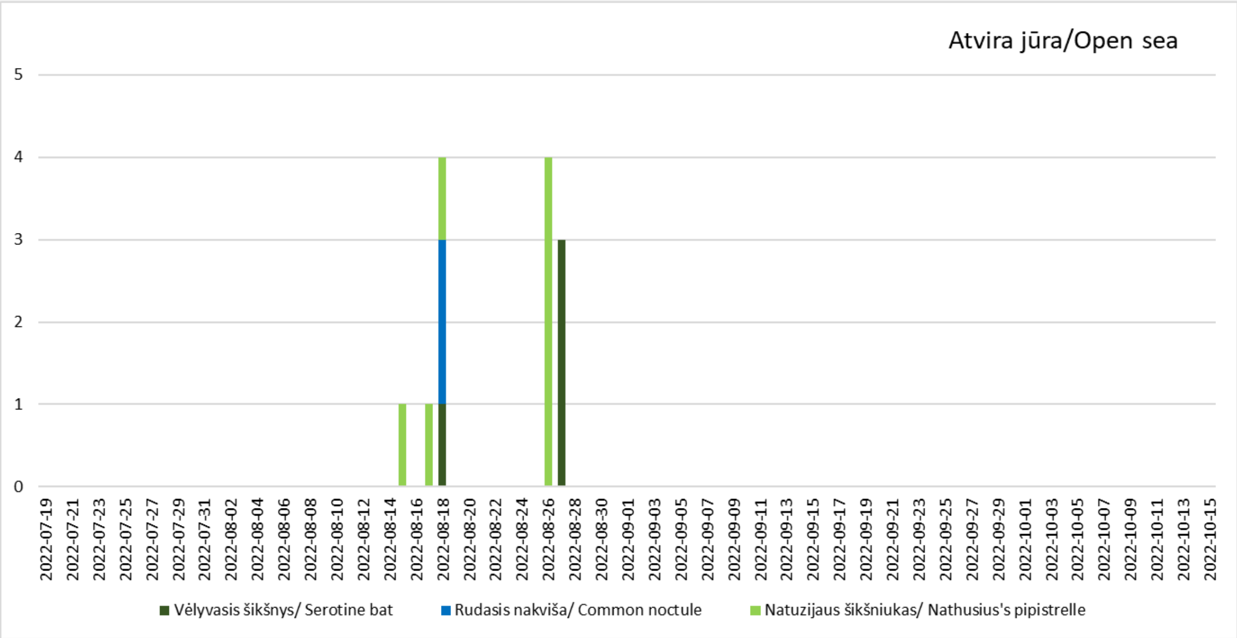


Fig. 5.4.64. Bat migration phonology in the open sea in 2022.

By comparing the days with overlapping data from two registration points, researchers can estimate the migration intensity between Palanga and Būtingė. Assuming all bats pass through Palanga, Būtingė captures about 9.6% of that number, indicating a significant decrease in bat activity as they move further offshore (refer to Fig. 5.4.65 and Table 5.4.31). In the area designated for the planned OWF, only 13 bat passes were registered during the autumn migration period, representing a mere 0.1% of the total bats recorded at the Palanga bridge. This suggests that bat migration intensity significantly diminishes in the offshore areas compared to coastal regions.

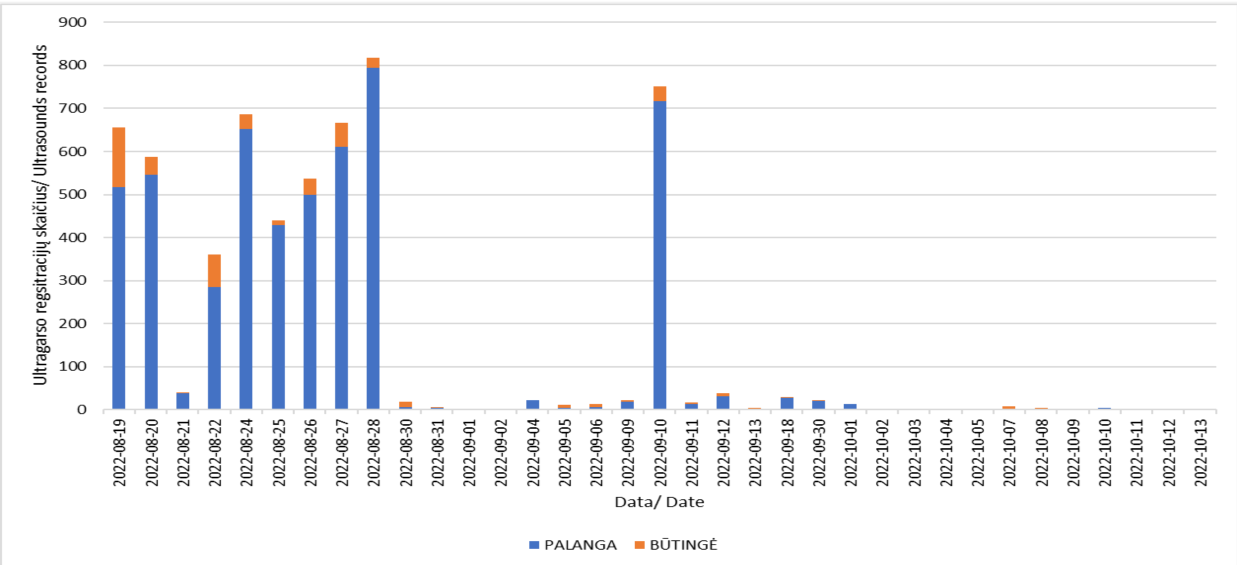


Fig. 5.4.65. Bat migration at two registration points, where data was recorded on the same nights in different locations in 2022.

Table 5.4.31. Bat migration intensity relative to distance from coastline (Palanga registration site as 100% baseline)

Date	Location		Būtingė percentage relative to Palanga
	PALANGA	BŪTINGĖ	
2022-08-19	518	138	26,6
2022-08-20	547	40	7,3
2022-08-21	39	1	2,6
2022-08-22	286	75	26,2
2022-08-24	653	33	5,1
2022-08-25	430	10	2,3

Date	Location		Būtingė percentage relative to Palanga
	PALANGA	BŪTINGĖ	
2022-08-26	499	38	7,6
2022-08-27	611	56	9,2
2022-08-28	795	23	2,9
2022-08-30	7	11	157,1
2022-08-31	5	2	40,0
2022-09-01	1	0	0,0
2022-09-02	3	0	0,0
2022-09-04	23	0	0,0
2022-09-05	4	7	175,0
2022-09-06	7	7	100,0
2022-09-09	19	4	21,1
2022-09-10	717	34	4,7
2022-09-11	14	3	21,4
2022-09-12	32	6	18,8
2022-09-13	2	1	50,0
2022-09-18	28	1	3,6
2022-09-30	20	3	15,0
2022-10-01	14	0	0,0
2022-10-02	0	0	0,0
2022-10-03	1	1	100,0
2022-10-04	0	0	0,0
2022-10-05	0	0	0,0
2022-10-07	0	8	100,0
2022-10-08	0	5	100,0
2022-10-09	0	0	0,0
2022-10-10	5	0	0,0
2022-10-11	0	0	0,0
2022-10-12	0	0	0,0
2022-10-13	1	0	0,0
Total	**5,281**	**507**	**9,6**

The 2022 research data clearly indicates that bat migration is most intense along coastal areas, particularly close to the shoreline. As bats move further offshore, the intensity of migration decreases markedly. At approximately 5–7 km from the shore, bat detections over the sea drop to just 9.6% of the numbers recorded near the coast. Consequently, the likelihood of intensive bat migration through the PEA area is very low. As such, the planned OWF is not expected to have a significant impact on bats, given the diminished migration activity at these offshore distances.

5.4.4.3.2 2024 research data

In 2024, more intensive bat studies were conducted in the coastal zone, with repeated surveys at the Palanga bridge (monitoring point Palanga2) and a new site established at the balcony of the Palanga lifeguard station (monitoring point Palanga1) (Fig. 5.4.66). Additionally, an offshore detector was installed on a buoy used for measuring hydrometeorological parameters in the planned OWF area, intended to collect data from February to October 2024. The same equipment used in 2022 was deployed for bat monitoring, with observations carried out from July 26 to October 17. Unfortunately, technical malfunctions impacted the data collection. The detector on the Palanga pier suffered damage from an electrical discharge soon after installation, disrupting its clock settings and causing it to operate for only half the night until September 14. Meanwhile, the offshore detector on the buoy experienced technical issues and ceased functioning on April 27, failing to record any bat activity.

Fig. 5.4.66. Bat detectors installed on the Palanga lifeguard station (Palanga1) on the left and on the Palanga bridge (Palanga2) on the right.

In 2024, at monitoring point Palanga1, located on the lifeguard station, a total of 26,227 bat passes were recorded. Nathusius' pipistrelle accounted for approximately half of these, with 14,825 passes (56.5%). Lesser noctules were the second most numerous, with 3,396 passes (12.9%), followed by Soprano pipistrelles at 2,760 passes (10.5%) (Table 5.4.30).

Meanwhile, at monitoring point Palanga2 on the Palanga bridge, Daubenton’s bats dominated the recordings with 1,430 passes (48%), followed by Northern bats with 470 passes (15.8%) and Lesser noctules with 394 passes (13.2%) (Table 5.4.30).

These results suggest that pipistrelles, including Nathusius’ and Soprano pipistrelles, migrate intensively along the land area adjacent to the coastline, preferring sheltered areas and avoiding open water. In contrast, Daubenton’s bats and larger species like Northern bats are more prevalent over water near the shore. The highest bat migration intensity along the Baltic Sea coastal strip in 2024 was observed between August 15 and September 8, with nightly counts ranging from 1,000 to 2,350 bat passes, predominantly Nathusius’ pipistrelles. As the migration season progressed, bats continued migrating actively until around September 24, with 100 to 500 passes recorded on certain nights. A similar migration pattern was noted in 2022, with peak activity between August 10 and August 30 (Fig. 5.4.67 and 5.4.68).

Variations of a few days are typical in phenology due to weather conditions, leading to the conclusion that the primary bat migration period is from August through early September.

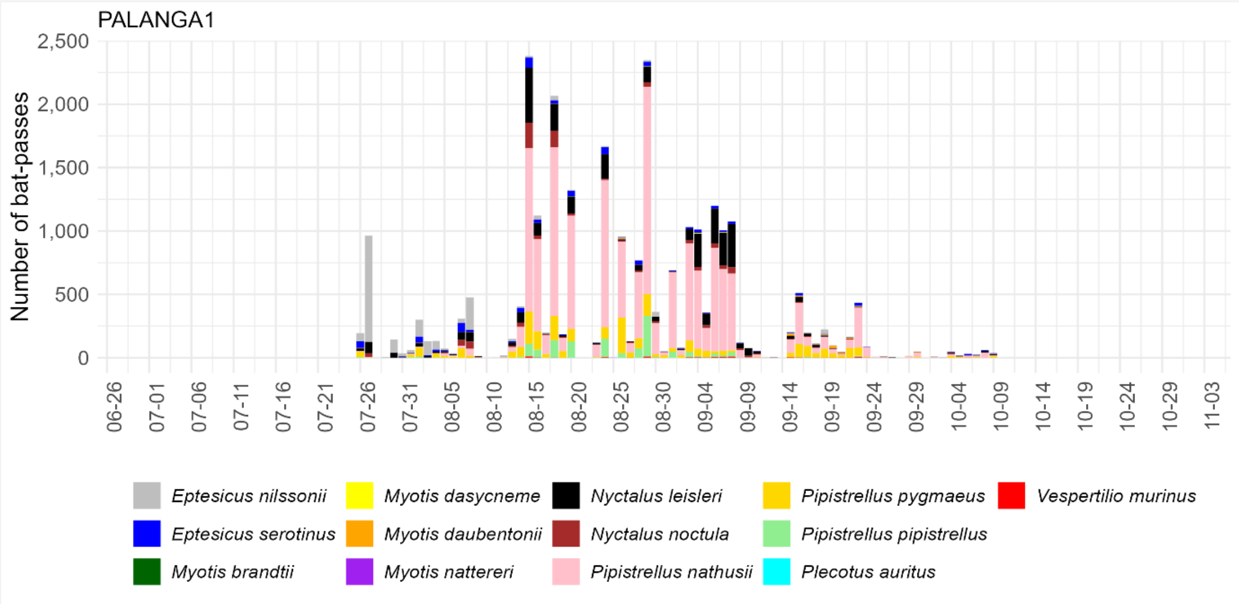


Fig. 5.4.67. Bat migration phonology in Palanga on the lifeguard station in 2024**.**

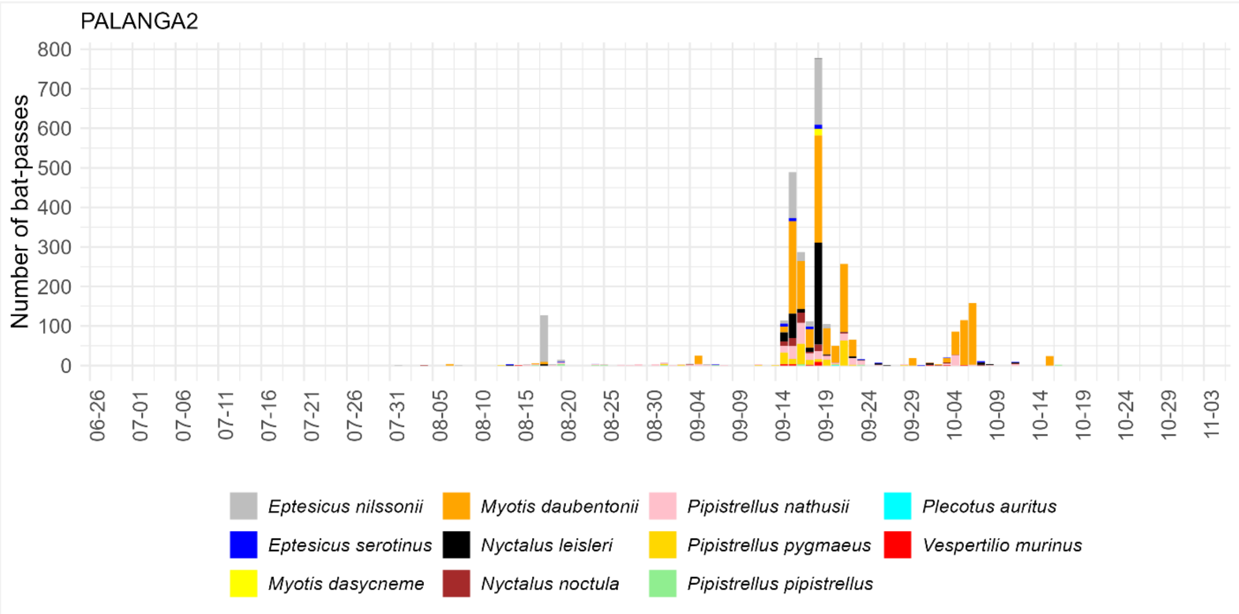


Fig. 5.4.68. Bat migration phonology in Palanga on the end of the bridge in 2024.

During the migration period, bat species exhibited varying levels of activity. Nathusius' pipistrelle showed the highest activity, with registrations exceeding 1,800 bat passes per hour in August (Fig. 5.4.69). Their activity typically began in the second hour after sunset and peaked until about an hour before sunrise, with the most intense activity occurring in August and September. In comparison, Soprano pipistrelles demonstrated lower activity levels, peaking at up to 450 passes per hour in August (Fig. 5.4.70). Like Nathusius' pipistrelles, their activity started in the second hour after sunset and ended an hour before sunrise. The Lesser noctule exhibited a similar pattern to the pipistrelles but maintained consistent activity levels throughout both August and September (Fig. 5.4.71).

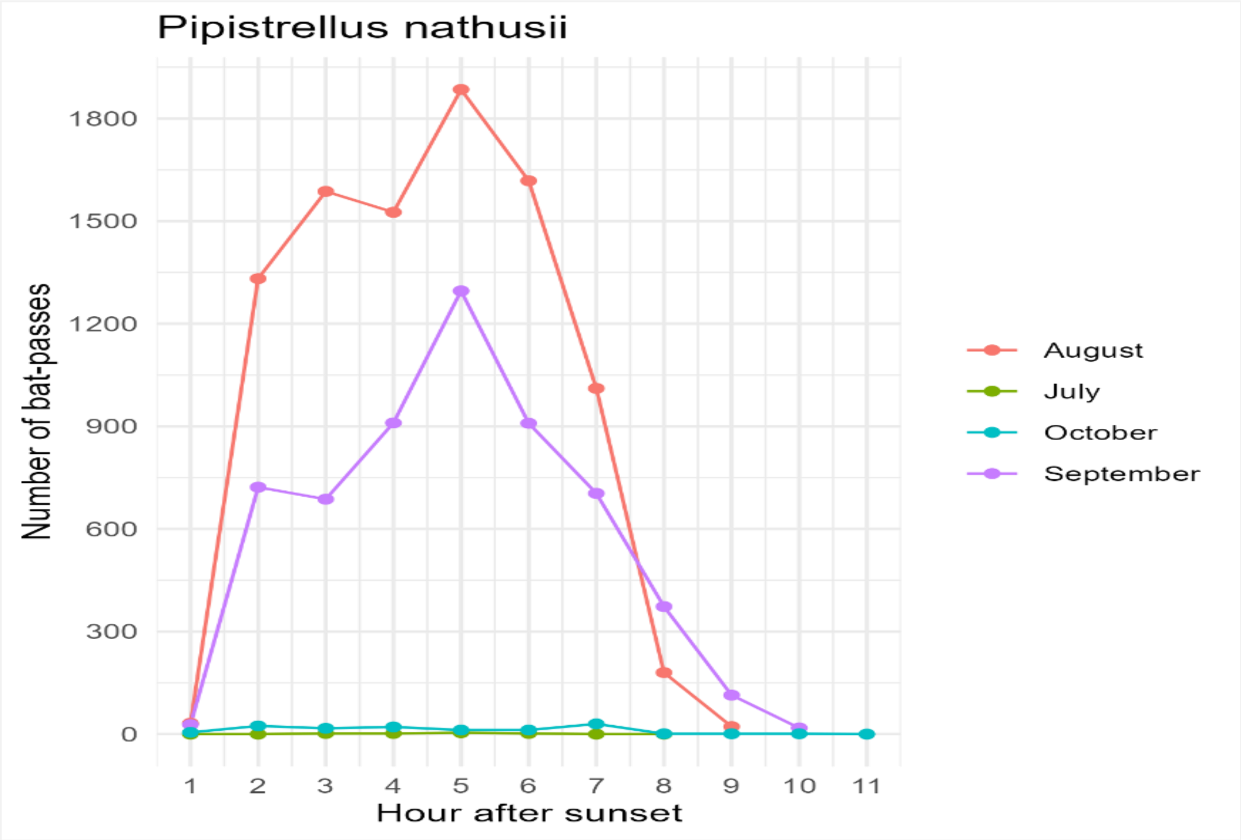


Fig. 5.4.69. Hourly activity of Nathusius's pipistrelle in different months.

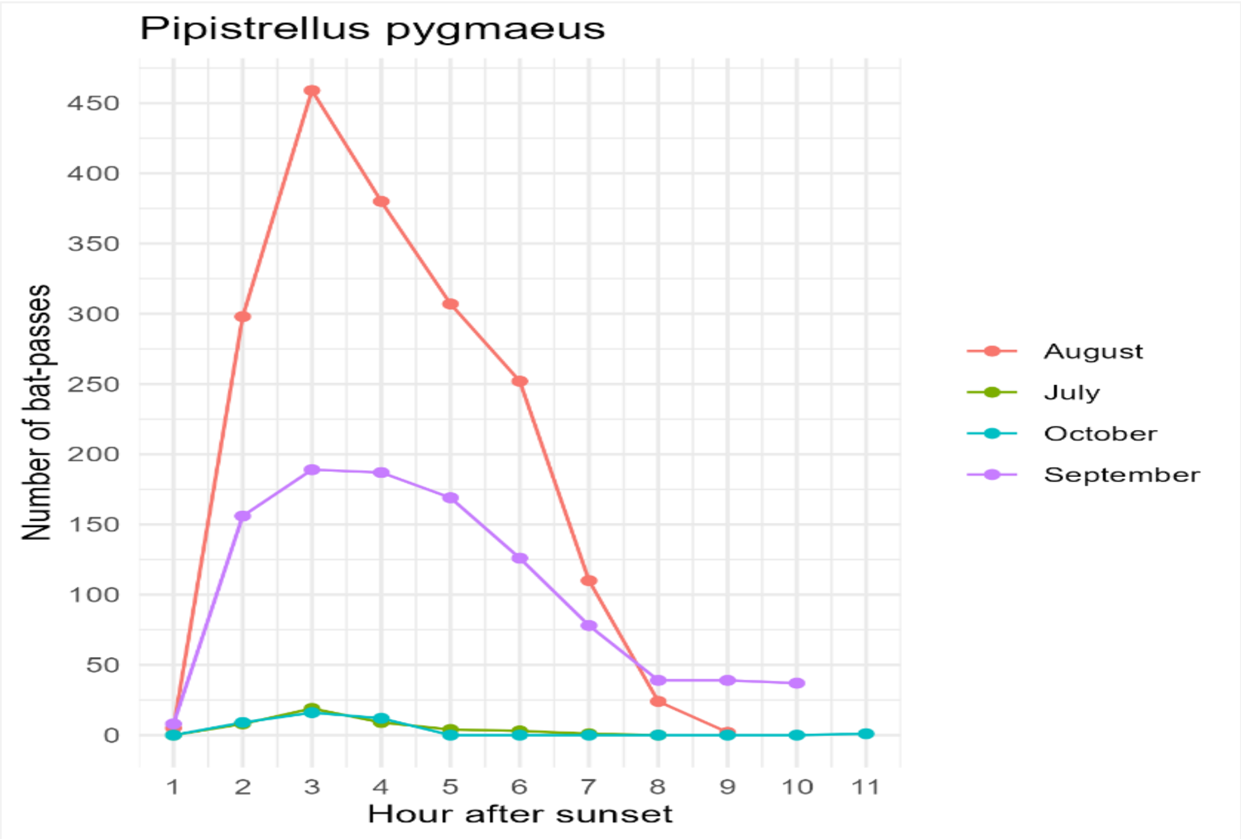


Fig. 5.4.70. Hourly activity of *Soprano pipistrelle* in different months.

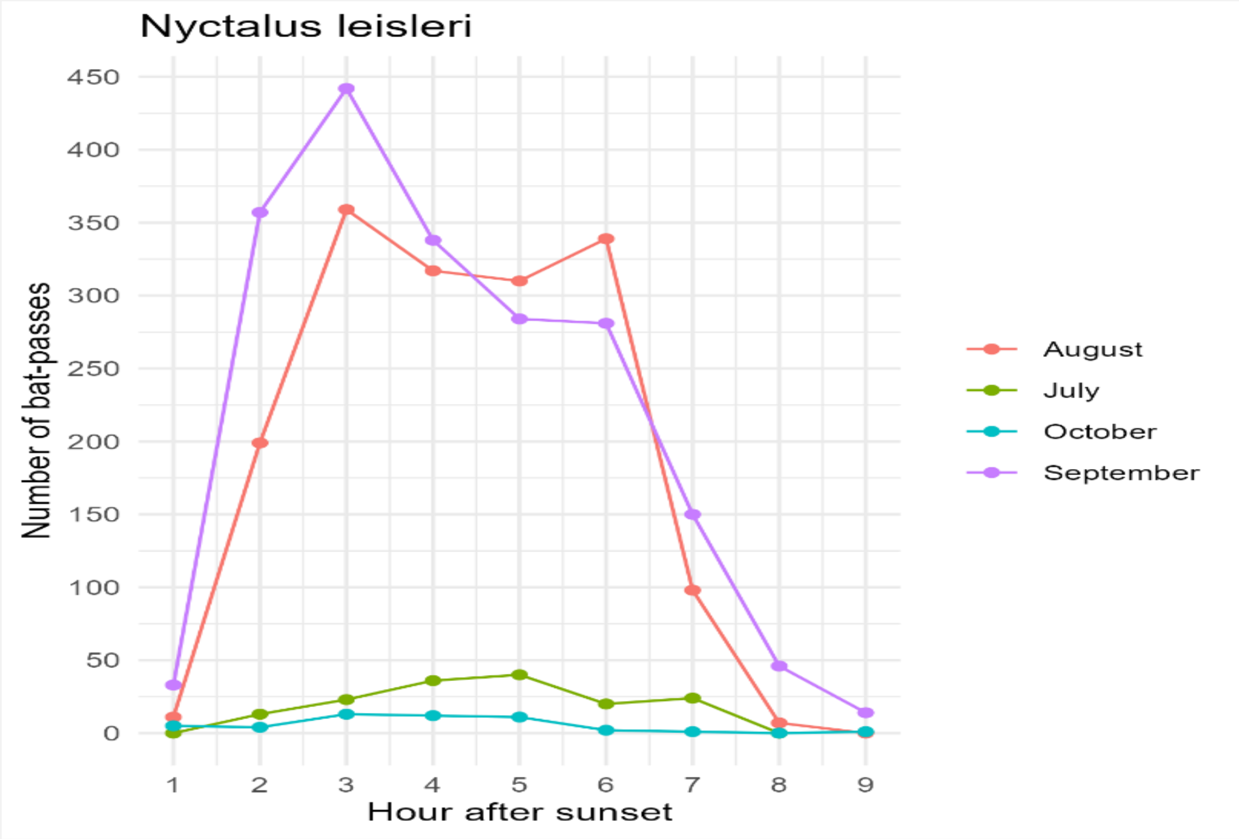


Fig. 5.4.71. Hourly activity of Lesser noctule in different months.

The distribution of bat flights each night during the 2024 migration period reveals a distinct pattern: migration along the coast typically begins in the second hour after sunset and continues actively until 1–2 hours before sunrise. This later start time for bat recordings suggests that these are not local bats but migratory bats arriving from further distances, as detected by the monitoring equipment (Fig. 5.4.72). In contrast, at the Palanga bridge in August 2024, bat flights were recorded starting at sunset, likely indicating local bats drawn to feed on insects congregating near the bridge (Fig. 5.4.73). From mid-September onwards, the pattern shifted to reflect bats arriving from further afield, with the first flights recorded 1–1.5 hours after sunset, suggesting the continuation of migration activity rather than local feeding behaviours.

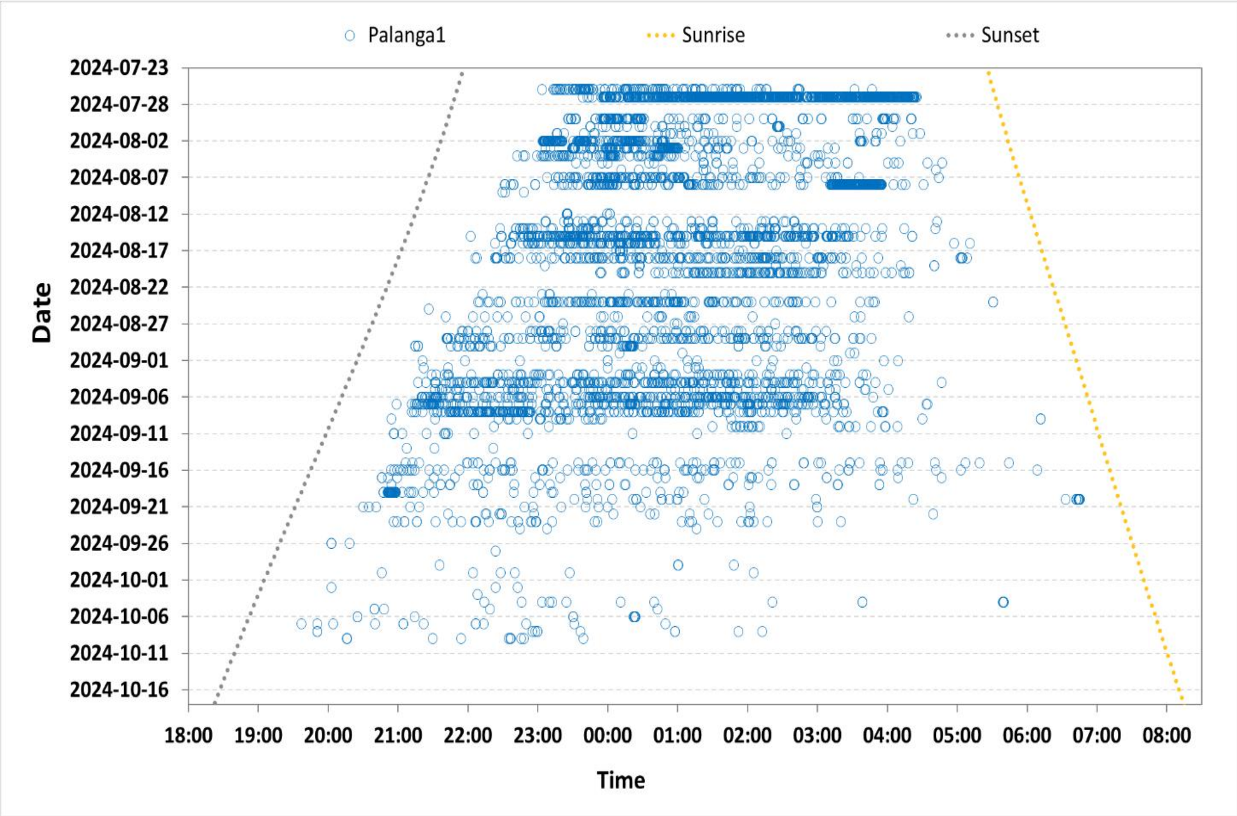


Fig. 5.4.72. Bat migration phonology during the recording period at the measurement point on the Palanga lifeguard station.

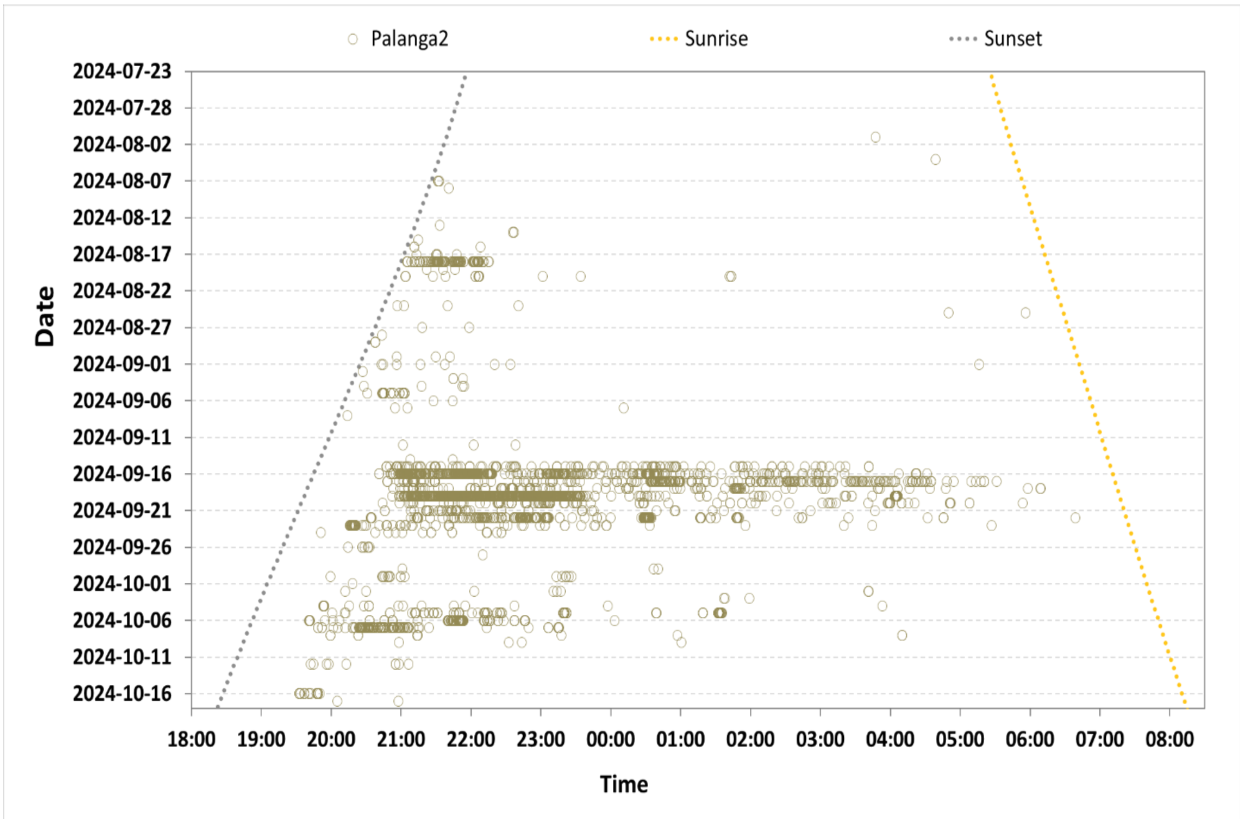


Fig. 5.4.73. Bat migration phonology during the recording period at the measurement point on the Palanga bridge.

Research data indicates that the most intensive bat migration occurs along the coastal land stretch near the dunes, with minimal activity over the open sea, suggesting bats found offshore are far from their typical migration routes. Spring surveys conducted from ships in both 2022 and 2024 recorded no bats at sea, reinforcing this pattern. During the bat research period from late July to October, up to 26,000 bat passes were recorded at the land-based monitoring site located 30 m from the sea. In contrast, about 12,000 bat passes were recorded at the Palanga bridge (300 m from the shore), 515 bat passes were recorded at sea near Būtingė (5,000–7,000 m from the shore), and only 13 bat passes were detected in the open sea (30,000–35,000 m from the shore). This distribution suggests bats do not intentionally migrate over the open sea, and those found offshore may be lost or displaced by wind. Physically, bats lack the capability to cross the Baltic Sea near Lithuania in one night, placing those located 30–40 km offshore at significant risk of mortality due to predation by gulls after daybreak. The planned OWF, situated 30–40 km offshore, may serve as both a refuge for disoriented bats and a potential site of mortality. Lost bats might search for food around WTGs or attempt to settle there at daybreak. Hence, the conclusion is that the planned OWF will not impact migrating bats, as their migration does not occur in the open sea off Lithuania.

5.4.4.4 Potential impact on bats

It has been established that OWFs can affect bats migrating over the sea, particularly in areas where short distances can be crossed overnight, such as the route from the Netherlands to the UK. In such regions, OWFs may impact migrating bats due to their proximity to established migration paths. However, in open sea areas where OWFs are located far from the coast, the impact is classified as very low or negligible. There is a low probability that some bats may experience negative effects from direct collisions with turbine blades or barotrauma, which occurs due to pressure differences in the rotor zone that can be fatal.

Significant negative impacts on bats are not expected, as the intensity of bat migration decreases significantly with increased distance from the shore. Studies have shown high migration activity up to 300 m from the shore at Palanga, particularly above the Palanga bridge. However, at 5–7 km offshore in Būtingė, bat migration intensity is less than 10% of that recorded at the end of the Palanga bridge. In the open sea, only isolated individuals, likely accidental strays, have been registered. Based on these data, it has been determined that bat migration does not occur 30–40 km from the shore within the PEA area, with only isolated individuals potentially reaching this distance without clear direction. Consequently, while bats at such distances may attempt to find roosting sites or feed, leading to potential mortality, the overall impact is considered insignificant.

During the construction phase of the OWF, lost bats at sea may try to roost on vessels involved in the installation process, presenting a potential but minor concern for bat interaction with offshore structures.

5.4.4.4.1 Potential cumulative impacts on biodiversity of different activities taking place and/or planned in the analysis area and its vicinity (e.g. fishing, shipping)

There are no other anthropogenic threats to bats in the sea, such as fishing or intensive shipping.

5.4.4.4.2 Potential cumulative transboundary impact

The planned OWFs on the Latvian side and similar developments in Poland are situated further offshore, suggesting that bat activity in these areas is likely to be very low. While current data is insufficient to accurately assess the threat posed by these OWFs to bats, it is plausible that, considering all neighbouring OWFs collectively, a small number of migrating or disoriented bats may perish during migration. However, given the reduced bat activity expected in these more remote offshore locations, the overall impact on bat populations is anticipated to be minimal.

5.4.4.5 Preventive, mitigation and compensatory measures for impacts on bats

It is unknown whether the OWF will attract bats as a landmark at sea; if so, bat activity may increase, and measures may need to be taken to stop the OWF during the bat migration period.

Measures are designed in accordance with the EU Habitats Directive (92/43/EEC) and the recommendations of the EUROBATS Agreement, with the aim of preventing significant adverse effects on bat populations. The main goals of mitigation actions are to verify the data collected during the EIA and to test our hypothesis in practice. For this, we will need to determining of bat species composition and relative abundance in offshore areas during the construction and operational phases, and to identification of environmental conditions under which bat activity occurs at sea are necessary.

1) During construction:
   - It has to be ensured that bat migration can be monitored during the construction and operation of the OWF. Monitoring shall be carried out using ultrasonic detectors installed on vessels during construction and on WTGs and the OSS during OWF operation. During construction, detectors have to be installed on at least two vessels involved in building the OWF from April to October. The data collected during construction has to be assessed when preparing the monitoring programme for the operational phase of the OWF. The species composition and environmental conditions (wind speed, direction, temperature, precipitation) during which bat activity was recorded in the open sea must be determined.

- On land, in the forest area where deforestation is planned for cable installation, prior to felling, the identification of day roosts of breeding bats has to be repeated (as bats could have settled in new sites since the initial assessment was carried out). If breeding sites are identified, they have to be preserved, or tree stumps with hollows and cavities shall be relocated to adjacent forest areas so as not to deteriorate the living conditions of species listed in the Habitats Directive. Relocation shall be carried out outside the breeding and migration periods – from the end of November until the beginning of April. All works shall be undertaken to ensure that the conservation status of bat species listed in Annex II and Annex IV of the Habitats Directive is not deteriorated.

2) During OWF operation:

- Due to the likelihood that the OWF may attract bats, bat activity monitoring shall be carried out. Bat activity has to be recorded using ultrasonic and, if possible, visual monitoring equipment. Detectors should be placed around the perimeter of the OWF, with at least two detectors in the first rows of WTGs facing north, west, and south, as well as one detector in the centre of the OWF and one at the substation. Ultrasonic microphones should record activity in the rotor-swept zone from early April to the end of October.
- Simultaneously, on the coast near Būtingė and Palanga, one ultrasonic detector each should be installed to collect data on activity in the coastal zone, enabling comparison of bat activity at sea and on land. During measurements, data on wind speed, direction, and temperature has to be collected both at sea and on land.
- After the first year of operation, the collected data has to be evaluated, and the OWF's operation adjusted accordingly: if the impact is found to be significant (as per existing Regulation), the most appropriate mitigation measures (technological or phenological) must be selected.

5.4.4.5.1 Compensatory measures

To reduce the likelihood of potential harm to bats both on land and at sea, and to compensate for any possible bat mortality or loss of daytime roosting habitats, the developer should install temporary special roosting sites along the coast, designed specifically for bats, where migrating individuals can safely rest. Such roosting sites should be established in at least 10 locations important for bat foraging, from the Latvian coastline to Klaipėda. In the forested area where tree felling is planned for cable installation, 10 bat boxes or artificial roosts suitable for breeding and daytime shelter for different bat species will be installed in adjacent plots.

Figure 5.4.74. Nesting boxes for migrating bats.

5.4.4.5.2 Bat monitoring

The plan for monitoring bats involves continuous observation during the construction phase and for three years post-construction. After this initial period, monitoring will be repeated for two years every five years. If monitoring reveals a more significant negative impact than anticipated in the EIA, mitigation measures must be implemented. These could include temporarily halting wind turbine operations during the peak migration periods in autumn and/or spring to minimize harm to bats.

Table 4.6.32. Potential impacts of the OWF on bats and summary of mitigation measures

Phase	Impact	Nature	Scale	Duration	Impact	Mitigation measures	Notes
Construction (offshore)	Noise from construction	Negative direct effects – bat disturbance	Local (within the OWF and surrounding areas)	Short-term (only during installation work)	Impact at sea – insignificant	Not applicable.	-
	Physical destruction of seabed habitats	Insignificant	Local (within the OWF)	Short-term (only during installation work)	Impact at sea – insignificant	Not applicable.	-
	Increased vessel traffic and noise	Insignificant	Local (within the OWF and surrounding areas)	Short-term (only during installation work)	Impact at sea – insignificant	Not applicable.	May attract bats as a roosting site.
Construction (onshore)	Habitats destruction	Negative direct effect – bat roosting site destruction	Local (within the cable zone in forest area)	Short-term (only available during installation work)	Impact on land – insignificant	Retain roost trees where possible. If removal is necessary, relocate trunks/stumps with cavities or hollows to adjacent forested areas.	Also, artificial roosting sites erection in the forest.
Operation	Movement and noise of surveillance vessels	Insignificant	Local (within the OWF and surrounding areas)	Short-term (only during the vessels stay)	Impact at sea – insignificant	Not applicable.	May attract bats as a roosting site.
	Displacement from the habitat	Insignificant	Local (within the OWF and surrounding areas)	Long-term (will last until the end of the OWF's operation)	Impact at sea – insignificant	Not applicable.	-
	Direct collision	Negative direct impacts – bat collisions OWF or barotrauma	Local (within the OWF)	Long-term (will last until the end of the OWF's operation)	Potentially insignificant or low-significant impact. If bats were to die due to collisions with wind turbines, this would most likely be caused by bats lost at sea, which would likely die anyway	Monitoring of bat activity.	Determined by bat activity. It is possible that the OWF will attract bats lost at sea.

Phase	Impact	Nature	Scale	Duration	Impact	Mitigation measures	Notes
	Intimidation	Insignificant	Local (within the OWF and surrounding areas)	Short-term	Impact at sea – insignificant	Not applicable.	-
	Barrier effect	Insignificant	Local (within the OWF)	Long-term (will last until the end of the OWF's operation)	Impact at sea – insignificant	Not applicable.	-
	Occurrence of secondary habitats	Positive indirect effects due to potentially greater choice of resting habitats and abundance of food objects	Local (in OWF area)	Long-term (will last until the end of the OWF's operation)	Positive impact	Not applicable.	Additional resting and feeding areas between WTGs lead to additional risk of mortality.
Decommissioning	Noise from construction	Insignificant	Local (within the OWF and surrounding areas)	Short-term (only during work)	Impact at sea – insignificant	Not applicable.	-
	Destruction of secondary habitats	Insignificant	Local (separate WTGs)	Long-term	Impact at sea – insignificant	Not applicable.	-
	Increased vessel traffic and noise	Insignificant	Local (within the OWF and surrounding areas)	Short-term (only during installation work)	Impact at sea – insignificant	Not applicable.	May attract bats as a roosting site.

Colour code

(green)	Positive impact
(light blue)	No impact or impact insignificant (not to be considered, no measures are applicable)
(blue)	Minor impact: decisions during design, preventive or mitigation measures
(light orange)	Moderate impact: addressed by mitigation measures
(orange)	Significant impact: mitigation and/or compensation measures are necessary.

5.4.5 Marine mammals

5.4.5.1 Survey methods

5.4.5.1.1 Methods for assessing the current state

During the warm season, marine mammals in the OWF area were monitored alongside bird surveys from a vessel, while during the cold season, observations were conducted from an aircraft. Additionally, passive acoustic monitoring of harbour porpoises has been carried out in the OWF area from September 27, 2023, to February 11, 2025. Data retrieval and hydrophone maintenance were carried out during for the following periods of acoustic gear deployment:

- September 27, 2023–November 22, 2023.
- December 14, 2023–March 8, 2024.
- March 8, 2024–July 21, 2024.
- July 21, 2024–October 25, 2024.
- October 25, 2024–February 11, 2025.

Marine mammal surveys from a vessel were conducted alongside bird surveys from May to October, once per month, following transects spaced 4 km apart. The surveys were carried out along predefined transect routes, with marine mammals observed from the vessel. No vessel-based surveys were conducted from November to April; instead, this period was compensated with aerial surveys. Marine mammals resting or swimming at the water surface were recorded using digital video technology developed by HiDef, following the methodology outlined in the European Seabird-at-Sea (hereinafter – ESAS) program (Garthe & Hüppop, 1996, 2000) and the BSH guidelines of StUK4 (BSH, 2013).

Harbor porpoises emit acoustic clicks almost continuously for echolocation and communication (Wisniewska et al., 2016), making passive acoustic monitoring (hereinafter – PAM) an effective method for studying them (Kyhn, 2010). In this study, F-POD acoustic loggers (Chelonia Ltd., UK) were used to detect and record porpoise clicks and ambient noise. PAM was conducted from September 27, 2023, to February 6, 2024, with a three-week break. According to StUK4 (BSH, 2013), baseline monitoring of harbour porpoises requires one POD station per project area, or at least two POD stations if the project is located within 20 km of a protected area of significance to harbour porpoises. Although the CN OWF lies within 20 km of a marine protected area, that site is not designated as being of significance to harbour porpoises; therefore, only the baseline requirement of one station would formally apply. As defined by BSH, each POD station consists of three individual POD devices. However, previous studies have reported substantial POD loss rates ranging from 25% to 100%, which can jeopardize data integrity. To mitigate this risk, enhance spatial coverage, and ensure robust data collection, eight F-POD dataloggers were deployed and, evenly distributed across the project area in a 4.5 km (2.43 nm) grid (Fig. 6.4.7, Table 6.4.10). This design substantially exceeds the minimum requirements of StUK4. Furthermore, studies such as those conducted at the Kattegatt Syd OWF site and in Danish “Natura 2000” areas have demonstrated that five stations are sufficient to statistically detect interannual differences in harbour porpoise activity (Kyhn & van Beest, 2022). Given that the CN OWF is at least 30% smaller than these sites, the deployment of eight dataloggers represents more than twice the relative monitoring effort, thereby improving redundancy, minimizing potential data gaps from losses, and increasing the likelihood of detecting spatial and temporal patterns in harbour porpoise occurrence. According to specifications, the F-PODs have a detection radius of 400 m for registering clicks emitted by harbour porpoises. The receivers were suspended 3 to 10 m above the seabed using custom-designed anchoring systems, each equipped with a surface buoy. To protect the equipment from trawling, a request was submitted to the Lithuanian authorities, resulting in imposed fishing and navigational restrictions. The total deployment time of the F-POD loggers was 2,052 days, 7 hours, and 59 minutes, with 1,140 days, 18 hours, and 50 minutes dedicated to active acoustic recording.

The FPOD stores FP1 files, which is analysed in the custom made FPOD manufacturer produced software FPOD.exe v 2.06 (Chelonia Ltd., 17th March 2023). With this software FP3 files were extracted with the KERNO-F 1.0 classifier (unpublished algorithm) to find click trains. Click trains are grouped into narrow band high frequency origin, e.g. harbour porpoises, dolphins or boat sonars. For each origin category, click trains are categorised into either ‘high’, ‘medium’ or ‘low’ probability of arriving from the stated source. Fallowing BSH guidelines of StUK4 (BSH 2013) for monitoring of harbour porpoises in this study only narrow band high frequency click trains were selected and only when categorized with a high or moderate probability of arriving from a narrow band high frequency species.

5.4.5.1.2 Methods for assessing potential impacts

One of the primary objectives of the EIA was to conduct initial underwater noise measurements within the CN OWF. These measurements were carried out from December 2023 to February 2025. Collected data aimed to assess underwater noise levels across different frequency bands and analyse noise propagation conditions, which were used for modelling noise transmission from the OWF and establishing a baseline for evaluating potential environmental changes during the construction, operation, and decommissioning phases of the wind farm. Data collection followed international measurement standards and the recommendations of the Expert Group of the MSFD (BSH, 2011; Dekeling et al., 2014 a, b, c; Van der Graaf et al., 2012)

The primary focus of the underwater noise monitoring was the registration of ambient sea noise using autonomous SoundTrap ST600STD noise recorders (Ocean Instruments Ltd., New Zealand). These recorders are equipped with omnidirectional hydrophones operating within a frequency range of 20 Hz to 60 kHz. They were deployed approximately 3 m above the seabed using elastic composite lines to prevent unwanted interference from metal components such as chains.

In the subjected measurements, noise data were registered in the frequency range from 20 Hz up to 20 kHz, where the mentioned above frequencies show the central frequencies of 1/3-octave frequency bands (HELCOM, 2021). In the HELCOM document is underlined also that to cover in full way all the 1/3-octave frequency bands in the entire range of 20 Hz–20 kHz (totally 34 bands), the acoustic data should be recorded in frequency range from 17.8 Hz up to 22.39 kHz (Table 1 in HELCOM (2021)).

All recorded data from the measurement campaign underwent thorough analysis. First, noise time series affected by acoustic signal oversaturation (clipping) were identified and excluded. Spectral analysis was then performed using the Fourier Transform to examine noise characteristics.

Additionally, sound pressure levels (hereinafter – SPL) were calculated for 1/3-octave frequency bands with central frequencies of 63 Hz and 125 Hz, as these are identified as key descriptors of ambient sea noise under the MSFD (Dekeling et al., 2014 a, b, c). The broadband SPL was also calculated for the 20 Hz to 20 kHz frequency range, following HELCOM guidelines (HELCOM, 2021).

Noise recorders SoundTrap ST600STD let to record noise data in digital format (sud-files) with the resolution of 16 Bits and chosen frequency sampling in the range from 16 kHz up to 192 kHz (in the subjected study the frequency sampling Fs = 64 kHz was chosen). The noise measurements were performed in continuous mode, within 5 min. time duration of the particular files of noise data recordings (see Table 5.4.33).

Table 5.4.33. Underwater noise measurement data series

Measurement campaign No.	Date (dd-mm-yyyy)		Station No.	Data coverage %	Total # of data files
	start of measurement	end of measurement			
1	14.12.2023	08.03.2024	0	100	24,558
			5	100	24,481
2	08.03.2024	21.07.2024	0	89	34,387
			5	100	38,935
3	21.07.2024	25.10.2024	0	100	27,670
			5	100	27,578
4	25.10.2024	06.02.2025	0	100	29,844
			5	100	29,853

During the survey, vertical temperature and salinity profiles were also measured at each monitoring station. These measurements were conducted using Sea & Sun Technology's CTD90, Valeport SWiFT, or AML Oceanographic Base-

X sound velocity profilers. The sound speed was calculated based on temperature, salinity (conductivity), and pressure (depth) data using the widely accepted UNESCO algorithm proposed by Chen and Millero (1977).

The primary objective of this technical report is to assess the extent of the underwater noise impact generated during pile-driving activities within the CN OWF area, focusing particularly on key sensitive species such as the harbour porpoise (*Phocoena phocoena*), seals (*Phocidae*), and swim-bladdered fish species. Numerical modelling was conducted to simulate the propagation of pile-driving noise, with the sound source positioned at the south-westernmost point of the CN OWF area. This specific location was selected for modelling purposes as it represents both the deepest part of the site and the point nearest to the Swedish "Natura 2000" site Hoburgs bank och Midsjöbankarna (SE0330308), which is designated for the protection of the harbour porpoise (*Phocoena phocoena*) (see Figure 5.4.75).

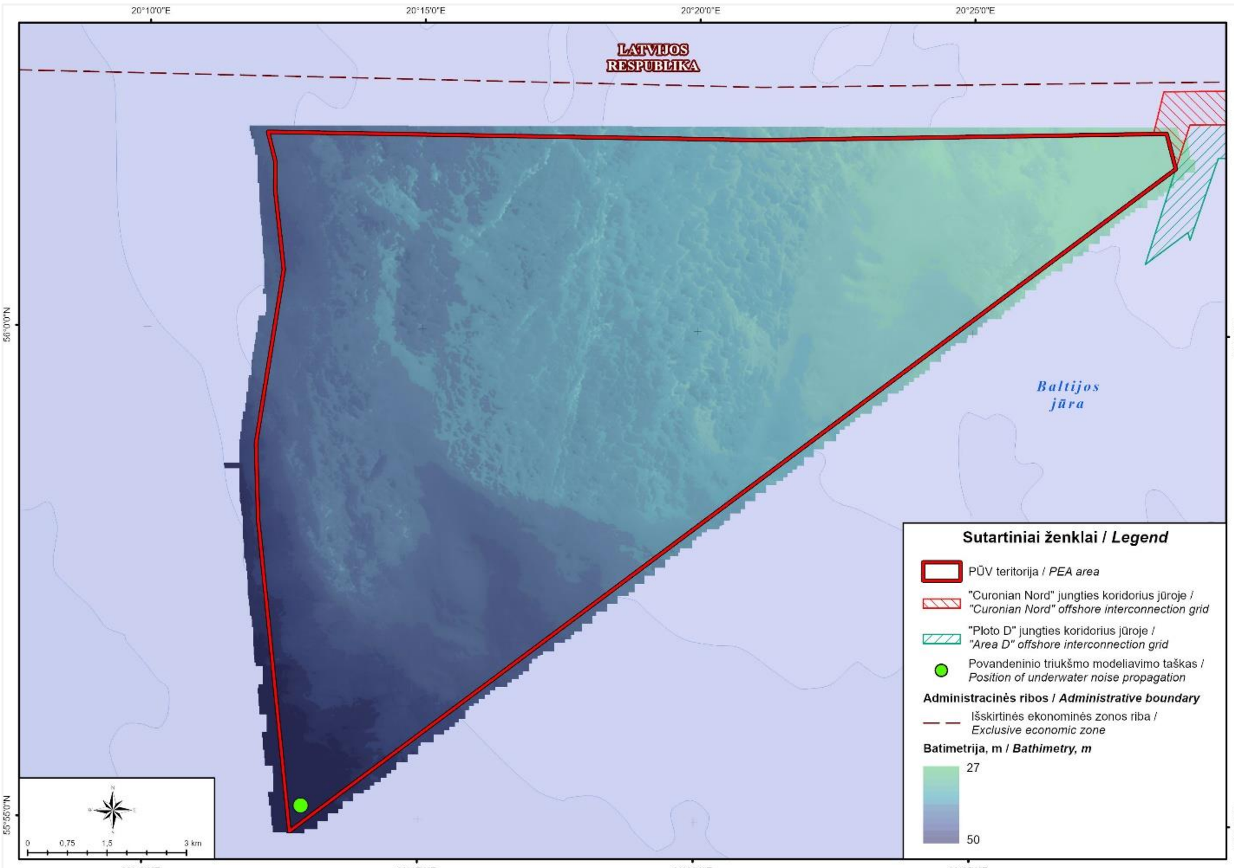


Fig. 5.4.75. Location of sound source for modelling inside the CN OWF.

Table 5.4.34. Pile driving site location

Longitude (DD.MM)	Latitude (DD.MM)	UTM-34 E [m]	UTM-34 N [m]
20°12.8787	55°55.1264	450 917	6197318

5.4.5.1.3 Modelling of underwater noise propagation

Below is a description of the applied MIKE-Underwater Acoustic Simulator (MIKE-UAS), its assumptions, and environmental data used as input parameters, including the sound source spectrum, the auditory capabilities of marine mammals, and noise exposure criteria based on relevant threshold values.

The signal generated by the underwater sound source attenuates due to geometric spreading of the acoustic wavefront, sound absorption, scattering, refraction, and reflection from the boundaries of the water medium. The MIKE-Underwater Acoustic Simulator (MIKE-UAS) software, developed by the Danish Hydraulic Institute (hereinafter – DHI), was used to perform numerical calculations of underwater noise propagation. The model calculates the transmission loss (hereinafter – TL) during sound propagation along a specified bathymetric profile throughout the entire water column. The model assumes that the sound source is an omnidirectional point source located at a certain depth (either in the water column or on the seabed) at the start of the profile at r = 0 meters. (see Fig. 5.4.76).

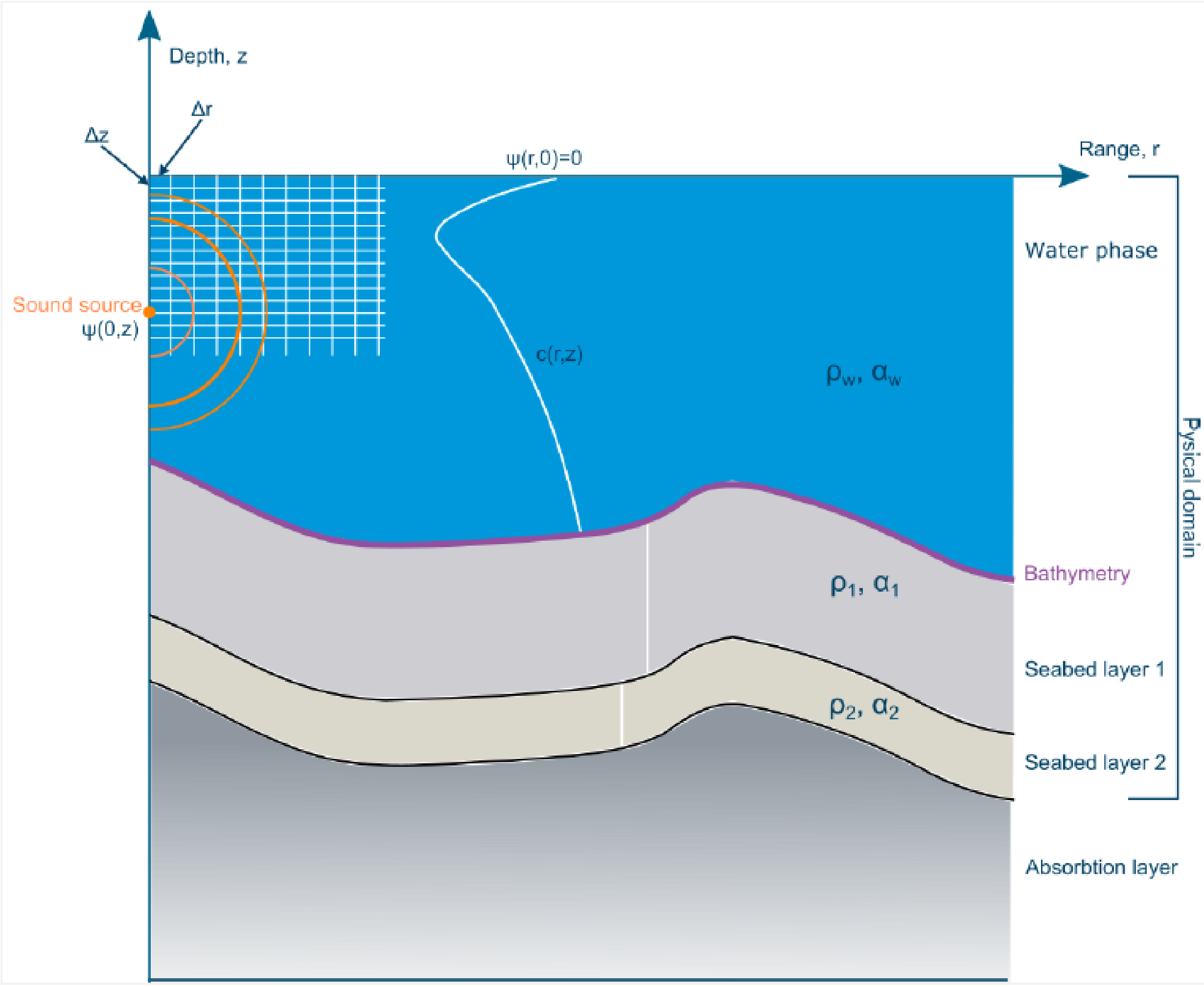


Fig. 5.4.76. Scheme of the two-dimensional acoustic system model, source: DHI, 2017.

The MIKE-UAS model is designed for numerical simulations of underwater sound wave propagation across a broad frequency range. Typically, the model is applicable up to a 1/3-octave bandwidth with a centre frequency of 40 kHz, though computational time increases significantly at frequencies above 1 kHz.

According to the guidelines provided in the *Underwater Acoustic Simulator. Simulation of Sound Propagation. User Guide* (DHI, 2017), the essential input parameters for the model include:

1. Bathymetry data: bottom relief information along the modelling profile, expressed as depth z(r) in m
2. Physical parameters of the aquatic environment, including:
    - Vertical sound velocity profile c(z) in m/s
    - Sound absorption coefficient in seawater αw in dB/λ, determined from temperature T in°C, salinity S in PSU, and pH levels, following the empirical formula by Francois and Garrison (1982a, b)
3. Physical parameters of seabed layers, including:
    - Thickness of seabed layers in m
    - Density ρ in kg/m³

- Compressional wave sound speed cp in m/s
- Sound absorption coefficient α in dB/λ

4. Sound source parameters: position of the sound source in the water column (in our case, 1 m above the seabed) and its sound exposure level SEL in dB
5. Frequency range: defined in 1/3-octave bands
6. Output computational grid: defined by horizontal step Δr, vertical step Δz, and the maximum depth zmax.

Numerical calculations of TL were performed along 72 azimuthal transects with an angular spacing of Δθ=5° and a maximum range of R_{max}=200 km (see Fig. 5.4.77).

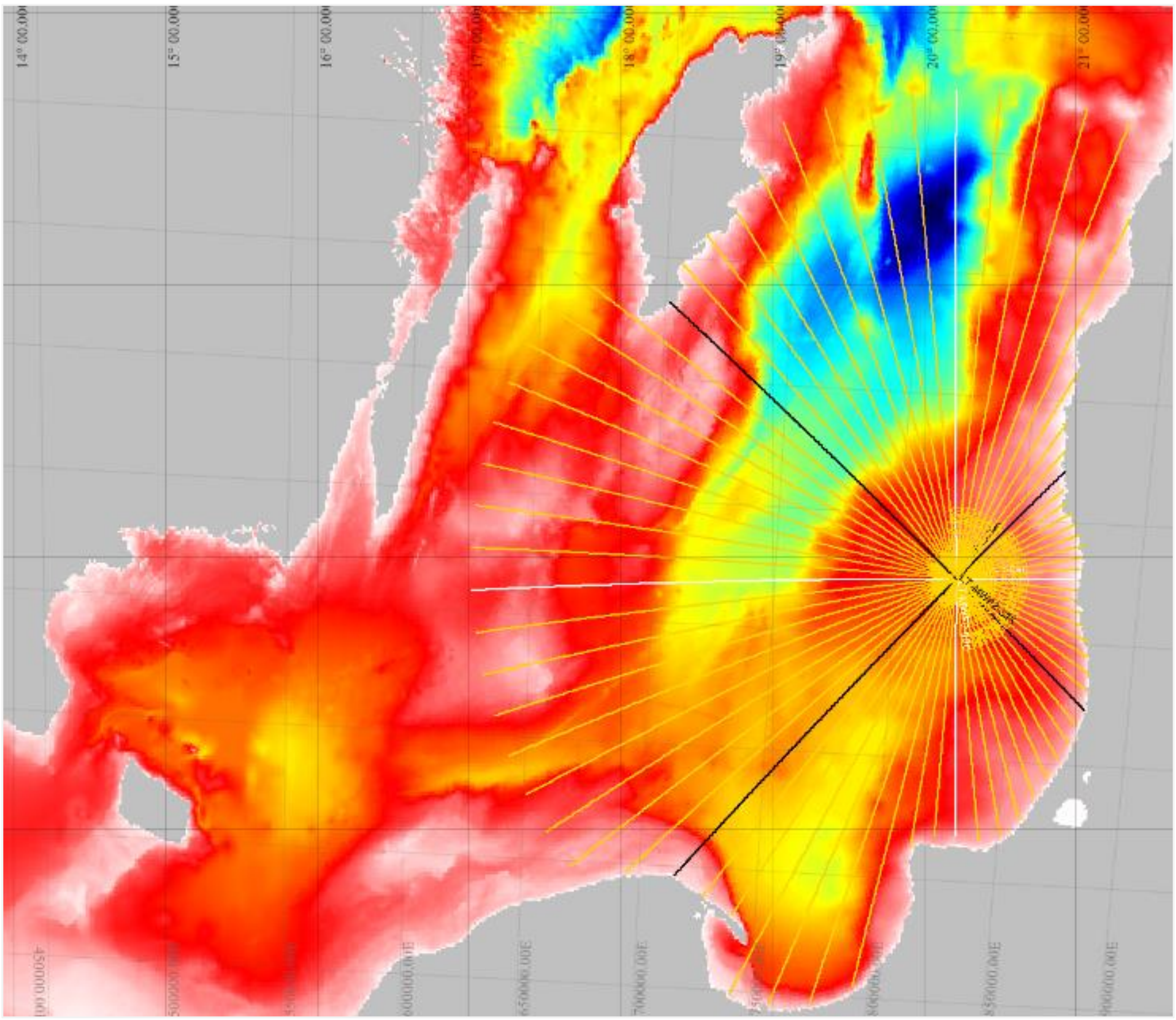


Fig. 5.4.77. Scheme of the azimuthal profiles along which the numerical modelling of underwater noise propagation was performed.

Due to the significantly lower salinity, sound absorption in the Baltic Sea differs fundamentally from that in oceanic waters. This distinction is particularly evident in the low-frequency range up to approximately 500 Hz, as well as in the mid-to-high frequency range between roughly 1 kHz and 500 kHz.

In the investment area, the seabed profile was modelled as a three-layer structure. The geoacoustic parameters of each seabed layer, based on Lurton (2010), are provided in Table 5.4.35.

Table 5.4.35. Seabed profile within the geoacoustic parameters

Seabed layer [m]	Material	Geoacoustic properties
0–2	silty sand	C_p = 1,650 m/s α = 1,1 dB/λ ρ = 1,800 kg/m^3
2–42	sand-silt-clay	C_p = 1,560 m/s α = 0,2 dB/λ ρ = 1,600 kg/m^3
42–92	clay	C_p = 1,470 m/s α = 0,08 dB/λ ρ = 1,200 kg/m^3

5.4.5.1.4 Assessment of noise-related impacts on marine mammals

In general, marine mammals are divided into functional groups of hearing based on scientific knowledge regarding the properties of hearing ability and the sound sensitivity of individual groups of animals. The basic characteristics of hearing, related to a specific frequency range of sounds perceived by representatives of a given group of animals, have been included in the study of the NOAA National Marine Fisheries Service (NMFS, 2018, 2024).

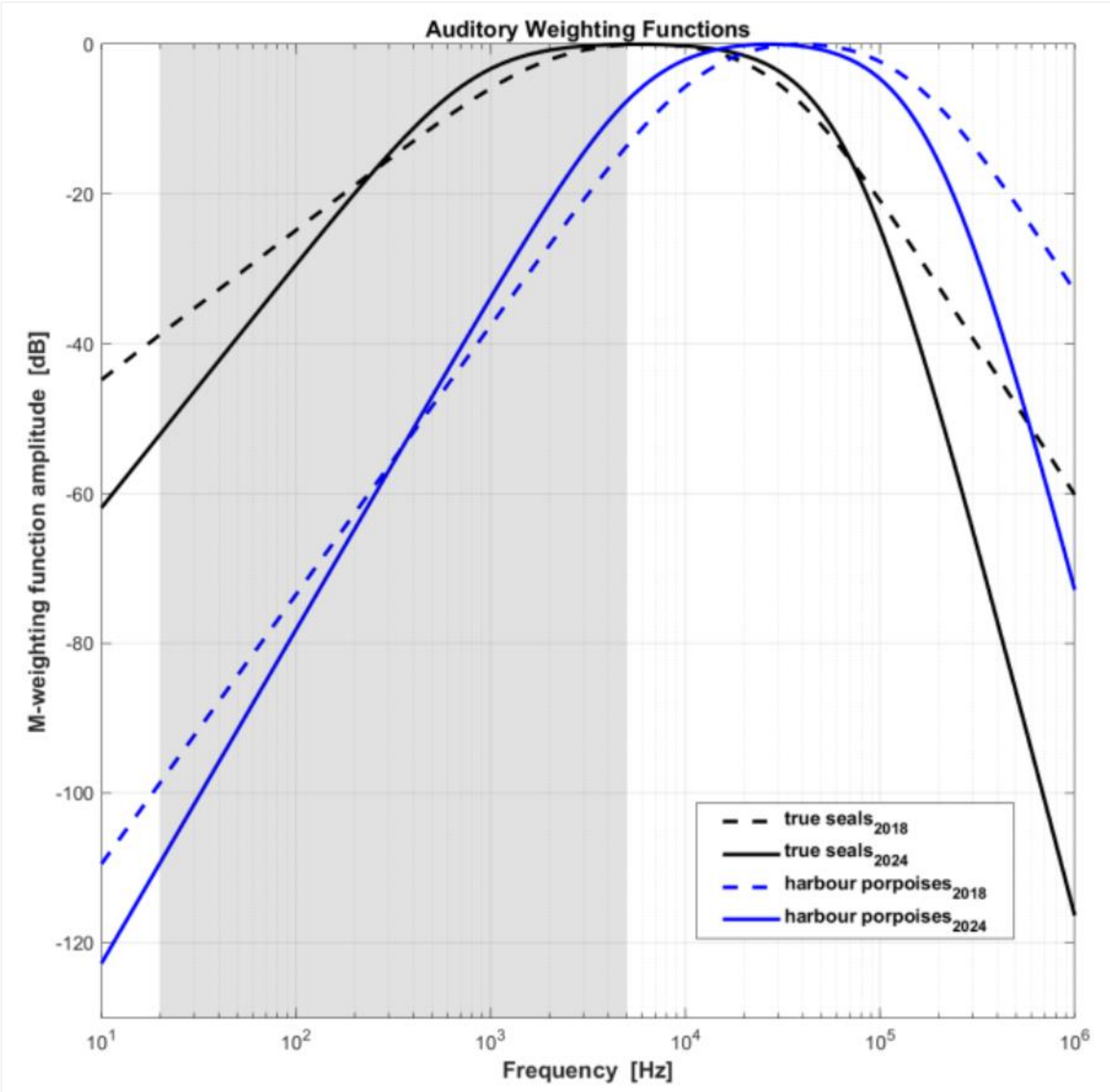


Fig. 5.4.78. M-weighting frequency functions W(f) for marine mammals using of high-frequency sounds (VHF-cetaceans), including harbour porpoises (*Phocoena phocoena*, in blue) and true seals (*Phocid Pinnipeds* PW, in black), with dashed and solid curves based on the previous (NMFS, 2018) and updated knowledge (NMFS, 2024), respectively. Grey background depicts the frequency range of interest applied in the numerical modelling (20Hz−5kHz).

Finally, based on the obtained weighted SEL ($SEL_{weighted}$) (Fig. 5.4.79), the potential negative impact ranges of noise on marine mammals, including the harbour porpoise (*Phocoena phocoena*), seals (*Phocidae*), and swim-bladdered fishes, were estimated. These impacts could potentially lead to hearing damage in the form of a temporary shift in the hearing threshold (Temporal Threshold Shift, hereinafter – TTS) or auditory injury (AUD INJ).

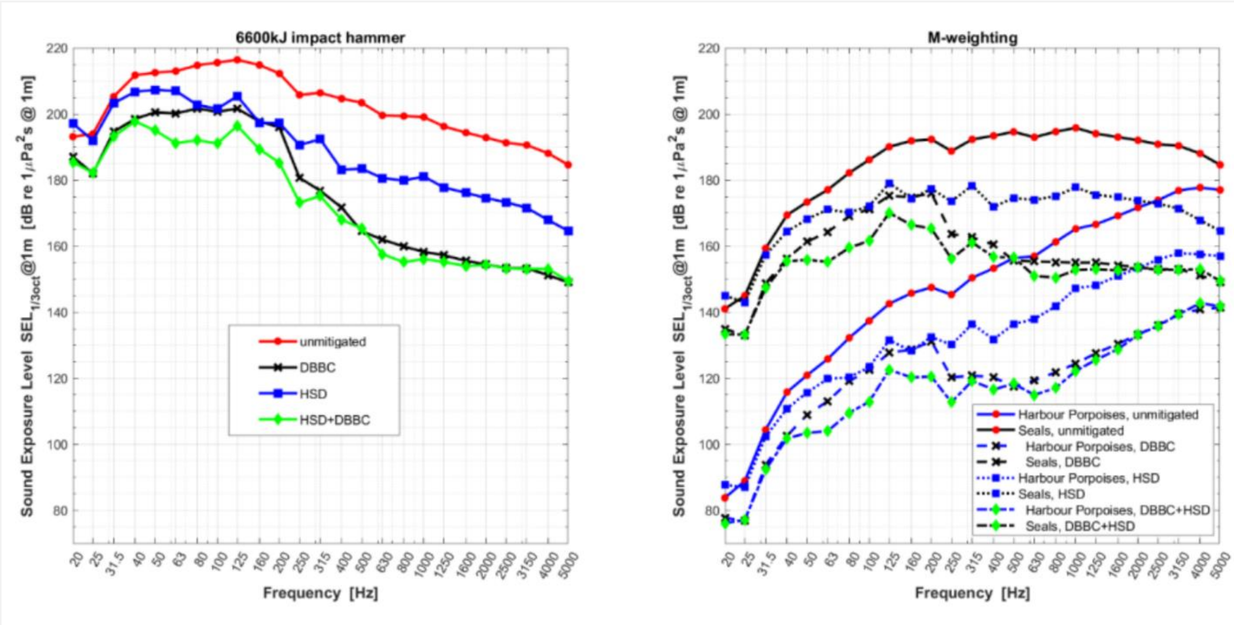


Fig. 5.4.79. Spectra of the sound source (monopile 10 m in diameter; 6,600 kJ impact hammer) expressed in units of sound exposure levels SEL1/3oct at a distance of 1 m [dB re 1μPa^{2}s@1m] for unmitigated (red curve) and within a DBBC, HSD and their combination scenario (black, blue and green curves on the left subplot, respectively). The appropriate spectra considering the hearing ability of harbour porpoises and true seals (on the right; blue and black curves, respectively).

In accordance with best practice guidelines, the cumulative SEL (SEL_{cum}) was evaluated to assess the potential impact during pile driving. The cumulative noise dose was defined as a "noise event", consisting of a series of consecutive pile strikes. The total sound exposure level during pile driving was calculated over a 5.81-hour period, encompassing 8,713 pile strikes (based on Ignitis Renewables, 2024). The difference between the exposure level of a single pile strike and the complete pile installation was found to be significant, resulting in a 39.4 dB increase in underwater noise exposure level.

In the context of estimating the behavioural response (hereinafter – BR) to the total underwater noise dose, the method of a "moving receiver" is often applied. The cumulative SEL (SEL_{cum}) that a "receiver" (marine mammal) is exposed to while swimming away from the disturbance area is calculated along its "escaping routes."

Following the guidelines from the Danish Energy Agency, revised by Tougaard (2021), a generalized fleeing speed of v = 1.5 m/s for all marine mammal species, including harbour porpoises (*Phocoena phocoena*) and seals (*Phocidae*), was used as a precautionary first approximation in the calculations (For the detailed calculations, see Annex 8).

5.4.5.2 Survey area

PAM of harbour porpoises was conducted within the boundaries of the planned OWF site, using eight F-POD recorders and two underwater noise measurement hydrophones. Marine mammal vessel-based surveys were also carried out within the OWF area and the adjacent region, in conjunction with seabird surveys from vessels (Figure 5.4. 80). The F-POD recorders were evenly distributed across the planned OWF area in a 4.5 km (2.16 nautical mile) grid (Table 5.4.36). At the central station (5) and the northwestern corner station (0), F-POD acoustic recorders and underwater noise loggers were deployed together.

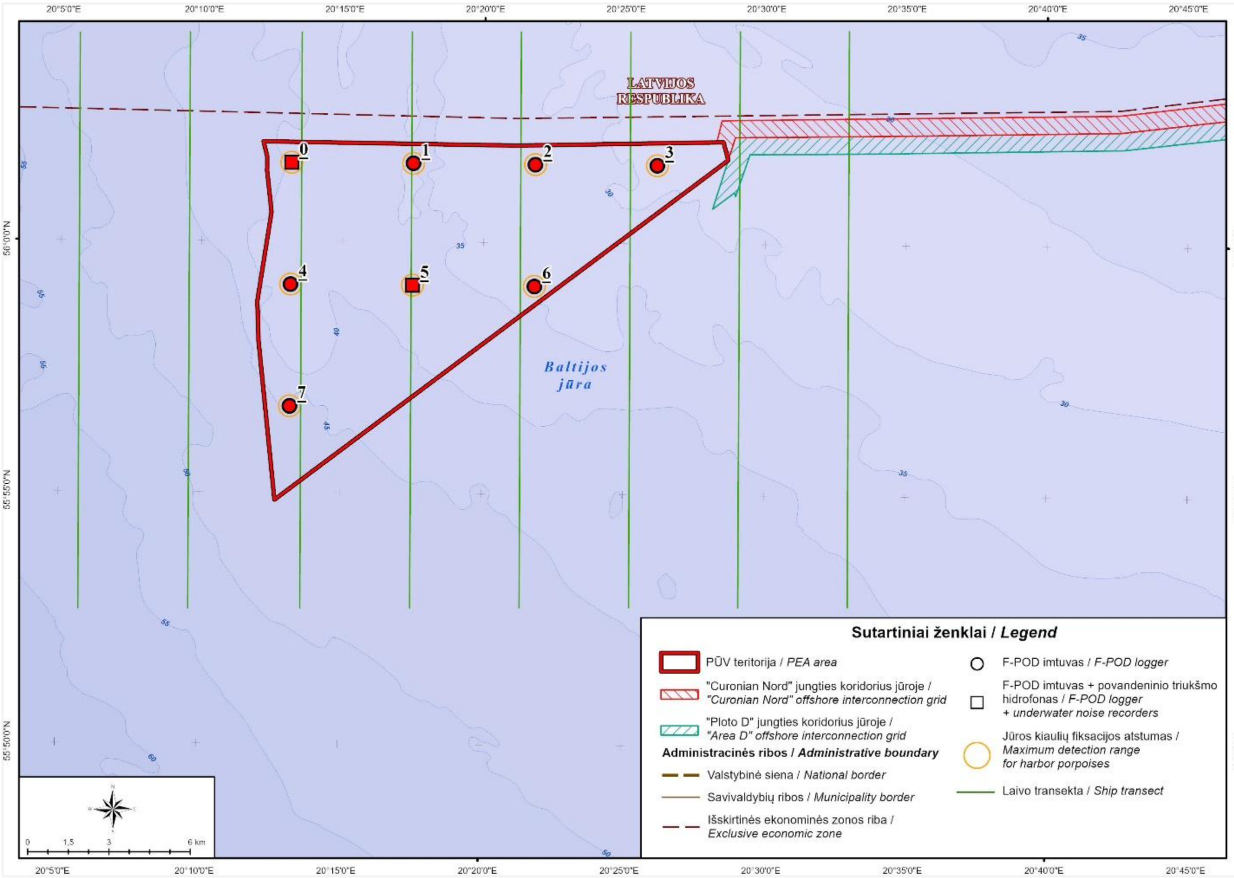


Fig. 5.4.80. Layout of vessel-based survey transects, F-POD and underwater noise recorders within the CN OWF.

Table 5.4.36. Positions of F-POD and underwater sound recorders

Station No.	Acoustic loggers	Longitude (WGS84)	Latitude (WGS84)
0	F-POD / underwater sound recorder	20°13,165'E	56°1,587'N
1	F-POD	20°17,493'E	56°1,590'N
2	F-POD	20°21,822'E	56°1,590'N
3	F-POD	20°26,150'E	56°1,587'N
4	F-POD	20°13,171'E	55°59,163'N
5	F-POD / underwater sound recorder	20°17,495'E	55°59,166'N
6	F-POD receiver	20°21,819'E	55°59,166'N
7	F-POD receiver	20°13,178'E	55°56,739'N

5.4.5.3 Current state

Three species of seals inhabit and breed in the Baltic Sea: grey seal (*Halichoerus grypus macrorhynchus*), ringed seal (*Phoca hispida botnica*), and Atlantic harbour seal (*Phoca vitulina vitilina*). Among these, only the grey seal, is in listed in the Red Book of Lithuania, signifying its status as part of Lithuanian fauna. While the other two species have been observed in Lithuanian marine waters, they are not formally listed among the Lithuanian wildlife.

These marine mammals typically rest and breed on remote rocky islands, sandy beaches, sea ice, and even buoys, avoiding human activity (Thompson & Härkönen, 2008). In the 20th century, seals were frequent visitors to the

Lithuanian coast, though only a few individuals were recorded annually. Since 2000, grey seal sightings in Lithuania have become more common (Natkevičiūtė, Kulikov, & Grušas, 2013).

The number of grey seals counted in the whole Baltic Sea region in 2021 was approximately 42,000 individuals. Assuming a haul out-fraction of 70%, the total population estimate would be around 60,000 animals. In the southern Baltic Sea Grey seal estimated number is just below 7,000 (HELCOM, 2023). Seals are regular observed in the Lithuanian marine waters, particularly in the cold season when they migrate after the fish. However, the exact number of these animals is not known (see Fig. 5.4.81).

There is still uncertainty about whether the grey seal population has reached, or is approaching, the carrying capacity of the Baltic Sea environment – the maximum number of individuals that can be sustained in the area. While the overall distribution of grey seals continues to expand, it has not yet returned to its historical range in the southwestern Baltic. Moreover, fitness indicators such as blubber thickness and pregnancy rates remain below the threshold values set for GES. Consequently, despite the population's growth, it is currently assessed as not having reached good condition (HELCOM, 2023).

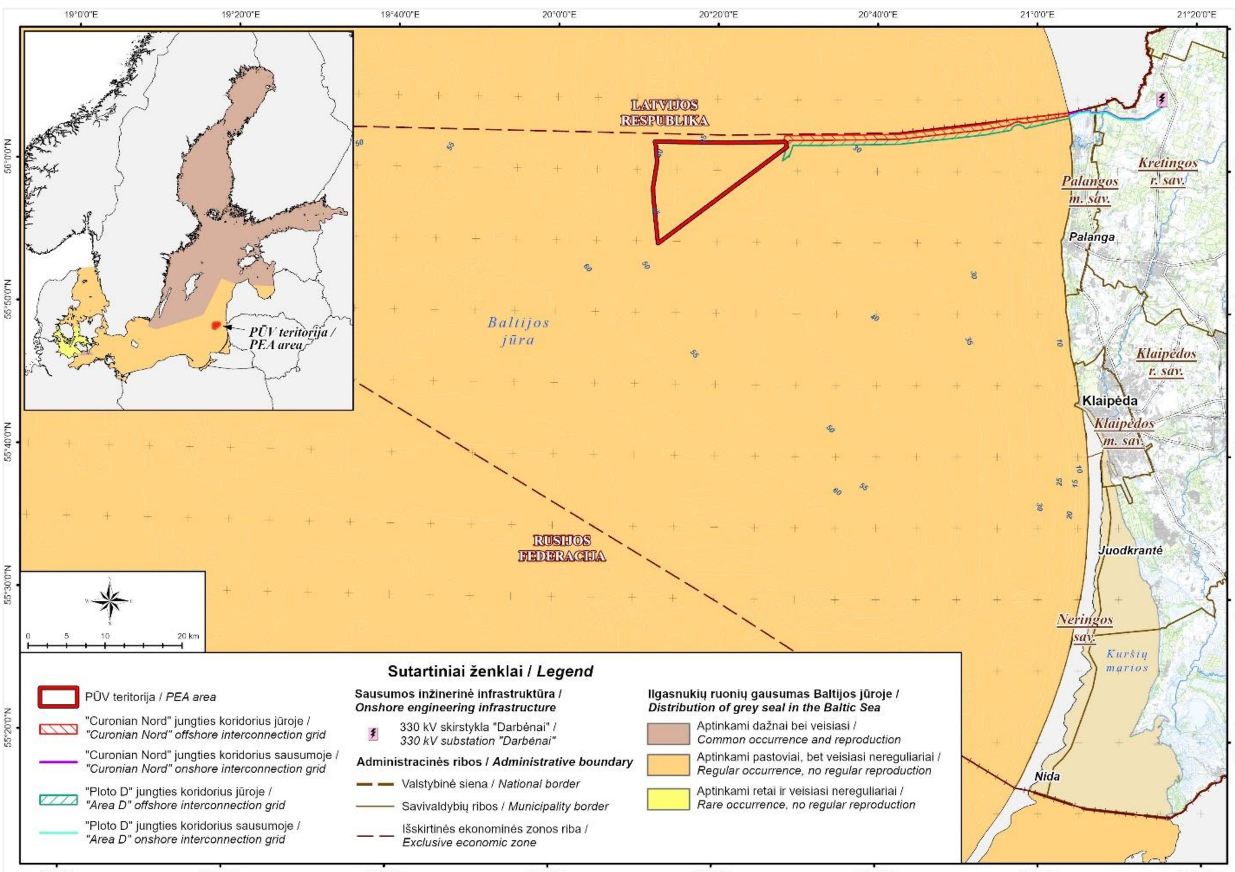


Fig. 5.4.81. Distribution of Grey Seals in the Baltic Sea, Based on Expert Data (HELCOM HOLAS 3 Data, 2023).

The Baltic Sea is home to two distinct populations of harbour porpoises: one inhabiting the Belt Sea, Sound, Kattegat, and Skagerrak, and another found along the coasts of Poland, and eastern Sweden in the central Baltic Sea. These porpoises migrate seasonally, moving from the northeastern to the southeastern Baltic between November and April. Their typical diving depth ranges from 20 to 60 meters, with occasional dives reaching up to 200 meters. They primarily feed at night, selecting feeding grounds based on the movements of their prey. According to PAM conducted in the Baltic Sea between 2011 and 2013, the estimated population of Baltic Sea harbour porpoises was approximately 500 individuals (Carlén, 2018).

Most of Lithuania's EEZ is considered to be of medium importance for harbour porpoises (see Fig. 5.4.82), with detection probabilities varying seasonally between 10% and 20% (Carlén, 2018; HELCOM 2023). The highest average probability of encountering harbour porpoises in the PEA occurs during winter, while the lowest is observed in summer. This seasonal pattern was further confirmed by research conducted in 2022, which recorded six harbour porpoise encounters in December. However, compared to other regions of the Baltic Sea, the likelihood of porpoise detection in the Lithuanian EEZ remains significantly lower than in the southeastern Baltic or along the western Baltic coasts.

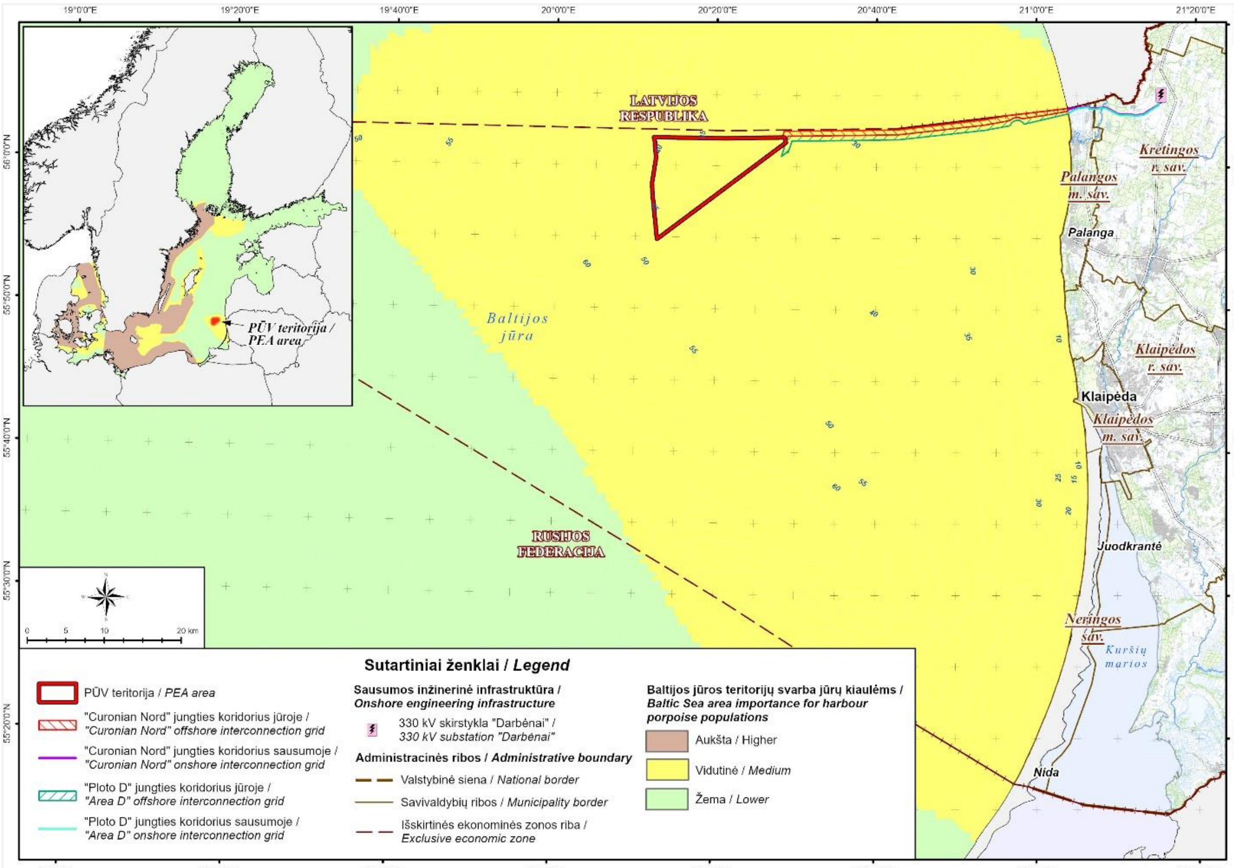


Fig. 5.4.82. The harbour porpoise importance map in the Baltic Sea, LIFE SAMBAH Project Results (HELCOM HOLAS 3 Data, updated October 2023).

5.4.5.3.1 Seals

Vessel-based survey results. Between June 2023 and October 2024, eight surveys were conducted, recording a total of 12 seals. Identifying seals to the species level during vessel-based surveys is challenging. However, it is assumed that the majority of seals observed along the Lithuanian coast are Grey Seals. Seal occurrence in the EIA area was assessed across spring, summer, and autumn seasons (Figures 5.4.83–5.4.85). Regardless of the season, all seal sightings were concentrated in adjacent areas to the west and south of the OWF area. Only a single Grey Seal was recorded within the EIA area in May 2024.

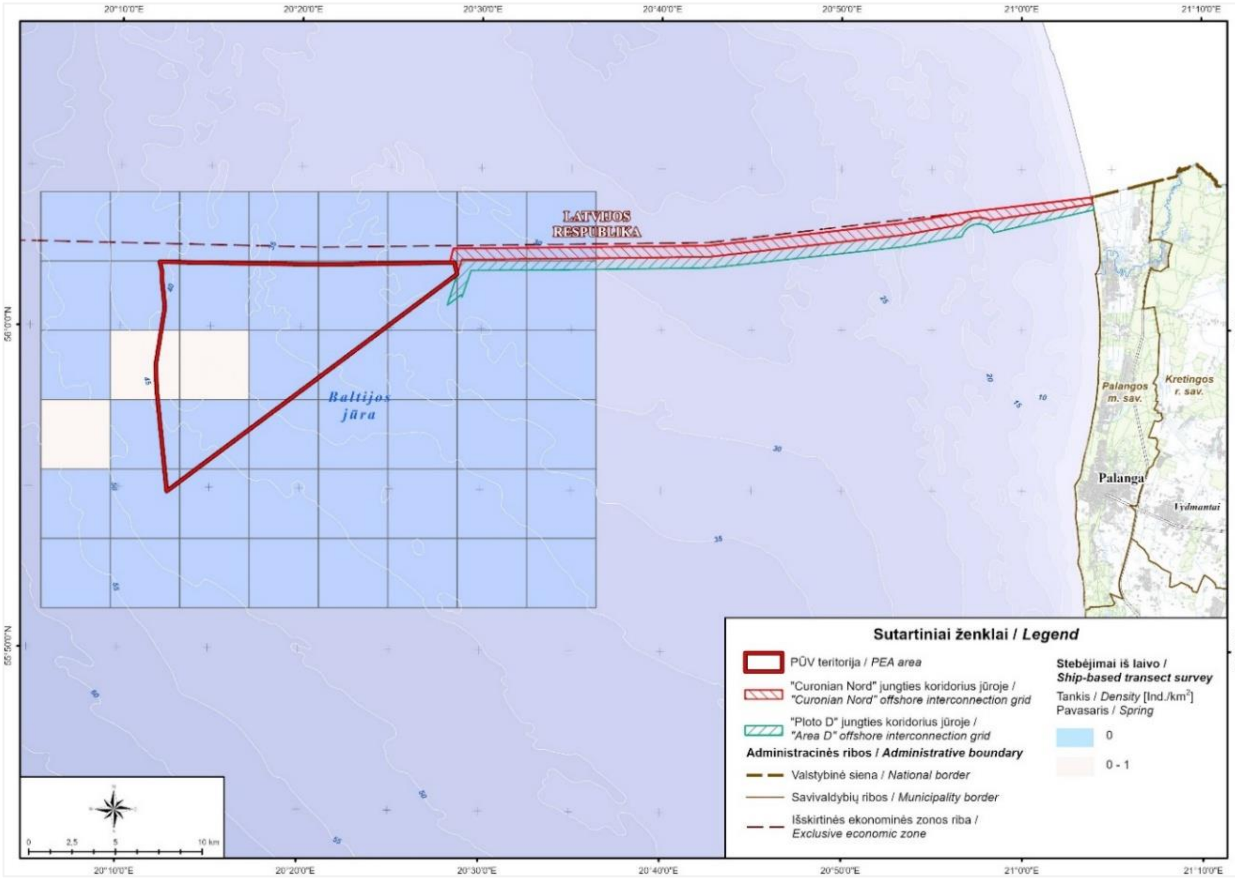


Fig. 5.4.83. Distribution and observation frequency of Grey Seals during vessel-based surveys in the spring of 2024.

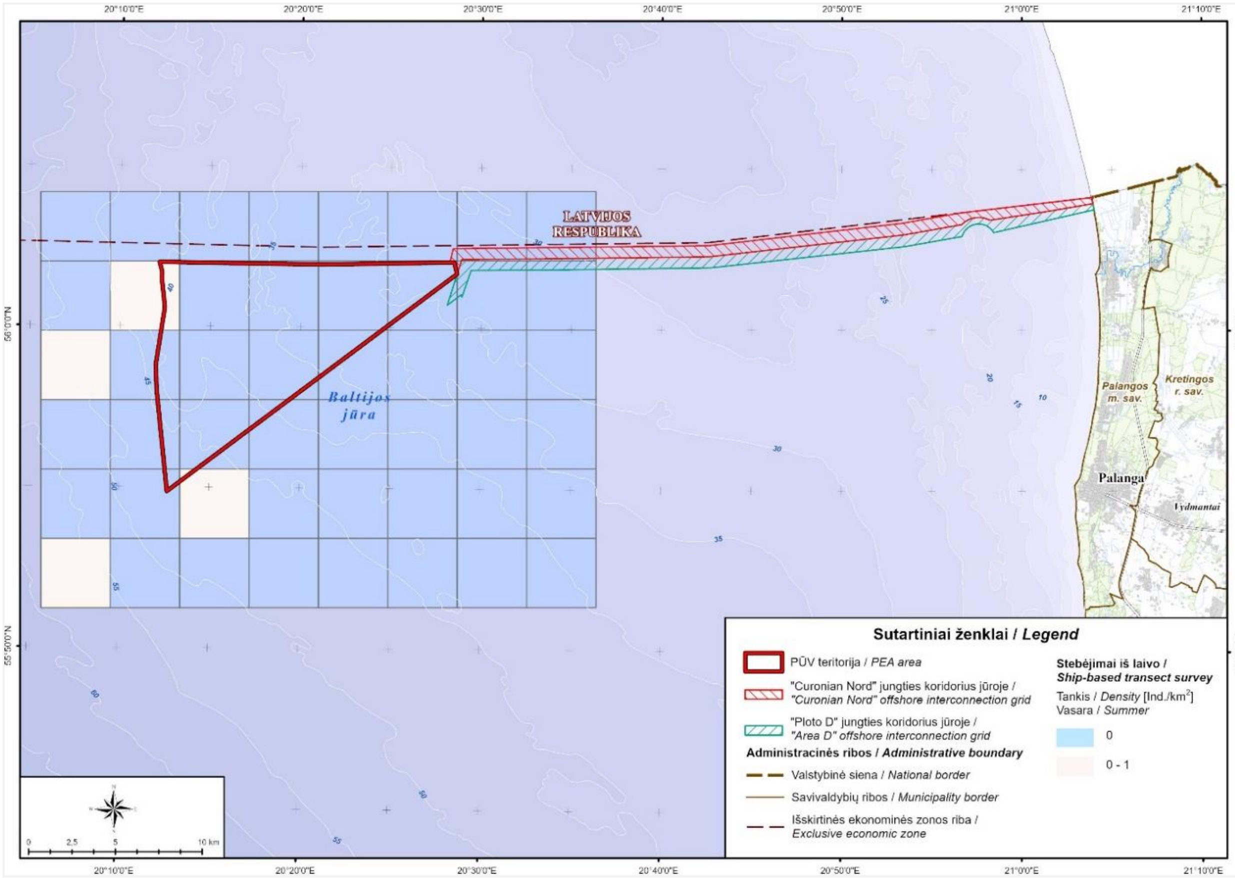


Fig. 5.4.84. Distribution and observation frequency of Grey Seals during vessel-based surveys in the summer of 2024.

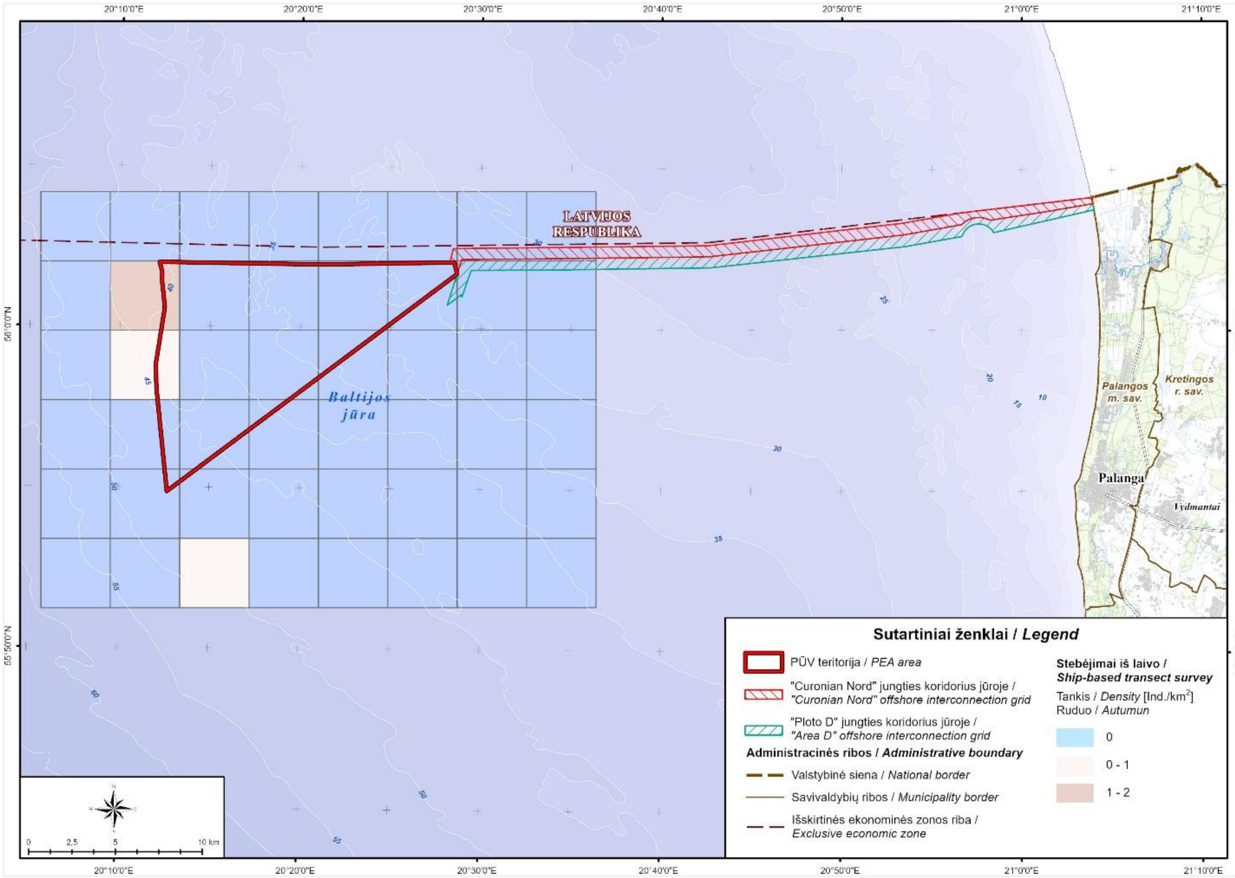


Fig. 5.4.85. Distribution and observation frequency of Grey Seals during vessel-based surveys in the autumn of 2024.

5.4.5.3.2 Harbor porpoise

After analysing the acoustic datalogs, six harbour porpoise encounters were detected in the CN OWF area throughout the study period (Fig. 5.4.86). Due to the low number of encounters, harbour porpoise seasonal presence and gain limited insights into seasonal patterns at PEA territory are confirmed. With such sparse data, analysing daily or monthly trends or assessing porpoise presence levels is not feasible. However, the recorded encounters are in line the findings of Amundin et al. (2022) and Carlen et al. (2018), who suggest that from November to April, harbour porpoises in the Baltic Sea are more widely dispersed, with no clear spatial separation between the Baltic Proper and Belt Sea populations.

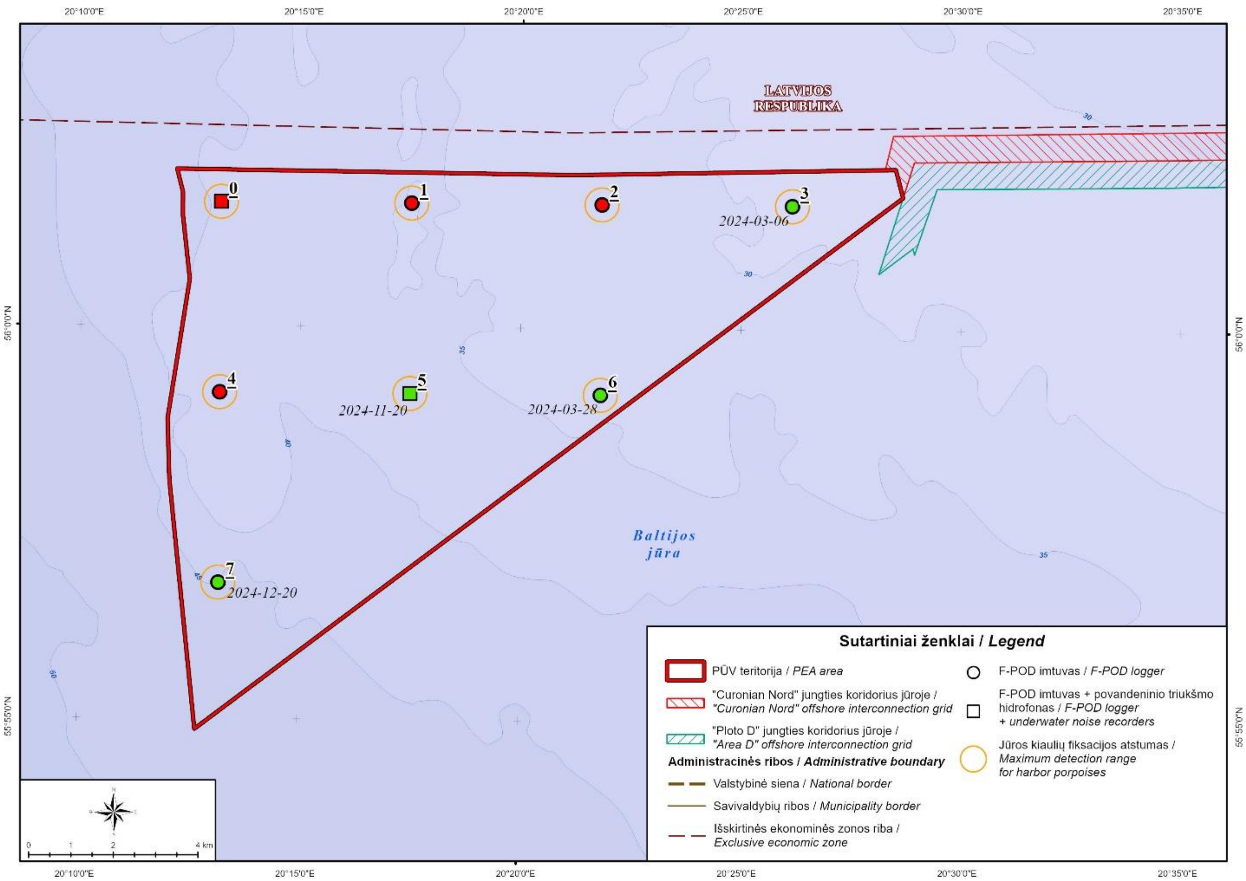


Fig. 5.4.86. Harbour porpoise detections within the PEA area.

Table 5.4.37. Harbour porpoise detection periods and recording duration – detection positive minutes (DPM)

Curonian Nord station	Date	Encounter	DPM
7	20/12/2024	1	1
5	20/11/2024	1	1
6	28/03/2024	1	1
6	28/03/2024	1	1
6	28/03/2024	1	1
3	06/03/2024	1	1

Since harbour porpoise visits were recorded in the EIA area between November and March, their detection probability for this period was calculated to better assess the area's importance for the porpoise population. This assessment was based on data from the SAMBAH (Static Acoustic Monitoring of the Baltic Sea Harbour Porpoise) produced probability of detection of harbour porpoises' maps. The detection probability values for 1x1 km grid cells from November to March were averaged for the entire project area. Additionally, the detection probability for February was evaluated, as SAMBAH data indicate that this month has the highest likelihood of harbour porpoise presence in Lithuania's EEZ. Both during the period of registered presence and February, the EIA area has one of the highest probabilities of harbour porpoise occurrence within the Lithuanian EEZ. Other areas with similar or higher detection probabilities are located in designated "Natura 2000" sites, which include SAC Sambian Plateau, SPA "Kuršių nerijos pajūris", and SPA Klaipėda-Ventspils Plateau within Lithuania's territorial waters. Therefore, the project area holds significant importance for harbour porpoises.

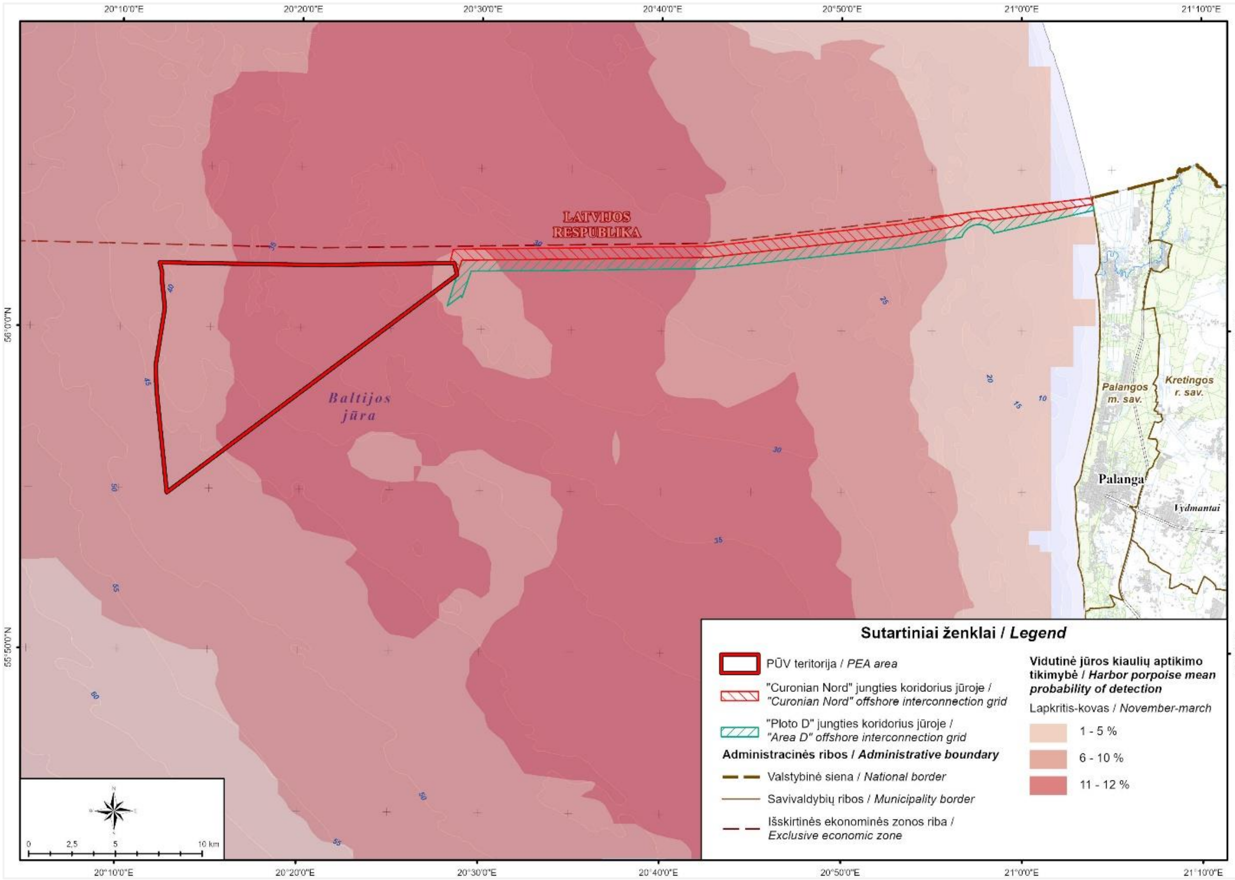


Fig. 5.4.87. Average probability of Harbour Porpoise detection from November to March (according to Carlen et al. 2018).

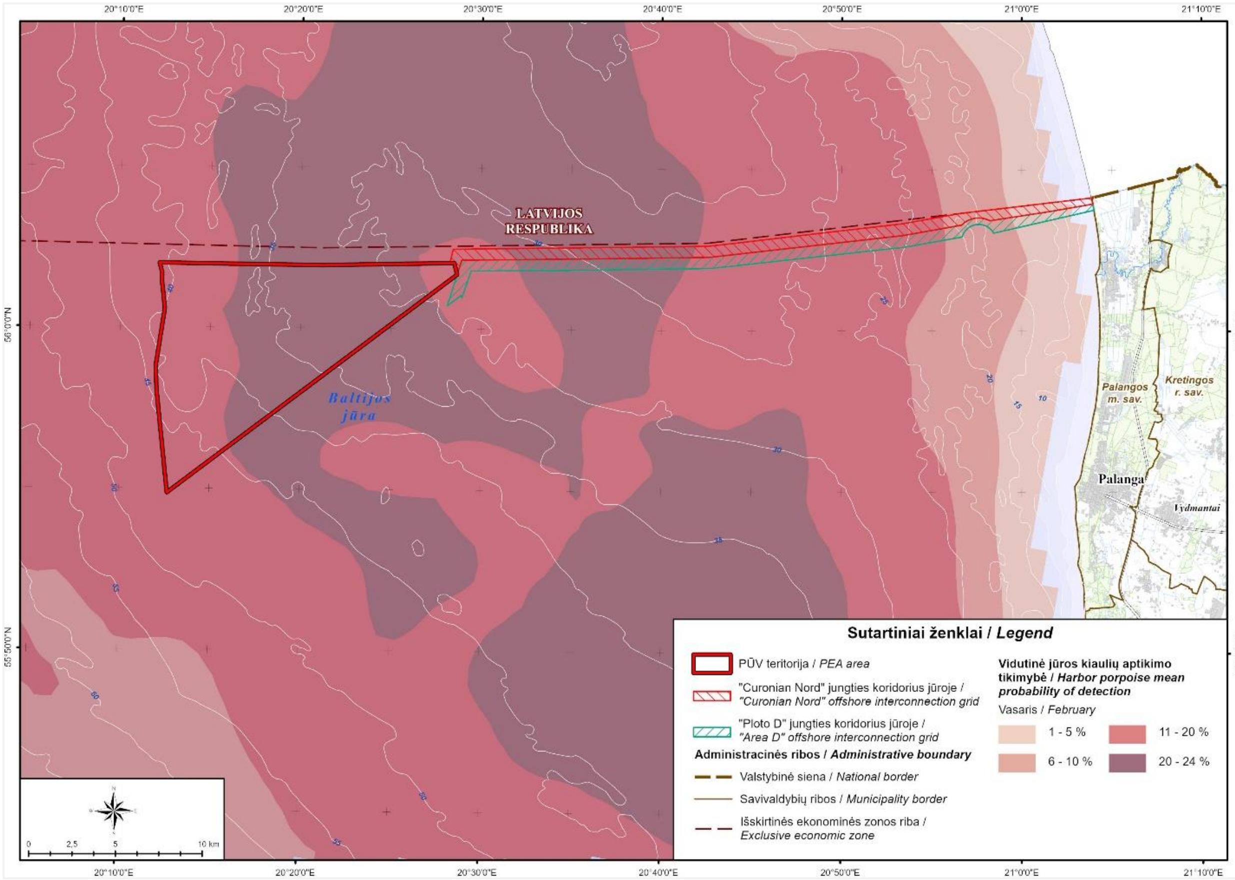


Fig. 5.4.88. Probability of Harbour Porpoise detection in February (according to Carlen et al. 2018).

5.4.5.4. Potential impact to marine mammals

Most marine organisms rely on sound as a crucial sensory tool for exploring their environment and performing essential life functions. Marine mammals, along with certain fish and invertebrates, use acoustic signals for spatial orientation and underwater navigation, locating food, evading predators, mating, reproduction, alerting others to danger, and nurturing their young.

Anthropogenic noise has long been recognized globally as a form of pollution and is considered one of the most harmful pollutants affecting both terrestrial and underwater ecosystems. Advances in measurement and monitoring technologies have provided increasing evidence of its negative impact on marine life. This noise serves as a major stressor for marine organisms, leading to changes in hearing sensitivity, as well as behavioural and physiological disruptions.

High intensity underwater noise of anthropogenic origin, especially one occurring in the low frequency range, has a negative impact on the following marine organisms' aspects:

- Development – including underdevelopment / body deformity, higher caviar and/or juvenile mortality, decreased growth rate (Aguilar de Soto et al., 2013; Nedelec et al., 2014; 2015).
- Anatomy – hearing loss, extensive internal trauma, disorientation (Hastings et al., 1996; McCauley et al., 2003; André et al., 2011; Solé et al., 2017).
- Physiology – including of increase in stress hormones, metabolism, oxygen consumption (Wysocki et al., 2006; Anderson et al., 2011; Nichols et al., 2015; Spiga et al., 2016).
- Behaviour – e.g. increased aggression, decreased defensive behaviour and feeding habits, distraction (Kastelein et al., 2008; Fewtrell and McCauley, 2012; La Manna et al., 2016; Nedelec et al., 2017).

- Masking of echolocation sounds used by marine animals for their fundamental life functions (amongst others, Thomsen et al., 2006; Codarin et al., 2009).

During the construction phase, the primary source of impact on marine mammals is the intense underwater noise generated by impact pile driving, one of the most common methods for installing WTG foundations. The impact generates stress waves that travel through the pile, interacting with the surrounding environment, allowing acoustic energy to propagate into the water and causing vibration in the seabed, which can, in turn, reintroduce acoustic energy back into the water column (Denes et al., 2016). Most of this acoustic energy is concentrated in the low-frequency range, typically below 500 Hz (Bellmann et al., 2020). The intense underwater noise produced during pile driving can have various harmful effects on marine mammals and fish. Research has primarily focused on two key impacts: behavioural disturbances and hearing system damage. The latter includes TTS – a reversible reduction in hearing sensitivity, sometimes referred to as temporary hearing loss – and permanent threshold shift (hereinafter – PTS), which results from prolonged exposure to high noise levels, causing irreversible damage to sensory cells in the inner ear (Skjellerup et al., 2015). Noise level values and the preliminary impact distance from the noise propagation source are presented in Tables 5.4.38 and 5.4.39.

Operational offshore wind farms (OWFs) also generate underwater noise, though at lower levels compared to the construction phase. This continuous, low-frequency noise – produced primarily by turbine blade rotation and associated underwater vibrations – has the potential to affect marine mammals such as harbour porpoises (*Phocoena phocoena*) and seals (*Phocidae*).

Table 5.4.38. Noise impact criteria for harbour porpoises (Phocoena phocoena) and true seals (Phocid pinnipeds) applied in the work to estimate impact ranges of pile driving noise.

Reference	Effect	Marine Mammal group	Sound type	SELweighted [dB re 1 μPa²s]
NOAA National Marine Fisheries Service (NMFS 2024)	Auditory injury	Harbour Porpoise	Single strike and cumulative	159
	TTS			144
	Auditory injury	Seals (*Phocidae*)		185
	TTS			168
Tougaard (2021)	Behavioural Reaction	Harbour Porpoise	Single strike	94*
Russel et al. 2016	Behavioural Reaction	Seals (*Phocidae*)	Single strike	158

*calculated based on $SPL_{rms125ms}$=103 [dB re 1µPa] VHF-weighted value proposed by Tougaard (2021)

During the decommissioning phase, as in the construction phase, high-intensity underwater noise may be generated, potentially affecting marine life. Although such impacts are generally considered to be of lower significance than those during construction, several key pressure factors should be taken into account:

- Underwater noise: the decommissioning of WTGs, MPs, and subsea cables can generate impulsive or continuous underwater noise. Particularly, monopile extraction may produce elevated sound pressure levels capable of disturbing marine mammals. If sound exposure thresholds are exceeded, there is a risk of inducing TTS, or in extreme cases auditory injury. Elevated noise levels may also trigger behavioural responses such as area avoidance, displacement from critical habitats, or disruption of essential life functions including foraging, breeding, and communication.
- Temporary habitat displacement: noise associated with decommissioning activities may lead to spatial displacement of individuals from foraging or breeding grounds and may interfere with intraspecific communication. Additionally, artificial reef structures or hard substrates formed by turbine foundations may be removed. These structures often serve as aggregation sites for fish and invertebrates, forming important feeding grounds for marine mammals. Their removal may reduce local prey availability.

- Increased vessel traffic: decommissioning operations typically involve a high density of support and service vessels. Elevated vessel traffic can disturb marine mammals, particularly in areas already subject to intense maritime activity. Associated risks include behavioural disturbance from continuous noise, and an increased likelihood of vessel collisions, especially for echolocating species that rely on acoustic cues for navigation and communication.

5.4.5.4.1. Harbour porpoises

Harbour porpoises exhibit exceptional auditory sensitivity in the high-frequency range (ultrasound frequencies) from approximately 20 kHz to 140 kHz. Research suggests that even noise generated during the development and construction phase of OWF installation can disrupt their feeding behaviour (Sarnocińska et al., 2020). Consequently, both the installation and decommissioning of OWF structures have a significant impact on their behaviour. Studies indicate that the distance at which harbour porpoises avoid piling sites varies, ranging from 15 km (Carstensen et al., 2006; Tougaard et al., 2006) to 26 km (van Beest et al., 2018), with short-term effects observed as close as 10 km (Tougaard et al., 2012). In rare cases, harbour porpoises have been observed within OWF areas during installation (Brandt et al., 2011). However, pulsed pile-driving noise has been found to cause hearing damage in harbour porpoises at distances of less than 2 km from the noise source (Brandt et al., 2009). Any hearing impairment can disrupt their echolocation abilities, making it difficult to locate food and potentially leading to mortality. However, no increased mortality of harbour porpoises has been documented during OWF installation (Leopold and Camphuysen, 2008).

Table 5.4.39. Estimated impact distances for harbour porpoises

Negative effect	Threshold $SEL_{VHF\text{-}weighted}$ [dB re 1 μPa²s]	Maximum distance RMAX (km)							
		Unmitigated		DBBC		HSD		DBBC + HSD	
		winter	summer	winter	summer	winter	summer	winter	summer
AUD INJ (single strike)	159	-	-	-	-	-	-	-	-
AUD INJ (5.81h cum.)		8.72	7.5	-	-	0.62	0.84	-	-
TTS (single strike)	144	0.41	0.41	-	-				
TTS (5.81h cum.)		87.41	31.5	0.43	0.5	5.2	4.84	0.46	0.52
Behavioural reaction BR (single strike)	94	≥md	141.2	2.33	2.30	19.5	12.4	2.44	2.64

5.4.5.4.2. Seals

Seals are known to tolerate high noise levels, even when these cause temporary hearing loss or a permanent shift in their hearing threshold, provided that feeding opportunities are available. Importantly, partial hearing loss does not necessarily result in mortality. An example of this behaviour was observed during the installation of the Nysted Wind Farm in the Belt Sea, south of Lolland Island, Denmark, where an increase in seal numbers was recorded in areas adjacent to the construction sites between spring and summer 2002, likely because the seals exploited disoriented fish as an easy food source (Tougaard et al., 2006).

Table 5.4.40. Estimated impact distances for seals

Negative effect	Threshold $SEL_{PW\text{-}weighted}$ [dB re 1 μPa²s]	Maximum distance RMAX (km)							
		Unmitigated		DBBC		HSD		DBBC + HSD	
		winter	summer	winter	summer	winter	summer	winter	summer
AUD INJ (single strike)	159	-	-	-	-	-	-	-	-
AUD INJ (5.81h cum.)		6.2	6.3	0.25	0.22	0.59	0.82	-	-
TTS (single strike)	144	0.21	0.19	-	-				
TTS (5.81h cum.)		54.5	22.1	2.36	2.6	4.8	4.8	0.72	0.91
Behavioural reaction BR (single strike)	94	10.7	8.6	2.05	2.22	4	3.6	0.7	0.91

5.4.5.4.3. Cumulative impact

Cumulative effects on marine mammals are only likely if multiple wind farms are installed or decommissioned simultaneously in adjacent waters. This could restrict access to key feeding areas and alter fish migration patterns and aggregation sites. To mitigate these impacts, the phased installation of different OWFs should be coordinated at both national and transboundary levels.

Harbour porpoises are particularly sensitive to underwater noise, and while some studies indicate partial behavioural habituation to the continuous low-frequency noise generated during the normal operation of offshore wind turbines, the extent and ecological significance of this adaptation remain unclear (Tougaard et al., 2020). Seals are frequently observed within wind farm areas; however, the potential effects of operational noise on their acoustic communication and foraging efficiency have not been comprehensively assessed (Russell et al., 2016). To date, there is no conclusive evidence that operational noise or associated vibrations alone result in large-scale habitat displacement or degradation of foraging grounds.

The impact of OWFs on marine mammal behaviour typically occurs within a few hundred meters of the wind farm, and for harbour porpoises, the effect may not extend beyond 100 m (Tougaard et al., 2009). Even when marine mammals swim close to operational OWFs, there is no risk of damaging their hearing organs (Tougaard et al., 2008). After installation works, an increase in the detection frequency of harbour porpoise signals in OWF areas compared to neighbouring regions has been observed. Explanations for this phenomenon include an increase in prey (fish) availability and/or restrictions on commercial fishing activities in the area (Scheidat et al., 2011; Teilmann and Carstensen, 2012). The elimination of fishing with static gillnets in OWF area would also reduce the risk of marine mammal bycatch. Therefore, the effect on marine mammals can range from positive to slightly negative. Other impacts on marine mammals, such as potential changes in hydrological regimes, electromagnetic fields, or other factors related to OWF effects, remain unpredictable.

The effects of the OWF can be closely linked to commercial fishing activities. During construction, intensified trawling or gillnet fishing may occur in adjacent areas, driven by expectations of higher catches as fish disperse from the installation zone, particularly during pile driving. Intensive net fishing may attract seals to the area, while increased trawling and vessel traffic in nearby waters could disrupt the feeding efficiency of harbour porpoises, especially between October and March.

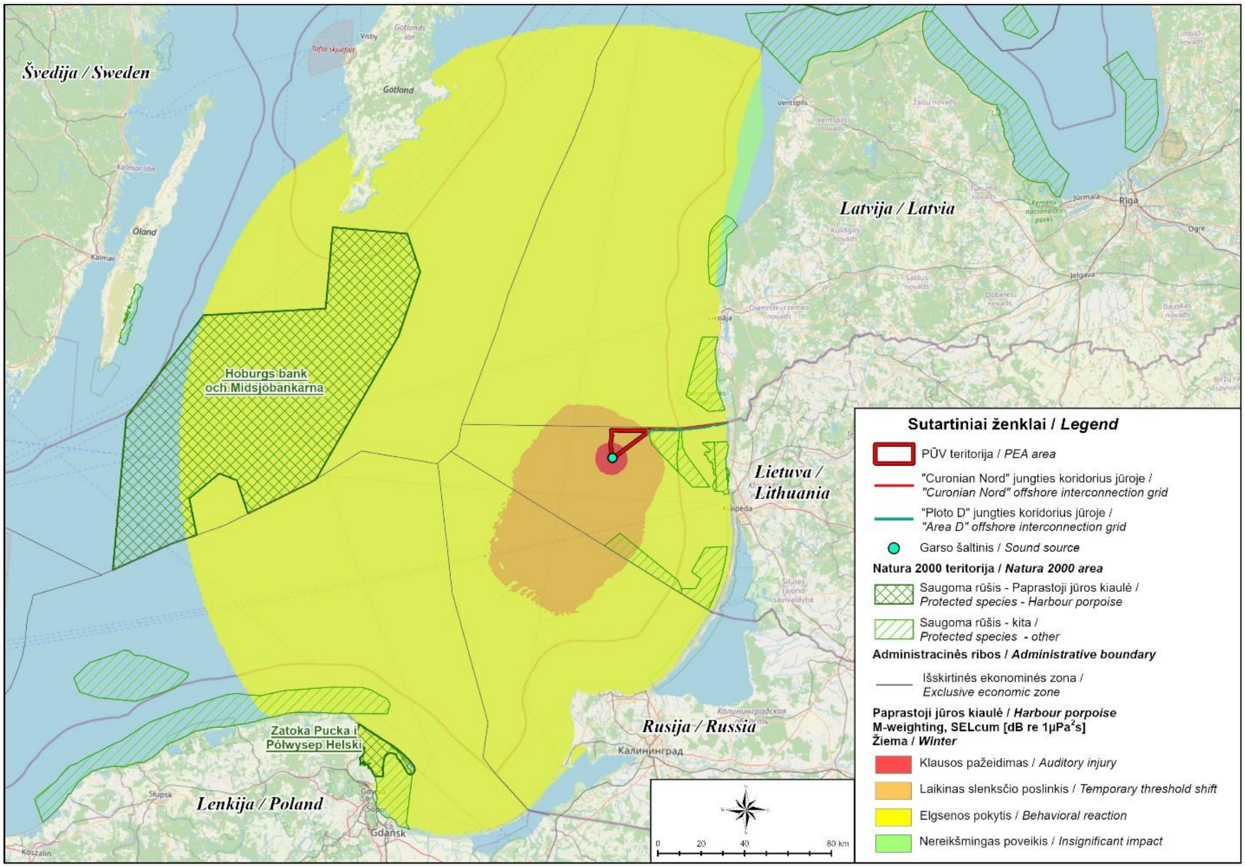


Fig. 5.4.89. Noise map of potential impact on harbour porpoises (*Phocoena Phocoena*) obtained based on the scenario of the unmitigated cumulative SELcum [dB re 1µPa^{2}s] (VHF-weighted) for winter.

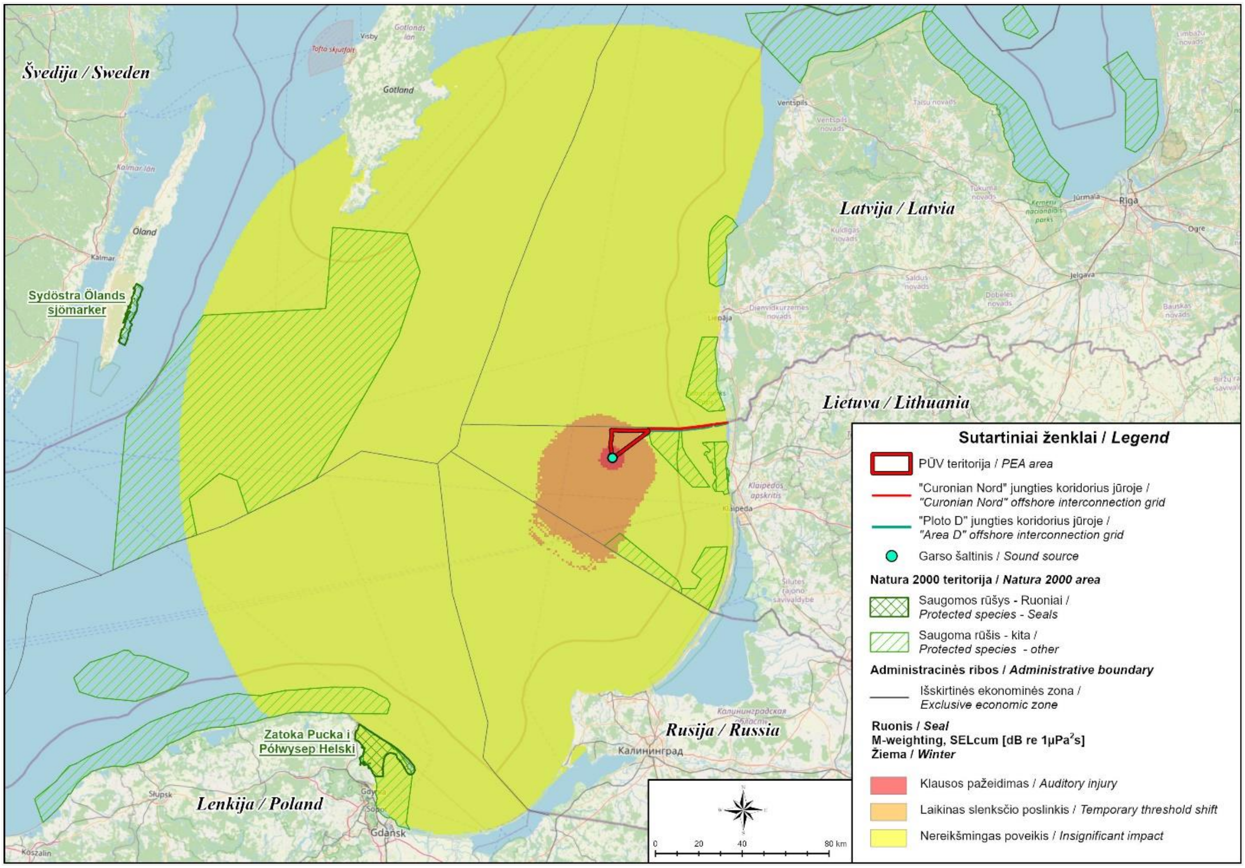


Fig. 5.4.90. Noise map of potential impact on seals (*Phocidae*) obtained based on the scenario of the unmitigated cumulative SELcum [dB re 1μPa^{2}s] (PW-weighted) for winter.

5.4.5.5. Mitigation, and compensation measures to address impact on marine mammals

5.4.5.5.1. Mitigation measures during the construction phase

During the construction phase, the most significant impact on marine mammals is the underwater noise generated during pile driving. This impact can be particularly significant in winter, when natural conditions result in the greatest propagation of underwater noise. If practicable, foundation installation works should be scheduled to avoid piling during the winter season, when the likelihood of encountering harbour porpoises in Lithuanian EEZ waters is highest.

To prevent injuries to marine mammals (such as hearing loss) due to pile driving, the primary underwater noise mitigation measure before pile driving is acoustic deterrence of animals. This can be done in two ways, often used together. The first method involves the use of additional acoustic deterrent devices (ADDs) to scare marine mammals away from the piling zone. The second method is the soft start piling technique, meaning the strike energy is gradually increased at the beginning of pile driving, allowing animals to move away while avoiding sudden, highly harmful noise pulses (Tougaard and Mikaelsen, 2020).

Additionally, technical measures to dampen impulsive noise generated during pile driving should be used. One of the most effective methods is the deployment of double bubble curtains (hereinafter – DBBC) around the piling area (Fig. 5.4.91). This measure can reduce the distance of extreme impact on harbour porpoises by up to 90% (Nehls et al., 2016).

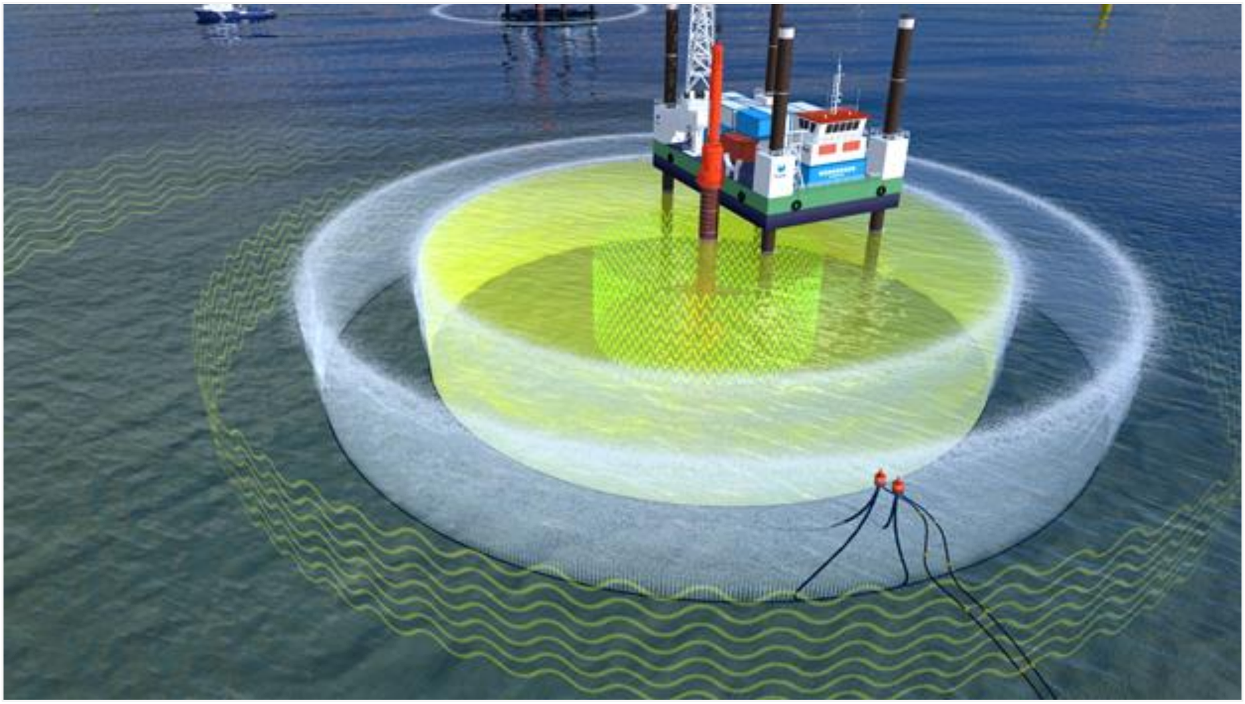


Fig. 5.4.91. Principle of DBBC. Source: Wikimedia Commons, Werner Evers, licensed under CC BY-SA 3.0 DE. https://commons.wikimedia.org/wiki/File:Big_Bubble_Curtain_Schalld%C3%A4mpfung.jpg.

Another commonly applied noise reduction technology is Hydro Sound Dampers (hereinafter – HSD) a noise mitigation system designed to reduce underwater noise generated during offshore pile-driving activities, such as the installation of WTG foundations. The HSD system employs nets equipped with gas-filled elastic balloons and durable polyethylene foam elements that absorb and scatter sound waves, thereby diminishing noise propagation in aquatic environments. The HSD is frequently used alongside other noise mitigation measures, such as DBBCs or impermeable barriers, to comply with stringent underwater noise regulations.

Noise propagation modelling and assessment of impacts on marine mammals for the CN OWF were conducted based on noise generated during the pile driving of a 10-meter diameter monopile, using an IQ6 hammer with a maximum power output of 6,600 kJ.

x

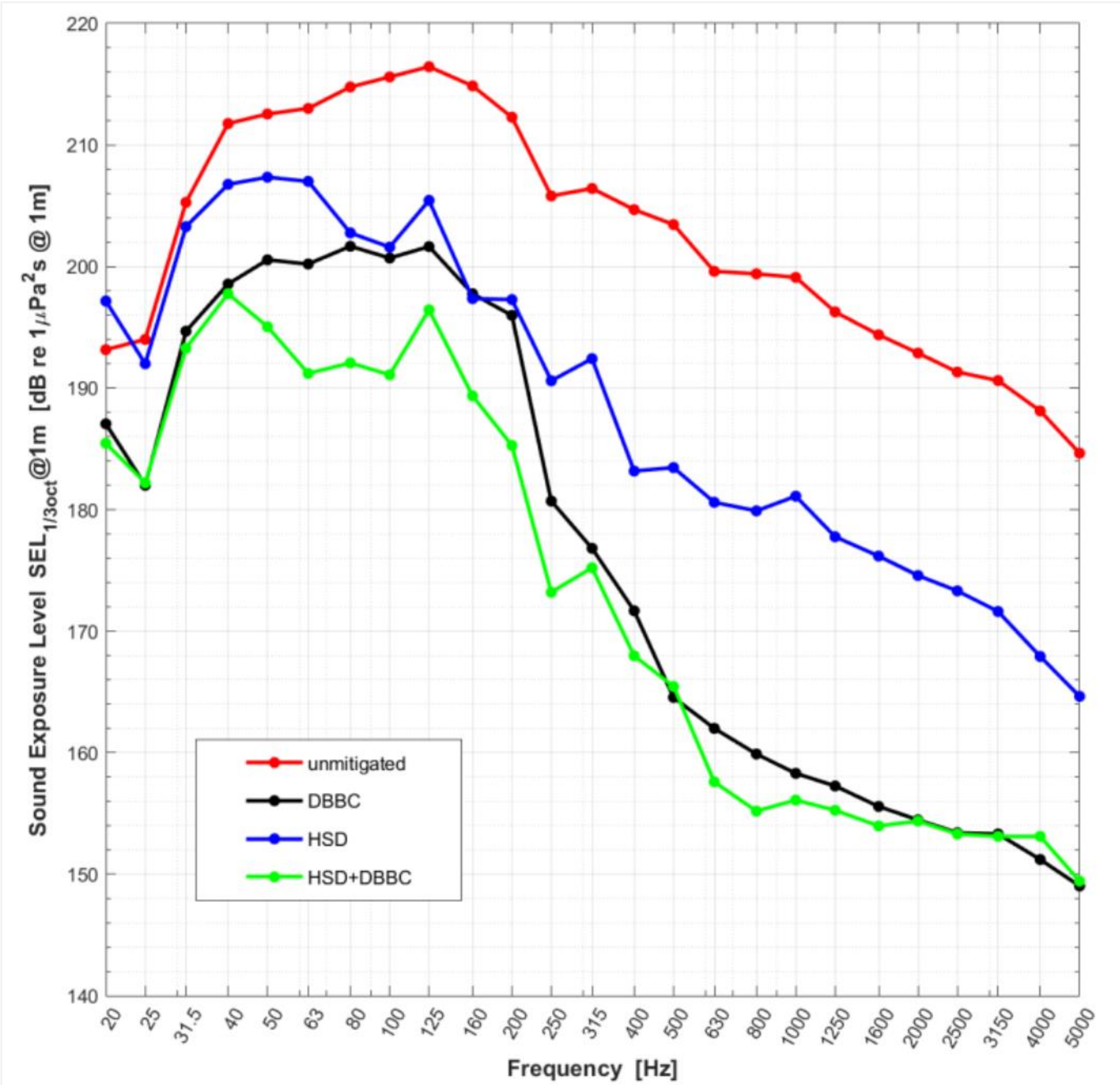


Fig. 5.4.92. Source level spectra of the modelled pile-driving noise defined as sound exposure level SEL in 1/3-octave bands [dB re 1µPa^{2}s@1m], in frequency range applied in modelling (20Hz−5kHz). The unmitigated SELunmitigated (red curve) and with mitigation measures in the form of DBBC SEL_{DBBC}, HSD SEL_{HSD} and with a combination of both $SEL_{DDBC+HSD}$ (black, blue and green curves, respectively) [on the basis of the results published in Bellmann et al. (2020)].

In accordance with the considered noise exposure criteria for particular representatives of marine mammals, values of the weighted sound exposure level $SEL_{weighted}$ used to estimate the impact effects in the form of exceeding the TTS and AUD INJ thresholds and BR of harbour porpoises were calculated considering single strike emission as well as cumulative noise dose.

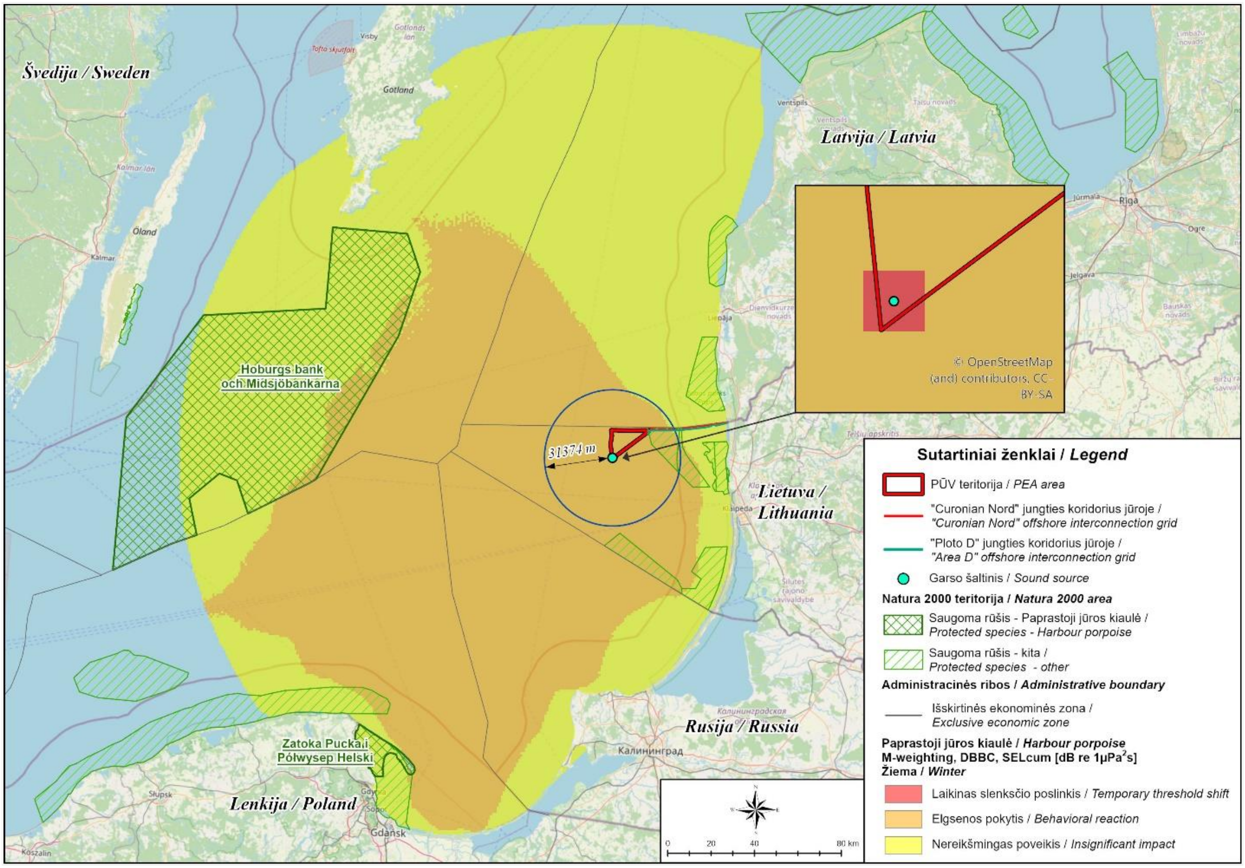


Fig. 5.4.93. Noise maps of potential impact on harbour porpoises (*Phocoena Phocoena*) obtained based on the scenario of the DBBC-mitigated cumulative SELcum, DBBC (dB re 1μPa^{2}s) (VHF-weighted) for winter.

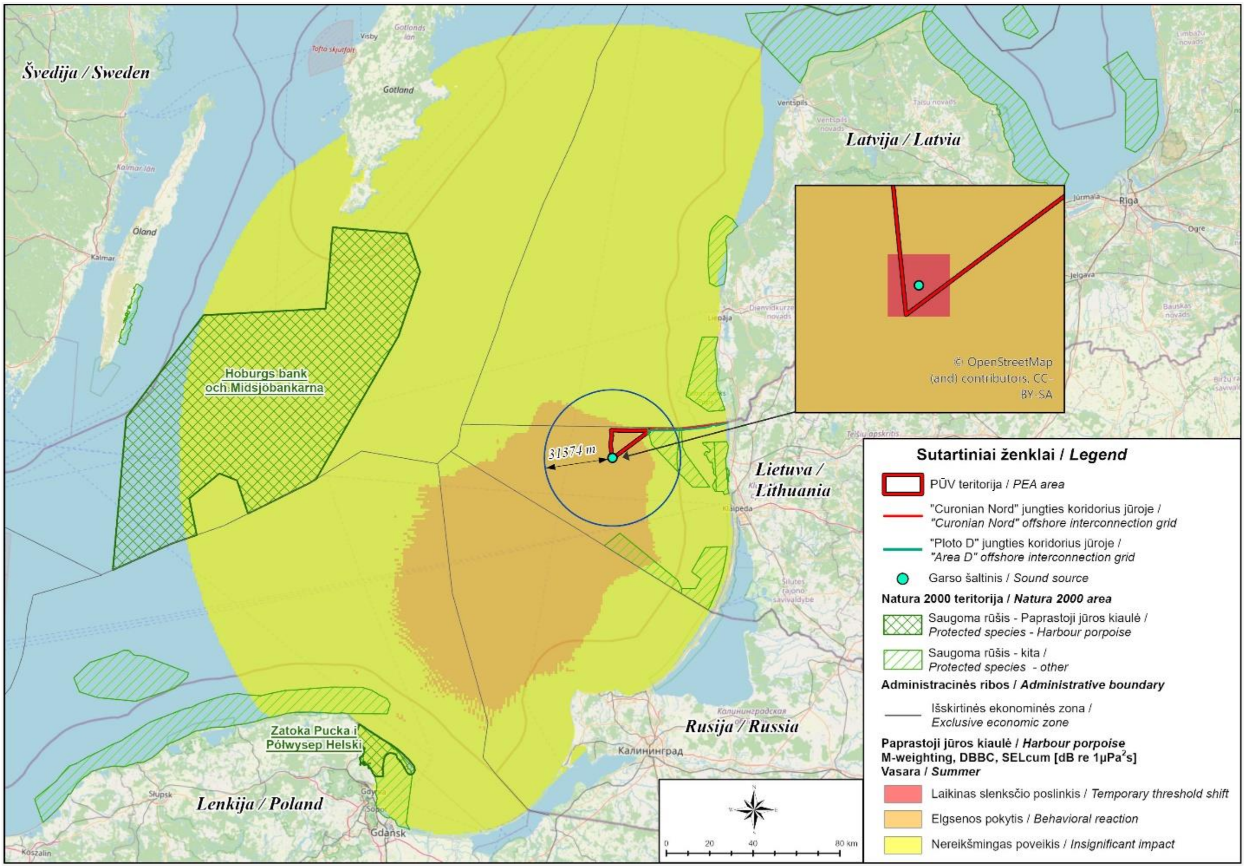


Fig. 5.4.94. Noise maps of potential impact on harbour porpoises (*Phocoena Phocoena*) obtained based on the scenario of the DBBC-mitigated cumulative SEL_{cum}, DBBC (dB re 1µPa^{2}s) (VHF-weighted) for summer.

The results obtained of numerical modelling of noise propagation during pile driving performed in the CN OWF area, have revealed that for a single sound event (single strike) with using of mitigation in the form of DBBC or DBBC coupled with HSD (Tables 5.4.39 and 5.4.40):

1) for harbour porpoises (*Phocoena phocoena*):
   - Weighted sound exposure level values $SEL_{weighted}$, calculated using the M-frequency weighting function (VHF-weighted) to reflect the hearing sensitivity of high-frequency marine mammals (HF-cetaceans), do not exceed thresholds of 159 dB re 1 µPa^{2}s associated with auditory injury AUD INJ, for both cases considered single strike and cumulative scenarios.
   - In the case of cumulative exposure, the potential onset of TTS is estimated to be within 0.43 to 0.5 km for DBBC and 0.46 to 0.52 km for DBBC coupled with HSD.
   - In case of single strike scenario, behavioral reaction may occur at distances of about 2.3 km for DBBC only and from 2.44 to 2,64 km when used in combination DBBC with HSD.
   - Considering a harbour porpoise individual as a “moving receiver”, fleeing during the piling process, the cumulative sound exposure levels were estimated at 130.7 dB re 1 µPa^2·s for DBBC and 131.1 dB re 1 µPa^2·s for the DBBC combined with HSD system.
2) for seals (*Phocidae*):
   - Weighted sound exposure level values $SEL_{weighted}$, calculated using the M-frequency weighting function (PW-weighted) to reflect the hearing sensitivity of seals, do not exceed threshold of 183 dB re 1 µPa^{2}s associated with auditory injury AUD INJ solely for single strike event.

- In the case of cumulative exposure, auditory injury AUD INJ may occur only when applying a single noise mitigation measure – the DBBC (approximately 0.25 km). When the DBBC + HSD combined mitigation system is used, the AUD INJ threshold is not exceeded at any distance.
- In the case of cumulative exposure, the potential onset of TTS is estimated within 2.4 to 2.6 km for DBBC and within 0.7 to 0.9 km when DBBC is coupled with HSD.
- In case of single strike scenario, behavioural reaction may occur at distances of about 2.1 to 2.2 km for DBBC and within 0.7 to 0.9 km when DBBC is coupled with HSD.

To verify of propagation model by in-situ measurements and demonstrate of compliance with acoustic criteria, a set of control distances was proposed in the guideline published by Danish Energy Agency (Tougaard et al., 2023). If measurements are performed during piling, a minimum set of receiver ranges should be considered like the reference one R=750 m and a set of other ones, including 1000, 1500, 2000, 3000 m from the position of pile-driving. Moreover, according to the mentioned above document, it is recommended to include a hydrophone position in between 5000 and 10000 meters as well.

When compared to unmitigated conditions, the implementation of mitigation measures such as DBBC results in a significant reduction of the potential noise impact range, as anticipated. At the primary distance of 750 m, the model predicts similar sound exposure levels of approximately SEL_{ss}, DBBC = 163.6 dB re 1µPa²s in winter and SEL_{ss}, DBBC = 164.5 dB re 1µPa²s in summer and for the DBBC + HSD case the SEL_{ss} in winter and summer are predicted to be 157,8 dB re 1µPa²s and 158,7 dB re 1µPa²s, respectively.

Table 5.4.41. Broadband sound exposure level SEL of single hammer strike at different distances from the pile-driving position applying noise mitigation measures and their combinations.

Broadband Sound Exposure Level $SEL_{20Hz-5kHz}$ [dB re 1µPa²s] in summer (S) and winter (W)					
Distance (m)	Season	Unmitigated	DBBC	HSD	DBBC + HSD
750	W	178.0	163.6	168.6	157.8
	S	178.9	164.5	169.5	158.7
1,000	W	176.8	162.4	167.4	156.6
	S	176.3	161.9	166.9	156.1
1,500	W	174.2	159.8	164.8	154.0
	S	173.4	159.0	164.0	153.2
2,000	W	173.3	158.9	163.9	153.1
	S	171.5	157.1	162.1	151.3
3,000	W	169.4	155.0	160.0	149.2
	S	169.7	155.3	160.3	149.5
5,000	W	164.2	149.8	154.8	144.0
	S	163.8	149.4	154.4	143.6
10,000	W	158.1	143.7	148.7	137.9
	S	155.4	141.0	146.0	135.2

Other mitigation methods involve use of pile sleeves, which are cylindrical casings made from materials like steel, placed around the pile to isolate it from direct contact with water. This isolation helps reduce the transmission of impulsive noise into the marine environment. Additionally, noise reduction screens, such as double-walled steel tubes (Noise Mitigation Screen, NMS) with air-filled gaps, can be utilized. These screens, often combined with DBBCs, effectively attenuate noise by reflecting and absorbing sound waves. Implementing these measures during construction and maintenance phases can concentrate noise within specific areas, thereby minimizing disturbances to marine mammals' feeding behaviours.

Since noise monitoring has demonstrated that most anthropogenic noise generated in OWFs is detectable by marine mammals, it is advisable to use designated shipping lanes and corridors during the construction and maintenance phases. This approach helps concentrate noise in specific areas, thereby reducing potential disturbances to the feeding activities of marine mammals.

5.4.5.4.1. Mitigation measures during the operation and decommissioning

During the operation phase of OWF, the noise generated by OWF‘s is lower compared to construction, but it can still have some impact on marine mammals and fish. Several technologies can help reduce this noise:

- Technical measures
  - Use of low-noise turbine designs: advanced WTG designs, such as direct-drive turbines (which eliminate the need for a gearbox), reduce mechanical vibrations transmitted into the water.
  - Application of damping materials and isolation techniques: rubberized or composite foundation coatings can help absorb vibrations and reduce underwater noise propagation.

During OWF decommissioning, same as in the construction phase, high-intensity underwater noise can be generated, necessitating the use of special measures to protect marine mammals and other marine species sensitive to acoustic disturbances. To reduce the noise impact on marine mammals during wind turbine decommissioning, the following measures should be implemented:

- Gradual noise increase (soft-start): applying this measure during decommissioning allows for a gradual increase in noise levels, providing marine mammals with the opportunity to move away from the noisy work area. This approach, often combined with marine mammal deterrent devices (such as ADDs), helps avoid sudden acoustic disturbances that could cause stress and disrupt animal behaviour.
- If harbour porpoise presence is detected in the area during the November–April period, decommissioning works are suspended for one week from the last detection or underwater noise mitigation measures must be applied to avoid the possible effect on marine mammals.
- Pile cutting technologies: technologies such as diamond wire cutting, employed during the removal of WTG foundation structures, allow for operations with minimal noise generation. These cutting methods help reduce noise levels, thereby mitigating negative impacts on marine mammal habitats.

Table 5.4.42. Summary of potential impact of the OWF and mitigation measures for marine mammals

Stages	Impact	Type	Scale	Duration	Significance	Mitigation Measures
Construction	Noise and vibration	Negative direct impact – disturbance and potential hearing damage to marine animals	Localised (within the OWF and adjacent territory)	Short-term (likely only during construction works)	Moderate impact due to potential hearing damage and temporary displacement of animals	Use of ADDs and soft start to scare away animals; application of noise mitigation measures during pile-driving works.
	Physical destruction of benthic habitats	Negligible impact due to a potentially reduced abundance of prey items	Localised (within the OWF area)	Short-term (due to the small affected area, habitats are expected to recover quickly)	Negligible impact – limited area is affected compared to available foraging grounds	Not applicable.
	Disturbance due to movement and anchoring of maintenance vessels	Negative direct impact – displacement of marine mammals	Localised (within the OWF and adjacent territory)	Short-term (likely only during construction works)	Negligible impact – a temporary reduction in animal abundance may occur along shipping routes	Recommended, and mandatory from November to April, that only common navigation routes and designated shipping corridors are used for vessel traffic to and from the project area during construction.
Operation and Maintenance	Movement and anchoring of maintenance vessels	Negative direct impact – displacement of marine mammals	Localised (restricted to vessel navigation routes)	Localised (restricted to vessel navigation routes)	Negligible impact – a temporary reduction in animal abundance may occur along shipping routes	Recommended, and mandatory from November to April, that only common navigation routes and designated shipping corridors are used for vessel traffic to and from the OWF area during its operation. Restrictions do not apply to cable repair and maintenance activities.
	Presence of underwater structures	Negative direct impact – behavioural changes in marine mammals and possible reduction in their abundance	Localised (within the OWF area)	Long-term (lasting until the end of the OWF operational phase)	Negligible impact – marine mammals may avoid the OWF area, but this is unlikely to affect their overall abundance in Lithuanian marine waters	Not applicable.
	Formation of secondary habitats	Positive indirect impact due to a	Localised (within the OWF area)	Long-term (lasting until the	Positive impact	Not applicable.

Stages	Impact	Type	Scale	Duration	Significance	Mitigation Measures
		potentially increased abundance of prey items		end of the OWF operational phase)		
Decommissioning	Noise and vibration	Negative direct impact – disturbance and potential hearing damage to marine animals	Localised (within the OWF and adjacent territory)	Short-term (likely only during the decommissioning works)	Moderate impact due to potential hearing damage and temporary displacement of animals	If harbour porpoises are detected during decommissioning, noisy activities should not be conducted during winter, or impact noise mitigation measures shall be applied.
	Destruction of formed secondary habitats	Negative indirect impact due to a potentially reduced availability of feeding grounds or prey	Localised (individual WTGs)	Long-term	Negligible impact – limited area is affected compared to available foraging grounds	Not applicable.
	Movement and anchoring of maintenance vessels	Negative direct impact – displacement of marine mammals	Localised (within the OWF and adjacent territory)	Short-term (likely only during the decommissioning works)	Negligible impact – due to the very low likelihood of encountering harbour porpoises in the study area. The impact magnitude may change if harbour porpoises are observed during project monitoring activities	Recommended, and mandatory from November to April, that only common navigation routes and designated shipping corridors are used for vessel traffic to and from the project area during decommissioning.

Colour code

	Positive impact
	No impact or impact insignificant (not to be considered, no measures are applicable)
	Minor impact: decisions during design, preventive or mitigation measures
	Moderate impact: addressed by mitigation measures
	Significant impact: mitigation and/or compensation measures are necessary.

5.4.6. Baltic Sea fish

5.4.6.1 Survey methods

5.4.6.1.1 Methods for assessing the current state

The evaluation of the fish community was based on data collected during the Baltic International Bottom Trawl Survey (hereinafter – BITS), the Baltic International Acoustic Survey (hereinafter – BIAS), and the Baltic Acoustic Spring Survey (hereinafter – BASS) conducted within the PEA area or adjacent waters.

The BITS is a standardized scientific survey conducted in the Baltic Sea to assess demersal (bottom-dwelling) fish stocks. Its primary objective is to provide fishery-independent stock indices for the two Baltic cod stocks, as well as for flounder and plaice. In Lithuania, trawling is conducted using a small standard TV3 trawl, following the TV3 520# specifications. The stretched mesh size in the codend is 20 mm. Each haul lasts 30 minutes at a towing speed of 3 knots, in accordance with the BITS survey manual.

The BIAS, conducted in October, and the BASS are standardized scientific surveys in the Baltic Sea aimed at assessing clupeid fish stocks, primarily herring (*Clupea harengus*) and sprat (*Sprattus sprattus*). While BIAS focuses on stock size assessment, BASS evaluates the abundance and distribution of clupeid stocks during their spawning season. Both surveys rely on acoustic data collection using scientific echosounders such as the SIMRAD EK80, with BIAS employing a hull-mounted 38 kHz ES38-10 transducer. Trawling is conducted to verify species composition and size distribution, utilizing a pelagic trawl with a vertical opening of approximately 12 m and a codend mesh bar length of 10 mm. Vessels typically operates at 8 knots during acoustic measurements, while fishing hauls are conducted at 3.0 knots for 30 min. in both midwater and near the seabed, with depth determined based on observed fish shoal echograms.

The assessment of the nearshore fish community utilizes the HELCOM methodology, which standardizes data collection techniques to ensure consistent monitoring across the Baltic Sea. This typically involves the use of gillnets with various mesh sizes to capture fish populations across different size classes. In your study, Nordic coastal multi-mesh gillnets with mesh sizes of 14, 17.5, 20, 30, 40, 45, 50, 55, 60, and 70 mm were employed. These mesh sizes enable the capture of a wide range of fish sizes, which is essential for evaluating the structure and health of the fish community. By using a multi-mesh design, the methodology ensures the sampling of both juvenile and adult fish, providing a comprehensive overview of the fish populations in the area. This approach aligns with HELCOM (2015) recommendations for standardized monitoring and data collection of coastal fish communities in the Baltic Sea.

The analysis of fish community structure was conducted using catch data from stationary multi-mesh gillnets collected under the Lithuanian National Fisheries Data Collection Program (DCP), provided by the Marine Research Institute of Klaipėda University.

5.4.6.1.2 Methods for assessing potential impacts

The impact assessment on fish was conducted by modelling noise exposure effects using the same methodology applied to marine mammals (see Sections 5.4.5.1.2 and Annex 8).

5.4.6.2 Survey area

In the current state analysis, particular emphasis was placed on both the PEA area and the adjacent waters, where potential impacts on fish communities are anticipated, especially during the construction phase of the CN OWF. Consequently, data from pelagic and acoustic trawl surveys conducted within the PEA area and within a 5.5 nautical mile radius surrounding it were examined. All survey data correspond to ICES statistical rectangle 40H0 within ICES Subdivision 26, a spatial unit defined by specific geographic coordinates. This unit forms part of a broader, standardized area-based framework utilized for the assessment of fish stocks, marine habitats, and other ecosystem components.

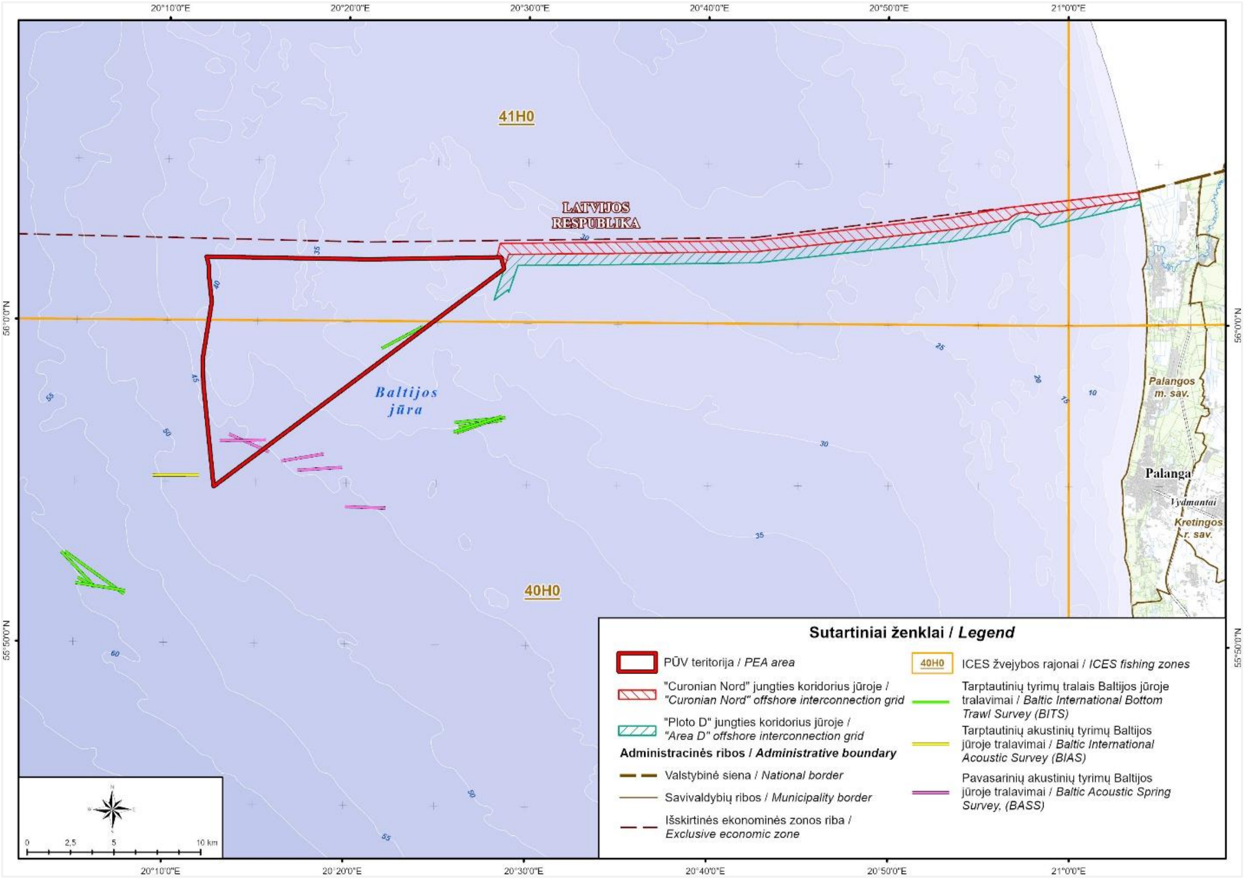


Fig. 5.4.95. Positions of hauls of Baltic Bottom and Acoustic Surveys.

5.4.6.3 Current state

A total of 65 cyclostome and fish species have been recorded in the Lithuanian waters of the Baltic Sea, including 21 freshwater species, 33 marine species, and 11 migratory species. Around 19 of these species are protected under the Habitats Directive, the Berne Convention, or the CITES Convention (Convention on International Trade in Endangered Species of Wild Fauna and Flora). Additionally, 5 species are listed in the Lithuanian Red Book, and 18 species are classified as very rare. While some species are commonly observed in Lithuanian marine waters, others – such as swordfish (*Xiphias gladius*), anchovy (*Engraulis encrasicolus*), and hooknose (*Agonus cataphractus*) – have been recorded only once or a few times.

Atlantic herring (*Clupea harengus*), Atlantic cod (*Gadus morhua*), and European flounder (*Platichthys flesus*) are among the most abundant quota managed fish species in Lithuania's EEZ and are targets of commercial fisheries.

Lithuania has the smallest share of Baltic Sea waters among the Baltic states, encompassing approximately 3.5% of the sea and less than 100 km of coastline. Herring eggs and larvae are found here, particularly north of Palanga. Around 20% of the juvenile herring biomass in the eastern Baltic is located within Lithuania's Exclusive Economic Zone (EEZ), with the remainder distributed across the EEZs of Russia and Latvia. No distinct feeding areas for fish have been identified in the Baltic Sea's coastal or economic zones, as suitable substrates for feeding are available throughout Lithuania's EEZ. The fish community composition varies seasonally, primarily influenced by spawning, feeding, and winter migrations. In the Curonian Nord OWF area, the fish community is predominantly made up of benthophagous European flounder and Atlantic cod. Over the past nine years, fishing intensity in this area has been very low. This region serves as a crucial feeding ground for both Baltic flounder and Atlantic cod. Recent studies indicate an increase in smaller Baltic cod size groups in the area. It appears that restricting bottom trawling and gillnet fishing in this zone could further enhance its importance as a feeding ground for these species. In the CN OWF, fish community is dominated by the same three main commercial fish species: Atlantic herring (*Clupea harengus*), Atlantic cod (*Gadus morhua*), and European flounder (*Platichthys flesus*). Occasionally, the shorthorn sculpin (*Myoxocephalus scorpius*) and European smelt (*Osmerus eperlanus*) stand out seasonally in terms of biomass and abundance (see Tables 5.4.43–5.4.45).

A shallow water zone extends along the entire Lithuanian coastline, forming part of both the Baltic Sea (north of Klaipėda straight) and Curonian Lagoon ecosystems. Short-term fluctuations in physical environmental factors, such as wind, wave height, and light, shape unique fish communities not found in any other surrounding ecosystems. These shallow waters are also crucial feeding and nursery grounds for the juveniles of many fish species. Additionally, they serve as feeding grounds for semi-migratory species that migrate between the Curonian Lagoon and the Baltic Sea coastline.

The following migratory fish species are found here: smelt (Osmerus eperlanus), vimba (Vimba vimba), salmon (*Salmo salar*), sea trout (*Salmo trutta*), whitefish (*Coregonus lavaretus*), twaite shad (*Alosa fallax*), eel (*Anguilla anguilla*), and river lamprey (*Lampetra fluviatilis*). Most migratory fish species remain close to the shore, typically at depths of up to 20 m, while salmon migrate long distances in pursuit of schools of pelagic fish. In the coastal zone where the waters of the Curonian Lagoon mix with the Baltic Sea, freshwater fish species are abundant, including bream (Abramis brama), pikeperch (*Sander lucioperca*), bleak (*Blicca bjoerkna*), ide (*Leuciscus idus*), roach (*Rutilus rutilus*), dace (*Alburnus alburnus*), asp (*Leuciscus aspius*), perch (*Perca fluviatilis*), ruffe (*Gymnocephalus cernuus*), three-spined stickleback (*Gasterosteus aculeatus*), and sichel (*Pelecus cultratus*).

During the summer season, marine and semi-anadromous fish species predominate in the Baltic Sea. In the autumn months of September and October, coastal waters experience a notable influx of anadromous fish species migrating towards rivers for spawning. By November, as water temperatures decline, the coastal zone witnesses an increased presence of sprat, a significant abundance of river flounder, and the appearance of Atlantic cod.

The Lithuanian EEZ and coastal waters are critically important areas for the reproduction of numerous commercial fish stocks. These waters host valuable spawning grounds for species such as smelt and turbot (*Scophthalmus maximus*), as well as feeding grounds for marine, freshwater, migratory, and semi-migratory fish species. Additionally, major migration routes of many fish species pass through this region. Several non-commercial fish species that are nevertheless important for the feeding of commercial fish – such as gobies, eelpouts, lumpfish (*Cyclopterus lumpus*), and three-spined sticklebacks – also spawn here. The Lithuanian coastal zone is particularly significant for the recovery of sprat stocks, with a large abundance of sprat eggs and larvae found, especially north of Palanga. Approximately 20% of the year-class biomass of sprat in the eastern Baltic is located within the Lithuanian EEZ, with the remainder distributed across the Russian and Latvian EEZs.

According to data from the BITS conducted between March 5, 2020, and February 21, 2025, a total of 16 fish species were caught using standardized bottom trawls within Lithuania's EEZ. These species include: Altantic cod (*Gadus morhua*), European sprat (*Sprattus sprattus*), Shorthorn sculpin (*Myoxocephalus scorpius*), European flounder (*Platichthys flesus*), European plaice (*Pleuronectes platessa*), herring (*Clupea harengus*), Eelpout (*Zoarces viviparus*), Three-spined stickleback (*Gasterosteus aculeatus*), European smelt (*Osmerus eperlanus*), Lumpfish (*Cyclopterus lumpus*), Turbot (*Scophthalmus maximus*), Sand goby (*Pomatoschistus minutus*), Round goby (*Neogobius melanostomus*), European perch (*Perca fluviatilis*), Twaite shad (*Alosa fallax*), and European anchovy (*Engraulis encrasicolus*).

According to the BITS data, a total of 14 fish species were caught through standardized bottom trawling in the CN OWF from 2020 to 2024 (Table 5.4.43): Atlantic cod (*Gadus morhua*), European sprat (*Sprattus sprattus*), Shorthorn sculpin (*Myoxocephalus scorpius*), European flounder (*Platichthys flesus*), European plaice (*Pleuronectes platessa*), Atlantic herring (*Clupea harengus*), Eelpout (*Zoarces viviparus*), Three-spined stickleback (*Gasterosteus aculeatus*), European smelt (*Osmerus eperlanus*), Turbot (*Scophthalmus maximus*), Sand goby (*Pomatoschistus minutus*), Twaite shad (*Alosa fallax*) and Lumpfish (*Cyclopterus lumpus*). On average, 7 fish species were caught during the various trawl operations. The waters of the CN OWF are dominated by the three main commercial fish species mentioned above (Table 5.4.44 and 5.4.45).

Table 5.4.43. Fish biomass (B) in 2020–2024 (according to: BITS trawling, catches calculated per one hour of trawling)

Species	2020		2021	2022		2023		2024	2025
	Q1	Q4	Q1	Q1	Q4	Q1	Q4	Q1	Q1
Twaite shad		2	<< 1		4		1	< 1	
Atlantic herring	18	60	41	24	3	60	100	30	
Atlantic cod	69	212	12	8	149	12	91	169	18
Three-spined stickleback				<< 1					
Shorthorn sculpin	0,3		1	9	2	5	< 1	1	23
European smelt	<< 1	8		<< 1	< 1	< 1		< 1	
European flounder	61	286	22	47	288	48	29	42	161

Species	2020		2021	2022		2023		2024	2025
	Q1	Q4	Q1	Q1	Q4	Q1	Q4	Q1	Q1
European plaice						<< 1	<1		
Sand goby		<< 1							
Turbot				< 1		< 1	<< 1	1	3
European sprat	< 1	<< 1	< 1	< 1	1	2	5		
Eelpout				< 1		< 1			
Lumpfish									<1

Table 5.4.44. Dominance of fish species in the community by biomass (B) during the period 2020–2025

Dominance category	2020 Q1	2020 Q4	2021 Q1	2022 Q1	2022 Q4	2023 Q1	2023 Q4	2024 Q1	2025 Q1
Eudominant	**Atlantic cod**	**Atlantic cod**	**Atlantic herring**	**Atlantic herring**	**Atlantic cod**	**Atlantic herring**	**Atlantic herring**	**European flounder**	**European flounder**
	European flounder	**European flounder**	**European flounder**	**European flounder**	**European flounder**	**European flounder**	**Atlantic cod**	**Atlantic herring**	
Dominant	**Atlantic herring**	**Atlantic herring**	**Atlantic cod**	**Atlantic cod**		**Atlantic cod**	**European flounder**		**Atlantic cod**
									Shorthorn sculpin
Subdominant				European sprat	Shorthorn sculpin			Atlantic cod	
								Shorthorn sculpin	
Recedent				Shorthorn sculpin	Atlantic herring	Shorthorn sculpin	European sprat		
					European sprat				
Subrecent			Shorthorn sculpin		Twaite shad	European sprat			
Rare		European smelt							Turbot
Accidental	Shorthorn sculpin	Sand goby	Twaite shad	Three-spined stickleback	Shorthorn sculpin	European smelt	Twaite shad	European sprat	Lumpfish
	European smelt	European sprat	European sprat	European smelt	European smelt	European plaice	Shorthorn sculpin	Turbot	
	European sprat	Twaite shad		Turbot		Turbot	Turbot	European smelt	
	Twaite shad			Eelpout		Eelpout	European plaice		

Table 5.4.45. Dominance of fish species in the community by abundance (N) during the period 2020–2025

Dominance category	2020 Q1	2020 Q4	2021 Q1	2022 Q1	2022 Q4	2023 Q1	2023 Q4	2024 Q1	2025 Q1
Eudominant	**Atlantic herring**	**Atlantic herring**	**Atlantic herring**	**European flounder**	**Atlantic cod**	**Atlantic herring**	**Atlantic herring**	**European flounder**	**European flounder**
	European flounder	**Atlantic cod**		**Atlantic herring**	**European flounder**	**European flounder**		**Atlantic herring**	
	Atlantic cod	**European flounder**							
Dominant		**European smelt**	**European flounder**	**Atlantic cod**			**Atlantic cod**		**Atlantic cod**

							European sprat		**Shorthorn sculpin**
Subdominant	European sprat		Atlantic cod			Atlantic cod	European flounder	Atlantic cod	
						European sprat		Shorthorn sculpin	
Recedent									
Subrecent			European sprat			Shorthorn sculpin			
						European smelt			
Rare								European sprat	Turbot
Accidental	Shorthorn sculpin	Sand goby	Twaite shad	Three-spined stickleback	Atlantic herring	European plaice	Twaite shad	Turbot	Lumpfish
	European smelt	European sprat	Shorthorn sculpin	Shorthorn sculpin	Twaite shad	Turbot	Shorthorn sculpin	European smelt	
	Twaite shad	Twaite shad		European smelt	Shorthorn sculpin	Eelpout	Turbot		
				Turbot	European smelt		European plaice		
				European sprat	European sprat				
				Eelpout					
				Shorthorn sculpin					

The Shannon (H') and Pielou (J) indices were used to assess the species composition and evenness of the fish community. Throughout the study period, both indices showed relatively stable but consistently low values: in Q1 2020, H' = 1.02 and J’ = 0.57; Q4 2020, H' = 1.03 and J’ = 0.53; Q1 2021, H' = 1.07 and J’ = 0.55; Q1 2022, H' = 1.22 and J’=0.56; Q4 2022, H' = 1.02 and J’ = 0.52; Q1 2023, H' = 1.06 and J’ = 0.48; Q4 2023, H' = 1.02 and J’ = 0.49; Q1 2024, H' = 1.09 and J’ = 0.56; and in Q1 2025, H' = 0.72 and J’ = 0.49. Generally, H' values in biological communities’ range between 1.5 and 3. Therefore, the persistently low index values observed suggest a highly uneven distribution of fish species, with one or a few species dominating in terms of abundance. In this case, the results indicate that the fish community is primarily dominated by the key commercial species in the area.

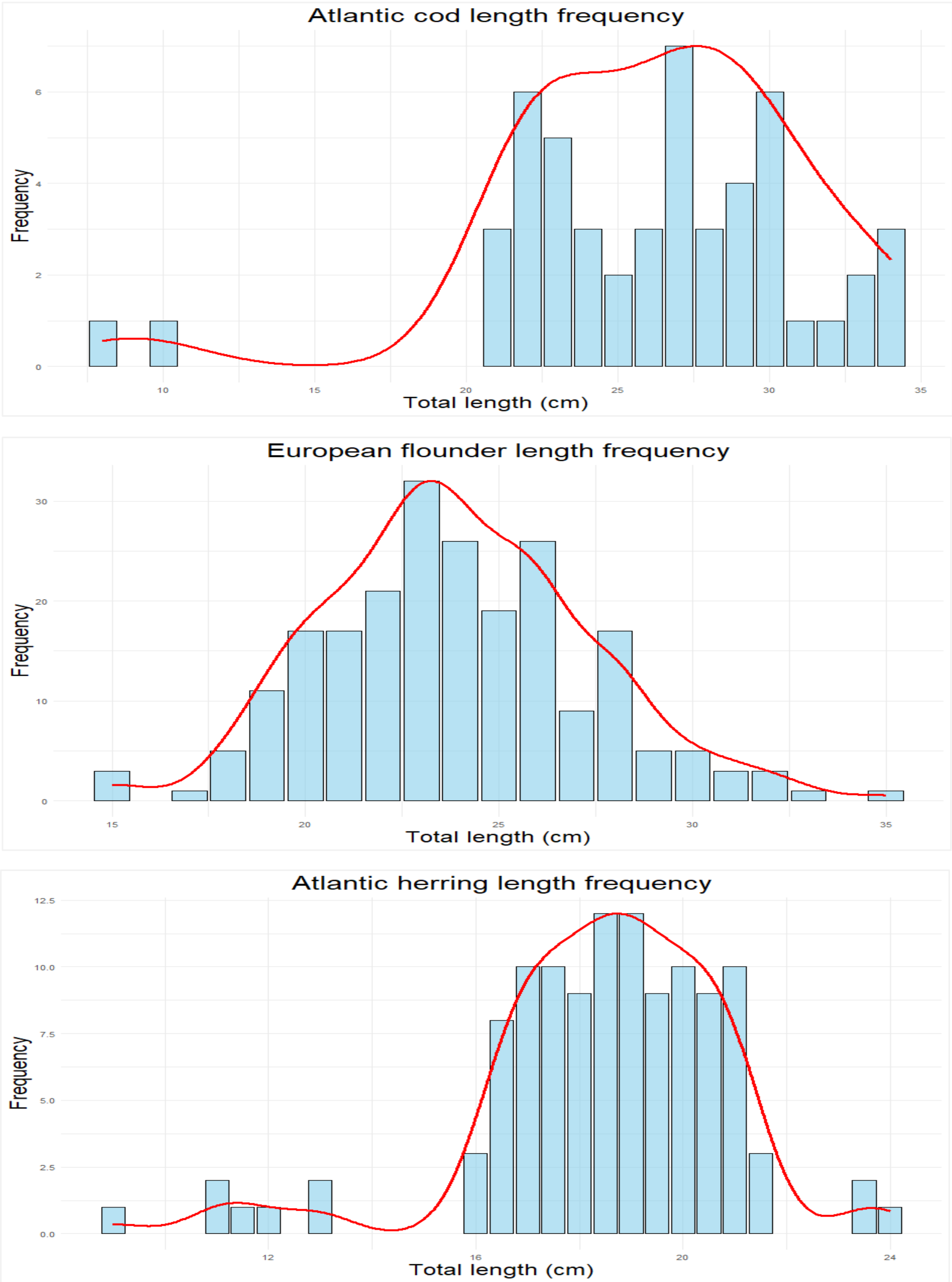


Fig. 5.4.96. Length frequency of the dominant species in the fish community in CN OWF in 2024–2025.

Based on the analysis of scientific trawl BITS surveys, the CN OWF, as well as the surrounding zones, are important feeding grounds for Baltic flounder, eastern Baltic cod, and herring.

The average length of herring in the CN OWF area was found to be 18.46 cm, slightly smaller than the 18.81 cm recorded in the 40H0 ICES statistical rectangle during the same period. Similarly, smaller sizes were observed for

Atlantic cod, with an average length of 26.04 cm in the OWF and 26.14 cm in the ICES 40H0 statistical rectangle, as well as for European river flounder, with average lengths of 23.88 cm and 23.99 cm, respectively. These findings suggest that the size structure of the dominant species in the area closely resembles that of the ICES statistical rectangle and is influenced by the age and condition of the resources in the Baltic Sea ICES 26 subdivision.

In the CN OWF area, the only protected fish species among those captured is the Twaite shad. This species holds EU importance, being listed in Annex II and V of the EU Habitats Directive 92/43 EEC and was listed in Lithuania's Red Book until 2005. As a migratory species, the Twaite shad inhabits the coastal waters of Europe, ranging from the Iberian Peninsula to the shores of Norway. It spawns in rivers along the southern and eastern Baltic Sea basin, including the Elbe, Oder, Vistula, Nemunas, Daugava, and Neva. In Lithuanian waters, it primarily spawns in the Curonian Lagoon, with juveniles migrating to the Baltic Sea from the Curonian Lagoon during their first year and dispersing along the eastern Baltic Sea coast.

Fish research data indicates that in nearshore fishery, Twaite shad are frequently found in schools alongside Baltic herring and Atlantic sprat. Since twaite shad were captured during the BITS survey next to the CN OWF, additional pelagic species surveys conducted between 2020 and 2024 were reviewed to assess the presence and abundance of juvenile twaite shad in the pelagic zone. Species composition and biological data on pelagic fish were gathered during the BIAS and the BASS within the CN OWF. During these surveys, five fish species were captured using standardized pelagic trawls, with two species, Atlantic herring (*Clupea harengus*) and European sprat (*Sprattus sprattus*), dominating the catches. The abundance of both species was similar, with European sprat showing an abundance and biomass in scientific trawling catches ranging from 20,690 to 252,850 individuals/hour and 160 to 6,166 kg/hour, respectively. For Atlantic herring, the abundance and biomass ranged from 344 to 252,834 individuals/hour and 17 to 1,048 kg/hour (Table 5.4.46). Twaite shad was not recorded in these pelagic surveys, and during the BITS trawling, fish captures were relatively rare, occurring in just over half of the scientific trawling sessions. Based on their dominance in terms of abundance and biomass, these species are classified as incidental or rare in the fish community.

Clupeid fish (*Clupeidae*), such as herring or twaite shad, are the most sensitive to underwater noise. They are considered hearing specialists due to their specific auditory adaptations—their swim bladder is connected to the inner ear. This adaptation allows clupeids to detect sounds at frequencies up to 200 kHz, and their hearing sensitivity often surpasses that of marine mammals. This heightened sensitivity makes clupeids more likely to perceive and react to anthropogenic noise sources. Their behavioral response potential is further influenced by their swimming capacity. The swimming speed of herring (*Clupea harengus*) depends on their activity level and body size but typically ranges between 1–2 body lengths per second, which corresponds to approximately 0.20–0.4 m/s for an average-sized herring (~19 cm long) (Blaxter & Batty, 1985). When evading predators or making sudden movements, herrings can reach speeds of up to 10 body lengths per second, about 2 m/s, although they can sustain such speeds only for very short durations (Blaxter & Batty, 1985; Herskin & Steffensen, 1998).

Table 5.4.46. Fish abundance (N) and biomass (B, kg/h) (according to 2020–2024 BIAS and BASS trawl surveys, catches recalculated per trawling hour)

Species	2020				2021		2022		2023		2024	
	Q2		Q4		Q4		Q4		Q4		IV Q4.	
	N	B	N	B	N	B	N	B	N	B	N	B
Atlantic herring					4	<1			252,834	1,048	344	17
European sprat	99,558	600	160,801	1,400	20,690	160	42,704	500	252,850	6,166		
European flounder					10	2						
Three-spined stickleback											26	<1
Shorthorn sculpin											4	<1

The fish community structure in the Lithuanian nearshore zone exhibited distinct seasonal variation during the monitoring periods of October 2023, February 2024, and May 2024. Atlantic herring (*Clupea harengus*) and European smelt (*Osmerus eperlanus*) consistently dominated as the eudominant and dominant species in autumn and winter, highlighting their prevalence during colder months. In spring, European flounder (*Platichthys flesus*) and round goby (*Neogobius melanostomus*) emerged as eudominant species, reflecting seasonal shifts (Table 5.4.47).

Several species maintained dominant or subdominant roles across seasons. These included Atlantic cod (*Gadus morhua*), European smelt (Osmerus eperlanus), European flounder (*Platichthys flesus*), round goby (*Neogobius melanostomus*), and shorthorn sculpin (*Myoxocephalus scorpius*), all demonstrating consistent presence and ecological importance.

Other species such as twaite shad (*Alosa fallax*), European perch (*Perca fluviatilis*), turbot (*Scophthalmus maximus*), European sprat (*Sprattus sprattus*), and vimba bream (*Vimba vimba*) were recorded with lower regularity and classified as subdominant or recedent.

Additionally, occasional records of white bream (*Blicca bjoerkna*), straightnose pipefish (*Nerophis ophidion*), common sole (*Solea solea*), and European whitefish (*Coregonus lavaretus*) were observed, categorized as subrecent, rare, or accidental.

In total, 15 fish species were recorded over the three sampling periods, indicating a moderately diverse, seasonally dynamic fish assemblage in the Lithuanian nearshore ecosystem.

Table 5.4.47. Dominance of fish species in the community by biomass (B) and abundance (N) in the Baltic Sea nearshore zone during the period of 2020–2025

Dominance category	2023 Oct		2024 Feb		2024 May	
	B	N	B	N	B	N
Eudominant		**Atlantic herring**		**Atlantic herring**	**European flounder**	**Round goby**
Dominant	**Atlantic cod**		**Atlantic herring**	**European smelt**	**Round goby**	**European flounder**
	European flounder		**Shorthorn sculpin**			
			European smelt			
Subdominant	Atlantic herring	European flounder	Atlantic cod	Atlantic cod	Twaite shad	
	European smelt		European flounder		European perch	
					Turbot	
Recedent	Round goby	Atlantic cod		Shorthorn sculpin	Shorthorn sculpin	
	Vimba bream	European smelt		European flounder	European smelt	
					European sprat	
Subrecent	White bream					Twaite shad
	Straightnose pipefish					European smelt
	Turbot					European perch
	Common Sole					Turbot
	European whitefish					
Rare		Round goby				Shorthorn sculpin
		Turbot				European sprat

Dominance category	2023 Oct		2024 Feb		2024 May	
	B	N	B	N	B	N
		Vimba bream				
Accidental		White bream				
		European whitefish				
		Straightnose pipefish				
		Common Sole				

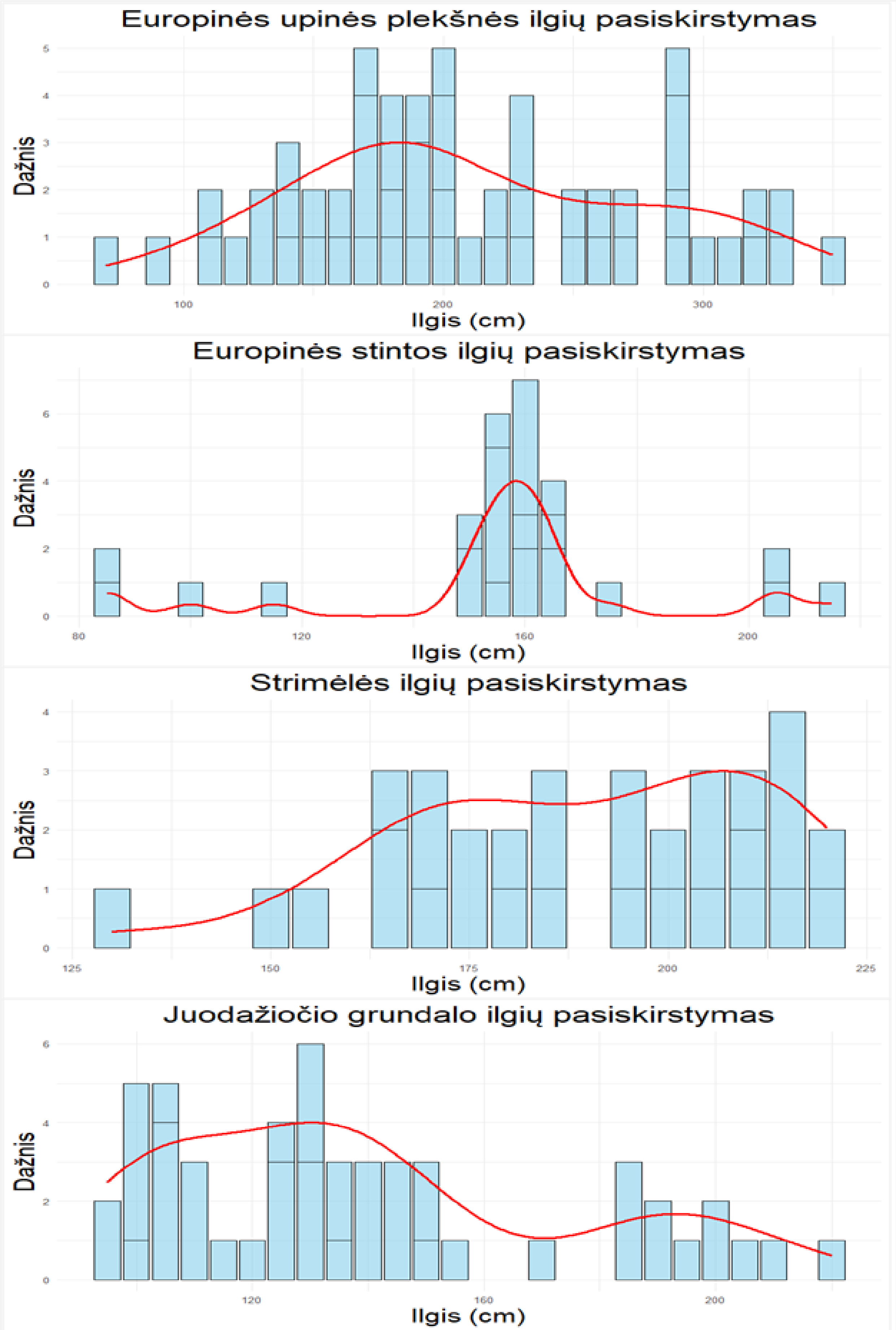


Fig. 5.4.97. Length frequency of the dominant species in the fish community in nearshore zone in 2024–2025.

The average length of herring in the nearshore zone was found to be 18.89 cm, slightly larger than the 18.81 cm recorded in the 40H0 ICES statistical rectangle during the same period. In contrast, smaller sizes were observed for European flounder, with an average length of 21 cm in the nearshore zone compared to 26.14 cm in the ICES 40H0 statistical rectangle. Similarly, European smelt and round goby exhibited smaller average sizes, measuring 15.51 cm and 13.96 cm, respectively. These results suggest that the size structure of dominant pelagic species in the nearshore zone is similar to that of the ICES 40H0 statistical rectangle, reflecting factors such as age and stock status in the Baltic Sea (ICES 26). However, benthic species tend to be somewhat smaller in the nearshore zone than in the statistical rectangle, which may indicate that the area serves as a nursery ground or that larger individuals are selectively targeted by nearshore fisheries.

5.4.6.4 Potential impact to Baltic Sea fish

After analysing the available literature and experiences from similar studies in other countries (DONGEnergy et al., 2006; Bergström et al., 2012; Galparsoro et al., 2022), five types of direct OWF impacts on fish have been identified:

- **Noise impact during development phase.** Although the adverse effects of anthropogenic noise on marine organisms, particularly mammals, fish, invertebrates (Shannon et al., 2016), and zooplankton (McCauley et al., 2017), have been recognized in recent years, there are still no established noise level limits that correspond to good environmental status. Previous studies have shown that high-intensity anthropogenic underwater noise, especially in the low-frequency range, negatively impacts marine organisms' development, including body deformities or underdevelopment, increased mortality of roe and/or juveniles, and reduced growth rates (Aguilar de Soto et al., 2013; Nedelec et al., 2014, 2015). This also leads to anatomical changes such as hearing loss, severe internal trauma, and disorientation (Hastings et al., 1996; McCauley et al., 2003; André et al., 2011; Solé et al., 2017); physiological changes, including elevated stress hormones, metabolism, and oxygen intake (Wysocki et al., 2006; Anderson et al., 2011; Nichols et al., 2015; Spiga et al., 2016); and behavioural changes, such as increased aggression, reduced defensive behaviour, change in feeding habits, and distraction (Kastelein et al., 2008; Fewtrell and McCauley, 2012; La Manna et al., 2016; Nedelec et al., 2017).

  The effects of underwater noise on fish depend on the type of activity being carried out. The most severe effects during the wind farm's life cycle occur during pile driving for foundation installation. In this phase, fish may experience barotrauma or cellular damage in the lateral line, which contains sensory vibrissae and neuromasts, disrupting one of their primary sensory systems (De Backer et al., 2014b; Halvorsen et al., 2012). These effects vary considerably among species. For instance, no increased mortality or pathology was observed in Californian anchovy (Engraulis mordax) and European sole (Solea solea) after 4 minutes of exposure to pile driving noise (Abbott et al., 2005; Bolle et al., 2012), whereas stress responses were detected in European seabass (Dicentrarchus labrax) up to 2 km from the noise source (Mooney et al., 2020). This variability is likely related to swim bladder morphology, with flatfish and other species having reduced bladders showing lower sensitivity. Atlantic herring (Clupea harengus) and European sprat (Sprattus sprattus), both present in the CN OWF area, are among the most noise-sensitive species, with peak sensitivity around 100 Hz within a hearing range from several dozen Hz to 3–4 kHz (Andersson, 2011). In contrast, Atlantic cod (Gadus morhua) primarily detects sounds above 500 Hz. Fish typically respond behaviourally to noise during construction or installation activities: for example, Boyle and New (2018) found that some species react to pile-driving noise at distances of up to 15.4 km by leaving the area, though many species show no or more localized responses. The potential impact is therefore greatest for large Baltic cod (if present) and pelagic fish species during pile driving. However, these effects are expected to be short-term, as fish are likely to return to feeding areas once installation is complete, resulting in only minor long-term impacts.
- **Impact of suspended sediments and particulate matter during construction.** Excavation and drilling activities can lead to increased water turbidity and higher concentrations of suspended sediments in the water column. This primarily affects fish larvae and juveniles, which are particularly vulnerable during these developmental stages. Turbidity can not only disrupt fish feeding in the area but may also affect fish spawning grounds. However, suspended sediment particles persist in the water for a relatively short time, with the extent of turbidity depending on the type of sediment and water currents. Considering the short duration of this impact, its localized nature, and the fact that fish spawning grounds in the EEZ are concentrated in the coastal zone where OWF installation is not planned, it can be concluded that this impact will be minimal. Some studies (Meager, Batty, 2007; Scott, 2006) suggest that during cable installation, water turbidity may attract potential predators (such as Atlantic cod and European flounder), which take advantage of the conditions to hunt plankton-feeding juvenile fish.
- **Impact of foundation structures on habitats.** The installation of OWF foundations will result in the partial loss of feeding grounds for benthophagous fish species such as European flounder, Atlantic cod, and

Shorthorn sculpin. However, considering the relatively small footprint of each individual foundation and the considerable spacing between turbines, it is anticipated that the localized negative impact on the benthic food base will be minor and ecologically insignificant.

In contrast, the introduction of hard substrates associated with OWF infrastructure is expected to foster an increase in organisms adapted to hard bottom, as the new structures provide favourable conditions for colonization. This process is likely to have a beneficial effect on the fish community by creating additional habitats and enhancing the availability of prey species. Research by Andersson et al. (2009), Stenberg et al. (2015), and Methratta and Dardick (2019) has demonstrated the positive long-term influence of OWF on fish community structure and species abundance. The new underwater structures are likely to serve as artificial reefs, offering shelter and refuge to various fish species. Such features may attract fish that actively utilize complex habitats for protection and foraging. As a result, during the operational phase of the OWF, an increase in both the diversity and abundance of fish species in the area is expected.

- **Noise and vibration generated by WTGs and OWF service vessels.** Fish exposure to operational noise from OWF mechanisms varies depending on species sensitivity and proximity to the noise source. While the stress responses of fish to such noise are not yet fully understood, potential effects cannot be disregarded, as low-frequency sounds fall within the hearing range of most fish species. The noise levels generated by OWFs are comparable to those produced by large cargo vessels (Tougaard et al., 2009). Studies on Atlantic salmon and Atlantic cod indicate that these species can detect OWF noise at distances of approximately 0.4 km and 13 km, respectively, under wind speeds of 8 m/s (Westerberg, 2005). Additionally, avoidance behaviour has been observed within a 4-meter radius of the wind turbines when wind speeds exceed 13 m/s (Wahlberg and Westerberg, 2005).
- Substrate-borne vibrations generated by WTG foundations propagate through the seabed and may affect benthic and demersal fish by altering local habitat conditions or masking substrate-coupled acoustic cues. While there is currently no evidence that such vibrations cause large-scale habitat displacement or degradation of critical feeding grounds, their potential to influence fish behaviour (e.g., avoidance or altered foraging) at local scales must be taken into consideration. Overall, the anticipated long-term impact of operational noise and vibration on fish populations is assessed as minor, though site-specific effects, particularly for low-mobility benthic species, remain uncertain due to limited empirical data.
- **Impact of electromagnetic fields.** AC in subsea electric cables generates electromagnetic fields, which are believed to potentially interfere with fish migration by disrupting their ability to detect the Earth's magnetic field (Gill et al., 2012) or by affecting species that rely on electromagnetic cues to locate prey (Gill, 2005). However, experimental studies on eel migrations off the Swedish coast (Westerberg & Lagenfelt, 2008) have not demonstrated any significant impact of electromagnetic fields from submarine cables on eel behaviour or swimming patterns. Similarly, research by Bochert and Zettler (2004) on juvenile European flounder indicated no adverse effects on fish development. Overall, most studies suggest that under typical conditions, the influence of electromagnetic fields on fish is minimal or negligible (Öhman et al., 2007; Gill & Bartlett, 2010; Normandeau et al., 2011). Nevertheless, as the number of OWF in the Baltic Sea increases, the potential cumulative effects of multiple subsea power cables on fish populations should be considered in future assessments.

Based on underwater noise monitoring data, a significant impact of anthropogenic noise has been identified – the SPL levels of anthropogenic noise consistently exceed the hearing threshold of clupeid fish, which is approximately 75–80 dB re 1 µPa at frequencies below 1,000 Hz (Enger, 1967; Andersson, 2011). This indicates that nearly all anthropogenic activities are detectable by noise-sensitive fish species.

Based on the modelling results (see section 5.4.5.1.2), if noise mitigation measures were not applied, a significant impact would be observed on the species most sensitive to noise – Atlantic herring (*Clupea harengus*), European sprat (*Sprattus sprattus*), and twaite shad (*Alosa fallax*). These fish species are particularly sensitive to low-frequency noise, ranging from several tens of Hz to 3–4 kHz, with peak sensitivity around 100 Hz, which means their impact zone would be relatively large. Underwater noise modelling results indicate that during pile driving, cumulative noise exposure may cause TTS up to a distance of 55,000 m, and PTS up to 5,200 meters.

Twaite shad is the largest clupeid fish species found in the planned OWF area. Due to its relatively larger swim bladder, this species is predicted to be the most sensitive to noise impacts during OWF construction. However, scientific trawl survey data show that only young, immature individuals weighing 25–100 g were caught, for which the noise impact is relatively lower and comparable to the impact level observed in Atlantic herring in the same area.

If underwater noise mitigation measures are not applied, the hearing abilities of these fish species could be impaired, potentially reducing their ability to avoid predators, disrupting intraspecific communication and schooling behaviour, and impairing their capacity to effectively navigate their environment. All these factors could lower their survival rates and have long-term effects on population dynamics and overall survival. Additionally, other species with large swim bladders, such as Atlantic cod (*Gadus morhua*), may also experience negative impacts, although their hearing sensitivity above 500 Hz is limited. Due to this sensitivity to noise, cod may actively move away from the impact zone.

Table 5.4.48. Estimated impact distances for swim-bladdered fish

Negative effect	Threshold $SEL_{unweighted}$ [dB re 1 μPa^2s]	Maximum distance RMAX (km)							
		Unmitigated		DBBC		HSD		DBBC + HSD	
		winter	summer	winter	summer	winter	summer	winter	summer
PTS (single strike)	203	-	-	-	-				
PTS (5.81h cum.)		5.5	5.1	0.74	0.92	2.01	1.82	0.33	
TTS (single strike)	186	0.24	0.21	-	-				
TTS (5.81h cum.)		64.1	24.3	7.9	6.73	14.2	9.93	4.1	3.64
Behavioural reaction BR (single strike)	135	190.0	112.0	32.8	18.0	92.0	33.4	15.2	10.8

During the operational phase, a positive impact on fish populations is expected due to the formation of secondary habitats on the wind farm foundations. Avoidance behaviour has been observed only within a few meters of operating turbines and only at high wind speeds (Wahlberg and Westerberg, 2005), so during the operation period, the effect on fish populations may even be beneficial due to the creation of artificial reef habitats. Once the installation or decommissioning works are completed, fish are expected to return to their feeding grounds, making the impact temporary.

During the decommissioning phase, the primary noise sources are associated with foundation removal, dismantling of above-water structures, and intensified vessel traffic within the project area. Foundation removal, particularly when foundations are extracted, can generate intense impulsive underwater noise comparable to that produced during pile driving. Alternatively, cutting foundations below the waterline results in lower noise levels, although over a longer duration. Dismantling above-water structures mainly involves crane operations and metal cutting, which primarily generate airborne noise and are therefore expected to have a limited impact on marine fauna. In addition, increased vessel activity contributes to continuous low-frequency noise (50–300 Hz), which may affect fish species sensitive to such acoustic disturbances.

5.4.6.5 Preventive, mitigation, and compensation measures to address impacts on Baltic Sea fish populations

To minimize the impact on fish resources, mitigation measures should be applied during the construction and decommissioning periods. The proposed measures during these periods are like those applied for the protection of marine mammals.

The results of underwater noise propagation modelling for fish species with specialized hearing adaptations (see Table 5.4.48) demonstrated that the use of a DBBC and the HSD pile-driving noise suppression system during MP installation significantly reduces noise impact:

- The single-strike SELs remain below hearing threshold values that cause TTS or hearing damage, while behavioural responses may be observed at distances ranging from 10.8 to 15.2 km.
- Under cumulative exposure conditions, the impact is reduced by over tenfold, with PTS potentially occurring within a radius of 0.33 to 0.42 km.

Recently, this method has often been combined with the use of Acoustic Deterrent Devices (ADDs) for marine mammal deterrence, helping to avoid sudden acoustic stimuli that could cause injury to fish.

During the operational phase, a positive impact on fish populations is expected due to the formation of secondary habitats on the wind farm foundations. Avoidance behaviour has been observed only within a few meters of operating WTGs and only at high wind speeds (Wahlberg and Westerberg, 2005), so during the operation period, the effect on fish populations may even be beneficial due to the creation of artificial reef habitats. Once the installation or decommissioning works are completed, fish are expected to return to their feeding grounds, making the impact temporary.

During the decommissioning phase, high-intensity underwater noise may be generated. Therefore, it is essential to apply underwater noise mitigation measures to protect fish from potential hearing loss or threshold shifts, particularly due to impulsive noise. To reduce the impact of underwater noise during OWF decommissioning, the following measures should be implemented:

- Gradual ramp-up of noise (soft-start) – applying this measure during decommissioning allows for a gradual increase in noise levels, giving fish an opportunity to move away from the noisy work area. Recently, this method has often been combined with the use of ADDs for marine mammal deterrence, helping to avoid sudden acoustic stimuli that could cause injury to fish.
- Use of low-noise monopile cutting technologies – during the decommissioning of OWF structures, methods such as diamond wire saw cutting can be applied as an alternative to high-impact techniques like blasting. These approaches substantially reduce underwater noise generation, thereby minimizing potential impacts on marine mammals and fish habitats.

While conducting fish and benthic community monitoring during the operational phase, if it is determined that the newly formed secondary habitats have a significant positive effect, it is recommended to partially leave the monopiles in place by cutting them at 1–2 m above the seabed, or to apply compensatory measures during the decommissioning phase of the OWF. Such measures would include the installation of artificial habitats of equivalent area, using 0.1–1 m boulder placed near the decommissioned foundations. These habitats should be installed within a maximum distance of 50 m from the dismantled WTGs and should be established no later than two years after the decommissioning date. Specific measures will be identified and selected during the planning phase of the OWF decommissioning.

Table 5.4.49. Summary of potential impact of the OWF on Baltic Sea fish and mitigation measures

Stages	Activities	Impact	Type	Scale	Duration	Significance	Mitigation Measures
Construction	Installation of underwater structures: OWF foundations and electrical cables	Increased turbidity	Negative direct impact on fish feeding and respiration	Localised (within the OWF area)	Short-term (likely only during construction works)	Negligible impact	Not applicable.
		Physical destruction of benthic habitats	Negative indirect impact due to the destruction of benthic habitats used by benthivores fish for foraging in areas where foundations are installed	Localised (at the footprint of individual WTGs foundations)	Short-term (due to the small affected area, habitats are expected to recover quickly)	Negligible impact	Not applicable.
		Noise and vibration	Negative direct impact from fish being displaced from the OWF construction area or alteration of migratory routes for diadromous species	Localised for most species around the OWF installation site; for others – those inhabiting the pelagic zone or possessing large, well-developed swim bladders – up to a distance of 15 km	Short-term (likely only during construction works)	Moderate impact	Use of deterrent methods or impulsive noise mitigation measures during piling operations.
Operation and Maintenance	Movement and anchoring of maintenance vessels	Disturbance	Negative direct impact as vessel movements may disturb and displace fish	Localised (restricted to vessel navigation routes)	Short-term (limited to maintenance activities)	Negligible impact	Not applicable.
	Presence of underwater structures	Noise and vibration	Negative direct impact as fish are sensitive to underwater noise	Localised (in small, discrete areas around individual WTGs)		Negligible, as it will not alter fish abundance or distribution within the OWF boundaries	Not applicable.
		Long-term (lasting until the end of the OWF operational phase)	Negative direct impact on sensitive fish species, including migratory species and fish in early developmental stages	Localised (around cables)	Long-term (lasting until the end of the OWF operational phase)	Minor impact in the Baltic Sea coastal zone, where the upstream migration of river lamprey (a species possessing	Installation of submarine power cables at a burial depth of at least 3 m to minimize electromagnetic field exposure.

Stages	Activities	Impact	Type	Scale	Duration	Significance	Mitigation Measures
						electroreceptive capabilities) potentially occurs.	
		Formation of secondary habitats	Positive indirect impact through the increase of potential food sources, shelter availability, and formation of new spawning and feeding habitats	Localised (within the OWF area)	Long-term (lasting until the end of the OWF operational phase)	Positive impact: a slight increase in the abundance of certain fish species and fish stocks.	Not applicable.
Decommissioning	Dismantling of structures	Increased turbidity	Negative direct impact on fish feeding and respiration	Localised (within the OWF area)	Short-term (likely only during the decommissioning works)	Negligible, as it will not affect fish abundance or distribution within the OWF	Not applicable.
		Noise and vibration	Negative direct impact due to fish being displaced from the decommissioning site of the OWF	Localised (at the decommissioned WTGs foundations)	Short-term (likely only during the decommissioning works)	Negligible impact	Not applicable.
		Recovery of primary benthic habitats	Positive indirect impact from the restoration of conditions suitable for original habitats, allowing recovery of benthic areas important for benthivores fish foraging	Localised (at the decommissioned WTGs foundations)	Long-term (duration not dependent on the assessed activity)	Negligible, as it will not impact the condition of natural benthic habitats	Not applicable.
		Destruction of formed secondary habitats	Negative indirect impact due to a reduction of artificial reef and available feeding or spawning grounds	Localised (foundations)	Long-term (hard substrate will be removed and the established epifaunal community destroyed)	Minor impact – destruction of habitats of non-natural origin	If foundations have been fully removed – restoration of equivalent habitat area in adjacent locations using boulders of various diameters (0.1–1 m), once valuable fish communities have formed.

Colour code

(green)	Positive impact
(light blue)	No impact or impact insignificant (not to be considered, no measures are applicable)
(blue)	Minor impact: decisions during design, preventive or mitigation measures
(light orange)	Moderate impact: addressed by mitigation measures
(orange)	Significant impact: mitigation and/or compensation measures are necessary.

5.4.7. Hydrobionts / Fish of inland waters of Lithuania

5.4.7.1. Survey methods

5.4.7.1.1. Methods for assessing the current state

The assessment of the current ichthyofauna status for the EIA report drew upon studies completed in 2022. These investigations, undertaken by researchers from the Nature Research Centre, Klaipėda University, and the Lithuanian Hydrobiologists' Society, focused on determining the ecological status of inland water bodies through the analysis of fish community composition.

Fish species composition, abundance, and biomass surveys in Lithuanian rivers are conducted using electrofishing, following the sampling strategy outlined in the CEN standard (CEN (2003) Water Quality – Sampling of Fish with Electricity, EN 14011, European Committee for Standardization, Brussels). The surveys adhere to the "Methodology for Fish Stock Research," as specified in the annex to the "Procedure for Fish Stock Research in Inland Waters," approved by the Minister of Environment of the Republic of Lithuania by the Order No. D1-767, September 25, 2012. Captured fish are placed in aerated water containers, identified to species level, and measured for total length (cm) and weight (g). After data collection, all fish are released back into the same waterbody from which they were caught.

Information about invasive species is provided based on data from the Invasive Species Information System (https://inva.biip.lt/).

5.4.7.1.2. Methods for assessing potential impacts

The assessment of the potential impact on the river ecosystem was carried out using an integrated methodological approach, which includes an analysis of the current ecological status and identification of vulnerable components. In evaluating the impact, consideration is given to the nature, duration, and seasonality of the planned works, as well as the distance to sensitive habitats such as spawning grounds or habitats of protected species. The significance and scale of the impact on areas located downstream from the planned activity site are also examined.

5.4.7.2. Survey area

The EIA area encompasses the Šventoji and Kulšė rivers, which will be intersected by the export cable corridors.

5.4.7.3. Current state

The lower reaches of the Šventoji River in the Baltic region serve as migration and spawning grounds for anadromous fish species, including salmon (*Salmo salar*), sea trout (*Salmo trutta trutta*), and river lamprey (*Lampetra fluviatilis*). Additionally, the river supports other rare and protected species such as the brook lamprey (*Lampetra planeri*), Ukrainian brook lamprey (*Eudontomyzon mariae*), European bullhead (*Cottus gobio*), bitterling (*Rhodeus sericeus*), and spined loach (*Cobitis taenia*). These species contribute to the river's rich biodiversity and emphasise its ecological significance.

According to electrofishing surveys conducted in 2022, a total of 11 fish species were recorded in the middle reaches of the Šventoji River. In terms of abundance, the dominant species in the community were the roach (*Rutilus rutilus*) and the bitterling (*Rhodeus sericeus*), while the northern pike (*Esox lucius*) was also among the dominant species in terms of biomass. Other fish species recorded in this section of the river include the bleak (*Alburnus alburnus*), stone loach (*Barbatula barbatula*), spined loach (*Cobitis taenia*), gudgeon (*Gobio gobio*), sunbleak (*Leucaspius delineatus*), European perch (*Perca fluviatilis*), Eurasian minnow (*Phoxinus phoxinus*), and rudd (*Scardinius erythrophthalmus*).

The export cable corridors will also cross the Kulšė River, a tributary of the Šventoji River. The remaining natural, unchanneled section of this river is vital for sea trout spawning. Periodic national salmonid fish monitoring reports high or very high densities of sea trout parr in this area. The river also hosts typical species found in small streams, including the stone loach (*Barbatula barbatula*), the Eurasian minnow (*Phoxinus phoxinus*), and the gudgeon (*Gobio gobio*).

Among the anadromous fish species present in Lithuanian waters, only the Twaite shad (*Alosa fallax*) and the European smelt (*Osmerus eperlanus*) were recorded within the PEA area. However, scientific trawling data indicate that these species were observed in low numbers both within the PEA area and in adjacent regions. Based on their occurrence and relative abundance in the fish community, both the European smelt and the Twaite shad are classified as accidental species. The migration of European smelt (*Osmerus eperlanus*) into the Curonian Lagoon occurs between November and March and prespawn schools primarily aggregate north of the Klaipėda Strait at depths of 6–40 m. The dominance of this species in the coastal fish community next to Šventoji in February 2024 further supports the periodic schooling and migration of smelt along the Baltic Sea coastline.

5.4.7.3.1. Invasive species

In the Šventoji River basin, the invasive fish species round goby (*Neogobius melanostomus*) is present exclusively at the river mouth. No other invasive fish species have been documented within the basin. However, other invasive aquatic organisms have been identified, including the signal crayfish (*Pacifastacus leniusculus*), the Ponto-Caspian amphipod (*Pontogammarus robustoides)*, the Ponto-Caspian mysid shrimp (*Paramysis lacustris*), and the American mink (*Neovison vison*).

5.4.7.4. Potential impact to inland waters fish communities

Laying connection cables via open trenching across rivers can significantly increase water turbidity and noise levels, negatively impacting sensitive aquatic species. During operation, the cables could create physical barriers due to fish electroreception, disrupting their natural orientation, which is particularly critical during migration periods.

Among the anadromous fish species present in Lithuanian waters, only the Twaite shad (*Alosa fallax*) and the European smelt (*Osmerus eperlanus*) were recorded within the PEA area. During the construction of the OWF, it is likely that the migration routes of these fish could be altered, or localized aggregations could form due to environmental disturbances associated with construction activities, such as increased water turbidity or underwater noise. However, due to their low presence and relative abundance in the CN OWF, the impact on these species is considered negligible.

Based on commercial fishery catches in the coastal zone and the Šventoji River, river lampreys (*Lampetra fluviatilis*) exhibit active spawning migration from coastal waters to rivers during the autumn months, particularly from October to December. Unlike most anadromous fish species, river lampreys do not return to their natal rivers for spawning but instead select the first suitable river encountered during migration. This behaviour suggests a broad dispersal strategy that may influence population connectivity and genetic diversity.

Since river lampreys (*Lampetra fluviatilis*) possess electroreception, a strong electromagnetic field source could act as a physical barrier, potentially disrupting their migration and leading to population fragmentation. The most significant impact is likely to occur during their accumulation in the coastal zone and the peak of their active migration into rivers.

The primary environmental risk associated with HDD is the inadvertent release of drilling fluid, which may occur if fractures develop in the subsurface during drilling operations. Such releases may introduce drilling fluid additives – such as sodium hydroxide (for pH regulation), synthetic oils (for lubrication), and polyamine-based granulation inhibitors – into the aquatic environment, some of which can pose risks to aquatic ecosystems. Localized deposition of these fluids on the riverbed could smother benthic communities and degrade habitats important for fish spawning and feeding. While these events are generally limited in scale and duration, larger uncontrolled discharges could adversely affect sensitive downstream habitats, including known spawning grounds for river lamprey *(Lampetra fluviatilis*) and salmonid species located approximately 2–2.5 km from the crossing site. Planned mitigation measures, such as continuous monitoring during drilling operations and the implementation of emergency response procedures, are expected to substantially reduce the likelihood and severity of such incidents.

Noise emissions from HDD are generally limited to the immediate vicinity of the drilling site and are of relatively low intensity compared to other in-water construction techniques. Therefore, significant behavioural disturbances to fish or other sensitive aquatic fauna, particularly during migration or spawning periods, are unlikely.

Overall, the use of HDD is anticipated to cause only short-term, highly localized effects on aquatic habitats, with no long-term or large-scale impacts expected when proper monitoring and mitigation measures are implemented.

Across the significantly smaller the Kulšė river and diches the interconnector cables are planned to be installed using open-cut method. This approach, involving dredging and bank erosion, may lead to increased sediment runoff and temporary reduce water clarity. Such impacts can negatively affect local fish and benthic invertebrate communities.

5.4.7.5. Preventive, mitigation, and compensatory measures

At the Šventoji River crossing, the project will adopt a trenchless method (HDD or similar). This method eliminates the need for in-stream excavation, thereby preventing direct disturbance to the riverbed and banks. Consequently, the risk of increased sedimentation, elevated turbidity, and potential degradation of fish spawning habitats and macroinvertebrate communities is effectively avoided. The use of HDD will also ensure that the river's hydromorphological conditions and ecological functions remain largely intact throughout the construction process. The primary potential impact on fish is associated with the release of drilling fluid additives into the water. To minimize environmental risks, it is recommended to use alternative or natural additives with minimal impact on protected areas, even in the event of a spill.

Some of fish and other aquatic organisms are sensitive to vibrations that may arise from the HDD technology. To prevent potential "migration barrier" effects, cable installation should be avoided during the active migration and spawning periods of salmonid fish and river lampreys (*Lampetra fluviatilis*).

The most sensitive periods for migratory fish in the Šventoji River and its tributaries are as follows:

- For salmonid fish: October 1 to January 15.
- For river lampreys (*Lampetra fluviatilis*): April 1 to May 15.

The cables across the Kulšė River will be installed using an open trench method. To minimize impacts on fish communities, construction should be carried out during periods of least intense fish migration. Additionally, sediment dispersion mitigation measures, such as sediment retention screens or other technologies to reduce sediment washout and water turbidity, are recommended.

Table 5.4.50. Summary of potential impacts of the construction of the OWF export cables onshore on inland fish and mitigation measures

Stages	Activities	Impact	Type	Scale	Duration	Significance	Mitigation Measures
Construction	Connection cable laying through surface water bodies	Increase of turbidity	Negative direct effects on fish nutrition and fish respiration	Local. Cable trenches at the excavation site and downstream	Short-term (only available during installation work)	Insignificant	At the intersection of the connection cable with the Šventoji River, a closed cable installation method is applied without digging the riverbed in an open way. At other intersections with the cable route, measures to reduce the turbidity must be applied.
		Physical destruction of bottom habitats	Negative direct impact: aquatic invertebrate and plant communities at the trench site will be destroyed, i. e. potential fish hiding places and food sources.	Local. Cable trenches at the excavation site	Short-term (due to the small area damaged, the habitat recovers quickly)	Insignificant	At the intersection of the connection cable with the Šventoji River, a closed cable installation method is used without excavating the riverbed in an open manner.
		Noise and vibration	Negative direct impact, fish will be scared away from the construction site or migration routes of passing fish will be changed	Local. Cable trenches at the excavation site	Short-term (only available during installation work)	Minor impact	At the intersection of the connecting cable with the Šventoji River, a closed cable installation method is used without excavating the riverbed in an open way. Cable laying work should not be carried out during periods sensitive to passing fish.

Stages	Activities	Impact	Type	Scale	Duration	Significance	Mitigation Measures
Operation and maintenance	Presence of underwater constructions	Electromagnetic fields	Direct adverse effects on sensitive fish (migratory fish and fish in early developmental stages)	Local (around electrical cables)	Long-term (will last until the end of the wind farm's operation)	Insignificant, as it will not change the behaviour and nature of fish migrations	At the intersection of the connection cable with the Šventoji River, the cable must be buried at least 3 m.
	Cable repair work	Increase of turbidity /Scaring of fish	Negative direct effects on fish nutrition and fish respiration	Local. Cable trenches at the excavation site and downstream	Short-term (only available during installation work)	Insignificant	Measures to reduce the turbidity must be applied.
		Noise and vibration	Negative direct impact, fish will be scared away from the construction site or migration routes of passing fish will be changed	Local. Cable trenches at the excavation site	Short-term (only available during installation work)	Minor impact	Do not carry out work during periods sensitive to passing fish.
Decommissioning	Dismantling of structures	Increase of turbidity	Negative direct effects on fish nutrition and fish respiration	Local. Cable trenches at the excavation site	Short-term (only available during installation work)	Not significant as it will not change the abundance and distribution of fish in inland water bodies	Avoid carrying out work during periods sensitive to passing fish. During decommissioning, measures to reduce the spread of debris must be applied.
		Noise and vibration	Negative direct impact, as fish will be scared away from the site of decommissioning works	Local. Cable trenches at the excavation site	Short-term (only available during installation work)	Insignificant	Avoid carrying out work during periods sensitive to passing fish.

Stages	Activities	Impact	Type	Scale	Duration	Significance	Mitigation Measures
		Re-destruction of restored benthic habitats	Positive indirect impact, as conditions will be restored for the original habitats suitable for benthic fish foraging	Local. Cable trenches at the excavation site	Long-term (will last until the end of the wind farm's operation)	Not significant as it will not affect the condition of natural bottom habitats	Not applicable.

Colour code

	Positive impact
	No impact or negligible impact – can be disregarded; no measures required.
	Minor impact – addressed during the design phase through preventive and/or mitigation measures.
	Moderate impact – to be managed with targeted mitigation measures.
	Significant impact – requires the implementation of mitigation and, if necessary, compensation measures.

5.4.8. Vegetation and habitats onshore

Onshore, the export corridors are planned in the conceptual solutions of the Engineering Infrastructure Development Plan, which has been subject to a SEIA. The selection of the optimal export cable routes has already taken into account the existing use of the environment and adjacencies, existing protected and “Natura 2000” sites, forests, wetlands and other naturally sensitive and important areas, as well as biodiversity data available in the Protected Species Information System (hereinafter – SRIS) and other available data. The EIA report details the biodiversity present along the routes of the interconnections and in the vicinity and assesses the potential significant effects on it.

5.4.8.1. Survey methods

5.4.8.1.1. Methods for assessing the current state

In early June 2024, vegetation surveys were carried out in the area planned for the export cable corridors (on non-forest land). In the vicinity of the planned export cable route, from the shoreline to the 330 kV substation Darbėnai, 13 survey sites (Fig. 5.4.98) were selected in the buffer zone (200 m on either side of the export cable route) in order to assess the different types of vegetation in the buffer zone (200 m on either side of the export cable route), reflecting the different vegetation types typical of the study area. A representative site was selected and a 10x10 m^2 area used to identify the dominant plant species. Based on the dominants, the habitat type was determined according to the EUNIS classification.

Information on habitats of EC importance is available from the www.geoportal.lt/map dataset Habitats of European Community importance. Information on forests is available from the Forest Cadastre dataset www.geoportal.lt/map. Information on natural grasslands and pastures, wetlands and spring-fed wetlands is available from the www.geoportal.lt/map dataset Areas of natural grasslands and pastures, wetlands and spring-fed wetlands for which special land use conditions are established.

Information on invasive plant species is provided based on data from the Invasive Species Information System (https://inva.biip.lt/). The population of the closest invasive species to the export cable route (*Canadian goldenrod*) was assessed during field surveys in early June 2024 to determine the area covered by the population.

Information on protected plantations is based on data from the SLUC database (data as of 01/01/2018). The survey of the area of protected plantations was carried out in June 2024 and January 2025.

5.4.8.1.2. Methods for assessing potential impacts

A vegetation and habitat vulnerability analysis has been carried out to assess potential impacts on vegetation and habitats (outside forest land). Impacts on grassland ecosystems were assessed based on the type of habitats identified as vulnerable (plant species identified) and the area of disturbed sites, calculated from the length and width of the connection routes in the habitat to be crossed.

The conclusion on the assessment of potential impacts and the potential for recovery of vegetation and habitats is based on an analysis of scientific studies presented in scientific articles (Weber et al. (2016), Klimkowska et al. (2007), Kiehl et al. (2010)) and on an expert assessment.

5.4.8.2. Study area

In terms of natural habitats, the study area is heterogeneous: up to Būtingė, the cable routes are planned to pass through partially naturalised meadows and pastures (Fig. 5.4.98). Further on, the interconnector cable routes are planned to pass through the forests of Būtingė and Laukžemė (Figure 5.4.99), and beyond these forests, the routes will cross agricultural areas sown with crops (Fig. 5.4.100). In grassland and pasture habitats, 8 survey sites were selected, and in areas of intensive agricultural activity 5 survey sites were selected. The geographical coordinates of the vegetation survey sites are given in Table 5.4.51 and the location in relation to the cable routes in Fig. 5.4.98 to 5.4.100. The survey area – buffer zones of the interconnector cable routes – 200 m on either side of each route.

Table 5.4.51. Vegetation survey sites

Survey site No.	Coordinates WGS84	
	Longitude	Latitude
1	21° 04' 26.17''	56° 04' 09.17''
2	21° 04' 23.80''	56° 03' 56.89''
3	21° 04' 34.71''	56° 04' 03.29''
4	21° 04' 47.46''	56° 04' 11.58''

Survey site No.	Coordinates WGS84	
	Longitude	Latitude
5	21° 04' 56.13"	56° 04' 08.96"
6	21° 05' 11.98"	56° 04' 07.32"
7	21° 05' 45.49"	56° 04' 15.32"
8	21° 06' 08.69"	56° 04' 16.36"
9	21° 11' 50.84"	56° 03' 43.33"
10	21° 13' 32.68"	56° 03' 49.19"
11	21° 15' 04.83"	56° 04' 19.81"
12	21° 15' 40.66"	56° 05' 00.82"
13	21° 15' 28.40"	56° 05' 03.28"

The vegetation aspects of the planned export cable corridors areas – habitats of European Community importance, natural meadows and pastures as well as areas which has special land-use conditions (natural meadows and pastures, wetlands and spring-fed wetlands), protected plantations and invasive plant species – have been analysed up to a maximum distance of 500 m on either side of each route corridor, and the assessment has been carried out for those habitats that fall within a distance of 200 m on either side of the route corridors.

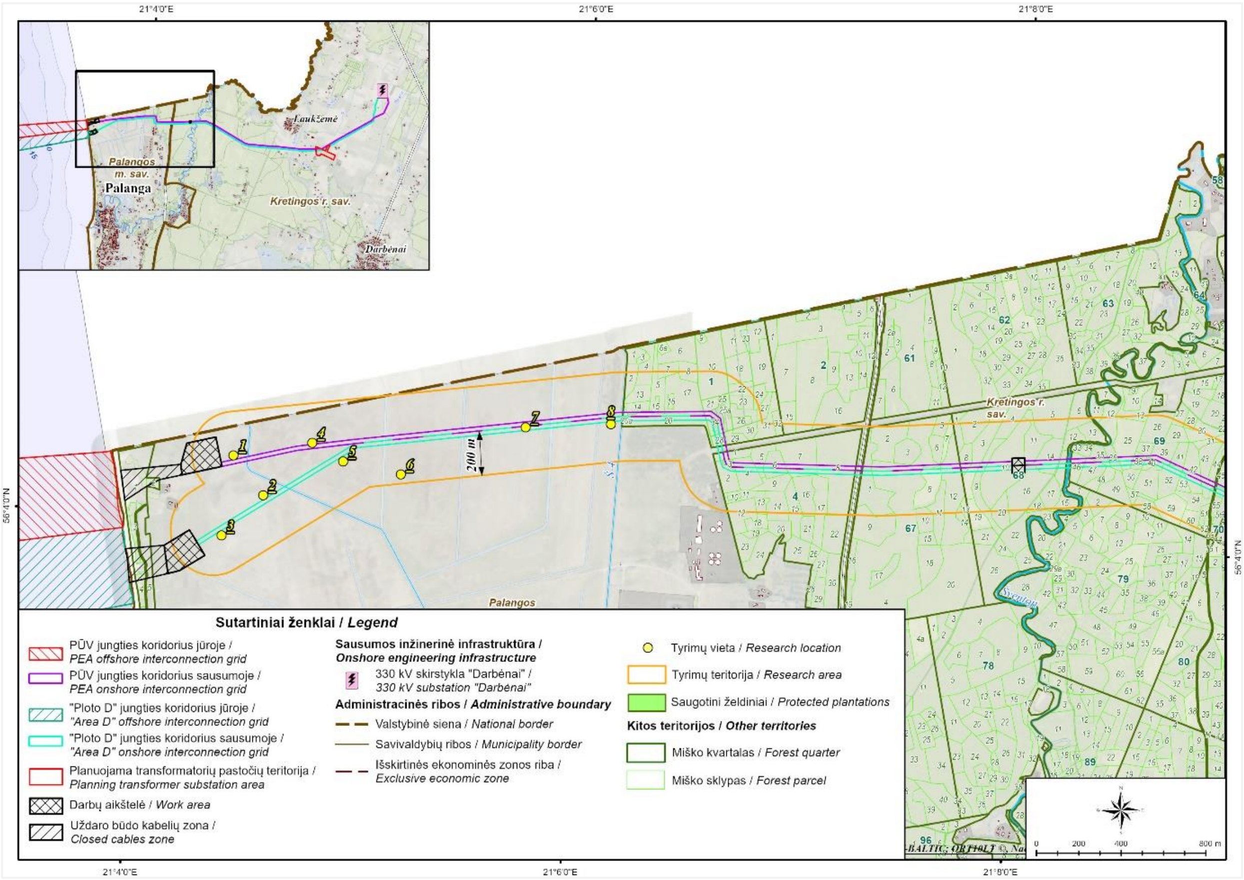


Fig. 5.4.98. Analysis area and vegetation survey sites (1 of 3).

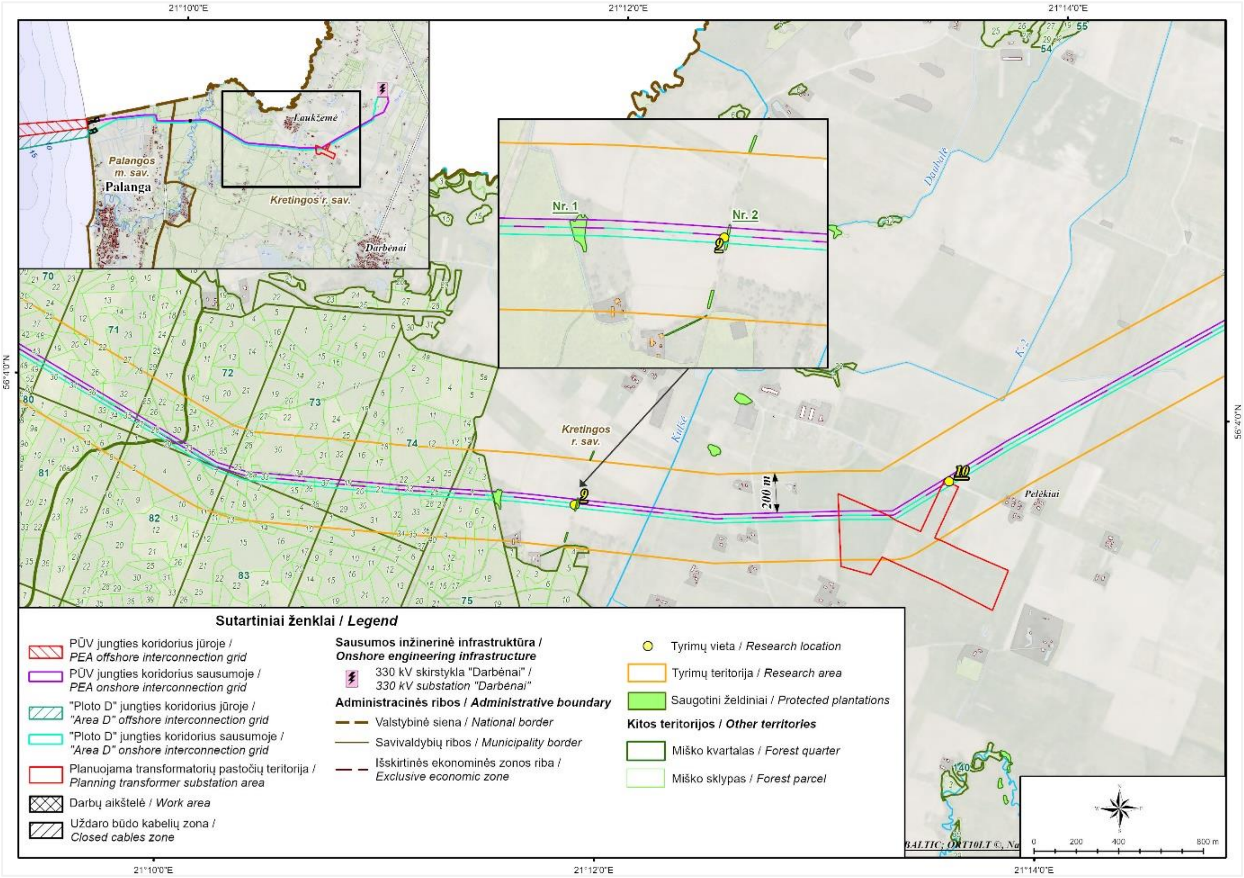


Fig. 5.4.99. Analysis area and vegetation survey sites (2 of 3).

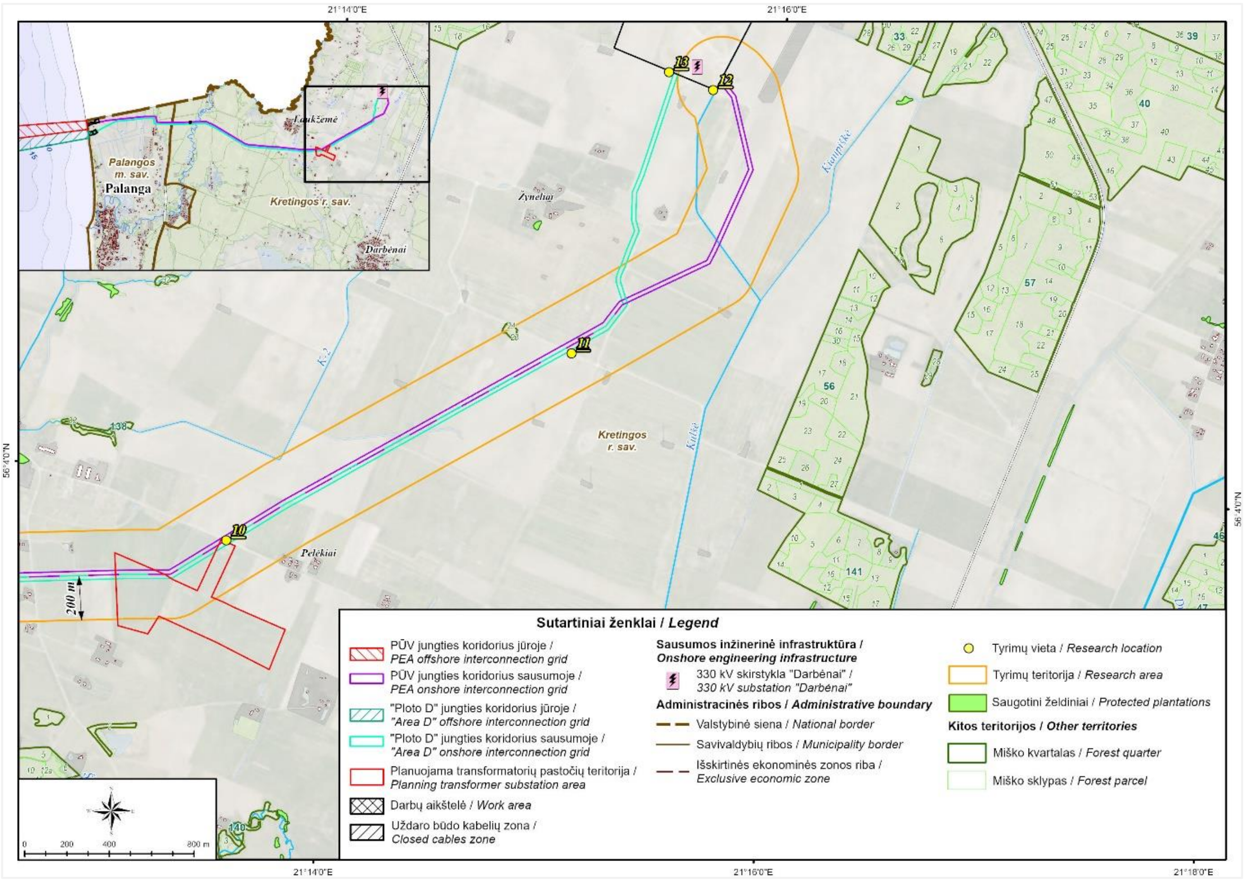


Fig. 5.4.100. Analysis area and vegetation survey sites (3 of 3).

5.4.8.3. Current state

5.4.8.3.1. Vegetation

In non-forested areas, the export cable corridors to and beyond the Būtingė and Laukžemė forests cross agriculture land use areas. In the areas up to Būtingė Forest, grassland habitats consist of wet and damp habitats where stands of reeds and tall sedges can also be found. The areas beyond Laukžemė Forest are predominantly cultivated land with monoculture crop fields.

Information on the habitats found in the vicinity of the planned interconnection routes is provided in Table 5.4.52.

Table 5.4.52. Habitat types, according to the EUNIS classification, crossed by export cable routes (*site identification number)

ID No.*	Plant species detected	EUNIS habitat type
1	Compact Rush (*Juncus conglomeratus*); Common Reed (*Phragmites australis*); Lady's Thumb (*Persicaria maculosa*)	E3.4: Moist or wet eutrophic and mesotrophic grasslands (Annex 2, Figure 1)
2	Cow Parsley (*Anthriscus sylvestris*), Orchard Grass (*Dactylis glomerata*), Meadow Fescue (*Festuca pratensis*), Meadowgrass (*Poa* sp.), Tufted Vetch (*Vicia cracca*)	E2.6: Agriculturally improved, re-seeded and heavily fertilised grassland, including sports fields and grass lawns (Annex 2, Figure 2)
3	Compact Rush (*Juncus conglomeratus*); Yellow Iris (*Iris pseudacorus*)	E3.4: Moist or wet eutrophic and mesotrophic grasslands (Annex 2, Figure 3)
4	Common Reed (*Phragmites australis*); Beaked Sedge (*Carex rostrata*), Yellow Iris (*Iris pseudacorus*); Reed Canary Grass (*Phalaris arundinacea*)	D5.2: Beds of large sedges normally without free-standing water (Annex 2, Figure 4)
5	Common Reed (*Phragmites australis*); Yellow Iris (*Iris pseudacorus*); Acute Sedge (*Carex acuta*); Beaked Sedge (*Carex rostrata*)	D5.2: Beds of large sedges normally without free-standing water (Annex 2, Figure 5)
6	Slender sedge (*Carex acuta*); Beaked Sedge (*Carex rostrata*); Yellow Iris (*Iris pseudacorus*); Common Reed (*Phragmites australis*)	D5.2: Beds of large sedges normally without free-standing water (Annex 2, Figure 6)
7	Scentless Chamomile (*Tripleurospermum perforatum*); Sticky Willy (*Galium aparine*), Compact Rush (*Juncus conglomeratus*); Yellow Iris (*Iris pseudacorus*), Lady's Thumb (*Persicaria maculosa*)	E3.4: Moist or wet eutrophic and mesotrophic grasslands The habitat is degraded, as indicated by the abundant growth of *Tripleurospermum perforatum* and *Persicaria maculosa*, characteristic of wet disturbed soils. In contrast, *Iris pseudacorus, Juncus conglomeratus* grows sparsely (Annex 2, Figure 7).
8	Scentless Chamomile (*Tripleurospermum perforatum*); Wall Speedwell (*Veronica arvensis*), Red Sorrel *(Rumex acetosella*), Dovesfoot geranium (*Geranium mollei*), Bentgrass (*Agrostis sp.*), Shepher's Purse (*Capsella bursa-pastorisi)*, Hop Clever (*Medicago lupulina*); Gray Chickweed (*Cerastium brachypetalum*), White Clover (*Trifolium repens*), Meadow Buttercup (*Ranunculus acris*), Silverweed (*Potentilla anserine*), Orchard Grass (*Dactylis glomerate*), Couch Grass (*Elytrigia repens*), Cow Parsley (*Anthriscus sylvestris*), Common Bugloss *(Anchusa officinalis)*, Canadian horseweed (*Conyza canadensis*), Hoary Alyssum (*Berteroa incana*)	I1.5: Bare tilled, fallow or recently abandoned arable land (Annex 2, Figure 8)
9	Regularly ploughed land, planted with herbaceous crops	I1.1: Intensive unmixed crops
10	Regularly ploughed land, planted with herbaceous crops	I1.1: Intensive unmixed crops
11	Regularly ploughed land, planted with herbaceous crops	I1.1: Intensive unmixed crops

ID No.*	Plant species detected	EUNIS habitat type
12	Regularly ploughed land, planted with herbaceous crops	I1.1: Intensive unmixed crops
13	Regularly ploughed land, planted with herbaceous crops	I1.1: Intensive unmixed crops

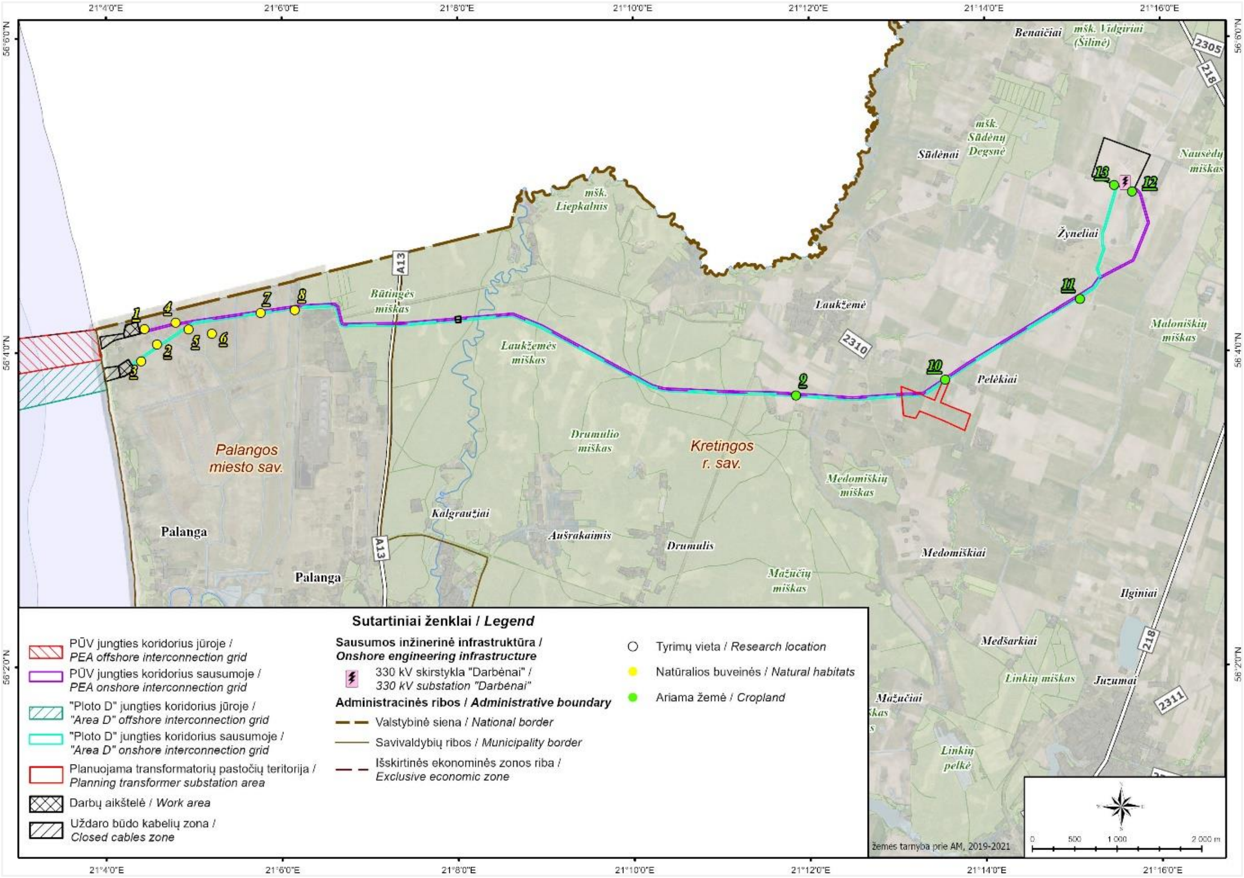


Fig. 5.4.101. Types of habitats identified according to the EUNIS classification.

5.4.8.3.2. Habitats of European Community importance

Coastal sand dunes habitats of EC importance are located approximately 145 m within the PEA onshore export cable corridor (CN OWF export cable corridor) and approximately 63 m from the boundary of the "Area D" onshore export cable corridor (see Table 5.4.53, Fig. 5.4.102). The grassland habitat (6510 Lowland hay meadows) is situated 267 m from the CN OWF onshore export cable corridor and 247 m from the "Area D" OWF's onshore export cable corridor (see Table 5.4.53, Fig. 5.4.106).

In the Darbėnai Forest District, the export cable routes intersect two habitats of type 2180, wooded coastal dunes (see Fig. 5.4.103). The cable route for the CN OWF crosses the first habitat over a stretch of 48 m, with preliminary clearing estimated at 0.0958 ha. The cable route for the "Area D" OWF crosses the first habitat over a stretch of 55 m, with preliminary clearing estimated at 0.1094 ha. The CN OWF export cable route crosses the second wooded coastal dune habitat over a stretch of 103 m, with clearing estimated at 0.1049 ha. The "Area D" OWF route crosses this habitat over 108 m, with preliminary clearing estimated at 0.2161 ha. Both habitats feature predominantly over-mature and middle-aged pines and maturing spruces (see Table 5.4.54).

The forest habitats 9010* Western taiga and 91D0* Bog woodland are located between 5 and 121 m from the PEA onshore export cable corridors (see Table 5.4.53, Fig. 5.4.104 to 5.4.105). These habitats are situated 6 m and 76 m away from the "Area D" onshore export cable corridor (see Fig. 5.4.104, 5.4.106).

Table 5.4.53. Information on habitats of EC importance

ID No.	Habitat	Note
1	2110 Embryonic shifting dunes 2120 White dunes 2130 Grey dunes (see Figure 5.4.102)	Distance from the habitats to the PEA onshore interconnection grid corridor worksite 145 m. Distance from the habitats to the worksite of the “Area D” onshore interconnection grid 63 m
2	2180 Wooded dunes of Atlantic, Continental and Boreal region (see Figure 5.4.103)	The route of the CN OWF onshore export cable corridor crosses 48 meters. Preliminary deforestation area is 0.0958 ha. The route of the “Area D” onshore export cable corridor crosses 55 m. Preliminary deforestation area 0,1094 ha
3	2180 Wooded dunes of Atlantic, Continental and Boreal region (see Figure 5.4.103)	Distance from the habitat to the CN OWF onshore export cable corridor 4 m.
4	2180 Wooded dunes of Atlantic, Continental and Boreal region (see Figure 5.4.103)	The route of the CN OWF onshore export cable corridor crosses 103 m. Preliminary deforestation area 0.1049 ha. The route of the “AreaD” onshore export cable corridor crosses 108 m. Preliminary deforestation area 0.2161 ha
5	9010* Western taiga (see Figure 5.4.104)	Distance from the habitat to the route of the “Area D” onshore export cable corridor 6, 11 m.
6	9010* Western taiga (see Figure 5.4.104)	Distance from the habitat to the CN OWF onshore export cable corridor 5 m and 6 m.
7	91D0* Bog woodland (see Figure 5.4.105)	Distance from the habitat to the CN OWF onshore export cable corridor 121 m.
8	91D0* Bog woodland (see Figure 5.4.105)	Distance from the habitat to the route of the CN OWF onshore export cable corridor 5 m.
9	91D0* Bog woodland (see Figure 5.4.106)	Distance from the habitat to the route of the “Area D” onshore export cable corridor 76 m
10	6510 Lowland hay meadows (see Figure 5.4.106)	Distance from the habitat to the route of the “Area D” onshore export cable corridor 247 m.

Table 5.4.54. Information on forest habitats of EC importance (2180 Wooded dunes of Atlantic, Continental and Boreal region) in Darbėnai Forest District, crossed by export cable corridor corridors

Forest Compartment	Forest Subcompartment	Type of tree	Age of stands	Deforestation area, ha		Forest group
				CN OWF corridor	“Area D” OWF corridor	
67	1	Spruce	Semi-matured	0.0958	0.1094	III. Protective
67	8	Pine	Over-matured	0.0719	0.1900	IV. Commercial
67	12	Pine	Semi-aged	0.0330	0.0261	IV. Commercial
			Total:	**0.2007**	**0.3255**	

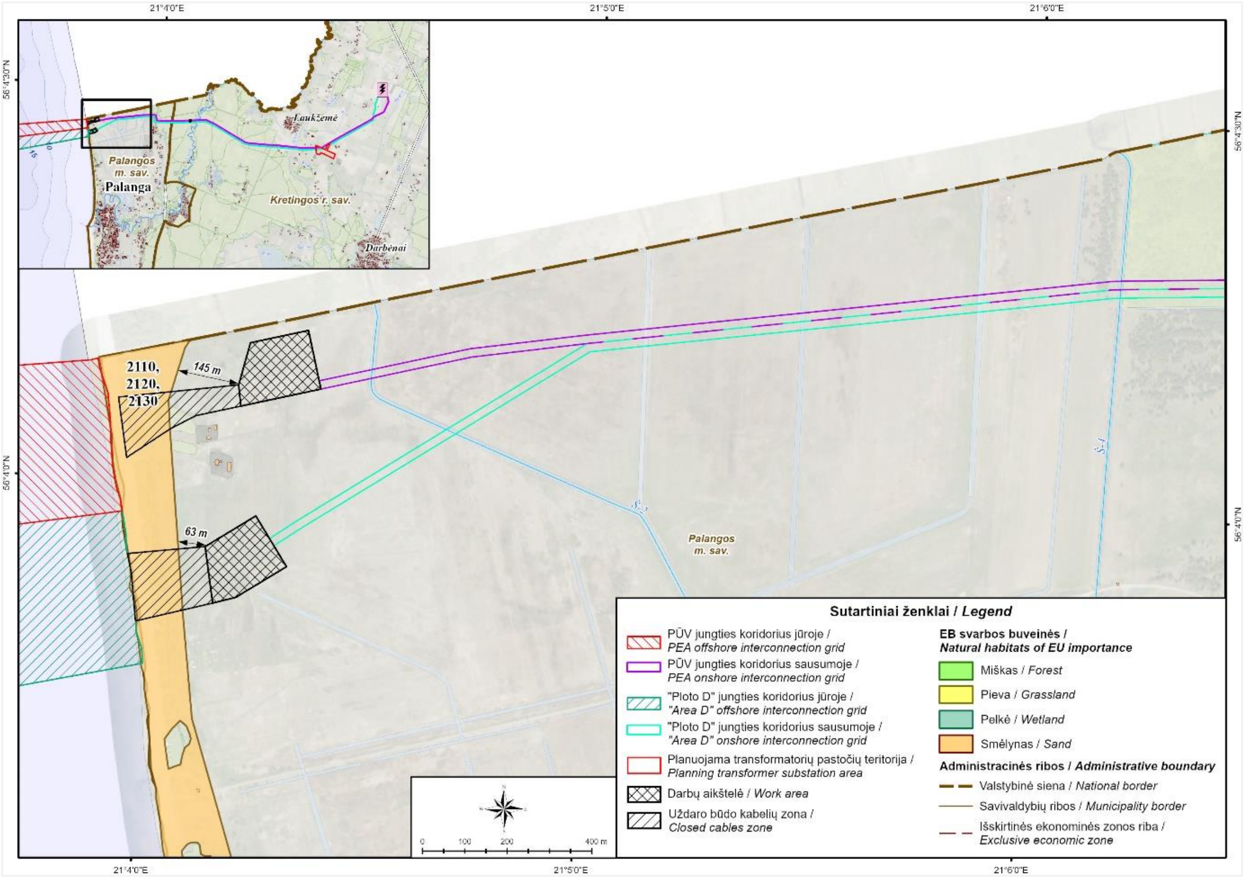


Fig. 5.4.102. Information on natural habitats of European Community importance (1 of 5).

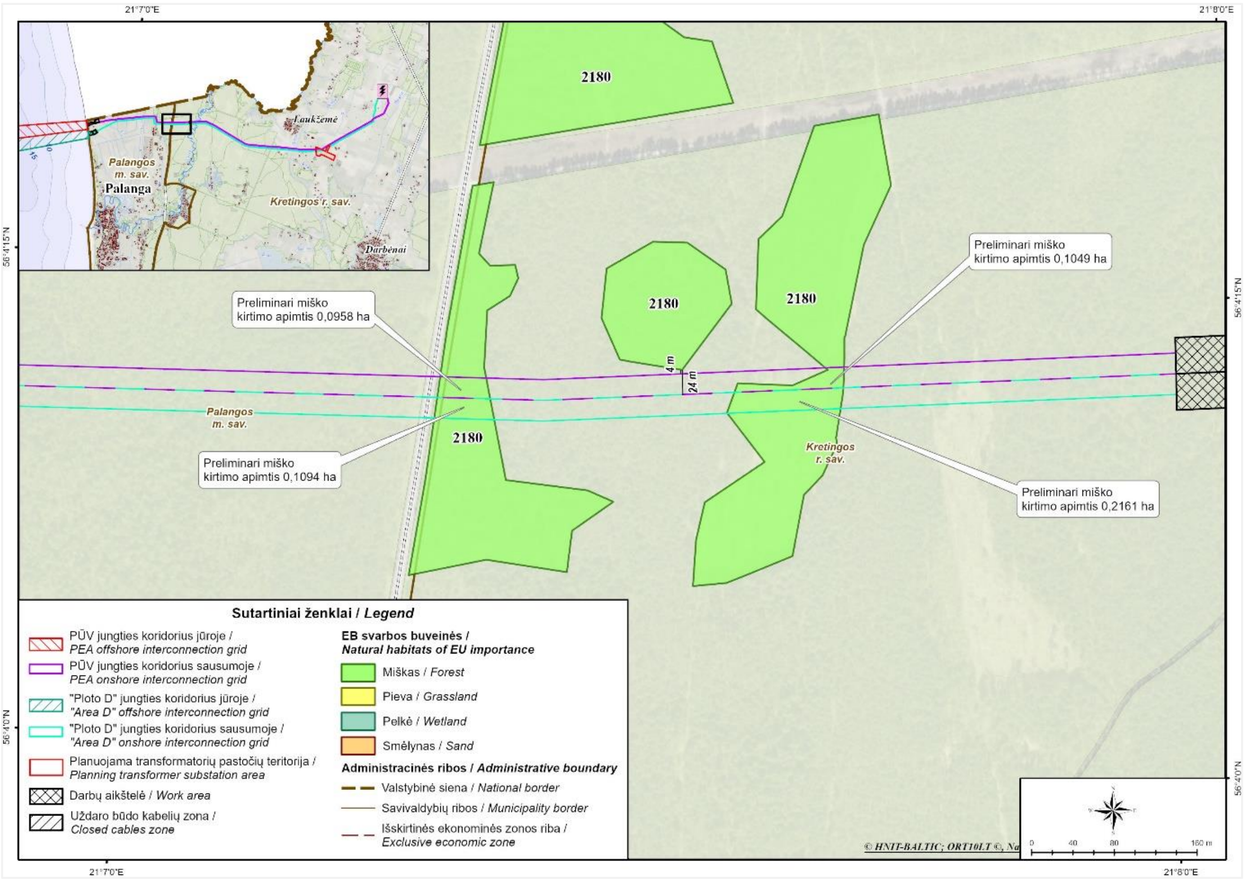


Fig. 5.4.103. Information on natural habitats of European Community importance (2 of 5).

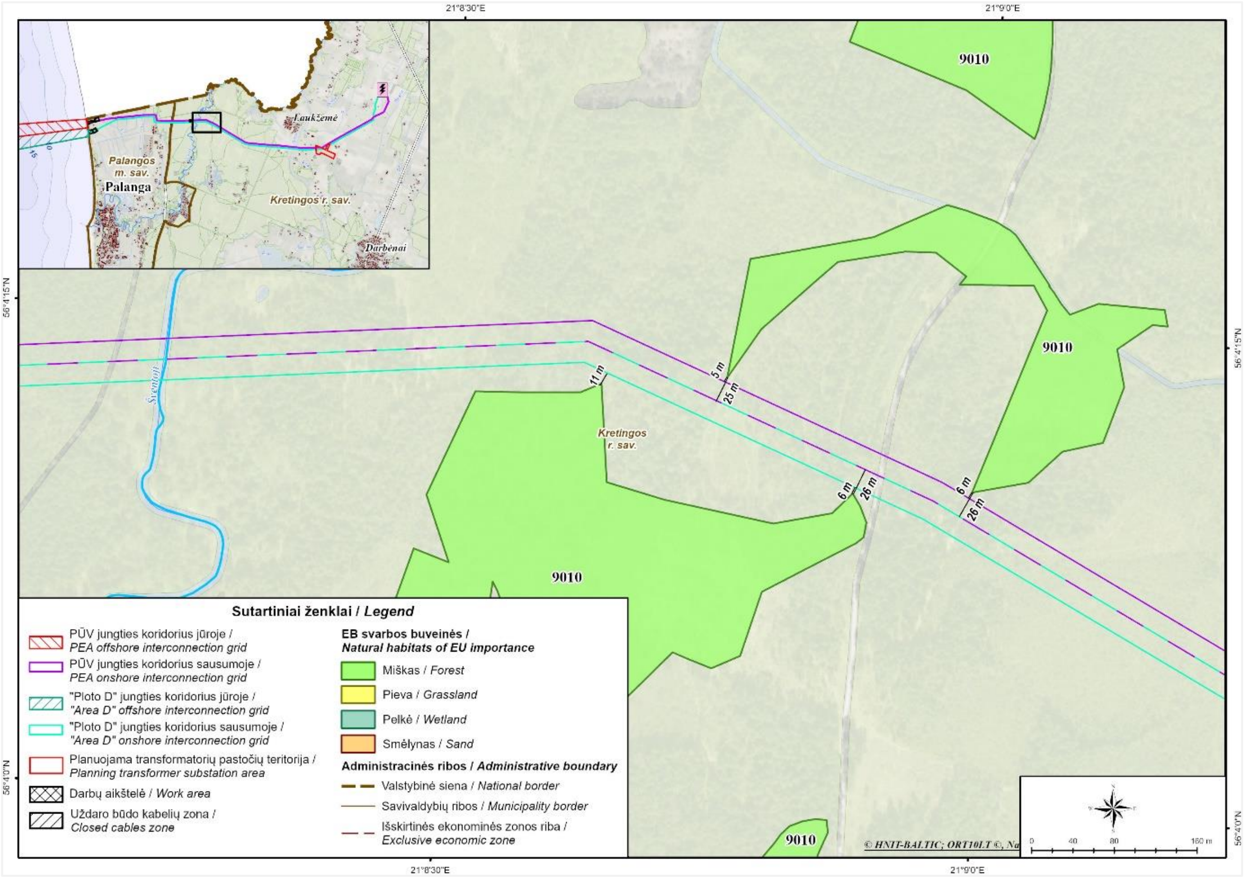


Fig. 5.4.104. Information on natural habitats of European Community importance (3 of 5).

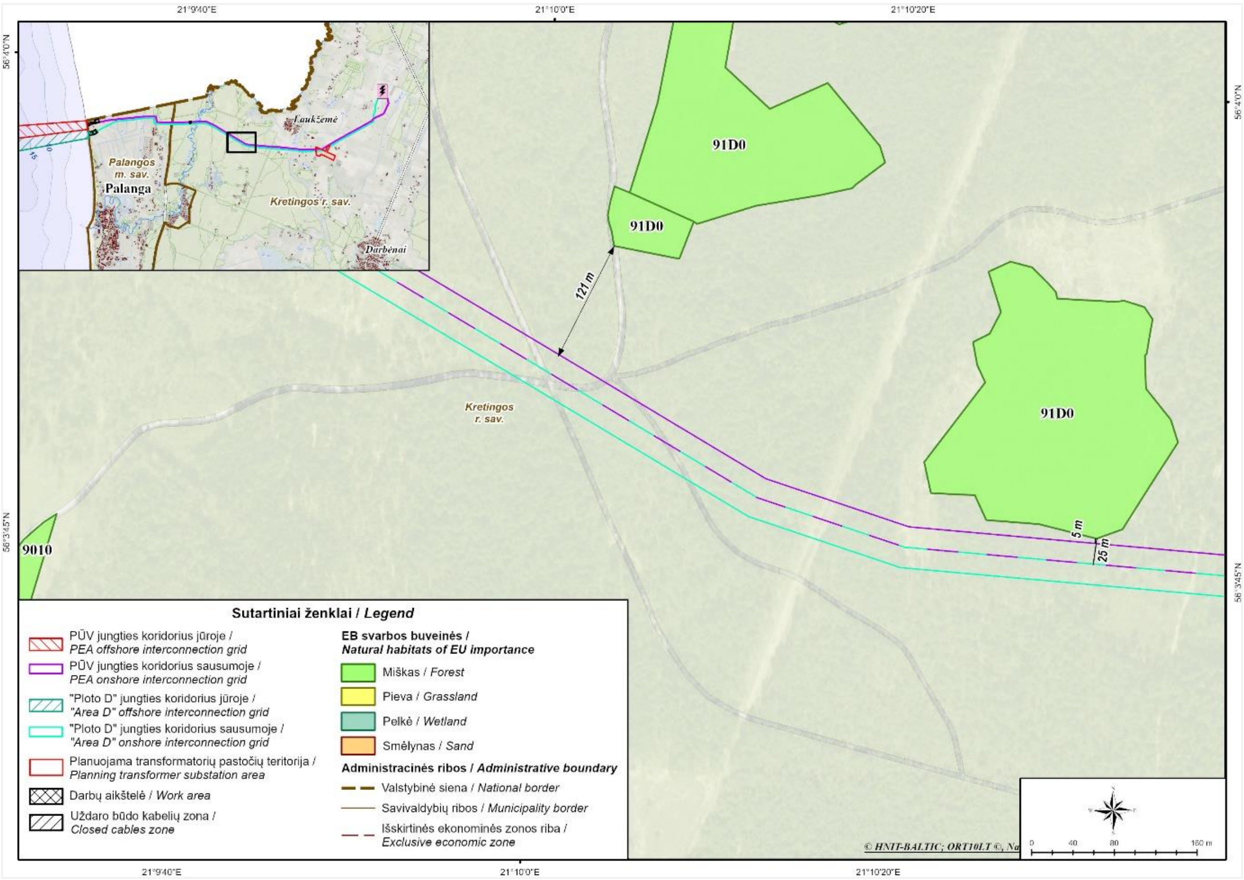


Fig. 5.4.105. Information on natural habitats of European Community importance (4 of 5).

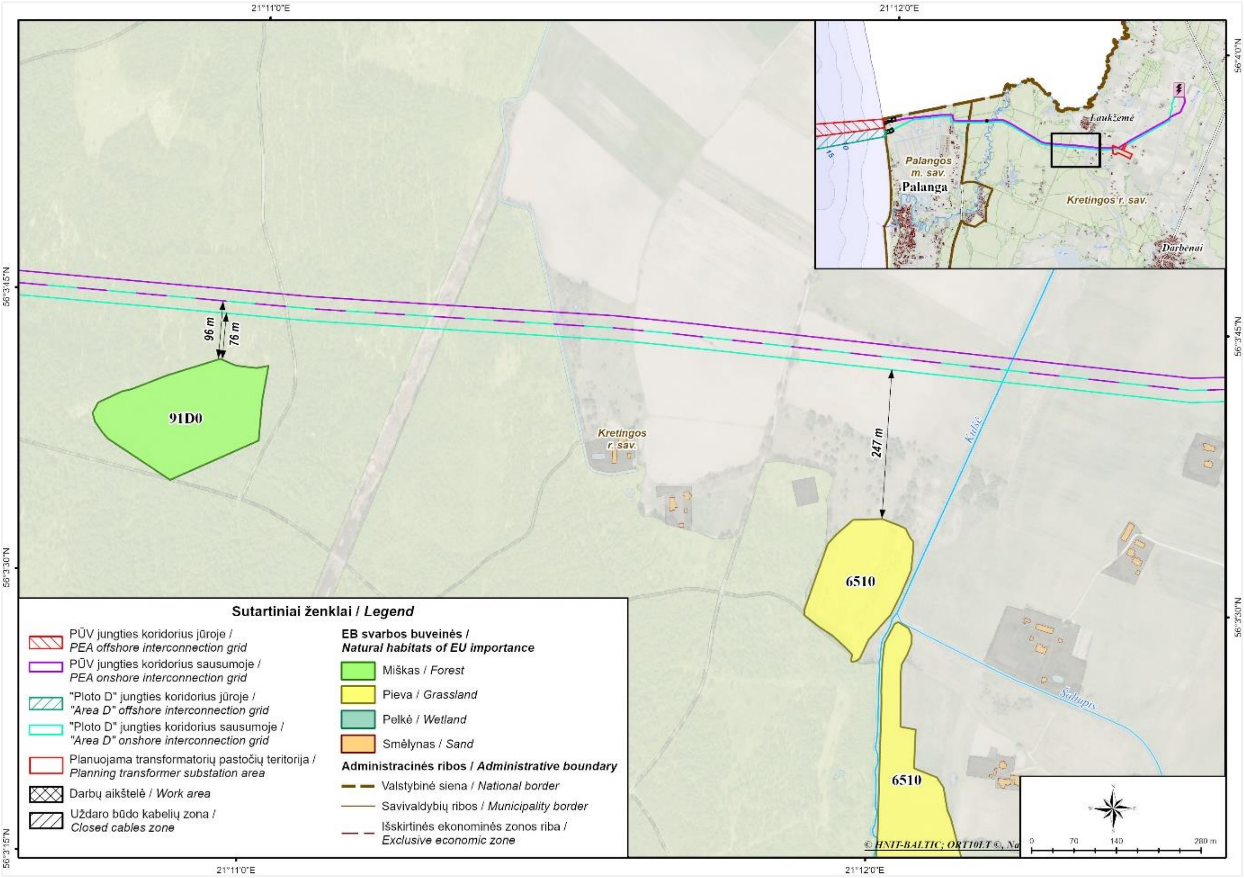


Fig. 5.4.106. Information on natural habitats of European Community importance (5 of 5).

5.4.8.3.3. Forests

The planned export cable corridor passes through the forests of Būtingė and Laukžemė (Fig. 5.4.107–108). As per construction method requirements, a 20-meter-wide work corridor is necessary for cable laying on land. Table 5.4.55 provides information on the species composition, maturity group, and forest type within this zone, along with the estimated area of deforestation required to establish the cable corridor.

Table 5.4.55. Stand species composition, maturity group and forest group

Forest Compartment	Forest Sub compart ment	Type of tree	Stand maturity group	Deforestation area, ha		Forest group
				CN OWF corridor	"Area D" OWF corridor	
Palanga Forest District						
1	5	Birch	Mature	0.0271		II. B. Recreational
1	14	Spruce	Young stand	0.0451		
1	15	Spruce	Young stand	0.0275		
1	17	Pine	Semi-aged	0.1842		
1	20	Pine	Semi-aged	0.4434	0.7325	
1	21	Birch	Semi-aged	0.0704	0.0698	
1	25	Spruce	Young stand	0.1296		
1	28	Pine	Semi-aged	0.1190	0.1133	
4	1	Pine	Semi-aged	0.0763	0.0750	
4	2	Pine	Semi-aged		0.1011	
4	3	Spruce	Young stand	0.0919	0.0602	
4	4	Pine	Semi-aged	0.1960	0.2062	
4	5	Birch	Semi-matured	0.0851	0.0619	

Forest Compartment	Forest Sub compart ment	Type of tree	Stand maturity group	Deforestation area, ha		Forest group
				CN OWF corridor	"Area D" OWF corridor	
4	6	Spruce	Mature	0.2075	0.2256	
4	7	Birch	Semi-matured	0.2945	0.2809	
4	8	Pine	Semi-aged	0.3667	0.3586	
			Darbėnai Forest District			
67	1	Spruce	Semi-matured	0.0865	0.1009	III. Protective
67	4	Pine	Semi-aged	0.0370	0.0228	
67	4	Pine	Semi-aged	0.5382	0.4366	IV. Commercial
67	6	Birch	Semi-aged	0.0008		
67	7	Pine	Over-matured	0.0003		
67	8	Pine	Over-matured	0.0772	0.1900	
67	12	Pine	Semi-aged	0.1869	0.1902	
68	3	Birch	Mature	0.0897	0.0957	
68	8	Pine	Semi-aged	0.0964	0.0626	
68	9	Pine	Semi-aged	0.0670	0.0672	
68	10	Pine	Semi-aged	0.3558	0.4670	
68	11	Pine	Semi-aged	0.0647		III. Protective ("Natura 2000" Baltijos Šventoji upė)
68	14	Pine	Semi-aged	0.2400	0.2121	
68	15	Spruce	Mature	0.0673	0.0730	
68	16	Pine	Semi-aged	0.0256	0.1072	
69	25	Spruce	Young stand	0.1427	0.1118	
69	35	Spruce	Semi-aged	0.1375	0.0645	
69	36	Spruce	Over-matured	0.0933	0.0952	
69	37	Pine	Semi-aged	0.0131		
69	38	Spruce	Semi-matured	0.1229	0.1208	
69	46	Spruce	Mature	0.1420	0.1290	
69	47	Spruce	Semi-aged	0.0777	0.1794	
69	48	Spruce	Semi-aged		0.0013	
69	39	Aspen	Mature	0.1794	0.0017	IV. Commercial
69	40	Alder	Semi-matured	0.0347	0.1808	
69	41	Pine	Semi-aged	0.0394		
69	42	Birch	Semi-aged	0.1852	0.1665	
69	43	Spruce	Semi-aged	0.1435	0.1107	
69	44	Spruce	Young stand	0.0029		
69	45	Birch	Semi-aged	0.0471		
69	52	Spruce	Semi-aged	0.1025	0.1892	
69	54	Pine	Over-matured		0.0233	
69	56	Spruce	Mature	0.1261	0.1650	
70	33	Spruce	Over-matured	0.2279	0.1277	
70	38	Birch	Semi-aged	0.0429	0.0012	
70	39	Birch	Semi-aged		0.0360	
70	41	Birch	Semi-aged	0.2310	0.3478	
70	42	Spruce	Mature	0.0673	0.0013	
70	43	Birch	Young stand	0.2407	0.222	
70	48	Birch	Young stand	0.1803	0.215	

Forest Compartment	Forest Sub compartment	Type of tree	Stand maturity group	Deforestation area, ha		Forest group
				CN OWF corridor	“Area D” OWF corridor	
71	19	Birch	Young stand	0.0010		
71	30	Birch	Young stand	0.2454	0.2508	
71	31	Birch	Young stand	0.1702	0.1741	
71	32	Pine	Semi-aged	0.1231	0.0003	
71	33	Spruce	Semi-matured	0.0167	0.0943	
71	34	Spruce	Semi-aged	0.0414	0.0974	
71	35	Spruce	Young stand	0.1910	0.1804	
71	36	Birch	Young stand	0.2300	0.2206	
72	27	Spruce	Young stand	0.0978	0.0974	
72	28	Spruce	Young stand	0.2655	0.2793	
72	29	Pine	Semi-matured		0.0118	
72	30	Pine	Semi-matured	0.1008	0.0122	
72	33	Pine	Semi-aged	0.1930	0.263	
72	36	Pine	Semi-matured	0.3273	0.1347	
73	29	Pine	Semi-matured	0.1439	0.0825	
73	33	Pine	Semi-aged	0.2703	0.2202	
73	34	Spruce	Semi-matured	0.2240	0.2098	
73	35	Birch	Young stand		0.0453	
73	36	Pine	Young stand	0.0929	0.1055	
73	37	Pine	Young stand	0.2319	0.2143	
73	28a	Pine	Young stand	0.0827	0.0803	
74	19	Spruce	Semi-matured	0.2061	0.1509	
74	20	Pine	Young stand	0.0601	0.1294	
74	21	Spruce	Young stand	0.2273	0.2981	
74	22	Pine	Semi-aged	0.0779	0.0064	
74	23	Pine	Young stand	0.1847	0.1379	
74	24	Pine	Semi-aged	0.0755	0.0004	
74	25	Birch	Semi-matured	0.0055		
74	26	Pine	Semi-matured	0.2176	0.2342	
74	27	Birch	Semi-aged		0.0410	
74	33	Pine	Semi-aged		0.0555	
75	3	Alder	Mature	0.0528	0.0240	
75	4	Birch	Semi-aged	0.2964	0.3303	
75	8	Oak	Semi-aged	0.0001	0.0205	
82	5	Pine	Semi-aged		0.0032	
82	6	Pine	Semi-aged		0.0240	
82	7	Pine	Semi-matured		0.1463	
83	1	Pine	Over-matured		0.0868	
83	2	Pine	Semi-aged		0.0011	
			Palanga Forestry Area, total	**2.3643**	**2.2851**	
			II. B. Recreational	2.3643	**2.2851**	
			Darbėnai Forestry Area, total	**8.9664**	**8.9797**	
			III. Protective	1.2503	1.2180	

Forest Compartment	Forest Sub compart ment	Type of tree	Stand maturity group	Deforestation area, ha		Forest group
				CN OWF corridor	"Area D" OWF corridor	
			IV. Commercial	7.7161	7.7617	

In the Palanga Forest District, the planned CN OWF export cable corridor passes through Group II.B recreational forests (deforestation area 2.3643 ha), where young stands account for about 12%, semi-aged stands for 62%, semi-matured stands for 16% and mature stands for 10%.

In the Darbėnai Forest District, in the protective forests of group III, the CN OWF export cable corridor crosses stand (deforestation area 1.2503 ha), where young stands account for about 11% of the area, semi-aged stands for 48%, semi-matured stands for 17%, mature stands for 17% and over-matured stands for 7%.

In the Darbėnai Forest District, in the group IV – commercial forests – the planned CN OWF export cable corridor crosses stands (deforestation area 7.7161 ha), where young stands account for about 32% of the area, semi-aged stands account for 40% of the area, semi-matured stands account for 17% of the area, mature stands account for 7% of the area, and over-matured stands account for 4%.

In Palanga Forest District, the planned export cable corridor for the "Area D" OWF crosses Group II B recreational forests (deforestation area 2.2851 ha), where young stands account for about 3%, semi-aged stands for 72%, semi-matured stands for 15% and mature stands for 10%.

In the Darbėnai Forest District, in the protective forests of group III, the "Area D" OWF export cable corridor crosses forest stands (deforestation area 1.2180 ha) with young stands accounting for about 9%, semi-aged stands for 48%, semi-matured stands for 18%, mature stands for 17% and over-matured stands for 8%.

In Darbėnai Forest District, the "Area D" OWF export cable corridor crosses forest group IV farm forest stands (f deforestation area 7.7617 ha), where young stands account for about 34% of the total, semi-aged stands account for 40%, semi-matured stands account for 16%, mature stands account for 4%, and over-matured stands for 6%.

The export cable corridors pass through the III group protective forests which surround the Šventoji River and the "Natura 2000" Baltijos Šventosios upė site. CN OWF onshore export cable corridor crosses the III Group Protective Forests in this area over a distance of around 560 metres, as does the 'Area D' OWF onshore export cable corridor over a distance of around 550 m (see Figure 5.4.108).

In the group III forests surrounding the "Natura 2000" Baltijos Šventosios upė site area, the CN OWF onshore export cable corridor crosses forest stands (deforestation area 1.1268 ha), with young stands accounting for about 13% of the total, semi-aged stands for 50%, semi-matured stands for 11%, mature stands for 19% and over-matured stands for 8%.

In the group III forests surrounding the "Natura 2000" Baltijos Šventosios upė site area, the "Area D" onshore export cable corridor crosses forest stands (deforestation area 1.0943 ha), where young stands account for about 10% of the total area, semi-aged stands for 52%, semi-matured stands for 11%, mature stands for 18% and over-matured stands for 9%.

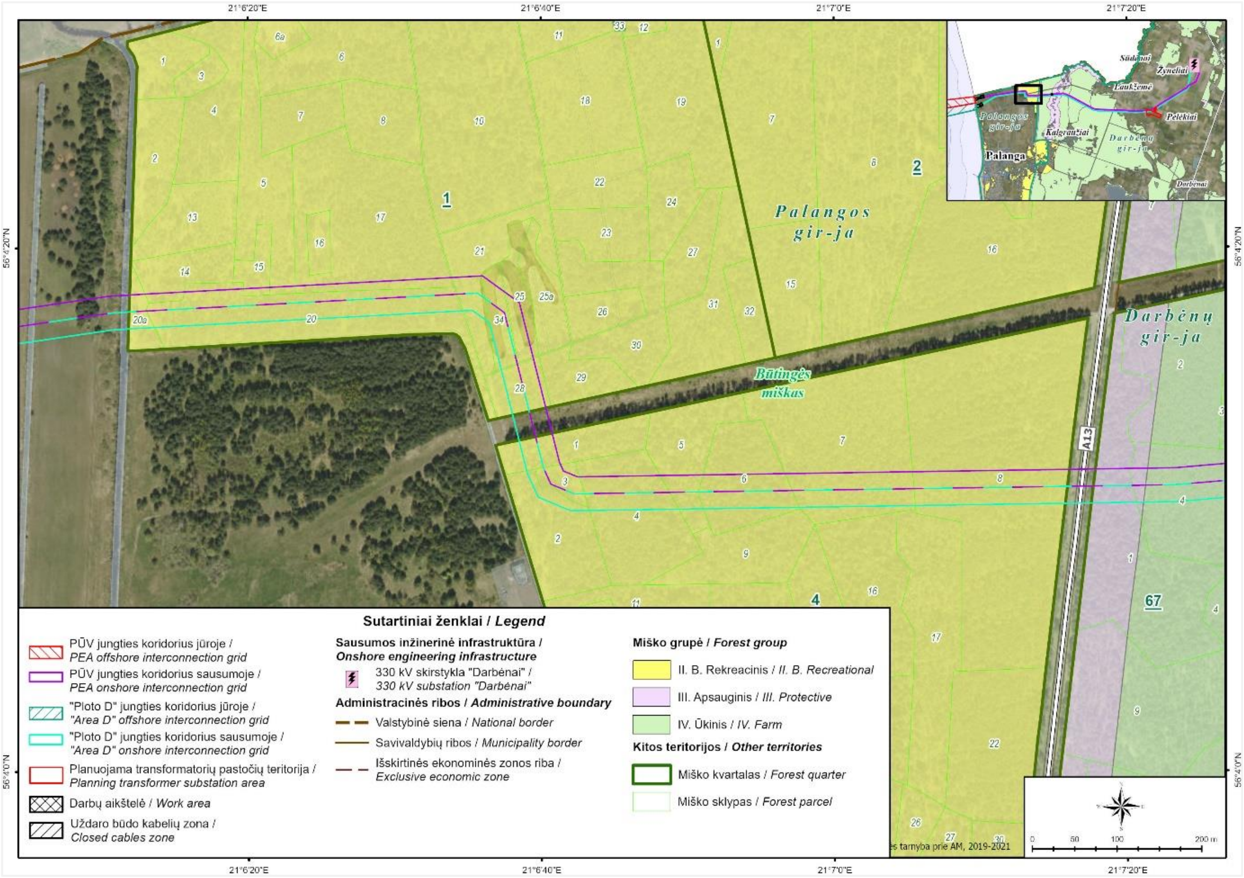


Fig. 5.4.107. Localization of the export cable corridors in Būtingė Forest, Palanga Forest District.

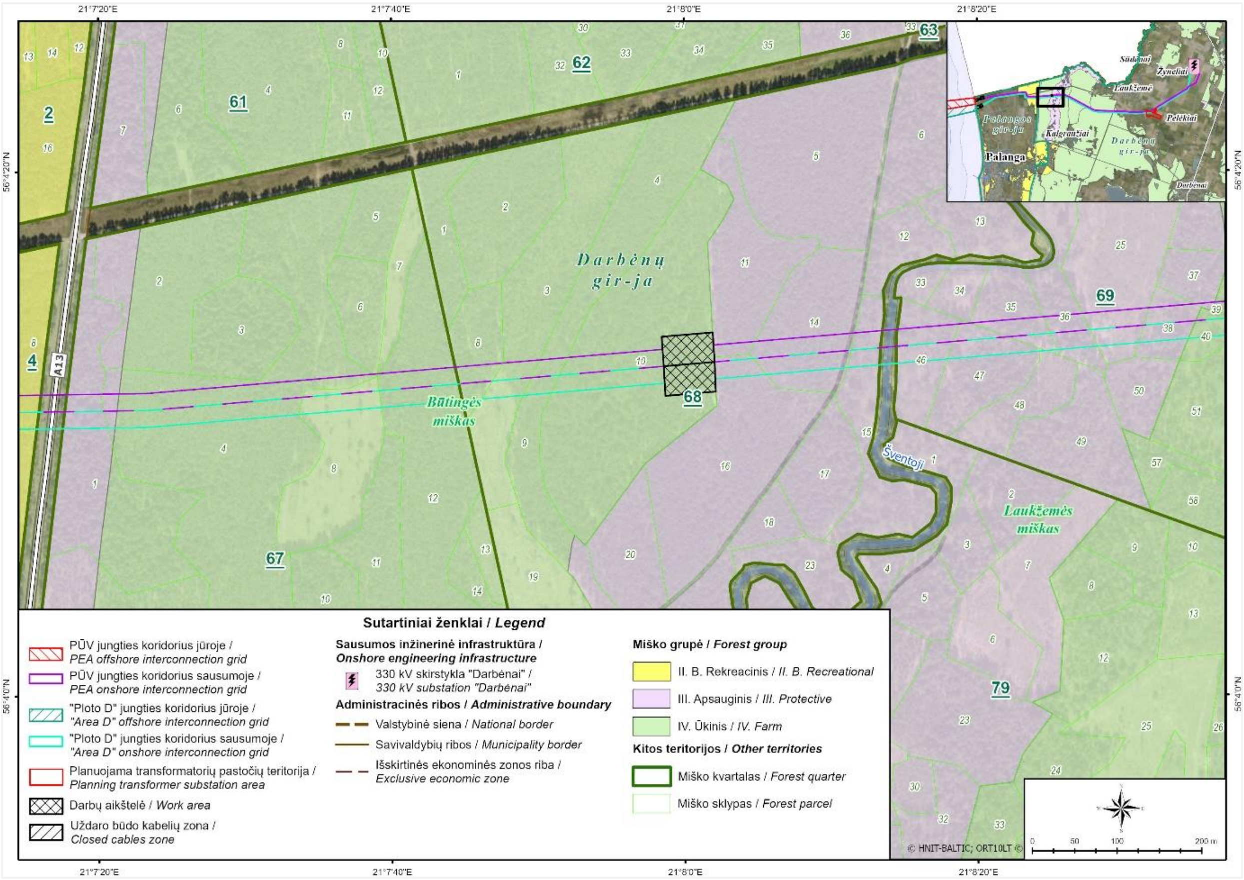


Fig. 5.4.108. Localization of the planned export cable corridors in Būtingė and Laukžemė forests, Darbėnai Forest District.

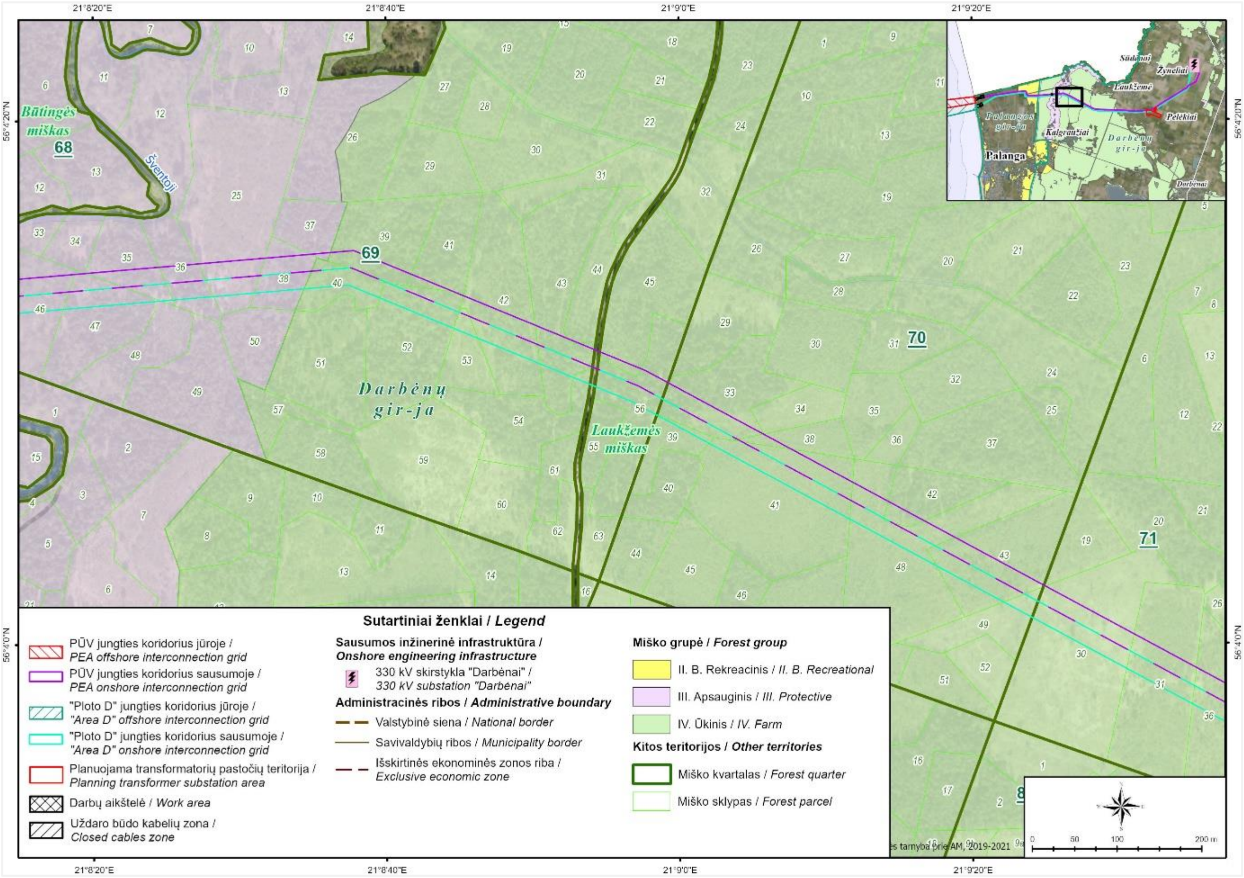


Fig. 5.4.109. Location of the planned export cable corridors in the Laukžemė Forest, Darbėnai Forest District (1 of 2).

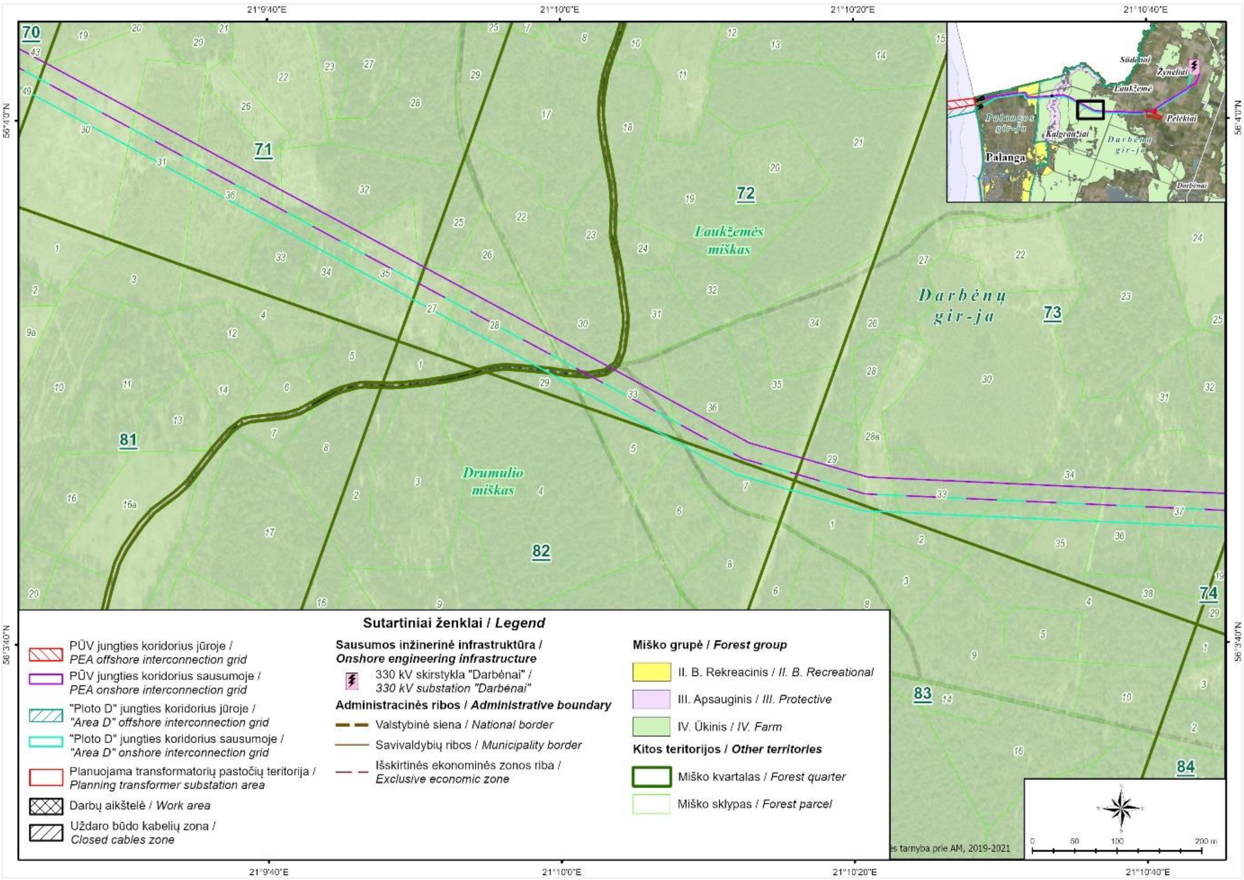


Fig. 5.4.110. Location of the planned export cable corridor in the Laukžemė Forest, Darbėnai Forest District (2 of 2).

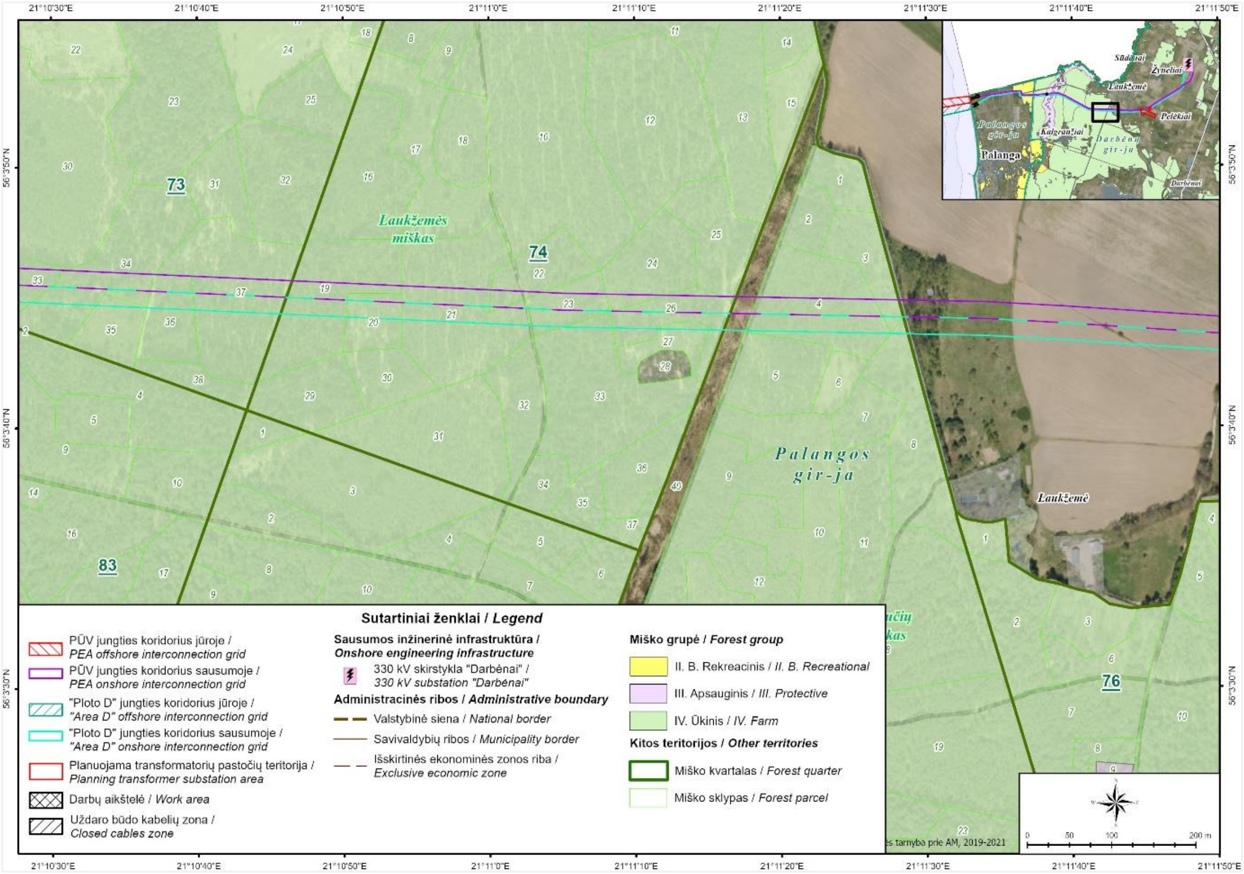


Fig. 5.4.111. Localization of the export cable corridors in the Laukžemė Forest, Palanga Forest District.

5.4.8.3.4. Natural meadows, pastures, wetlands and spring-fed wetlands

Information on natural grasslands and pastures, and wetlands and spring-fed wetlands adjacent to the export cable corridors (up to 500 m on either side of the routes), where SLUC apply, is provided in Figures 5.4.112 to 5.4.114 and Table 5.4.56.

The areas subject to SLUC are located between 45 m and 472 m from the CN OWF and "Area D" OWF export cable corridors.

Table 5.4.56. Natural grasslands and wetlands adjacent to the export cable corridors

No.	Territory type	Distance (m) to interconnector cable routes
1	Natural grassland and pasture (see Figure 5.4.112)	136
2	Wetland (see Figure 5.4.112)	328
3	Wetland (see Figure 5.4.112)	45
4	Natural grassland and pasture (see Figure 5.4.113)	160
5	Natural grassland and pasture (see Figure 5.4.114)	472

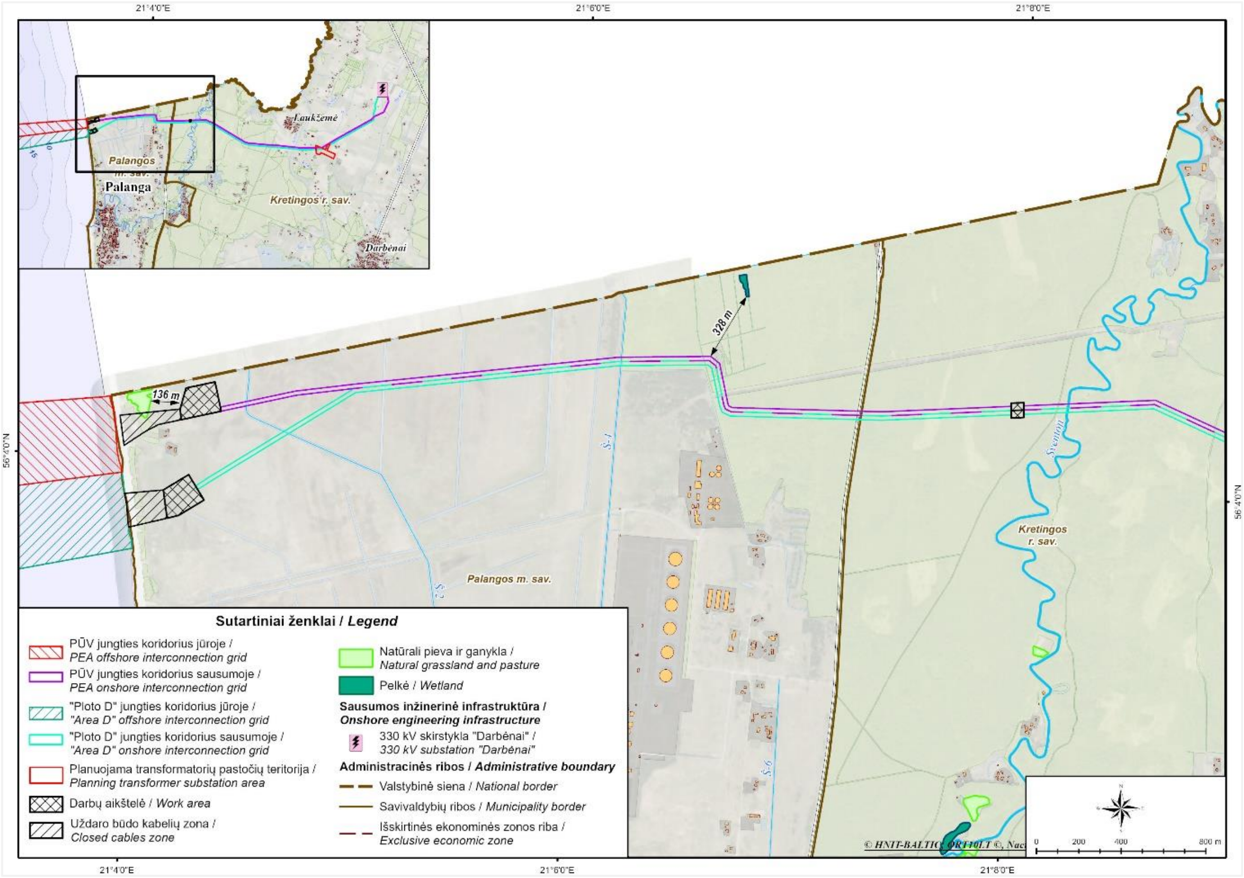


Fig. 5.4.112. Areas of natural grassland and pasture, wetlands and spring-fed wetlands adjacent to the export cable corridors (1 of 3).

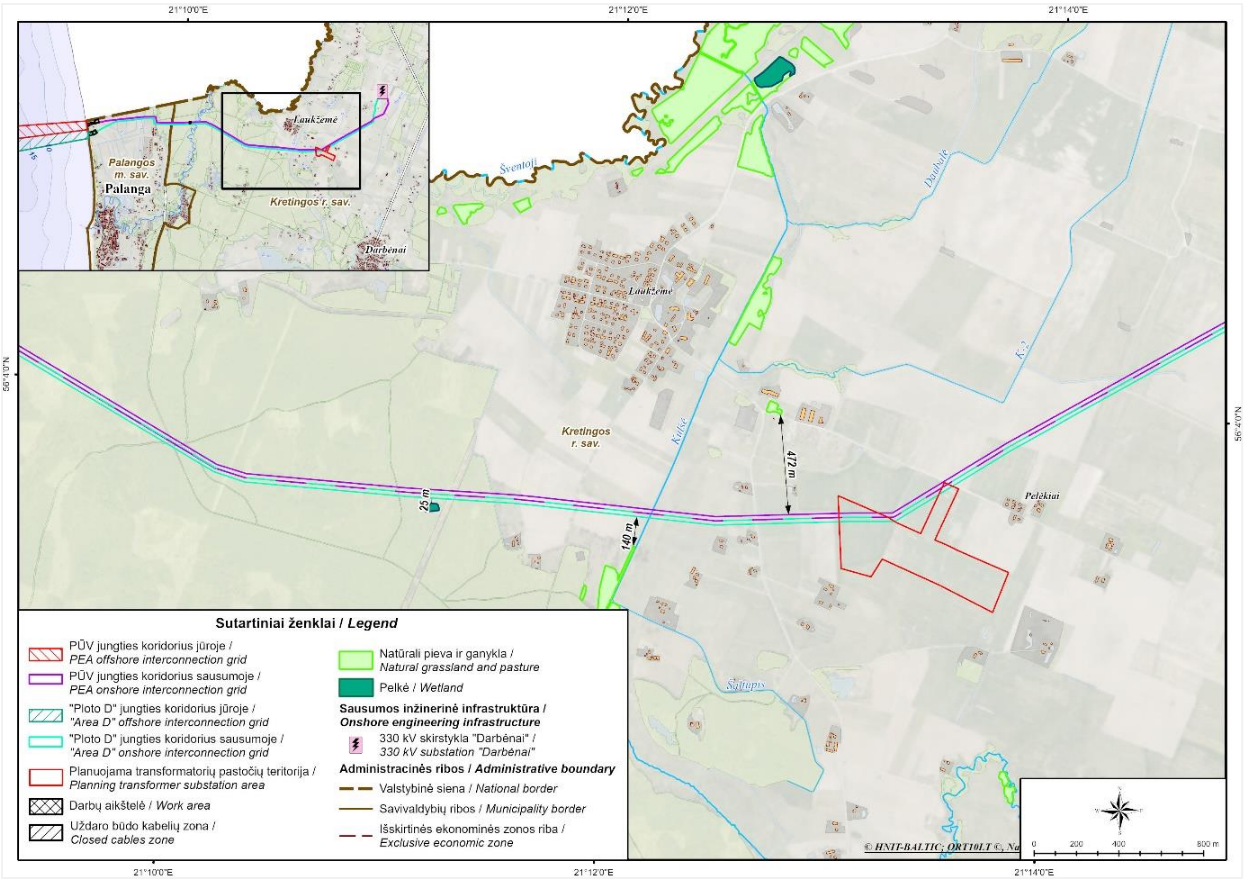


Fig. 5.4.113. Areas of natural grassland and pasture, wetlands and spring-fed wetlands adjacent to the export cable corridors (2 of 3).

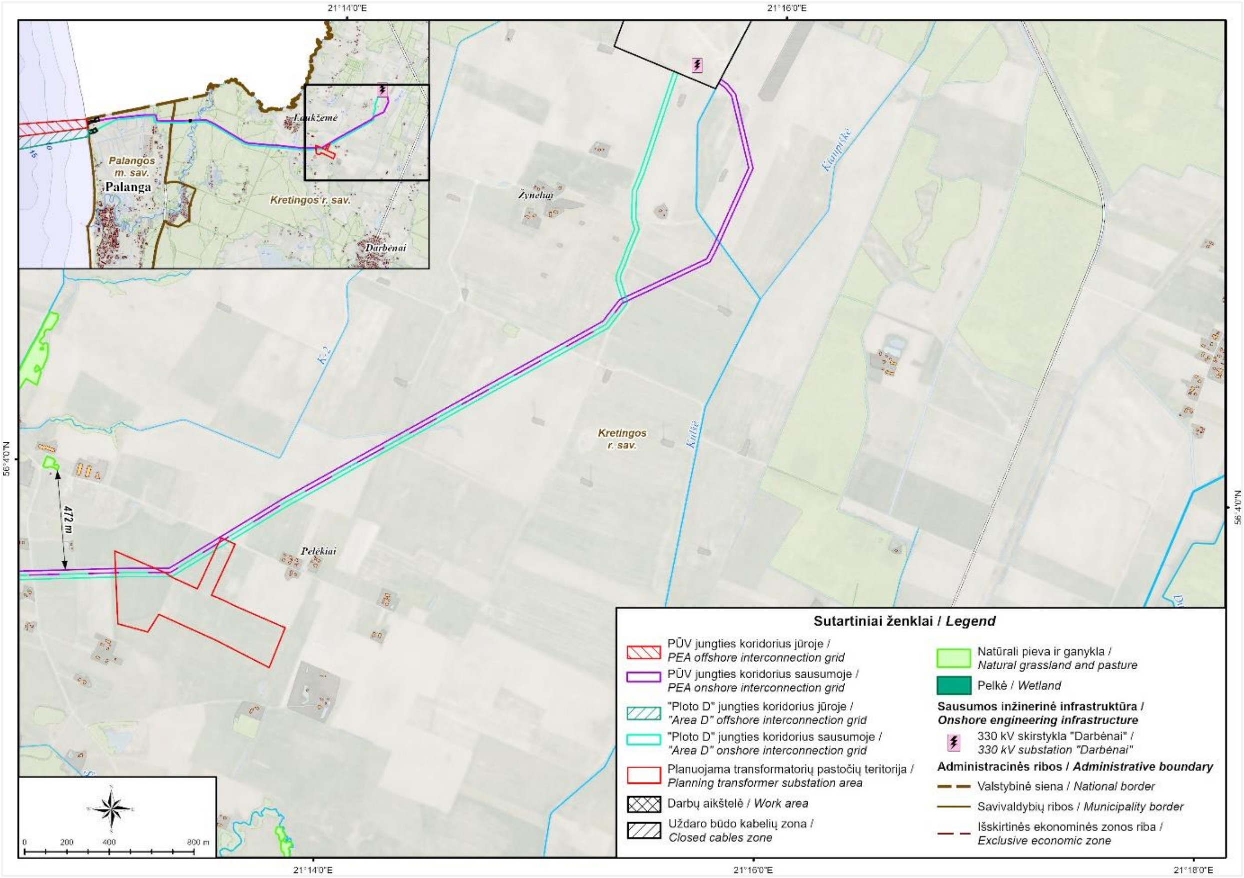


Fig. 5.4.114. Areas of natural grassland and pasture, wetlands and spring-fed wetlands adjacent to the export cable corridors (3 of 3).

5.4.8.3.5. Invasive species

According to the Invasive Species Information System, several invasive plant species have been recorded in the vicinity of the interconnector cable routes. Information on these invasive species is provided in Table 5.4.57 and Fig. 5.4.115. The closest invasive plant species to the proposed export cable corridor, at 199 m, is Canadian Goldenrod, with the population consisting of individual plants.

Table 5.4.57. Information on invasive plant species sites

No.	Species	Distance to export cable corridors
1	Baby's Breath	373 m
2	Large-leaved Lupine	574 m
3	Canadian Goldenrod	199 m

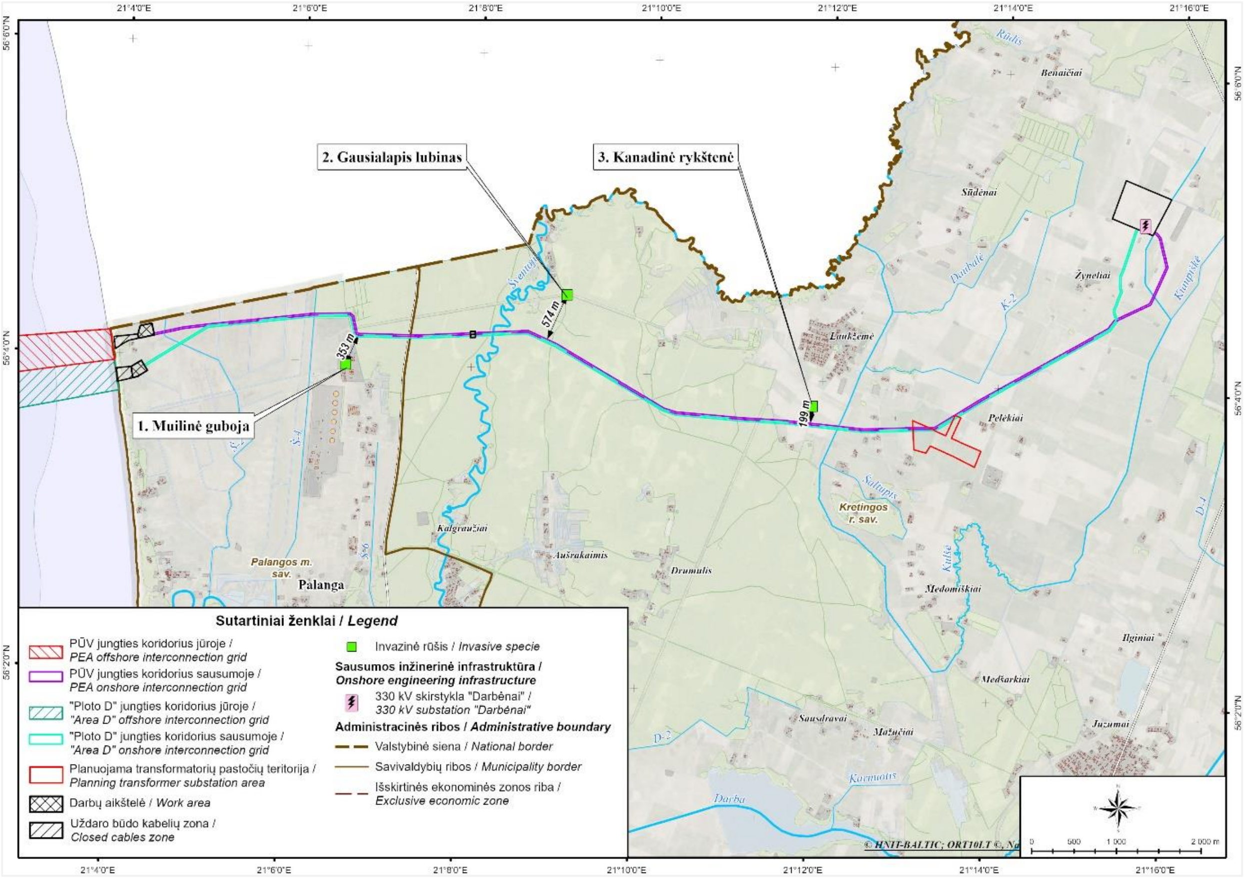


Fig. 5.4.115. Information on invasive species in the vicinity of the export cable corridors.

5.4.8.3.6. Protected vegetation

The planned route of the interconnector cables in Kretinga district, Darbėnai municipality, crosses protected vegetation areas (Fig. 5.4.116).

The Law on Plantations of the Republic of Lithuania[90] defines that "protected plantations – trees and shrubs that meet the criteria of growth location, species and dimensions approved by the Government of the Republic of Lithuania, according to which the trees and shrubs are classified as protected, and/or trees and shrubs that have been declared protected by a decision of a representative body of a municipality, which are dendrologically, ecologically, aesthetically valuable, significant to the cultural heritage and the landscape, and which are subject to a permit or a decision for deforestation, removal from the growing area, or intensive pruning".

The protected vegetation outside the Laukžemė forest (marked with index 1, Fig. 5.4.116) is a mixed stand of trees. The tree canopy consists of birch trees and occasional alder and spruce trees. The dominant trees are about 18–27 cm in diameter, with two birch trees having a trunk diameter of about 30 cm (growing in the central part of the stand and on the eastern edge). In the shrub canopy there are alder buckthorns and willows (*Salix* subgen *Caprisalix*).

The CN OWF onshore export cable corridor crosses the protected plantation (Nr. 2) in an area of 0.0121 ha (Fig. 5.4.116). The “Area D” onshore export cable corridor crosses the protected vegetation on an area of 0,0119 ha.

The protected vegetation along Miškas Street (marked with index 2, Fig. 5.4.116) consists of a group of three mature linden trees. The trunk diameters range from 60 to 120 cm. The trees are spaced approximately 17, 33, and 40 metres apart in a north-south direction. The southernmost linden in the group, which has three trunks, is severely damaged by rot, with one trunk broken off (Fig. 5.4.118).

The CN OWF onshore export cable corridor crosses this protected plantation (Nr. 2) over an area of 0.0121 ha (Fig. 5.4.116). The "Area D" onshore export cable corridor crosses the protected vegetation over an area of 0.0119 ha.

[90] https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.301807/asr

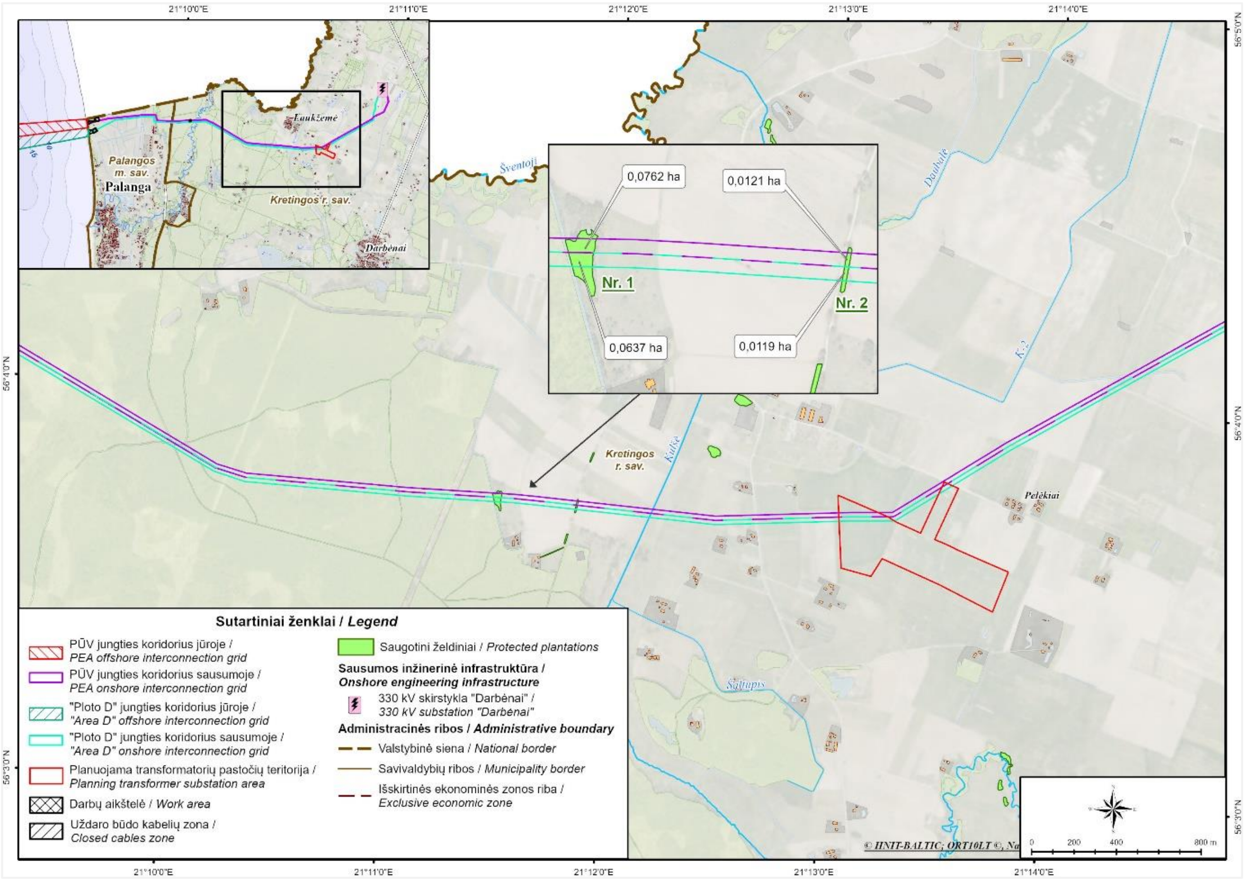


Fig. 5.4.116. Protected vegetation areas crossed by export cable corridors.

Fig. 5.4.117. Protected vegetation – a group of mature linden trees at Miškas Street (photo by Z. Gasiūnaitė, summer 2024).

Fig. 5.4.118. Southern three-trunk linden tree in the group of protected vegetation at Miškas Street (photo by R. Staponkus, 28-01-2025).

5.4.8.4. Potential impacts on vegetation and habitats

5.4.8.4.1. Impacts on vegetation

In non-forested areas, the export cable corridors are planned to traverse various grassland habitats and arable land, where cable installation will involve the removal of herbaceous vegetation due to excavation activities. In grassy areas, the recovery process following mechanical disturbance is relatively quick, rendering the impact on grassland habitats to be short-term and of low significance.

5.4.8.4.2. Impact on habitats of European Community importance

Habitats of EC importance are found in the vicinity of, and in some cases across, the route of the export cable corridor.

The landfall of the cables is planned to be located 145 m from the coastal sand habitats designated as 2110 Embryonic shifting dunes, 2120 White dunes, and 2130 Grey dunes. The export cable laying is planned to be executed using trenchless methods, with no work taking place in the area of these habitats. Consequently, no impact on these habitats of European Community importance is expected.

In Būtingė Forest, the export cable corridor is planned through 2180 Wooded dunes of Atlantic, Continental and Boreal region habitats. Within this habitat, the cable laying works would involve deforestation of 151 m for the CN OWF onshore export cable corridor and 163 m for the “Area D” onshore export cable corridor, as well as 20 m wide corridors, for a total area of approximately 0.5262 ha.

The excavation will result in the destruction of herbaceous vegetation, which is assessed to be of a short-term nature. Deforestation – a long-term impact as the forest will not be restored. The changes caused by the CN OWF would lead to fragmentation of the forest habitat. Following the completion of the construction works, ecotonal communities of clearings and forest-edge may form in these areas after reclamation. This new habitat type may have a positive impact on entomofauna (e.g. moths) and thus on the biodiversity of the habitat. It is recommended to preserve mature trees wherever possible during cable laying operations.

The forest habitats 9010* Western taiga, 91D0* Bog woodlands are not expected to be affected as they are located between 5 m and 121 m from the corridor of the export cable corridors, and no works are planned within their boundaries.

5.4.8.4.3. Impact on forests

The export cable corridors are planned to traverse the Būtingė and Laukžemė forests. As per construction technology requirements, a corridor approximately 20 meters wide is necessary for laying each export cable on land, necessitating the clearing of forest areas to create these corridors. A summary of the forest clearing area is provided in Table 5.4.58.

Table 5.4.58. Forest areas to be cleared in the export cable corridor (* forests on both sides of the SAC Baltijos Šventoji upė)

Forest Group	Tree maturity group	Deforestation in OWF export cable corridors, ha	
		CN OWF	"Area D" OWF
Palanga Forest District			
II B. Recreational forests	Young stand	0.2941	0.0602
	Semi-aged	1.456	1.6565
	Semi-matured	0.3796	0.3428
	Mature	0.2346	0.2256
	Over-matured	-	-
	Total, ha	**2.3643**	**2.2851**
Darbėnai Forest District			
III. Protective forests	Young stand	-	-
	Semi-aged	0.037	0.0228
	Semi-matured	0.0865	0.1009
	Mature	-	-
	Over-matured	-	-
	Total, ha	**0.1235**	**0.1237**
III. Protective forests*	Young stand	0.1427	0.1118
	Semi-aged	0.5586	0.5645
	Semi-matured	0.1229	0.1208
	Mature	0.2093	0.2020
	Over-matured	0.0933	0.0952

Forest Group	Tree maturity group	Deforestation in OWF export cable corridors, ha	
		CN OWF	"Area D" OWF
	Total, ha	**1.1268**	**1.0943**
IV. Commercial forests	Young stand	2.5044	2.6504
	Semi-aged	3.1144	3.1383
	Semi-matured	1.2766	1.2575
	Mature	0.5153	0.2877
	Over-matured	0.3054	0.4278
	Total, ha	**7.7161**	**7.7617**
Total area of forest within the corridor boundary		**11.3307**	**11.2648**

The construction of interconnector cables and excavation activities will lead to temporary disturbances to herbaceous vegetation. However, this vegetation is expected to naturally regenerate, making the impact short-term in nature. The impacts of deforestation are long-term and significant, as land use changes and the forest may not be restored to its original state. However, following the completion of construction works and subsequent reclamation, the resulting mosaic of forest habitats could foster the development of ecotonal woodland and forest-edge communities. This new habitat type has the potential to positively affect biodiversity, such as supporting entomofauna.

The export cable corridors pass through the Šventoji River, “Natura 2000” Baltijos Šventoji upė area and surrounding forests of the 3rd group. For the cable crossing of the Šventoji River trenchless technology shall be selected.

The following provisions have been established to assess the potential impacts associated with the construction of the export cable corridor: the inlet pipe work site (100 m^2), the outlet pipe installation site, the temporary access roads and the storage areas for the process equipment shall not extend beyond the limits of the work areas for the installation of the interconnector cable routes (20 m width per export cable corridor).

5.4.8.4.4. Impacts on natural grasslands and pastures and on wetlands and spring-fed wetlands

No impact on natural grasslands and pastures, wetlands and spring-fed wetlands, where SLUC apply, is expected as these areas are located between 45 and 472 m from the export cable corridors.

5.4.8.4.5. Impacts from invasive plant species

The construction of the export cable corridors is not expected to affect the spread of invasive plant species. The closest (199 m) population of invasive plant species is not within the works area.

5.4.8.4.6. Impact on protected vegetation

The export cable corridors are to be routed through two types of protected vegetation: a mixed stand and a plantation consisting of a group of 3 mature linden trees. The section through the mixed stand would result in the removal of approximately 0.1399 ha of trees and there would be no replanting of trees. The impact is long term and significant.

The installation of an export cable may require the removal of one of the mature linden trees, in which case the impact would be long-lasting and significant.

According to the Law on Plantations of the Republic of Lithuania (adopted by the Resolution of the Republic of Lithuania No. X-1241 of 28 June 2007, Consolidated version from 1 January 2025), Article 13 (1): "1. Deforestation of protected plantations, <...> may only be felled with a felling permit issued by the municipal executive authority and upon payment of the fees for the replacement value of the plantations declared to be protected by the decision of the municipal executive authority, <…>”. In this particular case, it will be necessary to apply to the Kretinga Municipality for permission to cut down protected vegetation.

5.4.8.5. Measures to prevent, mitigate and compensate for impacts on mainland vegetation and habitats

Measures to mitigate impacts on vegetation in grassland habitats:

- No imported soil may be used for reclamation of the site. Preserved local soil must be used for reclamation.
- Seed mixtures that are not representative of the previous vegetation must not be used in the restoration of the damaged vegetation cover. The area shall be left to regenerate itself.

- The work area must be checked for the presence of invasive plants prior to commencement of the work, and if invasive plants are detected, an invasive plant management plan must be drawn up, and measures taken to prevent the spread of such plants from the work area into adjacent areas.

Measures to mitigate impacts on forests:

- In order to reduce the impact on the Group III protective forest growing on the banks of the Šventoji River, at the intersection with the Šventoji River, using trenchless method (HDD or similar), it is planned to move the technological sites of the beginning and end of drilling works beyond the riverbank protection strip, and to plan the works in such a way that these sites are designed as far as possible from the riverbank, if possible, outside the river protection zone.
- No imported soil may be used for reclamation of the site. Preserved local soil must be used for reclamation.
- Leave the disturbances and changes made to the former forest areas to regenerate on its own after the completion of the construction works and during the reclamation of the site – do not plant purchased grass mixtures.
- The conversion of forest land to other land uses (deforestation) will be compensated by a monetary sum, which will be included in the revenue of the State Budget of the Republic of Lithuania, as well as in the General Forestry Needs Financing Programme, and will be used to finance the acquisition of land for new forests, the establishment of forests, and the financing of the other measures related to the care, protection and management of forests referred to in Article 7(2) of the Law on Forests.

Measures to mitigate impacts on protected vegetation:

- Design export cable corridors to preserve, where possible, large trees protected vegetation stands.
- Design the export cable corridors in such a way as to preserve, as many as possible, the mature linden trees in the protected vegetation area.
- No imported soil may be used for reclamation of the site. Preserved local soil must be used for reclamation.
- Leave the disturbances and changes made to the site to regenerate itself after the completion of the construction works and during the reclamation of the site – do not plant purchased grass mixtures.
- The compensation for the removal of protected vegetation will be based on the replacement value of the plantation, as determined and calculated by a decision of the municipality's representative body. This obligation is laid down in the Law on Plantations of the Republic of Lithuania (approved by Resolution No X-1241 of the LRS of 28 June 2007, consolidated version as of 1 January 2025).

Table 5.4.59. Potential impacts of the OWFs export cable corridors on vegetation and summary of mitigation measures

Stages	Impact	Nature	Scale	Duration	Relevance	Measures
Construction	Deforestation works in export cable corridors	Direct	Localised on-site installation of export cable and ONS (work zone width up to 20 m per corridor)	Long-term	Significant	Financial compensation for forest land conversion to other uses (deforestation).
	Removal of vegetation cover on the export cable corridors and in the area of the Pelėkiai Transformer Substation	Direct	Localised on-site installation of export cable and ONS (work zone width up to 20 m per corridor)	Short-term: during construction work	Impacts of low significance	Reclamation shall use preserved local soil. When restoring damaged vegetation cover, seed mixtures uncharacteristic of the pre-existing vegetation must not be used. The area shall be left to regenerate itself.
	Spread of invasive plants	Indirect	Localised on-site installation of export cable and ONS (work zone width up to 20 m per corridor)	Short-term: during construction work	Impacts of low significance	The works area must be checked for the presence of invasive plants prior to commencement of the work, and if invasive plants are detected, an invasive plant management plan must be drawn up, and measures taken to prevent the spread of these plants from the work area into adjacent areas.
Operation and maintenance	No effect on vegetation under normal operating conditions				Irrelevant	Not applicable.
Decommissioning	Removal of vegetation cover in the export cable corridors and in the area of the Pelėkiai Transformer Substation, if the cables and ONS are to be dismantled	Direct	Localised on-site installation of export cable and ONS (work zone width up to 20 m per corridor)	Short-term: during construction work	Impacts of low significance	Reclamation must use preserved local soil. When restoring damaged vegetation cover, seed mixtures uncharacteristic of the pre-existing vegetation must not be used. The area shall be left to regenerate itself.

Colour code

(light green)	Positive impact
(light blue)	No impact or impact insignificant (not to be considered, no measures are applicable)
(blue)	Minor impact: decisions during design, preventive or mitigation measures
(light orange)	Moderate impact: addressed by mitigation measures
(orange)	Significant impact: mitigation and/or compensation measures are necessary.

5.4.9. Onshore fauna

5.4.9.1. Survey methods

5.4.9.1.1. Methods for assessing the current state

Breeding bird surveys were conducted onshore in the planned export cable corridors area from May to July 2024. To assess the potential impact of the onshore cable laying, a 400 m buffer zone (200 m on either side) from the future cable location was surveyed (see Fig. 5.4.119). The main objectives of the surveys were to identify the most sensitive and vulnerable bird species.

The studies consisted of two types of surveys:

- Searching for nests of birds of prey in the forests.
- Conducting breeding bird surveys along the planned cable location.

Information about the fauna typical of the analysed area (reptiles, amphibians, and mammals) is provided based on data from www.geoportal.lt/map.

Information on invasive species is provided based on data from the Invasive Species Information System (https://inva.biip.lt/).

5.4.9.1.2. Methods for assessing potential impacts

The assessment of potential impacts on wildlife is based on expert knowledge and an integrated approach that includes an analysis of the current ecological status and identification of vulnerable components. The impact assessment considers the nature, duration, seasonality and distance of the planned works to sensitive habitats and nesting sites. The significance and extent of the impact on areas downstream of the planned activity are also considered.

5.4.9.2. Survey area

During the search for nests of birds of prey, all forests within a 400 m buffer zone (200 m on either side of the planned interconnection cable) were surveyed (see Fig. 5.4.11921).

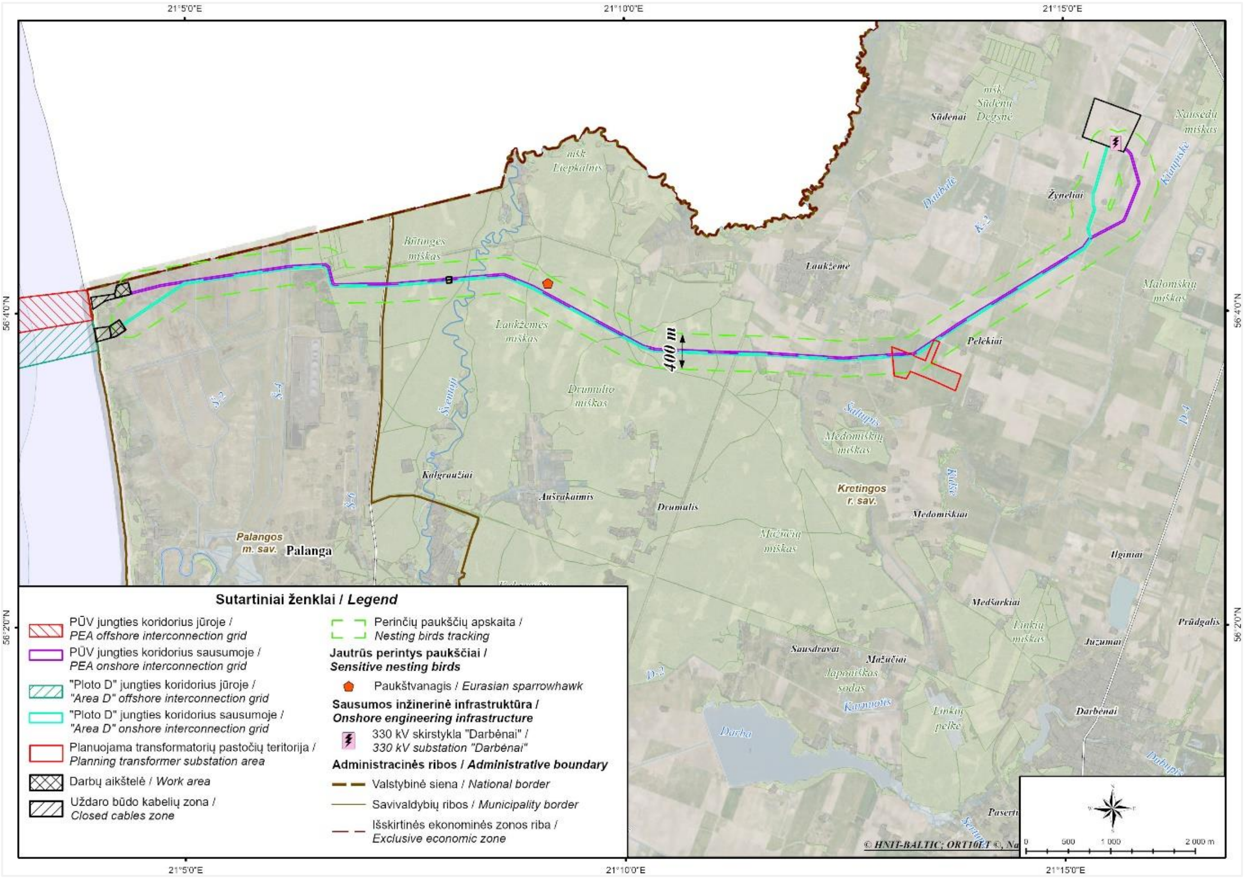


Fig. 5.4.119. Bird survey area.

According to the zoological geographical zonation of the Lithuanian National Atlas regarding invertebrate distribution, the cable corridor and the adjacent territory fall into the Western European faunal complexes (FK) of mixed forests and agrarian landscapes within moderately humid and transitional climate conditions of the Baltic province. This includes the Baltic Sea coast FK coastal sandy landscape with halophilic elements (AI) and the Samogitian-Curonian Highlands FK spruce forests and mixed spruce forests and agrarian landscapes with elements of boreal fauna (AII), located in the Minija subregion (Lithuanian Spatial Information Portal www.geoportal.lt) (see Fig. 5.4.120).

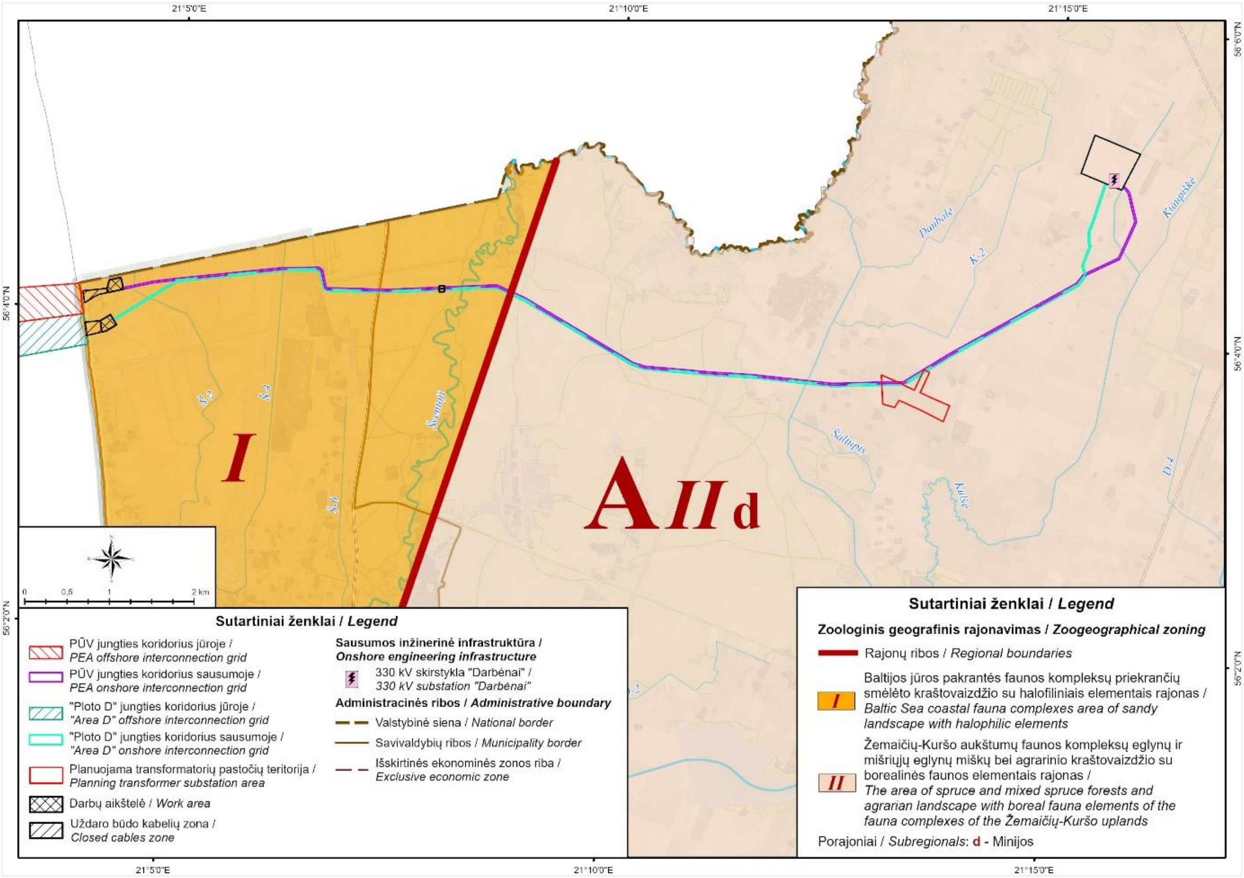


Fig. 5.4.120. The planned territory based on the zoological geographical zoning map of the Lithuanian National Atlas.

5.4.9.3. Current state

5.4.9.3.1. Birds

To assess the potential impact of laying export cables onshore, breeding bird surveys were conducted from May to July 2024. Research on birds of prey was carried out in an area with a 400-meter buffer zone (200 meters on both sides) from the proposed cable route. During the survey, all forests within the buffer zone were thoroughly explored. One nest of the Eurasian Sparrowhawk was discovered in the area (Fig. 5.4.121).

Throughout the breeding bird surveys, 76 bird species were identified within the research area (Table 5.4.60). All birds showing territorial behaviour were registered (n = 649). To better represent the data spatially, birds were grouped by similar ecological behaviour to five groups: birds of prey (Fig. 5.4.122), storks and cranes (Fig. 5.4.122), ducks (Fig. 5.4.122), shorebirds (Fig. 5.4.122) and passerines (Fig. 5.4.123).

According to The International Union for Conservation of Nature (hereinafter – IUCN), 3 bird species registered during surveys are listed under Vulnerable (VU) – Northern Lapwing, Common Redshank and Common Snipe, the rest – under Least Concerned (LC). 10 of the recorded species falls into List of Lithuanian Protected species and 12 under Bird Directive Annex I.

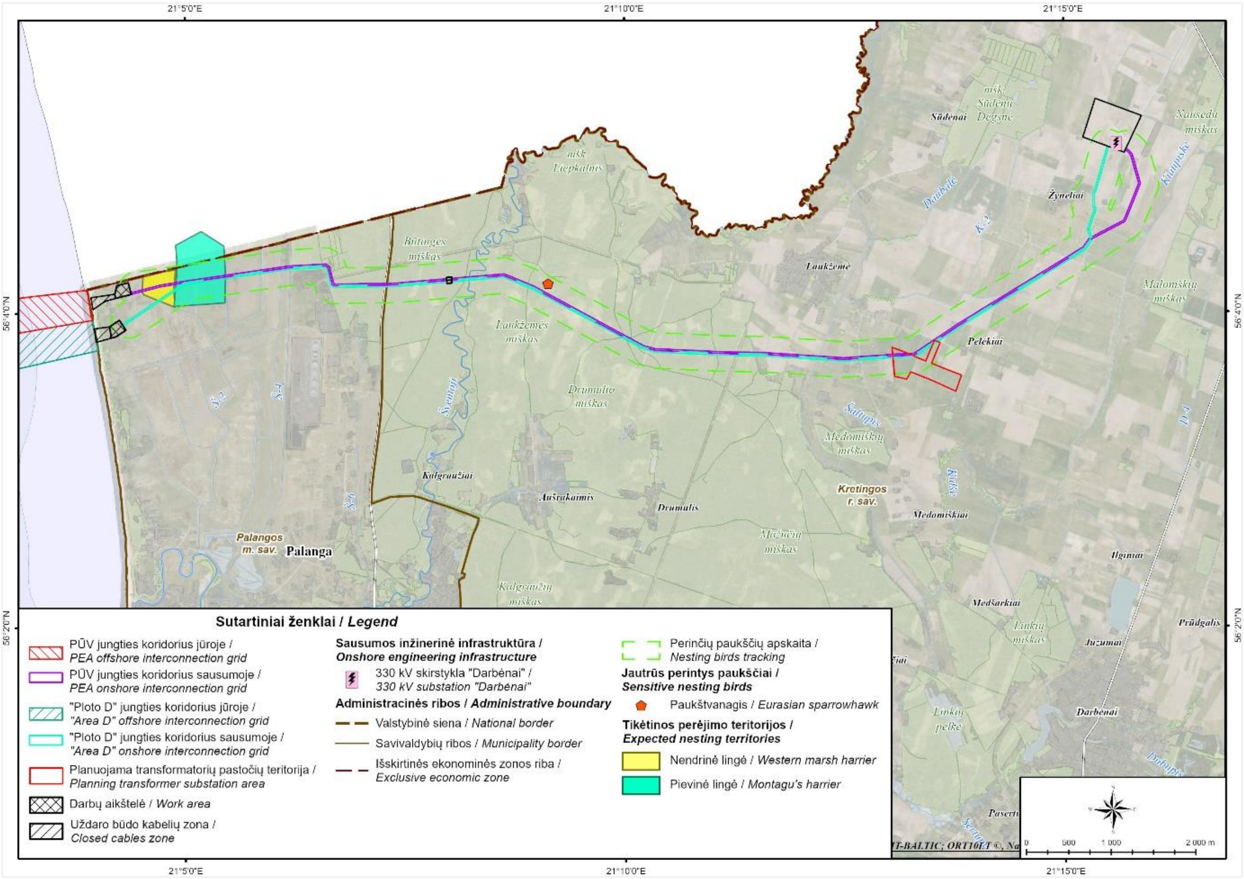
Table 5.4.60. Bird species recorded during breeding bird surveys

Bird group	Lithuanian name	English name	Scientific name	N° Ind.	IUCN	LSRS	EU/BD I
Antys / Ducks	Didžioji antis	Mallard	*Anas platyrhynchos*	5	LC		
	Dryžagalvė kryklė	Garganey	*Spatula querquedula*	2	LC	x	
Gandrai ir gervės /	Baltasis gandras	White Stork	*Ciconia ciconia*	2	LC		x
	Pilkoji gervė	Common Crane	*Grus grus*	4	LC		x

Bird group	Lithuanian name	English name	Scientific name	N° Ind.	IUCN	LSRS	EU/BD I
Storks and Cranes							
Plėšrieji paukščiai / Raptors	Paukštvanagis	Eurasian Sparrowhawk	*Accipiter nisus*	1	LC		
	Nendrinė lingė	Western Marsh Harrier	*Circus aeruginosus*	1	LC		x
	Pievinė lingė	Montagu's Harrier	*Circus pygargus*	2	LC	x	x
Sėjikiniai paukščiai / Waders	Paprastoji pempė	Northern Lapwing	*Vanellus vanellus*	14	VU		
	Juodakrūtis bėgikas	Dunlin	*Calidris alpina*	1	LC	x	
	Miškinis Tikutis	Wood Sandpiper	*Tringa glareola*	2	LC	x	x
	Brastinis tilvikas	Green Sandpiper	*Tringa ochropus*	2	LC		
	Raudonkojis tulikas	Common Redshank	*Tringa totanus*	2	VU	x	
	Slanka	Eurasian Woodcock	*Scolopax rusticola*	2	LC		
	Perkūno oželis	Common Snipe	*Gallinago gallinago*	5	VU		
Žvirbliniai / Passerines	Putpelė	Common Quail	*Coturnix coturnix*	5	LC		
	Griežlė	Corn Crake	*Crex crex*	3	LC	x	x
	Keršulis	Common Wood Pigeon	*Columba palumbus*	12	LC		
	Gegutė	Common Cuckoo	*Cuculus canorus*	7	LC		
	Lėlys	European Nightjar	*Caprimulgus europaeus*	1	LC	x	x
	Tulžys	Common Kingfisher	*Alcedo atthis*	1	LC	x	x
	Kukutis	Eurasian Hoopoe	*Upupa epops*	2	LC	x	
	Juodoji meleta	Black Woodpecker	*Dryocopus martius*	2	LC		x
	Didysis margasis genys	Great Spotted Woodpecker	*Dendrocopos major*	4	LC		
	Mažasis margasis genys	Lesser Spotted Woodpecker	*Dryobates minor*	1	LC		
	Dirvinis vieversys	Eurasian Skylark	*Alauda arvensis*	69	LC		
	Lygutė	Woodlark	*Lullula arborea*	3	LC		x
	Šelmeninė kregždė	Barn Swallow	*Hirundo rustica*	1	LC		
	Pievinis kalviukas	Meadow Pipit	*Anthus pratensis*	10	LC		
	Miškinis kalviukas	Tree Pipit	*Anthus trivialis*	11	LC		
	Baltoji kielė	White Wagtail	*Motacilla alba*	1	LC		
	Geltonoji kielė	Western Yellow Wagtail	*Motacilla flava*	3	LC		
	Geltongalvė kielė	Citrine Wagtail	*Motacilla citreola*	6	LC	x	

Bird group	Lithuanian name	English name	Scientific name	N° Ind.	IUCN	LSRS	EU/BD I
	Karietaitė	Eurasian Wren	*Troglodytes troglodytes*	16	LC		
	Strazdas giesmininkas	Song Thrush	*Turdus philomelos*	20	LC		
	Amalinis strazdas	Mistle Thrush	*Turdus viscivorus*	7	LC		
	Juodasis strazdas	Common Blackbird	*Turdus merula*	24	LC		
	Liepsnelė	European Robin	*Erithacus rubecula*	25	LC		
	Paprastoji raudonuodegė	Common Redstart	*Phoenicurus phoenicurus*	1	LC		
	Paprastoji kiauliukė	Whinchat	*Saxicola rubetra*	16	LC		
	Sodinė devynbalsė	Garden Warbler	*Sylvia borin*	3	LC		
	Juodagalvė devynbalsė	Eurasian Blackcap	*Sylvia atricapilla*	30	LC		
	Rudoji devynbalsė	Common Whitethroat	*Curruca communis*	10	LC		
	Pilkoji devynbalsė	Lesser Whitethroat	*Curruca curruca*	5	LC		
	Ežerinė nendrinukė	Sedge Warbler	*Acrocephalus schoenobaenus*	20	LC		
	Didžioji krakšlė	Great Reed Warbler	*Acrocephalus arundinaceus*	2	LC		
	Margasis žiogelis	Common Grasshopper Warbler	*Locustella naevia*	3	LC		
	Nendrinis žiogelis	Savi's Warbler	*Locustella luscinioides*	3	LC		
	Paprastoji tošinukė	Icterine Warbler	*Hippolais icterina*	1	LC		
	Ankstyvoji pečialinda	Willow Warbler	*Phylloscopus trochilus*	16	LC		
	Žalioji pečialinda	Wood Warbler	*Phylloscopus sibilatrix*	31	LC		
	Pilkoji pečialinda	Common Chiffchaff	*Phylloscopus collybita*	29	LC		
	Paprastasis nykštukas	Goldcrest	*Regulus regulus*	18	LC		
	Baltabruvis nykštukas	Common Firecrest	*Regulus ignicapilla*	3	LC		
	Margasparnė musinukė	European Pied Flycatcher	*Ficedula hypoleuca*	4	LC		
	Mažoji musinukė	Red-breasted Flycatcher	*Ficedula parva*	7	LC		x
	Didžioji zylė	Great Tit	*Parus major*	15	LC		

Bird group	Lithuanian name	English name	Scientific name	N° Ind.	IUCN	LSRS	EU/BD I
	Juodoji zylė	Coal Tit	*Periparus ater*	2	LC		
	Mėlynoji zylė	Eurasian Blue Tit	*Cyanistes caeruleus*	4	LC		
	Paprastoji pilkoji zylė	Marsh Tit	*Poecile palustris*	1	LC		
	Šiaurinė pilkoji zylė	Willow Tit	*Poecile montanus*	1	LC		
	Bukutis	Eurasian Nuthatch	*Sitta europaea*	3	LC		
	Miškinis liputis	Eurasian Treecreeper	*Certhia familiaris*	7	LC		
	Paprastoji medšarkė	Red-backed Shrike	*Lanius collurio*	5	LC		x
	Kėkštas	Eurasian Jay	*Garrulus glandarius*	1	LC		
	Riešutinė	Spotted Nutcracker	*Nucifraga caryocatactes*	1	LC		
	Kranklys	Northern Raven	*Corvus corax*	1	LC		
	Volungė	Golden Oriole	*Oriolus oriolus*	3	LC		
	Paprastasis kikilis	Common Chaffinch	*Fringilla coelebs*	90	LC		
	Dagilis	European Goldfinch	*Carduelis carduelis*	2	LC		
	Alksninukas	Eurasian Siskin	*Spinus spinus*	5	LC		
	Juodagalvė sniegena	Eurasian Bullfinch	*Pyrrhula pyrrhula*	4	LC		
	Raudongalvė sniegena	Common Rosefinch	*Carpodacus erythrinus*	1	LC		
	Svilikas	Hawfinch	*Coccothraustes coccothraustes*	3	LC		
	Eglinis kryžiasnapis	Red Crossbill	*Loxia curvirostra*	1	LC		
	Geltonoji starta	Yellowhammer	*Emberiza citrinella*	12	LC		
	Nendrinė starta	Common Reed Bunting	*Emberiza schoeniclus*	6	LC		
			Total	**649**			



Fig, 5.4.121. Nests and possible breeding territories of Birds of Prey within survey area.

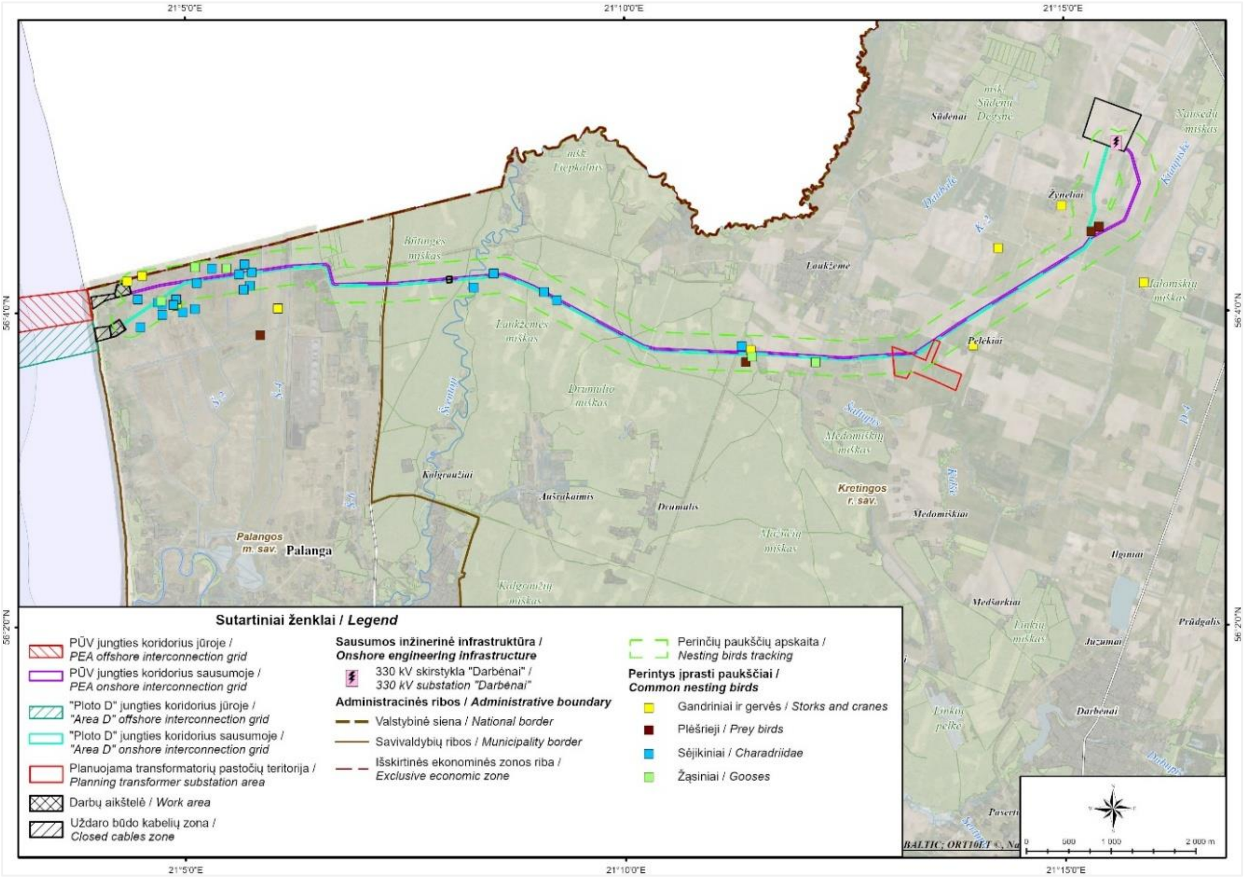


Fig. 5.4.122. Territorial bird registrations within survey area (1 of 2).

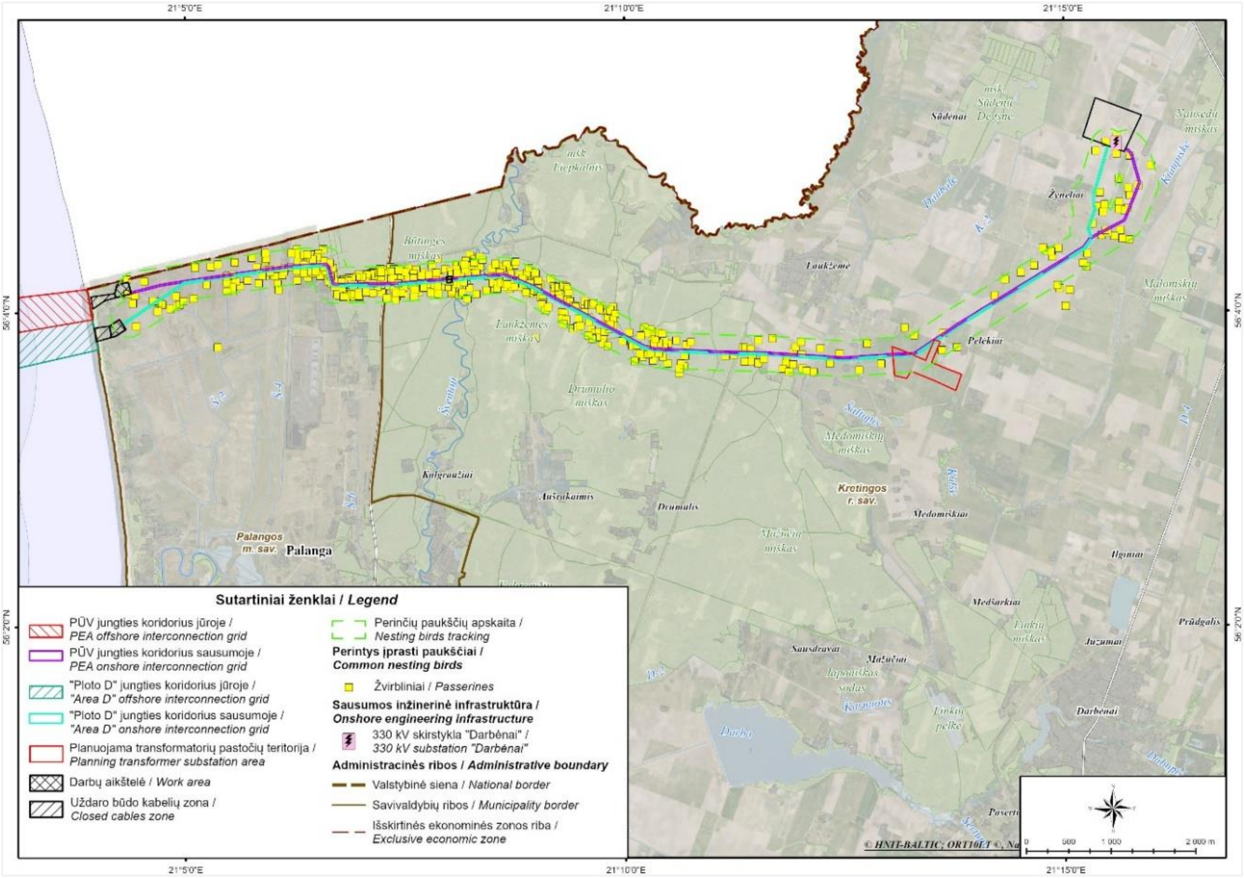


Fig. 5.4.123. Territorial bird registrations within survey area (2 of 2).

As expected, the most abundant species recorded were passerines, found across various habitats. Common Chaffinches dominated woodland areas, while Eurasian Skylarks were numerous in open landscapes.

The most sensitive species were recorded in meadows in the western part of the research area. Wet meadows are scarce in Northwestern Lithuania, making them crucial breeding grounds for some rare birds. The Citrine Wagtail, a rare passerine that breeds almost exclusively in wetlands, was quite abundant (n = 6). Other rare species exhibiting territorial behaviour during the breeding period included the Wood Sandpiper (n = 2), Common Redshank (n = 2), and Northern Lapwing (n = 14). These species used to be common breeders in suitable habitats, but their populations are now in decline. In spring, the meadows are flooded and attract thousands of geese, ducks, and shorebirds, highlighting the importance of maintaining the hydrological regime. If alteration is unavoidable, the effects should be reversible immediately after cable installation.

Additionally, territorial behaviour of Marsh and Montagu's Harriers was observed within the research area (see Fig. 5.4.121). Pairs of each species were seen making territorial flights above reedbeds, though no nests were found. It is essential to locate nests before beginning construction work. These studies must be carried out by an ornithologist with the appropriate expertise.

During the survey, activity of Common Buzzards, European Honey Buzzards, Eurasian Goshawks, and White-tailed Eagles was observed over the area; however, no nests were discovered for these species.

According to SRIS data, six species have been recorded in close proximity to the research area: Common Merganser (n = 1), Wood Sandpiper (n = 1), Red-breasted Flycatcher (n = 6), Common Kingfisher (n = 1), White Stork (n = 3), and Grey Partridge (n = 1) (see Figs. 5.4.124, 5.4.125, and 5.4.126).

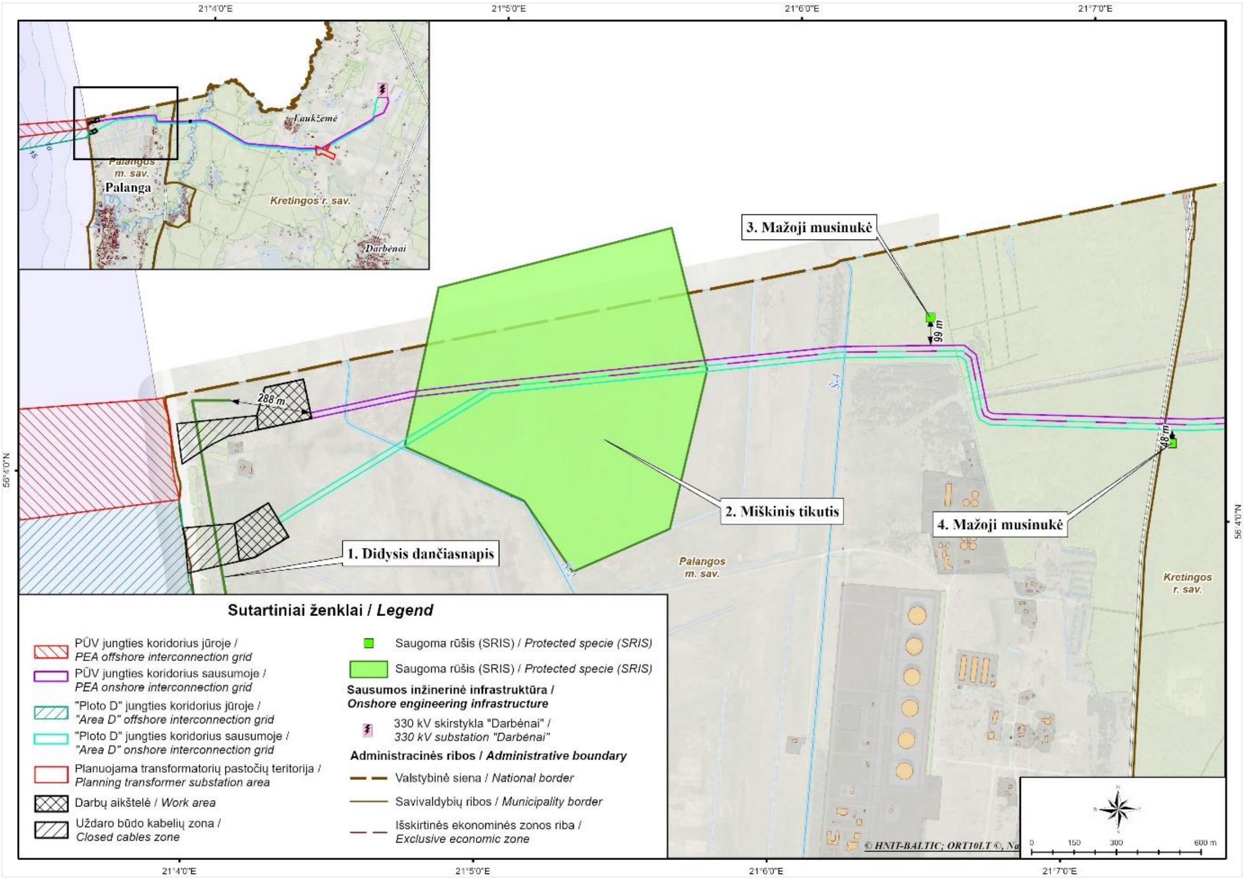


Fig. 5.4.124. Sites of protected species registered in the SRIS system (1 of 3).

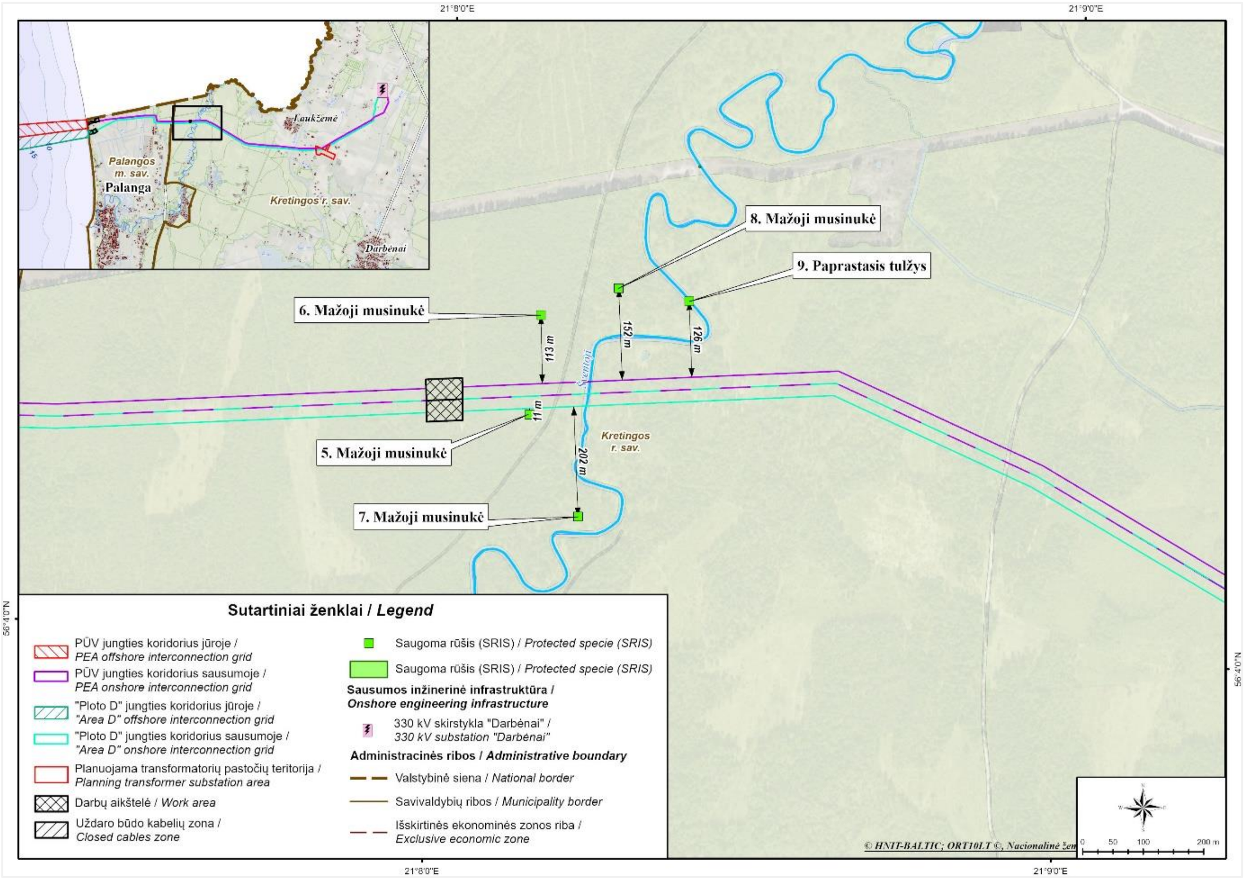


Fig. 5.4.125. Sites of protected species registered in the SRIS system (2 of 3).

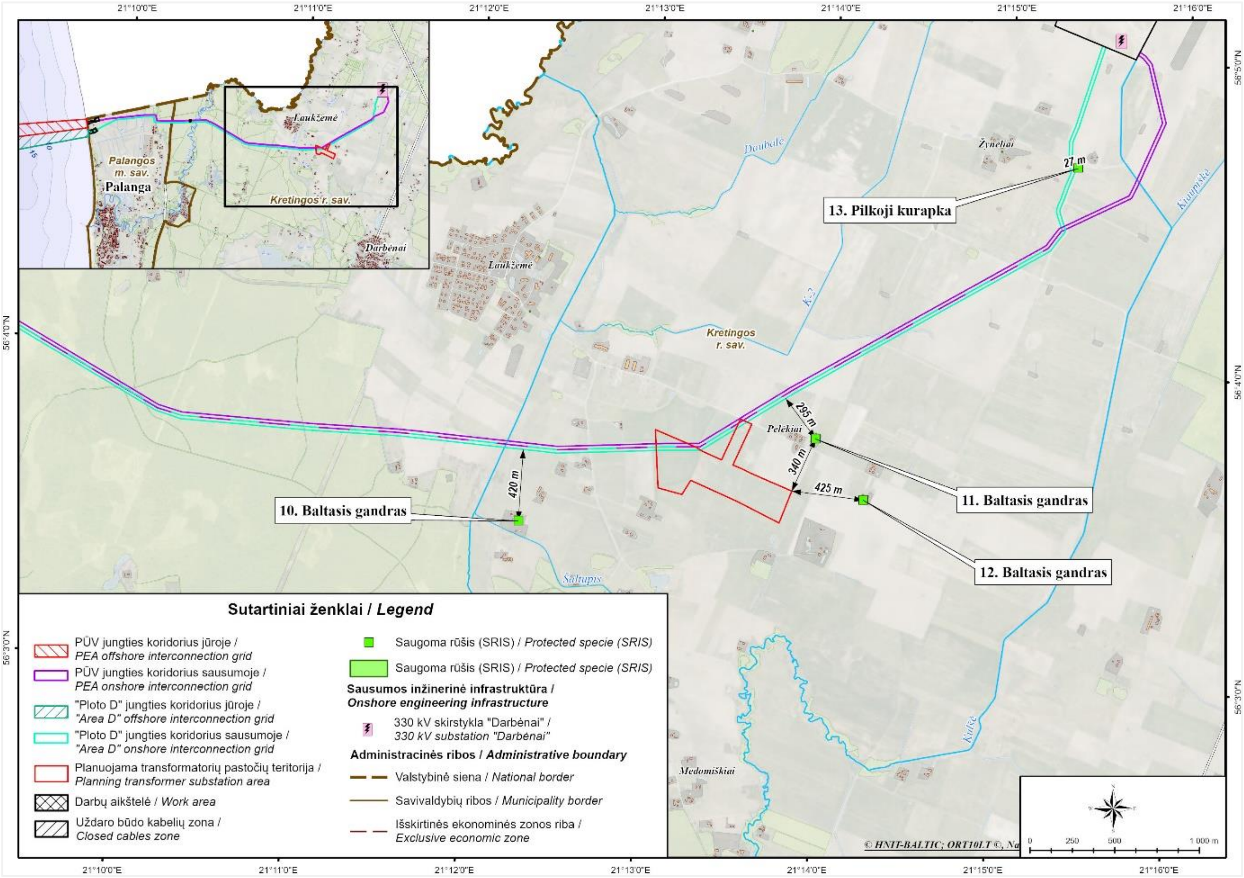


Fig. 5.4.126. Sites of protected species registered in the SRIS system (3 of 3).

5.4.9.3.2. Mammals

In non-forested areas, the export cable corridors to and beyond the Būtingė and Laukžmė forests cross agricultural land. In the areas up to the Būtingė forest, meadow habitats have formed in moist and wet environments, with vegetation dominated by reed and tufted sedge. Beyond the Laukžmė forest, arable land with monoculture crops predominates. These habitats commonly host small rodents, European hares (*Lepus europaeus*), badgers (*Meles meles*), polecats (*Mustela putorius*), red foxes (*Vulpes vulpes*), and common raccoon dogs (*Nyctereutes procyonoides*). In the evenings, roe deer (*Capreolus capreolus*) and large herds of wild boar (*Sus scrofa*) emerge from the nearby forests to forage in the Būtingė meadows. Eurasian beavers (*Castor fiber*) breed on the banks of large and small streams and canals, and traces of Eurasian otters (*Lutra lutra*) have been observed.

Fig. 5.4.127. Eurasian otter (*Lutra lutra*) (photo G.Gražulevičius).

The Eurasian water shrew (*Neomys fodiens*) can be found on the banks of water bodies, and various other species of voles and mice can be found in meadows and cultivated fields. The planned export cable corridors cross the Būtingė and Laukžme forests, where common large mammals live and breed – red deer (*Cervus elaphus*), moose (*Alces alces*) and wild boar (*Sus scrofa*).

Fig. 5.4.128. Moose (*Alces alces*) live and breed in the forests of Būtingė and Laukžme. (photo G.Gražulevičius).

5.4.9.3.3. Amphibians and reptiles

Reptile and amphibian species (including protected species) are not abundant and diverse in the onshore section of export cable corridors and the adjacent territory, however, in suitable habitats, common reptile and amphibian species typical for this region can be found, such as the common toad (*Bufo bufo*) and common frog (*Rana temporaria*) in the Būtingė meadows. The pool frog (*Rana lessonae*) can be found on the shores of water ponds. Areas with natural meadows and pastures, as well as swamps and springs, where amphibians breed and live, is located at a distance of 45 m to 472 m from planned construction area (Fig. 5.4.112–5.4.114 and Table 5.4.56). Mating occurs in May. For breeding, amphibians choose small, shallow water bodies, temporary ponds, bogs, and lakes. It spawns in almost all standing waters.

Fig. 5.4.129. The pool frog (*Rana lessonae*) found in small ponds (photo G.Gražulevičius).

Four species of reptiles are found in the area of the onshore section of export cable corridor and the surrounding area. The sand lizards (*Lacerta agilis*), the viviparous lizards (*Lacerta vivipara*), the grass snake (*Natrix natrix*) and the common slow worm (*Anguis fragilis*) breed here.

Fig. 5.4.130. The common slow worm (*Anguis fragilis*) (photo G.Gražulevičius).

Fig. 5.4.131. The grass snakes (*Natrix natrix*) breed in the survey area (photo G.Gražulevičius).

In the area of the planned onshore section of export cable corridor, reptiles are found near sandy slopes and coastal dunes. They can often be observed in the Būtingė and Laukžemė forests resting on stones or hiding under leaves or branches. Amphibians and reptiles hibernate in October or November and wake up in March or April. Mating begins in early May.

5.4.9.3.4. Invasive species

According to the Invasive Species Information System, there are no registered locations of invasive fauna species in the vicinity of the export cable corridor. The highest probability is to find American mink in the survey area.

Fig. 5.4.132. Invasive animal species – American mink (*Neovison vison*) – observed in the onshore section of export cable corridor and its vicinity (photo G.Gražulevičius).

The natural range of the American mink encompasses North America. It was introduced to Lithuania in 1930 for farming purposes. Mink was deliberately released into the wild in the Zarasai and Utena districts in 1950, and in the Ukmergė and Anykščiai districts in 1953. Following World War II, mink reached the western part of Lithuania, particularly the Nemunas Delta, from the Königsberg region, having escaped from destroyed mink farms. By around 1985, the American mink had spread throughout Lithuania, and their proliferation in the country continues unabated. The density of mink along a ten-kilometre stretches of riverbed ranges from 3 to 12 individuals (Balčiauskas et al., 2022). The population size in 2020–2021 was estimated to be approximately 10,000 individuals, with up to 100 individuals hunted annually. American mink inhabits various water bodies, typically residing along the banks of streams and rivers with dense vegetation, as well as in forest swamps, reedbeds, shallow lakes, wetlands, and coastal areas. They often settle under tree roots or use beaver lodges for shelter and raising their young (Balčiauskas et al., 1999).

The invasiveness of the American mink is attributed to its broad diet and the displacement of native European mink through alterations in the nutritional niche. Its diet primarily consists of rodents, voles, birds, amphibians, fish, and crustaceans, varying according to habitat (Balčiauskas et al., 1999).

The PEA does not entail modifications to suitable habitats or feeding areas for mink and therefore is not expected to impact the population of the American mink.

5.4.9.3.5. Potential Impact on birds

Potential impact on birds during export cable laying activities:

- Displacement – can lead to the destruction or alteration of bird habitats, including nesting sites, foraging and staging areas. Habitat changes may also result in birds avoiding the area, which can lead to reduced population densities.
- Disturbance – particularly through noise, visual impact, and human activity associated with the construction can lead to habitat avoidance, reduced reproductive success, and displacement from key areas.

No significant negative impact on birds is expected during the operational phase.

The impact on birds during the decommissioning phase is possible due to the dismantling of connection cables and will be similar to that during the construction phase: a temporary and local impact due to disturbance during the works and changes in the habitats formed, which may temporarily reduce the abundance of birds in the work area and its vicinity.

5.4.9.3.6. Reptiles and amphibians

Significant negative impacts could occur if habitats are destroyed or fragmented. Greater impacts are expected when laying cables through forested areas. The impact is particularly relevant for amphibians during spawning, i.e. in April–May.

5.4.9.3.7. Mammals

Short-term impact on game fauna and small mammals is related to disturbance during construction. However, in certain cases, long-term impact could appear if the animal has moved out of the area and then does not return to it for several years. This is relevant for large animals, especially predators that are attached to breeding areas. However, other species (roe deer, moose, wild boar) are also sensitive to disturbance during the breeding season (March–July), especially at the beginning of the breeding season (March–April). If construction work begins in a particular location after the animals have already started breeding, they may abandon their offspring, thus leaving them to death.

For information regarding bats, please refer to Chapter 5.4.4 of this report.

5.4.9.4. Preventive, mitigation and compensatory measures

5.4.9.4.1. Birds

Considering that the area, especially the meadows from the sea to the forest, is sensitive from a bird perspective, the following mitigation measures are envisaged:

- It is particularly important that the hydrological regime of the territory is not disturbed. Activities that may affect the hydrological regime should not be carried out from November to February. If it is impossible to carry out the work without changing the hydrological regime, the hydrological regime and water level must be restored immediately after the cable installation.
- Before carrying out any work, it is necessary to check whether there are any Western Marsh Harrier or Montagu's Harrier nests in the area where the work is planned or in its immediate vicinity. These surveys must

be carried out by an ornithologist with the appropriate expertise. If Western Marsh Harrier nest is found, work must not be carried out between April 1 and August 31, and between April 15 and August 31 for Montagu's Harrier. The restrictions apply within a 500 m radius of the nest.

- To avoid disturbance and displacement of birds and potential impact on bird breeding, feeding and resting habitats, preparatory infrastructure works (e.g. access roads) for cable laying activities in the section from the sea to the forest should be carried out from November to February.
- To avoid disturbing birds and potential impact on nesting sites, all tree and shrub cutting may not be carried out during the bird breeding period from March to July.
- If excavation work is planned to be carried out from March to July, a thorough check must be made before excavation work begins to ensure that there are no breeding birds in the excavation and storage areas. These surveys must be carried out by an ornithologist with the appropriate expertise.

A summary of the potential impact of cable laying works on birds and the appropriate mitigation measures is provided in Table 5.4.61.

5.4.9.4.2. Mammals

- If excavation activities are to be carried out from March to July, the excavated soil storage area must be inspected for the presence of juveniles before dumping the soil.
- The excavated soil will have to be pushed slowly to allow animals to escape.

5.4.9.4.3. Reptiles and amphibians

- If excavation work is to be carried out from March to July, the excavated soil storage area must be inspected for reptiles or amphibians before dumping.
- The excavated soil will have to be pushed slowly to allow animals to escape.
- It is particularly important that the hydrological regime of the territory is not disturbed. Activities that may affect the hydrological regime must be carried out from November to February. If it is impossible to carry out the work without changing the hydrological regime, the hydrological regime and water level must be restored immediately after the cable installation.

Table 5.4.61. Summary of potential impacts of cable laying works on birds, mammals and reptiles onshore and relevant mitigation measures

Stages	Impact	Nature	Scale	Duration	Importance	Mitigation measures
			Birds			
Installation	Cutting trees and shrubs	Negative direct impact – disturbance of birds and possible destruction of nesting sites	Local (within the export cable laying area and adjacent territory)	Short-term (during installation)	Potential impact of minor significance – temporary fluctuations in bird abundance	Tree and shrub cutting is not carried out from March to July inclusive.
	Physical destruction of habitats	Negative direct impact – potential reduction in migration, feeding and resting areas	Local (within the export cable laying area and adjacent territory)	Short-term	Potential impact of minor significance – temporary fluctuations in bird abundance	If Western Marsh Harrier nest is found, work must not be carried out between April 1 and August 31, and between April 15 and August 31 for Montagu's Harrier. The restrictions apply within a 500 m radius of the nest. Preparatory infrastructure works for cable laying activities in the section from the sea to the forest are carried out from November to February inclusive.
	Changes in the hydrological regime	Negative direct impact – potential reduction in migration, feeding and resting areas	From local in the export cable laying area to local in the hydrological network area	Short-term	Potential moderate impact – loss of habitat for birds breeding in wet meadows	It is particularly important that the hydrological regime of the territory is not disturbed. Activities that may affect the hydrological regime must be carried out from November to February inclusive.
	Excavation	Negative direct impact – possible destruction of nesting sites	Local (within the export cable laying area and adjacent territory)	Short-term (during installation)	Potential moderate impact – destruction of nesting sites	If excavation activities are planned to be carried out from March to July inclusive, a thorough check should be made before excavation work begins to ensure that there are no breeding birds in the soil storage areas.
Operation and Maintenance	No effects are expected under normal operating conditions				Insignificant	Not applicable.
Decommissioning	Excavation	Negative direct impact – possible destruction of nesting sites	Local (within the export cable laying area and adjacent territory)	Short-term (during dismantling)	Potential moderate impact – destruction of nesting sites	If excavation activities re planned to be carried out from March to July inclusive, a thorough check should be made before

Stages	Impact	Nature	Scale	Duration	Importance	Mitigation measures
						excavation work begins to ensure that there are no breeding birds in the soil storage areas.
			Reptiles and amphibians			
Installation	Changes in the hydrological regime	Negative direct impact – potential habitat destruction	From local in the export cable laying area to local in the hydrological network area	Short-term	Possible moderate impact	It is particularly important that the hydrological regime of the territory is not disturbed. Activities that may affect the hydrological regime must be carried out from November to February inclusive.
	Excavation	Negative direct impact – potential habitat destruction	Local (within the export cable laying area and adjacent territory)	Short-term (during installation)	Possible moderate impact	If excavation activities are planned to be carried out from March to July, the area where the excavated soil is stored must be checked for reptiles or amphibians before dumping. The excavated soil is moved slowly to allow animals to escape.
Exploitation	No effects are expected under normal operating conditions.				Insignificant	Not applicable
Decommissioning	Excavation	Negative direct impact – potential breeding habitat destruction	Local (within the export cable laying area and adjacent territory)	Short-term (during dismantling)	Possible moderate impact	If excavation activities are planned to be carried out from March to July, the area where the excavated soil is stored must be checked for reptiles or amphibians before dumping. The excavated soil is moved slowly to allow animals to escape.
			Mammals			
Installation	Forest cutting	Negative direct impact – disturbance	Local (within the export cable laying area and adjacent territory)	Short-term (during installation)	Potential impact of minor significance	Not applicable.
	Physical loss of habitats	Negative direct impact – possible reduction in feeding and resting areas	Local (within the export cable laying area and adjacent territory)	Short-term	Potential impact of minor significance s	Not applicable.

Stages	Impact	Nature	Scale	Duration	Importance	Mitigation measures
	Excavation	Negative direct impact – potential habitat destruction	Local (within the export cable laying area and adjacent territory)	Short-term (during installation)	Possible moderate impact	The excavated soil will have to be pushed slowly to allow animals to escape.
Exploitation	No effects are expected under normal operating conditions				Insignificant	Not applicable.
Decommissioning	Excavation	Negative direct impact – potential breeding habitat destruction	Local (within the export cable laying area and adjacent territory)	Short-term (during dismantling)	Possible moderate impact	The excavated soil will have to be pushed slowly to allow to escape.

Colour code

	Positive impact
	No impact or impact insignificant (not to be considered, no measures are applicable)
	Minor impact: decisions during design, preventive or mitigation measures
	Moderate impact: addressed by mitigation measures
	Significant impact: mitigation and/or compensation measures are necessary.

5.4.10. Plankton

The Baltic Sea ecosystem is characterized by pronounced seasonality and vertical distribution of plankton, driven by temperature fluctuations, variations in light availability, and nutrient dynamics. As a result of these environmental factors, different plankton communities dominate in different seasons. In spring, phytoplankton is mainly composed of diatoms and dinoflagellates, while zooplankton includes rotifers, copepods, and cladocerans. During summer, filamentous cyanobacteria capable of nitrogen fixation become dominant, along with green algae and some dinoflagellate species. At the same time, the zooplankton community is marked by an increased abundance of cladocerans, particularly Bosmina coregoni, although copepods remain ecologically significant. In autumn, overall plankton biomass declines; however, wind-induced mixing and the upward transport of nutrients into surface waters can trigger a secondary bloom of diatoms (Gasiūnaitė et al., 2005; Hjerne et al., 2019).

5.4.10.1. Research methods

5.4.10.1.1. Research methods for assessing the current state

Phytoplankton and zooplankton samples in the Baltic Sea were collected from 8 stations (coinciding with F-POD‘s recorders, Fig. 5.4.79) in summer (21st July 2024) and autumn (13th November 2024, only phytoplankton).

For phytoplankton analysis, water samples were collected with a fixed-capacity (2 L) water sampler from the photic zone: 0–1 m, 2.5 m, 5 m, 7.5 m, and 10 m depths and mixed in a large plastic bucket, from which one sample was taken for algae studies (HELCOM, 2021). Additionally, one sample was taken from the bottom layer (1–5 m from the bottom). All samples were kept at +5°C, live samples were kept for up to two days until analysis.

For zooplankton analysis, an integrated surface (0–25 m) and deep (0–~ 40) zooplankton samples were taken in each station using a standard WP-2 net (100 µm mesh size and a 57 cm opening diameter). The samples were preserved in 4% formaldehyde solution.

The plankton samples were investigated using automated counting and measurement devices.

The unfixed *Phytoplankton* samples were analysed the next day using the laser excitation function of image recognition flow cytometry (FlowCam® Cyano, Yokogawa Fluid Imaging Technologies, USA). Samples were first filtered through a 300 and/or 100 µm mesh and examined using a 4x and/or 10x objective, respectively. 2–7 ml of each sample was examined. Image data identification was performed using VisualSpreadsheet®6 software (Yokogawa Fluid Imaging Technologies, USA) and then manually confirmed. Biological volumes for each species or higher taxon were taken from VisualSpreadsheet®6 software and adjusted as necessary (Olenina et al.,2006, Hrycik et al., 2019). The abundance of algae was calculated by counting the number of photos of specific species/groups counted by the program. The abundance of filamentous cyanobacteria, diatoms, and green algae was recalculated by taking their geodesic length and dividing accordingly: for cyanobacteria by 100 µm (as a counting unit according to HELCOM, 2021), and for diatoms and green algae by the average cell length of that species. The abundance of colonial algae species was equated to the number of counted colonies.

Zooplankton samples were analysed using the automated image recognition and analysis system ZooScan (HYDROPTIC Inc., France), following the protocol (Jalabert et al., 2022). Each sample was split using a Motoda box until it contained approximately 2,000–5,000 objects. Samples were prepared, scanned, and the high-quality images (2,400 dpi) were processed with the Zooprocess program and the image analysis software Image-J to generate individual object images (vignettes). These images were then imported into the EcoTaxa online platform, where automatic identification of zooplankton species/taxa was performed using LearningBaltic library[91]. For each sample, species/taxa, abundance, and organism size were determined.

5.4.10.1.2. Methods for assessing potential impacts

To assess the potential impact on plankton, several factors were assessed:

- Species composition – current situation during the different seasons.
- Mean abundance and/or biomass, size structure (for zooplankton) – in 8 more or less equally distributed PEA area.
- Comparison of species composition, abundance and/or biomass in the surface layer (0–10 m for phytoplankton and 0–25 m for zooplankton) and deep layer (~0.3–1 m above bottom for phytoplankton and 0–40 m for zooplankton).

[91] https://ecotaxa.obs-vlfr.fr/prj/13149

5.4.10.2. Survey area

In the current state analysis, the investigation was conducted in eight evenly distributed locations (Fig. 5.4.133) across the planned OWF area in a 4.5 km (2.16 nautical mile) grid, coinciding with the F-POD‘s recorders (Fig. 5.4.79, Table 5.4.36).

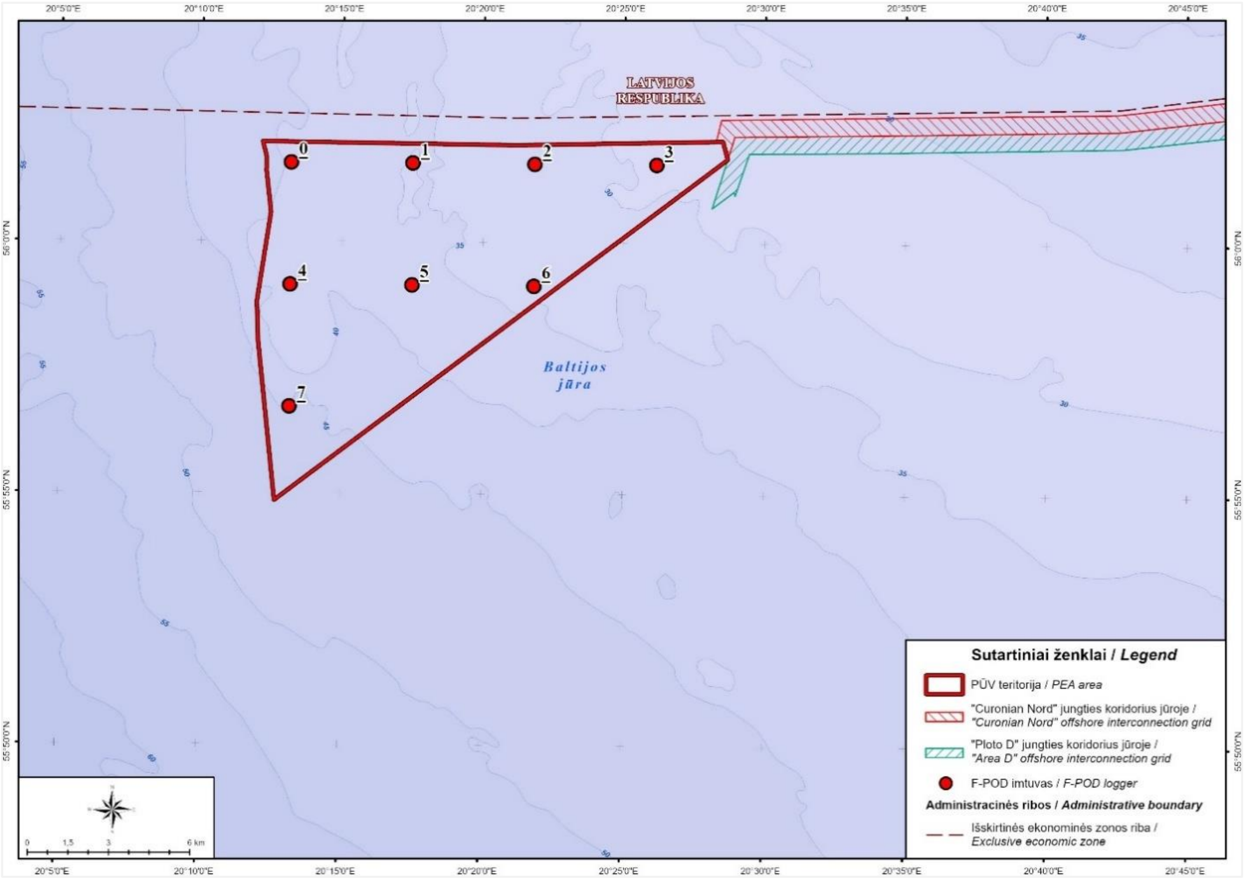


Fig. 5.4.133. Plankton sampling stations.

5.4.10.3. Observation results

5.4.10.3.1. Phytoplankton community diversity, abundance and biomass

During the study period, species characteristic of the summer (21st of July) and autumn (13th of November) seasons were found in the Baltic Sea, namely cyanobacteria and diatoms. Representatives of other algae groups, such as dinoflagellates, cryptophytes, and green algae, were sparse, with low biomass, and therefore were combined into a single group, named "Others". Species diversity and the proportions between stations did not vary significantly, with slightly higher phytoplankton abundance and biomass observed at stations further from the shore, gradually decreasing as the stations approached the shore (Fig. 5.4.134).

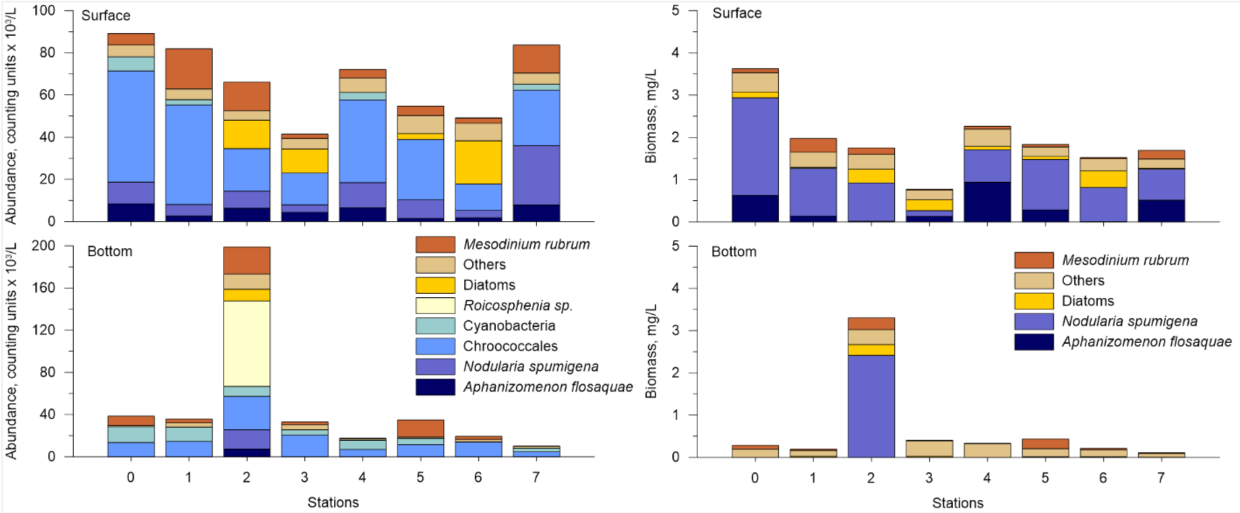
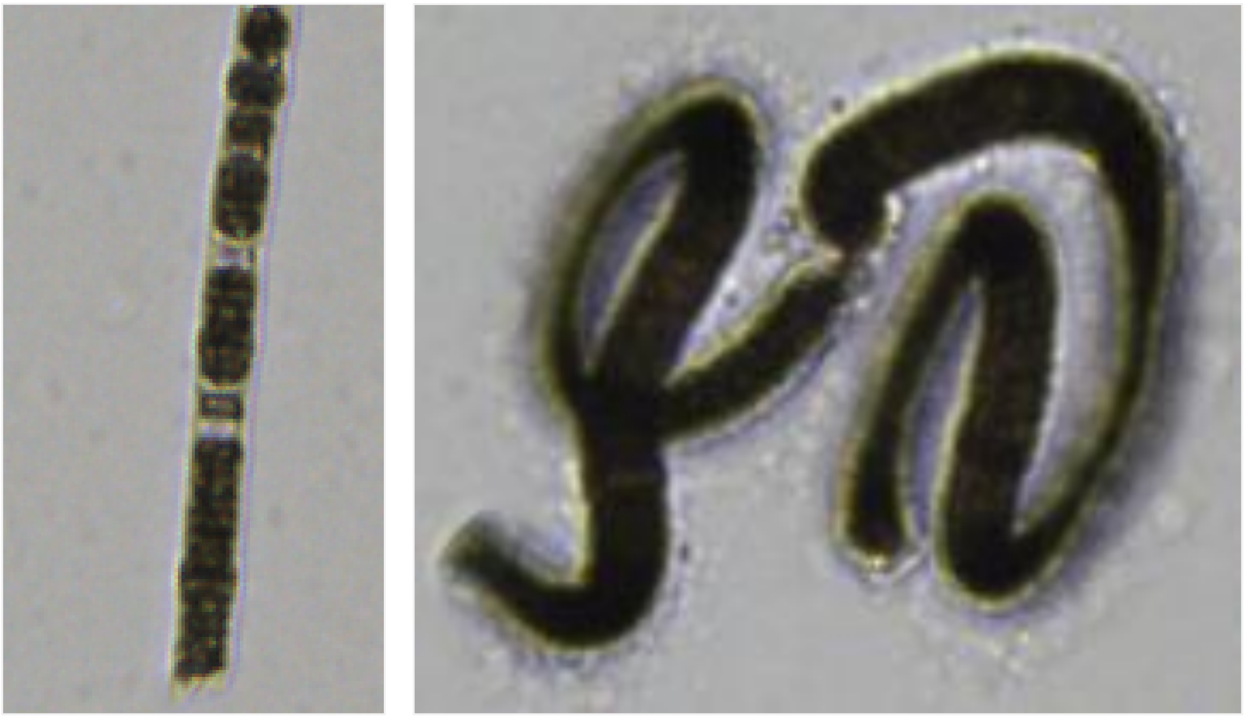


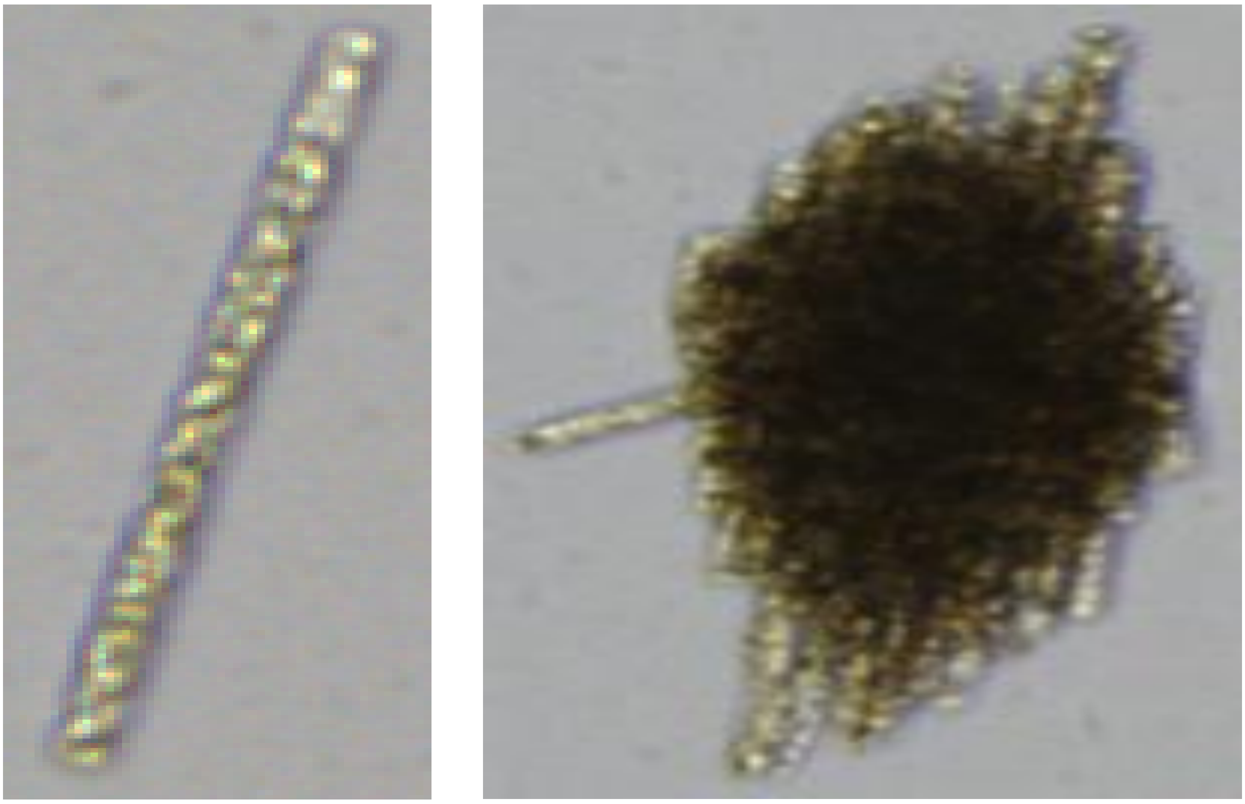
Fig. 5.4.134. Phytoplankton abundance and biomass in the CN OWF area stations on 21st July 2024.

During the summer research period, warm (water temperature fluctuated around 21–22°C) and calm weather prevailed, so the upper layers of the Baltic Sea were rich in fresh-brackish and freshwater cyanobacteria typical of the Baltic Sea. Among them, the *Nodularia spumigena* species dominated (Fig. 5.4.135A), which, together with another cyanobacterium *Aphanizomenon flosaquae* (Fig. 5.4.135B), formed a “carpet” on the water surface through which sunlight hardly penetrates into the deeper layers and thus competes with other algae. Such a mass abundance of algae is called a “water bloom”, which is observed in the Baltic Sea not every year, but only when climatic conditions are favourable for the mass reproduction of algae. This “bloom” is observed only in the uppermost water layer; therefore, when taking a sample from the water column from different depths, not many *Nodularia* filaments were found. However, these are sufficiently large colonies, so their biomass was significant among the total phytoplankton biomass (Fig. 5.4.134).

A



B



C

Fig. 5.4.135. The bloom of cyanobacteria (A) and dominant species *Nodularia spumigena* (B), and *Aphanizomenon flosaquae* (C) (Photos of organisms here and below were taken by FlowCam® Cyano, Yokogawa Fluid Imaging Technologies) in the offshore wind energy park "Curonian Nord" territory stations on 21st July 2024.

It should be noted that the cyanobacterium *Nodularia spumigena* produces hepatotoxic toxins (affecting the liver): nodularin and microcystins, which are toxic not only to aquatic organisms, but can also harm humans, as toxins accumulate in the tissues of marine organisms – molluscs, fish. *Aphanizomenon flosaquae*, which lives in the Baltic Sea, does not produce toxins (Šulčius et al., 2015), but the "carpet" of algae formed on the water surface during the bloom can negatively affect other algae or other aquatic organisms in deeper layers. Intensive turbulence during the summer could prevent the formation of cyanobacterial blooms. However, slow water movements are beneficial for the spread of these algae and provide them access to deeper, nutrient-rich layers (Oliver and Ganf, 2000).

In addition to these filamentous cyanobacteria, cyanobacteria of the order Chroococcales (e.g. *Woronichinia* spp., Fig. 5.4.136A) were abundant during the summer too. Colonies of these algae were numerous, but their cells are very small (1–2 x 1–3 µm), so their biomass was also low, and they were combined into a “Others” group with other algae (Fig. 5.4.136). Among green algae, *Binuclearia lauterbornii* and *Oocystis* sp. species were found in almost every sample, among cryptophytic algae (*Cryptophyceae* class) there were small representatives of the genera *Rhodomonas* and/or *Teleaulax* (Fig. 5.4.138 F), but due to their low abundance and biomass they were also combined into the group “Others”.

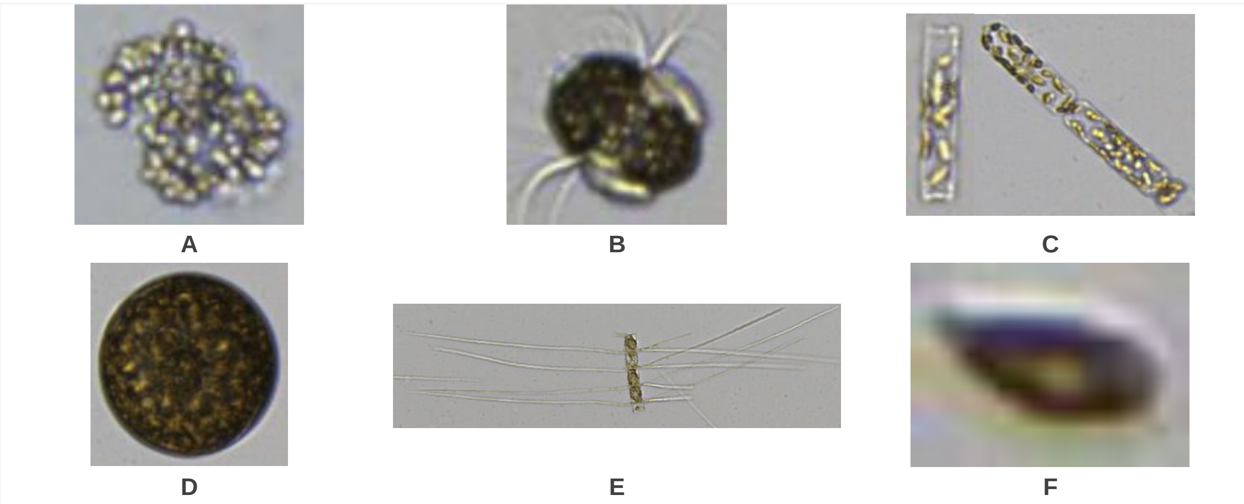


Fig. 5.4.138. Baltic Sea plankton organisms: A) the most abundant cyanobacterium of the Chroococcales order, *Woronichinia sp.*, B) the protozoan *Mesodinium rubrum*, C) *Dactyliosolen fragilissimus* and/or *Cerataulina pelagica*, D) *Coscinodiscus sp.*, E) *Chaetoceros sp.*, F) a representative of the *Cryptophyceae* class.

In the bottom layer, the biomass of algae was about two times lower than in the upper layer, except for station 2, where the total biomass was about eight times higher than at other stations. Such a high biomass could be due to the mixing of water throughout the water column (e.g. when dropping and/or lifting anchor), because the sample contained both the cyanobacterium *Nodularia*, which stays on the water surface, and more of those diatoms that live sessile on the bottom surface. When the bottom sediments are stirred, relatively light algae rise from the bottom to the water column with the water mass. An example is the diatom *Roicosphenia* sp., whose abundance in the sample was high (Fig. 5.4.134), but the biomass was small, therefore it did not significantly affect the total algal biomass. Among other algae with a larger number, small cyanobacteria of the order Chroococcales (e.g. *Woronichinia* sp.) can be mentioned.

A large number of motile protozoa *Mesodinium rubrum* were found in both surface and bottom samples (Fig. 5.4.136B). These are small mixotrophic protozoa (approx. 55x20 µm in size), most of which contain photosynthetic symbionts (containing chloroplasts and the pigment chlorophyll a), that is, this protozoan can both produce its own food, like plants, and feed on other organisms. In the aquatic ecosystem, *Mesodinium* is an important component, as it feeds on other algae, thus reducing the abundance of fine algae, and is an excellent food source for larger zooplankton or small fish.

In autumn, due to stronger winds, the water column is usually mixed all the way to the bottom, so diatoms usually dominate. Due to the relatively low water temperature during the sampling (10–11 °C), the diversity of algae species was low. During the observed period, the algae communities at the surface and near bottom did not differ significantly in terms of species diversity, abundance or biomass. As mentioned earlier, in summer, as well as in autumn, algae were more abundant at stations located further from the shore. Diatoms dominated in all samples – *Dactyliosolen fragilissimus / Cerataulina pelagica*, and *Chaetoceros* spp. (Fig. 5.4.136C, 5.4.136E, 5.4.137). It should be noted that these algae are described as marine (where salinity is 25–38 PSU), although they are also widespread in the southern Baltic, where salinity is >10 PSU. In Lithuanian territorial waters, salinity is usually ~7–8 PSU, these species were first observed in year 2005 and are found in greater or lesser numbers almost every autumn. It is believed that these algae are brought in Lithuanian territorial waters from the southern regions of the Baltic Sea after strong winds (Olenina, 2008). Although the latter algae do not produce toxic substances, it is mentioned that they can cause mechanical irritation of the gills of fish, which can lead to death (Taylor et al., 1985), or after mass blooms they can inhibit the growth of benthic crustaceans by clogging the gills (Lorrain et al., 2000).

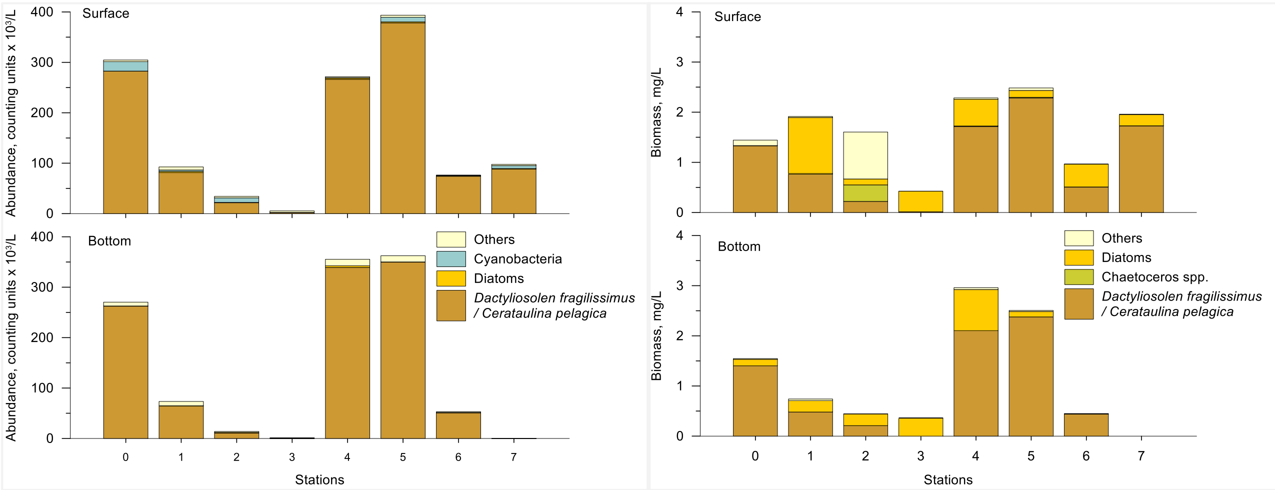


Fig. 5.4.137. Phytoplankton abundance and biomass in the offshore wind energy park "Curonian Nord" territory stations on 13th November 2024.

A significant part of the autumn community biomass was composed by another diatom, *Coscinodiscus* sp. This is a fairly large species (diameter ~100 µm, Fig. 5.4.138D), although the number of individuals in the samples was small. All diatoms require water mixing in order to survive in the water column, but very intense water mixing should prevent them from developing massively.

5.4.10.3.2. Zooplankton community diversity, abundance and size distribution

During the study period in the CN OWF area, 12 zooplankton species or higher taxa were identified (Fig. 5.4.138), belonging to three main taxonomic groups: *Cladocera* (branchiopod crustaceans), *Copepoda* (copepod crustaceans), and *Rotatoria* (rotifers). Only a few individuals of rotifers and copepod nauplii (the larval stage of copepods) were found in the samples, as these groups are too small (<200 µm) for the ZooScan to detect them. The system is designed to assess organisms ranging in size from 200 µm to 5 cm. Additionally, were identified non-living and non-zooplankton categories, which include objects such as detritus, dark (black) detritus, artifacts, bubbles, and fibres.

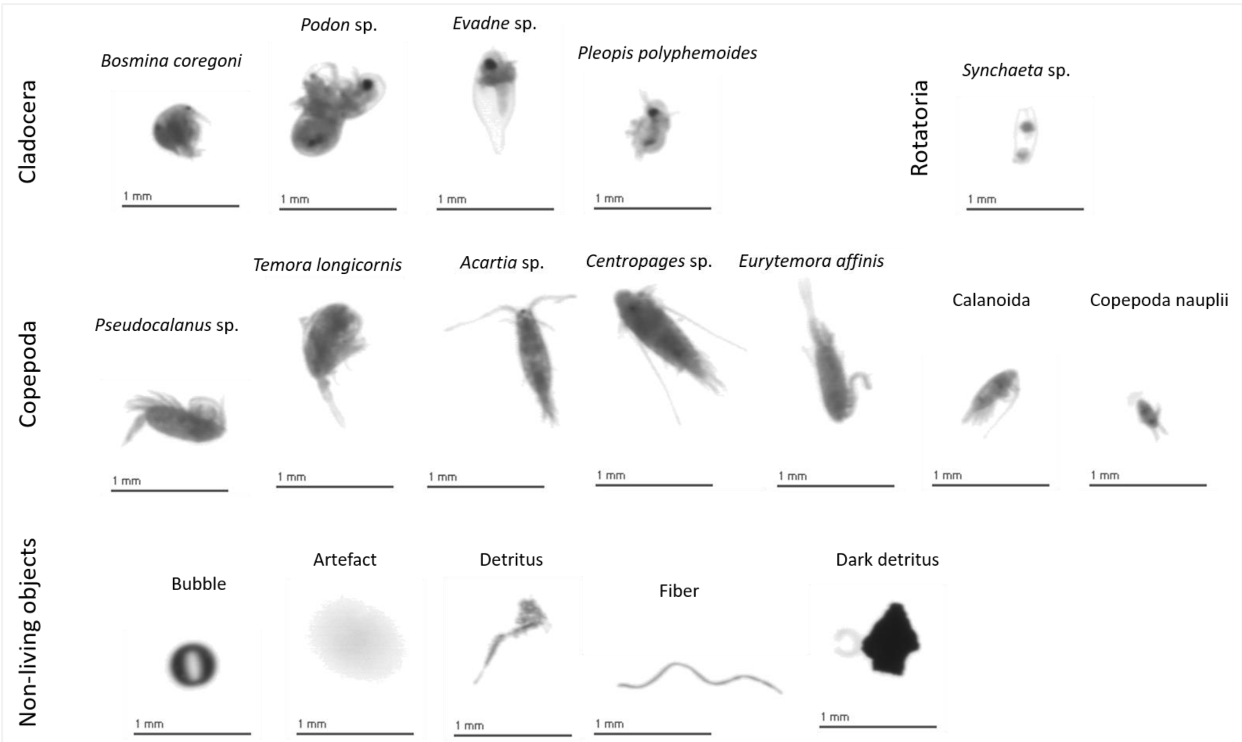


Fig. 5.4.138. Zooplankton species/taxa and non-living objects found in the study area (images made by ZooScan system).

The overall zooplankton abundance in integrated surface and deep samples showed only slight differences (Fig. 5.4.139A), suggesting that the zooplankton is concentrated in the surface layer (0–25 m) above the thermocline, with no organisms found below the thermocline. The only exception was a deep sample from station 6, where the highest zooplankton abundance was recorded. This could be influenced by a change in the net towing angle due to strong current, which might have affected the accurate estimation of the filtered water volume, indicating the need for a repeat investigation.

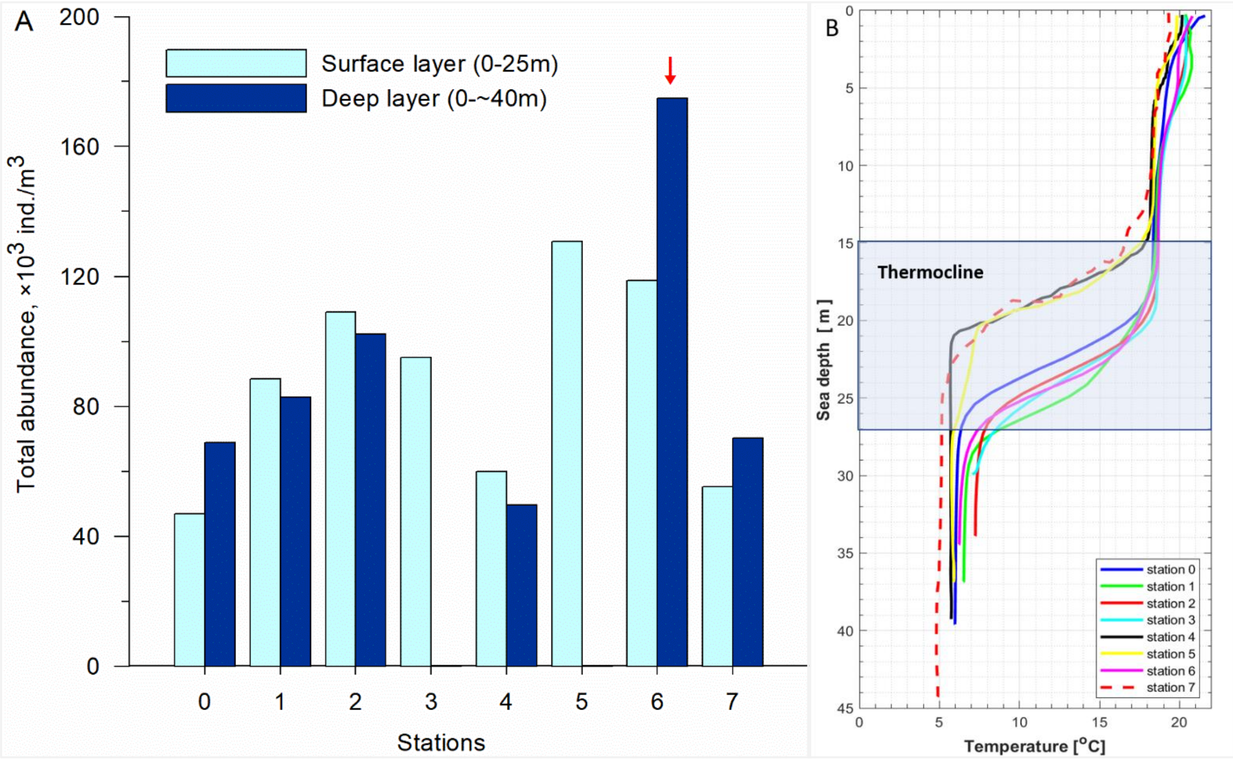


Fig. 5.4.139. Total zooplankton abundance (×103 ind./m3) in surface and deep layers (A); vertical temperature distribution (B) in the offshore wind energy park “Curonian Nord” territory stations 21st July 2024.

This concentration of zooplankton in the surface layer is a common pattern observed in many aquatic ecosystems including the Baltic Sea, as it provides optimal conditions for feeding and reproduction. This is because the surface waters are often richer in nutrients, and the conditions are more favourable for zooplankton in terms of food availability and oxygen levels. Below the thermocline, the water is often colder, and the oxygen levels are lower, making it less suitable for many zooplankton species. The thermocline is a layer in the water column where the temperature changes rapidly with depth, typically 10–15 meters. In the Baltic Sea, the thermocline normally develops at depths between 10 m and 30 m (Matthäus, 1984) during the warmer months, generally in late spring to early summer (around May to June), and it persists through the summer till late November/December (Rak et al., 2020). During our study period, the thermocline was very pronounced with slight depth variation between stations (Fig. 5.4.139B).

During the study period, the zooplankton community was dominated by the cladoceran species *Bosmina coregoni* in both surface and deep samples (Fig. 5.4.140). This species accounted for 50% to 90% of the total abundance in the samples. Copepod abundance (including Temora, Acartia, Centropages, etc.) was significantly lower than the cladocerans.

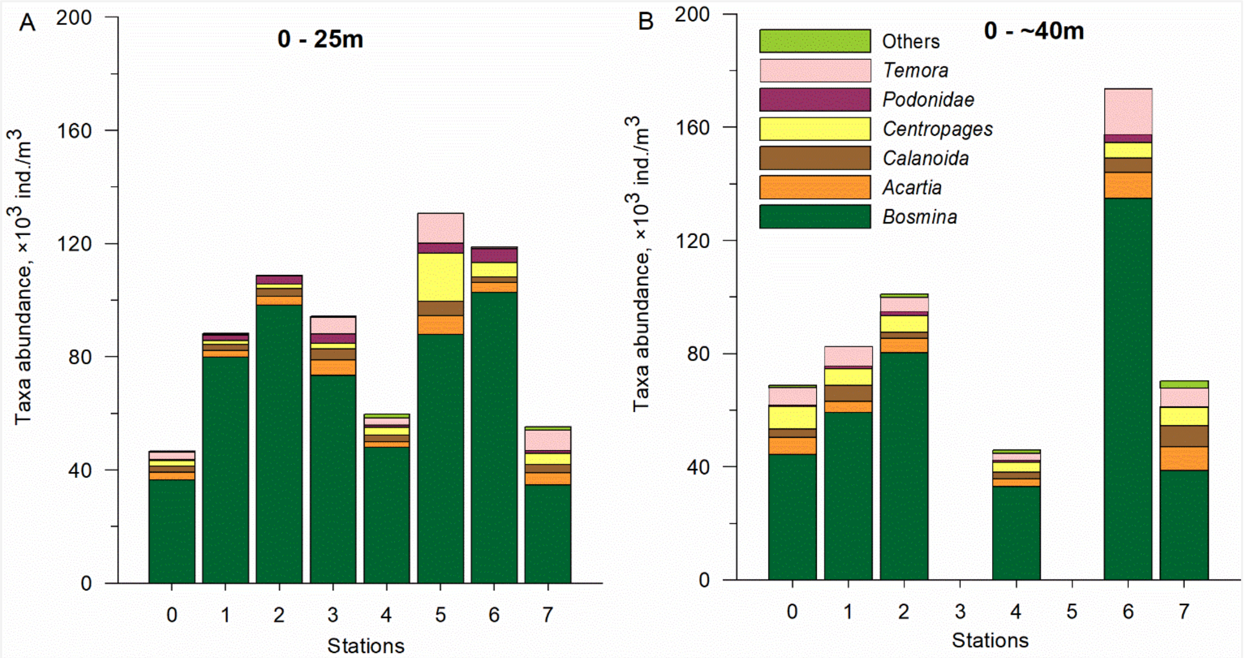


Fig. 5.4.140. Zooplankton species/taxa abundance distribution in surface layer 0–25m (A) and deep layer 0–40m (B) in the CN OWF area 21st July 2024.

Bosmina coregoni is a freshwater origin cladoceran crustacean species (species complex) found in brackish waters with low to moderate salinity, making the Baltic Sea suitable for its distribution. It thrives in areas with low salinity, especially in the southern and central parts of the sea, near river mouths and estuaries where freshwater inflows dilute the seawater. The species prefers warmer temperatures and eutrophic waters with high concentrations of phytoplankton. In the southern part of the Baltic, it the most abundant in June–July, but appears till September, within the water layer 0–22 m (Siudziński, 1975). In the central part of the Baltic Sea *Bosmina coregoni* reaches the highest abundance in the upper 10m layer when the temperature is ~20 °C during August (Schulz et al., 2012). In the Baltic, *Bosmina coregoni* plays a key role in the food web and nutrient cycling, especially in coastal and freshwater-influenced regions.

The study also found that the zooplankton community was predominantly composed of small individuals, ranging from 300 to 500 µm in size (mainly *Bosmina coregoni*), with no individuals exceeding 1,000 µm in size (Fig. 5.4.141). Zooplankton size fractions of 1,000–2,000 µm and > 2000 µm, characteristic of other regions (e.g., the Mediterranean Sea, Atlantic Ocean), were not found in our Baltic Sea waters.

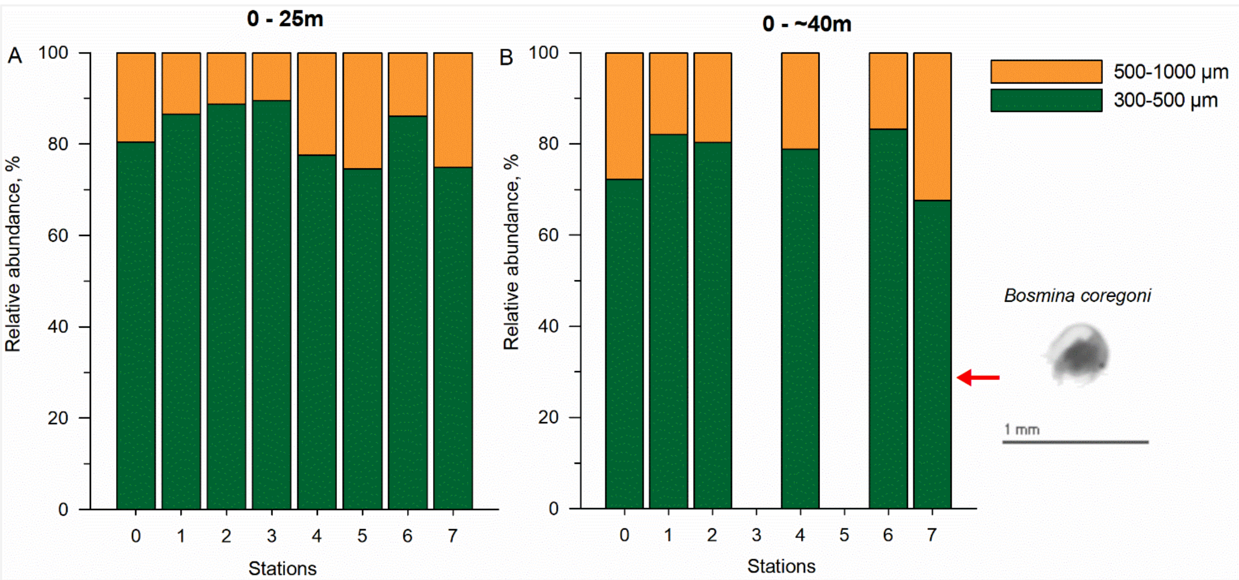


Fig. 5.4.141. Zooplankton size classes relative abundance (%) distribution in surface layer 0–25 m (A) and deep layer 0–40 m (B) in the CN OWF area 21st July 2024.

5.4.10.4. Potential impact on plankton

Plankton is highly dependent on the movement of water masses, the movement of which can be altered by OWF. At the same time, the availability of light and nutrients can be changed. While some studies indicate minimal impact, others suggest OWFs can disrupt plankton distribution and growth, potentially affecting the entire marine ecosystem. The effects are complex and can vary depending on wind conditions and specific characteristics of the wind farm. WTGs can both enhance and diminish plankton communities depending on local conditions and timing.

5.4.10.4.1. Potential impact on phytoplankton

Phytoplankton, the primary producers of aquatic ecosystems, which float passively in the water column, are constantly affected by the movement of water masses, whether caused by wind, the manoeuvring of ships, or other aquatic activities. This impact can be both direct and indirect, positive and negative.

During construction, cable installation, and decommissioning the largest impact could arouse due to increased turbidity – suspended sediments and particulate matter, caused by drilling and excavation work and raised from the bottom into the water column, can reduce the light transmission, which is vital for algae. On the other hand, during construction work, larger benthic microalgae may be raised into the water column along with sediments; this in turn, would change the structure of the algal community. On the other hand, more algae would mean a larger food base for zooplankton and juvenile fish, but turbidity can disrupt the feeding of zooplankton and fish in the area. The amount of turbidity depends on the type of sediment and water currents, although suspended sediment particles are only present in the water for a short time. It can be concluded that this impact will be minor, given its limited nature and short duration. Studies in the North Sea have shown a decrease in plankton after the laying of foundations and cables (Kordan, Yakan, 2024).

Movement and manoeuvring of vessels, both for construction and maintenance purposes, can have a significant impact on phytoplankton. This effect occurs in several aspects:

- Physical impact: turbulence and waves caused by ships change the structure of water layers, reduce light availability, weaken the efficiency of photosynthesis, and mix the water layers, lifting nutrients to the upper layers. This can stimulate the growth of some species, even the formation of algal blooms, or, conversely, inhibit it.
- Chemical impact: pollutants emitted by vessels – oil products, heavy metals and anti-fouling substances – are toxic to phytoplankton, inhibit their growth and can change the species composition.
- Indirect impact: noise and vibrations from ships affect zooplankton (consumers of phytoplankton), thus indirectly changing food webs.

The operation of an OWF can affect phytoplankton both directly and indirectly and can have both positive and negative effects:

- Water mixing and current changes. WTGs alter water currents and create additional turbulence that can mix different water layers, thereby bringing nutrients from deeper layers to the surface. This can change pelagic communities. In the North Sea, such water currents change the distribution of phytoplankton by up to about 20% (Morant et al., 2025). A model developed by Daewel et al. (2022) showed that nutrient uptake near WTGs can increase or decrease phytoplankton abundance by about 8–10%.
- Changes in light conditions. Shadows from platforms or underwater structures can reduce light availability, especially in deeper layers, which can reduce photosynthesis and phytoplankton biomass.
- Stratification changes: depending on the season, the resulting turbulence can disrupt water stratification, cover the entire water column, bringing nutrients from deeper layers, thereby increasing microalgal productivity, or disperse plankton aggregations. However, many models show that changes in plankton are usually small compared to natural variability (Daewel et al., 2022).
- Impact of noise and vibrations. Underwater noise generated during the operation of WTGs can affect phytoplankton indirectly and even stimulate their growth (Kordan, Yakan, 2024). Zooplankton, which are phytoplankton consumers, try to avoid vibrations and noise; therefore, as the number of organisms feeding on phytoplankton decreases, phytoplankton abundance increases, and hence phytoplankton species composition and population dynamics may change.
- Formation of artificial reefs: filter-feeding organisms (molluscs) settle on OWF structures, which, by intensively filtering the water, reduce water turbidity and at the same time reduce phytoplankton biomass (Wang et al., 2024); thus changing food webs in the long term.

Most plankton changes tend to be localized (within and near the wind farm boundaries) and their magnitude is small compared to natural variations between seasons and regions. To date, there is not enough data from which to assess the threat posed by wind farms.

5.4.10.4.2. Potential impact on zooplankton

- **Construction, cable installation, and decommissioning** generate impulsive underwater noise – particularly during pile driving – which can have significant negative effects on zooplankton, ranging from physiological damage to direct mortality. Zooplankton respond to underwater noise, vibrations, and pressure changes via mechanoreceptors – sensory structures located on swimming antennae, the body surface, and feeding appendages (Budelmann, 1992; Fields & Yen, 1997). Research studies indicates that intense acoustic impulses can cause internal tissue damage in sensitive species such as jellyfish and juvenile krill (Solé et al., 2017; McCauley et al., 2017; Prosnier, 2024). For instance, McCauley et al. (2017) found that acoustic pulses can reduce zooplankton density by up to 60% within one hour at a distance of 1 km from the sound source.
- **Movement and manoeuvring of vessels**, both during construction and for maintenance purposes, can also significantly impact zooplankton. These effects manifest in several ways:
  - Acoustic impact: underwater noise from vessels, particularly low-frequency sounds, can disrupt zooplankton movement, migration, and feeding behaviour. Chronic noise exposure may lead to physiological stress, with potential effects on reproduction and community composition (Kunc et al., 2016).
  - Physical impact: turbulence and wave action generated by vessels alter water column structure, reduce light penetration, and disturb the spatial distribution of phytoplankton – the primary food source for zooplankton, this can influence zooplankton abundance and spatial patterns (Hernandez-Becerril et al., 2020).
  - Chemical impact: pollutants discharged during ship operations, such as oil residues, cleaning agents, and heavy metals from antifouling paints, can inhibit phytoplankton growth, indirectly affecting zooplankton through food web interactions (Hernandez-Becerril et al., 2020).
  - Indirect impact: the combined effects of noise and pollutants can influence the entire trophic structure, with cascading impacts on fish, seabirds, and other higher-level consumers (Perry & Heyman, 2020). This may result in shifts in species dominance, reduced biodiversity, and behavioural changes at the ecosystem level.
- **OWF operation** can influence zooplankton both directly and indirectly:
  - Hydrodynamic changes: the installation of OWFs alters local current dynamics by reducing vertical stratification and enhancing turbulence and water mixing. These processes affect nutrient distribution, thermocline stability, and plankton vertical migration. Consequently, changes in phytoplankton concentrations can propagate through the food web and influence zooplankton biomass.
  - EMF exposure: subsea cables transmitting electricity from OWFs to the shore generate EMFs. Although the impact of EMFs on zooplankton is not yet fully understood, hypotheses suggest that such fields may affect plankton behavior and migratory patterns. However, more targeted and systematic studies are required (Taormina et al., 2018).
  - Noise and vibration: although underwater noise and vibrations are less intense during OWF operation than during construction, prolonged exposure may lead to sublethal stress, potentially influencing zooplankton behavior, migration, and population structure.
  - Formation of artificial reefs: WTG foundations serve as habitats for filter-feeding organisms (e.g., mussels), which can reduce local phytoplankton concentrations, potentially limiting food availability for zooplankton – especially for stationary or weakly migrating species. Moreover, it is known that filter feeders can directly affect zooplankton by reducing its availability (Saba et al., 2025).

5.4.10.5. Preventive, mitigation and compensatory measures for impacts on plankton

Since plankton organisms are directly dependent on the movement of water masses, it is recommended that all construction work be carried out during the cold season, when plankton abundance is the lowest, i.e. from November to March.

To reduce chemical contamination, it is recommended to use non-toxic, biological alternative antifouling materials, following the measures of the IMO, the EU Regulation on the use of biocides (528/2012).

Table 5.4.62. Summary of potential Impact of the OWF on phytoplankton and mitigation measures for phytoplankton

Phase	Activities	Impact	Type	Scale	Duration	Impact	Mitigation measures
Construction	Installation of underwater structures; Movement and anchoring of maintenance vessels	Noise and vibration	Indirect positive impact	Local (within the OWF and vessel navigation routes)	Short-term (only available during construction work)	Positive impact	Not applicable.
		Turbulence and waves	Double effect – bringing nutrients to the upper layers promotes algae development, intensive mixing prevents algae development	Local (within the OWF and vessel navigation routes)	Short-term (only available during construction work)	Negligible impact	Not applicable.
		Turbidity increase	Negative indirect impact – reduced water clarity reduces light transmission and reduces plankton abundance	Local (within the OWF and in the cable laying area)	Short-term (only available during construction work)	Minor impact	Recommended to carry out work during the cold season, from November to April, when plankton is least abundant.
		Chemical effects	Ship emissions directly negatively affect phytoplankton growth	Local (within the OWF and vessel navigation routes)	Short-term (only available during construction work)	Minor impact	It is recommended to use non-toxic, biological alternative antifouling materials
Exploitation		Noise and vibration	Indirect positive impact	Local (within the OWF and vessel navigation routes)	Long-term (lasting until the end of the OWF operational phase)	Positive impact	Not applicable.
	Movement and anchoring of maintenance vessels	Turbulence and waves	Double effect – bringing nutrients to the upper layers promotes algae development, intensive mixing prevents algae development	Local (within the OWF and vessel navigation routes)	Long-term (lasting until the end of the OWF operational phase)	Negligible impact	Not applicable.

Phase	Activities	Impact	Type	Scale	Duration	Impact	Mitigation measures
		Chemical effects	Ship emissions directly negatively affect phytoplankton growth	Local (within the OWF and vessel navigation routes)	Long-term (lasting until the end of the OWF operational phase)	Minor impact	It is recommended to use non-toxic, biological alternative antifouling materials
	Presence of OWF	Light conditions	Direct negative impact due to shading of structures	Local (within the OWF)	Long-term (lasting until the end of the OWF operational phase)	Negligible impact	Not applicable.
		Noise and vibration	Indirect positive impact	Local (within the OWF and vessel navigation routes)	Long-term (lasting until the end of the OWF operational phase)	Positive impact	Not applicable.
		Turbulence and current changes	Double effect – increased nutrients availability, changing community composition	Local (within the OWF)	Long-term (lasting until the end of the OWF operational phase)	Negligible impact	Not applicable.
		Occurrence of secondary habitats	Direct negative impact due to the increase in the number of filter feeders	Local (within the OWF)	Long-term (will last until the end of the wind farm's operation)	Negligible impact	Not applicable.
Decommissioning	Movement and anchoring of maintenance vessels, dismantling of underwater structures	Noise and vibration	Indirect positive impact	Local (within the OWF and vessel navigation routes)	Short-term (only available during construction work)	Positive impact	Not applicable.
		Turbulence and waves	Double effect – bringing nutrients to the upper layers promotes algae development, intensive mixing prevents algae development	Local (within the OWF and vessel navigation routes)	Short-term (only available during construction work)	Negligible impact	Not applicable.
		Turbidity increase	Negative indirect impact – reduced water clarity reduces light	Local (within the OWF and in the cable laying area)	Short-term (only available during construction work)	Minor impact	Recommended to carry out work during the cold season, from November

Phase	Activities	Impact	Type	Scale	Duration	Impact	Mitigation measures
			transmission and reduces plankton abundance				to April, when plankton is least abundant.
		Chemical effects	Ship emissions directly negatively affect phytoplankton growth	Local (within the OWF and vessel navigation routes)	Short-term (only available during construction work)	Minor impact	It is recommended to use non-toxic, biological alternative antifouling materials
		Destruction of secondary habitats	Positive direct impact due to the elimination of filter feeders	Local (separate towers)	Long-term	Insignificant	Not applicable.

Colour code

	Positive effects
	No impact or negligible impact (no consideration required; no mitigation measures applied)
	Minor impact (addressed through design-phase decisions, preventive or mitigation measures)
	Moderate impact (addressed through mitigation measures)
	Significant impact (mitigation and/or compensatory measures are required)

Table 5.4.63. Summary of potential Impact of the OWF on zooplankton and mitigation measures for zooplankton.

Phase	Activities	Impact	Type	Scale	Duration	Impact	Mitigation measures
Construction	Installation of underwater structures; Movement and anchoring of maintenance vessels	Noise and vibration	Direct and potentially negative impact	Local (within the OWF and vessel navigation routes)	Short-term (only available during construction work)	Minor impact	Recommended to carry out work during the cold season, from November to April, when plankton is least abundant.
		Turbulence and waves	Indirect effect – through phytoplankton changes, direct impact on zooplankton vertical distribution	Local (within the OWF and vessel navigation routes)	Short-term (only available during construction work)	Negligible impact	Not applicable.
		Chemical effects	Indirect through phytoplankton reduced growth	Local (within the OWF and vessel navigation routes)	Short-term (only available during construction work)	Negligible impact	Not applicable.
Exploitation	Movement and anchoring of maintenance vessels	Noise and vibration	Less than during the construction phase	Local (within the OWF and vessel navigation routes)	Long-term (lasting until the end of the OWF operational phase)	Negligible impact	Not applicable.
		Turbulence and waves	Indirect effect – through phytoplankton changes, direct impact on zooplankton vertical migration and distribution	Local (within the OWF and vessel navigation routes)	Long-term (lasting until the end of the OWF operational phase)	Negligible impact	Not applicable.
		Chemical effects	Indirect through phytoplankton reduced growth	Local (within the OWF and vessel navigation routes)	Long-term (lasting until the end of the OWF operational phase)	Negligible impact	Not applicable.
	Presence of OWF	Electromagnetic field	Possible impact on zooplankton behaviour and migration, currently not sufficiently studied	Local (within the OWF)	Long-term (lasting until the end of the OWF operational phase)	Negligible impact?	Not applicable.
		Noise and vibration	Less than during the construction phase	Local (within the OWF and vessel navigation routes)	Long-term (lasting until the end of the OWF operational phase)	Negligible impact	Not applicable.

Phase	Activities	Impact	Type	Scale	Duration	Impact	Mitigation measures
		Turbulence and current changes	Indirect effect – through phytoplankton changes, direct impact on zooplankton vertical migration and distribution	Local (within the OWF)	Long-term (lasting until the end of the OWF operational phase)	Negligible impact	Not applicable.
		Occurrence of secondary habitats	Indirect negative impact due to the decrease of phytoplankton consumed by filter-feeding invertebrates (e.g., mussels), but also to some extent, a direct effect by mussels facilitates a top-down decrease in zooplankton abundance	Local (within the OWF)	Long-term (will last until the end of the wind farm's operation)	Negligible impact	Not applicable.
Decommissioning	Movement and anchoring of maintenance vessels, dismantling of underwater structures	Noise and vibration	Direct and potentially negative impact is the same as during the construction phase	Local (within the OWF and vessel navigation routes)	Short-term (only available during construction work)	Minor impact	Recommended to carry out work during the cold season, from November to April, when plankton is least abundant.
		Turbulence and waves	Indirect effect – through phytoplankton changes, direct impact on zooplankton vertical migration and distribution	Local (within the OWF and vessel navigation routes)	Short-term (only available during construction work)	Negligible impact	Not applicable.
		Chemical effects	Indirect through phytoplankton reduced growth	Local (within the OWF and vessel navigation routes)	Short-term (only available during construction work)	Negligible impact	Not applicable.
		Destruction of secondary habitats	Positive direct impact due to the elimination of filter feeders	Local (separate towers)	Long-term	Negligible impact	Not applicable.
Colour code							

Phase	Activities	Impact	Type	Scale	Duration	Impact	Mitigation measures

	Positive effects
	No impact or negligible impact **(**no consideration required; no mitigation measures applied)
	Minor impact (addressed through design-phase decisions, preventive or mitigation measures)
	Moderate impact (addressed through mitigation measures)
	Significant impact (mitigation and/or compensatory measures are required)

5.5. Landscape

5.5.1. Survey methods

5.5.1.1. Methods for assessing current situation

The prevailing character and values of the local landscape and existing recreational areas are described based on the following: the National Landscape Management Plan; the general plans of the municipalities under consideration; data from national and international protected areas or conservation sites; and scientific and legal literature.

5.5.1.2. Methods for assessing potential impacts

To determine the intensity of the impact, the size of the area likely to be affected at sea, on the coast and on land is assessed, as well as the importance of the affected landscape/seascape and the magnitude of the change. The size and area of the new development, its dimensions in relation to existing landscape structures, and the presence or absence of impacts on unique protected landscapes and the values they contain are considered, as are impacts on landscape diversity.

The geo-ecological stability of the landscape is examined in terms of the position of the proposed OWF in relation to the natural framework and the changes that will take place in this structure.

The visual aspect of the landscape/seascape examines the aesthetic potential of the areas where the PEA is planned, the extent to which the OWF and its structures will be visible ("hight" and "width") and in which areas, how it will change the perception of the seascape at the tourism and recreation areas where landscape/seascape appreciation is a major focus.

The extent (scale) of the impact of the PEA on the landscape/seascape is determined using:

- The requirements of legislation, spatial planning and strategic documents.
- The comparative (analogy) method, for example, using an existing analogy for the visual assessment – an existing OWF in the Šilutė district, as seen from the Curonian Spit.
- Literature revision.
- The expert judgment assessments.

5.5.1.3. Visual impact assessment methodology

The visual impact of the proposed economic activity on the landscape is considered one of the most significant factors. The assessment was conducted in accordance with the zones of influence of WTGs as defined by J. Abromas (Abromas, 2021), the methodology for determining visual impact on natural landscape complexes and objects (2021) developed by J. Kamičaitytė-Virbašienė and G. Godienė for the Ministry of the Environment of the Republic of Lithuania, as well as international studies (Jallouli, Moreau, 2009; Wind Turbine Visibility, 2012; Sullivan et al., 2020; Sullivan et al., 2013). The assessment considered the height of WTGs, the position of the OWF relative to the coastline, the nature of the main affected areas, and other relevant contexts.

The quantitative visual impact of the site shall be determined by calculating the vertical and horizontal viewing angles of the proposed site in degrees. Vertical Viewing Angle (hereinafter – VVA) is calculated between two observation beams, the upper of which reaches the top of the WTG (the overall height) and the lower beam is directed towards the visible lower part of the WTG. The horizontal angle of view (hereinafter – HOV) is calculated between the two furthest horizontal objects as viewed from the assessed vantage poin.

WindPRO 3.3 software was utilized to assess the visual impact on the landscape. A visualization of the planned OWF was prepared using the WindPRO Photomontage model (Annex 4). The visual impact module of WindPRO 3.3 software, Zone of Visual Influence (hereinafter – ZVI), was employed to evaluate the visibility of the planned OWF and to spatially analyse these indicators, focusing on:

- Coordinates for OWF installations (X, Y, Z) and edge OWF facility positions.
- WTG height and rotor diameter.
- Digital elevation model of Lithuania (10 m resolution). Data source – National Land Service under the Ministry of Agriculture, 2017.
- Forest areas as visibility obstructions (Data source – forest areas and their elevation from the Forest Cadastre Database (revision date 2 May 2023), State Forest Service under the Ministry of the Environment; elevation ranges from 1 to 34 m).
- Calculation step – 25 m.

- An estimate of the degree of curvature (curvature of the sphere) of the Earth.
- The height of the point of the calculated VVA and HOV is based on the photographic height of the photo-fixation sites, with an absolute altitude of +1.8 m above sea level. The ZVI angles of view for the observation sites are calculated by estimating the height of the observation site plus the height of an eye (1.8 m).

The assessment of the site in terms of VVA values has been carried out according to the adapted Landscape Impact Assessment Matrix (Table 5.5.1) and has been carried out at the panoramic viewpoints of the landscape under consideration and at the selected seascape viewpoints (Table 5.5.2).

Table 5.5.1. Assessment of the visual impact of WTGs based on VVA (adapted from analogue method and literature sources)

Vertical viewing angle, degrees	Nature of the impact	Extent of impact
0	INVISIBLE	No impact
0.1–0.2	VISIBLE. Detected during the day and night in good weather, partially visible.	Very low
0.21–0.49	OBSERVABLE. The WTG structure is visible day and night; blades are visible in good visibility conditions. **Visual disturbance. Important in areas where valuable objects are visible at great distances in panoramic views.**	Minor
0.5–1	VISIBLE, but of little significance, subdominant. **Weak visual impact.** **Low visual pollution.** **Important in areas where the landscape is continuously monitored and where valuable objects are visible in long-distance panoramas.**	Moderate
1–2.79	VISIBLE, visually distinct, both the structure and blades are observed. Crosses the horizon and can no longer be ignored. Psychological, disturbing effect. Psychological disruptive impact. **Visual pollution, reducing aesthetic potential and hindering the perception of valuable panoramas.**	Above average
2.8–5.7	CLEARLY VISIBLE, movement of blades observed, stands out in the overall view. Psychological, disruptive impact. **Significant impact. Unacceptable visual pollution, reducing local aesthetic potential, competing with meaningful landscape features, and hindering the perception of panoramas important to local residents.**	Significant
5.71–10	HIGHLY VISIBLE, DOMINANT. Shapes panoramas and crosses the horizon line. Strong psychological impact. **Significant impact. Unacceptable visual pollution, reducing high local aesthetic potential and hindering the perception of valuable panoramas.**	Very significant
10–90	**OBSTRUCTS significant landmarks and forms the primary view.**	Fundamentally changing

(orange line) ***The limit of analogies****. The existing wind farm in Lankupiai, Šilutė district, is visible from the Curonian Lagoon coast of Juodkrantė at 0.47 and from the Curonian Lagoon coast of Nida at 0.21 VVA.*

(red line) ***Significant impact*** *according to the description of the EIA procedure for PEAs,* assessing the impact on the landscape of special structures over 30 m high, excluding OWFs, at a VVA level of 2.8.

(magenta line) ***Significant impact*** *according to the Renewable Energy Act: 10 m for each metre of mast height of the WTG, equating to a VVA of 5.7.*

Table 5.5.2. Examined landscape panorama viewpoints and selected seascape observation lookouts

No.	Name	Minimum distance to OWF, km
1	Pape beach (Latvia)	36.8
	Palanga City municipality	
2	Viewing platform at Fisherman's Daughters sculpture observation site	37.4
3	Palanga Bridge Observation deck	38.2
4	Palanga Bridge	37.9
	Kretinga District municipality	
5	Kretinga town surroundings from the railway viaduct site	50.0
	Klaipėda District municipality	
6	“Dutchman’s cap” cliff observation site	45.4
	Klaipėda City Municipality	
7	Klaipėda Port northern pier	50.9
8	Viewing point on the Smiltynė quay	52.5
	Municipality of Neringa	
9	Juodkrantė beach	67.0
10	Observation site at Nagliai Nature Reserve	75.6
11	Observation site at Vecekrugs dune	81.4
12	Nida beach	83.0

The report assesses the maximum possible visual impact of the PEA on the landscape by analysing:

- Points from which the panoramas are most sensitive to visual impact – landscape panorama viewpoints and selected seascape observation lookouts (see Table 5.5.2 and Fig. 5.5.4).
- Weather conditions that provide the best possible visibility.
- During the tourist season, when the number of observers is highest.

In all other circumstances, the visual impact of the OWF is considered to be negligible.

5.5.2. Survey area

From a landscape perspective, the current state is assessed at a regional scale, covering the area of the PEA itself and areas that may be affected by landscape changes or whose character influences the visual perception of the OWF. This encompasses the marine scape complex extending from the PEA area eastwards through the entire Lithuanian marine zone, including the territorial sea, the Curonian Spit, the Curonian Lagoon, and the coast of the municipalities in western Lithuania.

The area of the OWF is situated in the EEZ of the Republic of Lithuania, in adjacent waters, on the Baltic Sea shelf, in the southwestern part of the submarine coastal slope of the seabed uplift known as the Klaipėda-Ventspils Plateau, at a distance of 36.8 km from the shoreline (see Fig. 5.5.1). According to the morphological zonation of the landscape, the marine part of the OWF falls within the submarine plateau area (A) of the East Baltic Shallow Sea (I) in the Curonian-Western Samogitian area of the Baltic Sea (1), where the submarine plateau and depressions seascape dominate.

On land, the corridors of the proposed export cables extend along the Western Baltic Lowlands (B) in the Seaside Lowlands (II) and the Curonian Spit (C) in the Western Samogitian Highlands (III) (see Fig. 5.5.2).

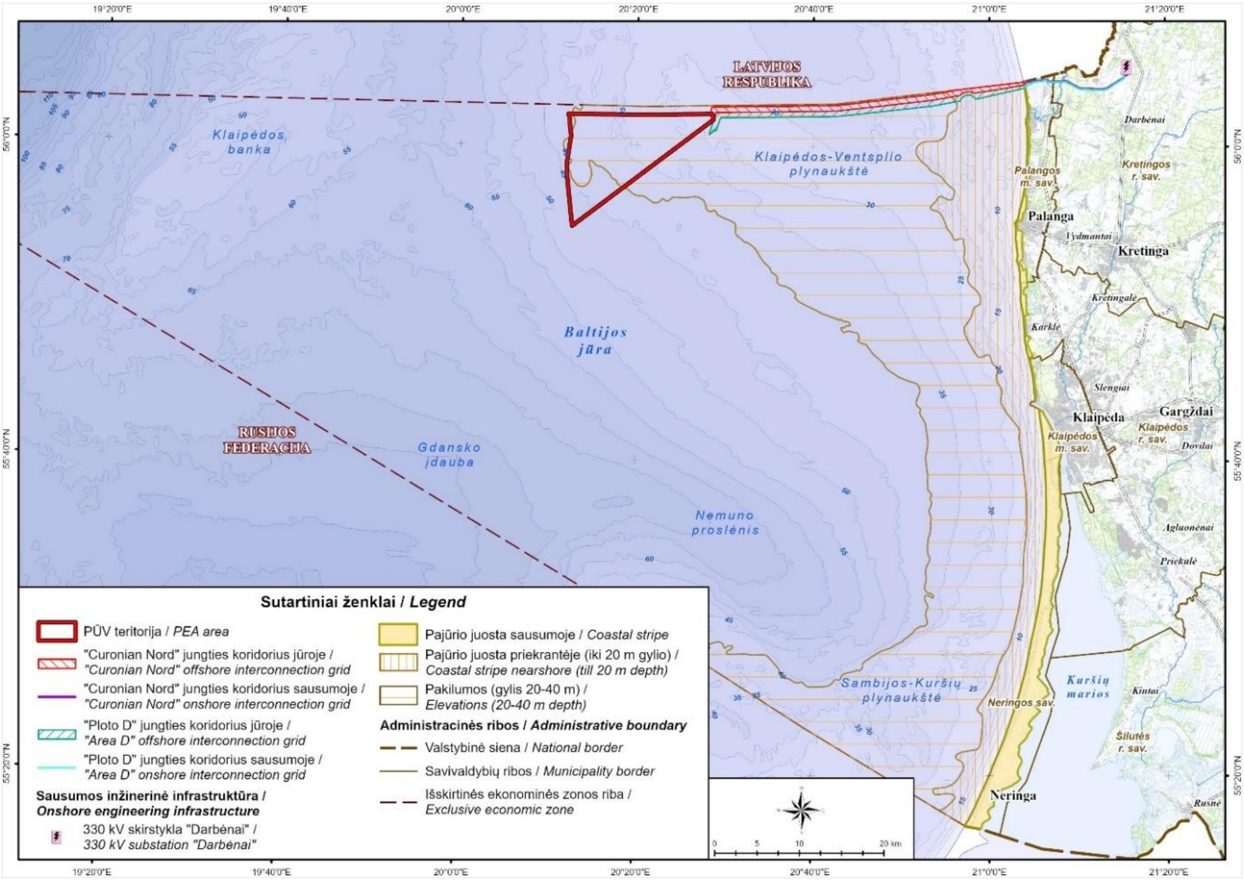


Fig. 5.5.1. Geographical location of the PEA site.

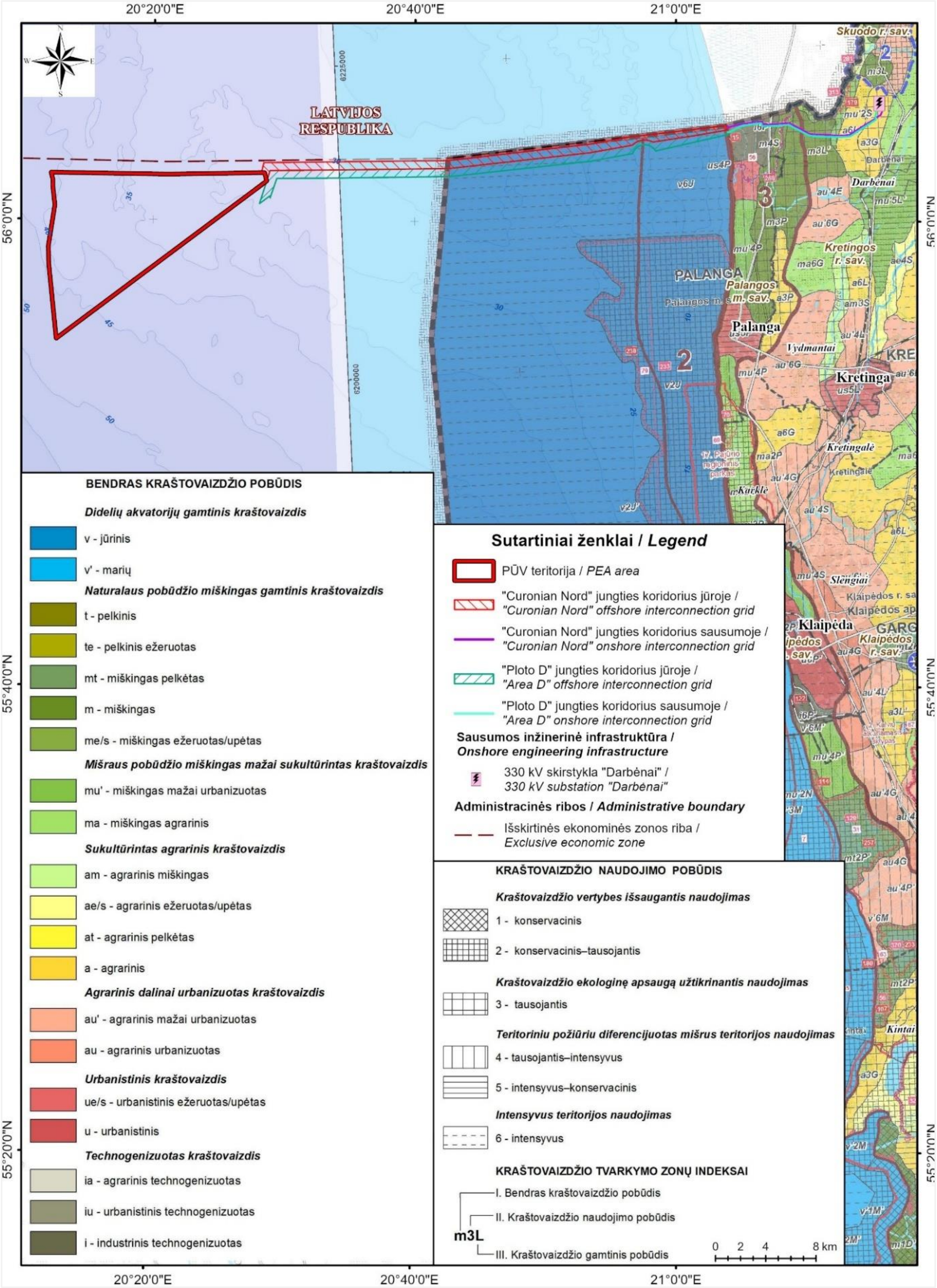


Fig. 5.5.2: Morphological structure of the landscape of the Lithuanian sea and coastal region (extracted from the Existing State of the Landscape Morphological Structure drawing of the National Landscape Management Plan).

5.5.3. Current state

5.5.3.1. Overall landscape character and values

According to the National Landscape Management Plan (hereinafter – NLMP), the Lithuanian Baltic coastline, including the beach and protective dune, is considered an area of high aesthetic potential at the national level, with the highest values found in the Curonian Spit and the Karklė section.

The coastal lowlands feature a variety of small landscape areas that are rare in Lithuania: the urbanised, forested Baltic coastal plain (BII 3, 0.27% of Lithuania's territory); the sparsely urbanised, forested Curonian Spit, protected as a national park and World Heritage Site (BII 4, 0.16%); the lagoon-like Curonian Lagoon (BII 5, 0.64%); and the urbanised agrarian plain of the Nemunas Delta (BII 5, 1.23%) (see Fig. 5.5.3).

In the coastal lowlands, to the east of the coastal strip, the aesthetic potential is predominantly moderate or below moderate. More scenic than the Coastal Lowland and Plain, but not prominent at the national level, is the landscape of closed or semi-closed spaces in the protective coppice of the continental forested coastline in the Coastal Strip (V1-2H1-3), where typically only one visual space is observed, with isolated vertical or horizontal landmarks, either larger or smaller (see Fig. 5.5.3).

The Curonian Spit, located more than 50 km from the PEA, has the highest aesthetic landscape potential. It is characterised by a landscape of strong and medium vertical articulation, with semi-enclosed and enclosed spaces, and around the Nagliai Reserve, a landscape of strong and medium vertical articulation of open spaces. The entire Curonian Spit is designated as particularly protected territory (hereinafter – PPT) under the NLMP, as an area with the highest aesthetic potential in Lithuania (see Figs. 5.5.3 and 5.5.4). The Curonian Spit National Park has been protected by UNESCO since 2000 as a World Heritage Site, recognised as an area of global importance. The panorama and silhouette of the Curonian Spit from the Curonian Lagoon is one of the attributes of the outstanding universal value of this UNESCO site.

The map of the Most Valuable Panoramic Viewpoints of the Lithuanian Landscape (hereinafter – VLKPAT) (see Fig. 5.5.4) highlights the PPTs and the open and semi-open landscapes with distinct and moderate vertical gradients in the Akmena river valley, featuring nine viewpoints (monitoring direction not specified).

Currently, the Lithuanian Baltic Sea lacks permanent vertical structures, with surface roughness determined only by transient elements such as waves and ships, which can reach up to 70 m in height.

In Lithuania, views of the sea from land are very limited, making seascape observation an exceptional experience. The sea horizon is visible only from the shoreline itself, beaches, the protective ridge on the mainland, the Curonian Spit coast, the Great Curonian Spit, the Dutchman’s Cliff in Karklė, and other specially constructed viewpoints. The largest visual barrier on the mainland coast is the coastal forests (40.21% forest cover on the Baltic coastal plain), although the protective ridge rises slightly above the surrounding plains and coastline (10–12 m above sea level at Palanga and 2–4 m above sea level at Būtingė).

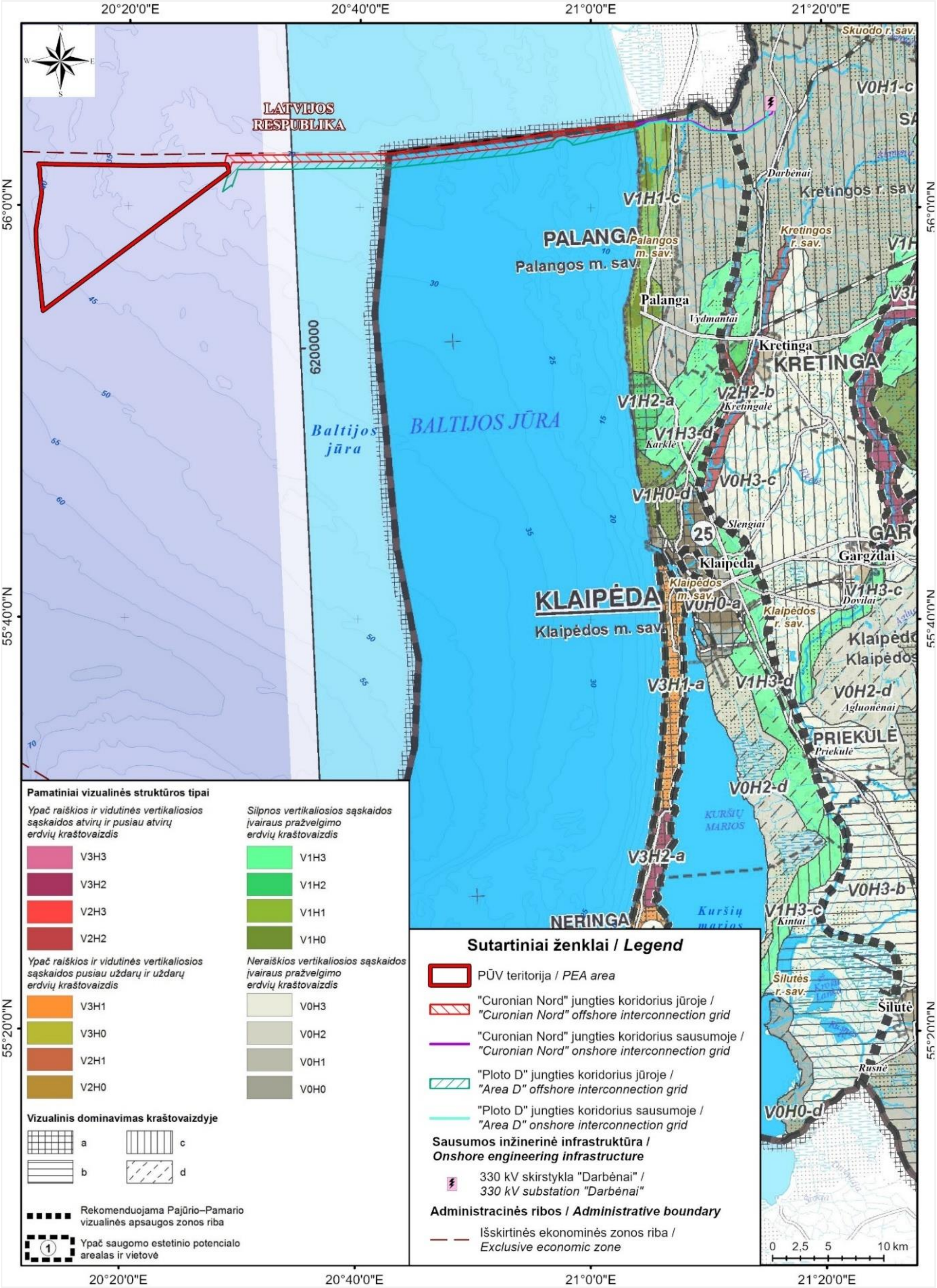


Fig. 5.5.3: Aesthetic potential of the landscape of the Lithuanian sea and coastal region (excerpted from the "Visual Aesthetic Potential of the Landscape" drawing in the Decision Part of the National Landscape Management Plan).

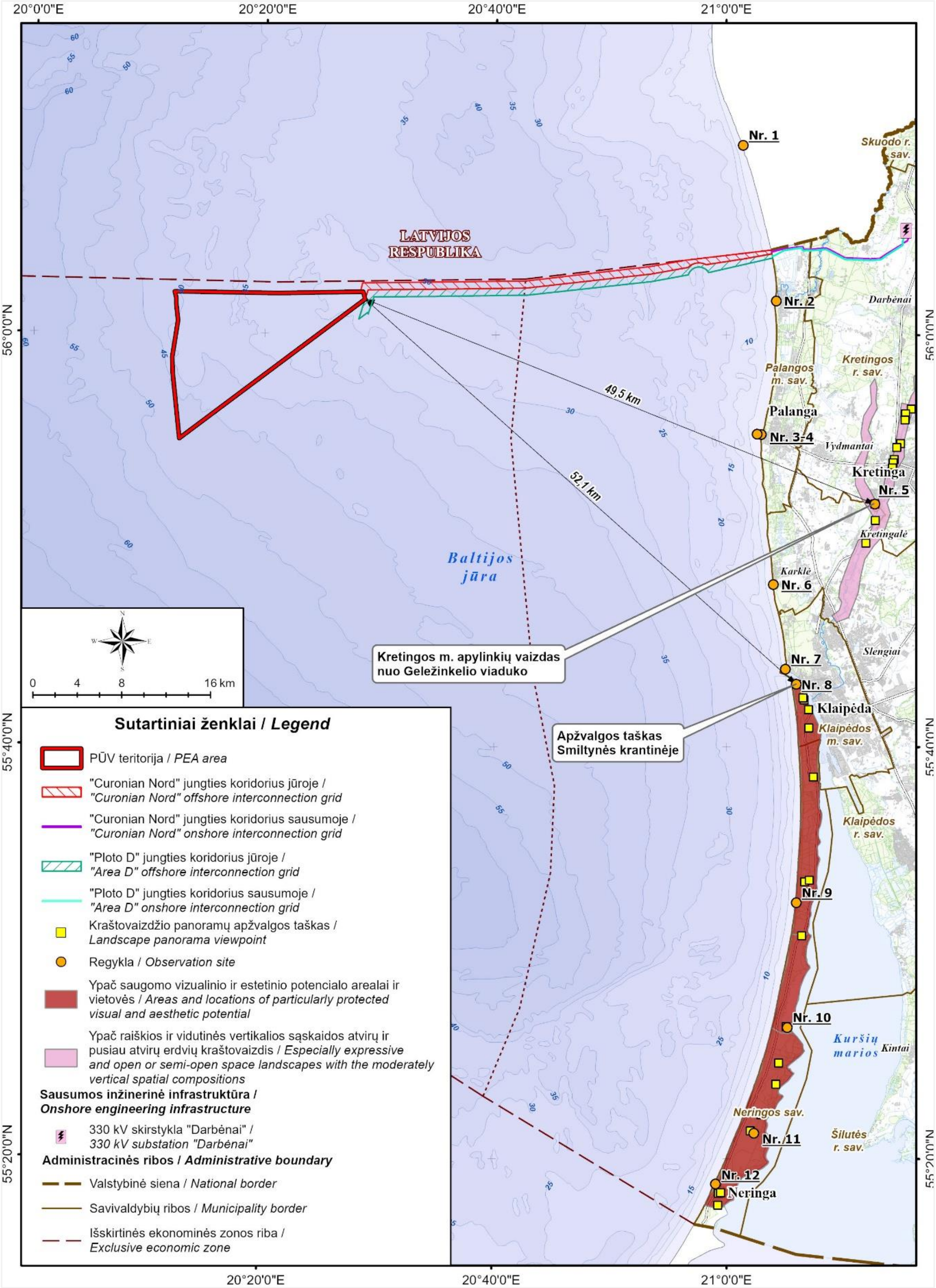


Fig. 5.5.4. The territory of the PEA in relation to the PPTs and observation sites of the Lithuanian landscape (excerpt from the map of the most valuable panoramas of the Lithuanian landscape.[92]

[92] Map of the most valuable panoramic viewpoints in the Lithuanian landscape, VSTT.

5.5.3.2. The natural framework of the Lithuanian Baltic Sea, its coastline and shoreline

Natural Framework (hereinafter – NF) – an integrated network of natural ecological compensation territories, ensuring the ecological balance of the landscape, natural connections between protected areas, other territories or habitats of environmental importance, as well as the migration of plants and animals between them (Article 12 of the Law on Environmental Protection of the Republic of Lithuania, Articles 21 and 22 of the Law on Protected Territories, Regulations of the Natural Framework approved by the Order of the Minister of Environment of the Republic of Lithuania No. D1-624 of 16 July 2010). It comprises a European and national ecological network linking various territories: reserves, conservation areas, state parks, restoration and genetic sites, ecological protection zones, as well as forestry, natural recreational and ecologically important agricultural areas. According to the NF regulations, the development of engineering infrastructure and the construction of OWFs is not prohibited in the areas of the natural framework.

In terms of the ecological functions performed by geosystems, terrestrial NF include:

- geo-ecological pathways (supportive)
- habitats for internal stabilisation of geosystems and
- axes (eco-compensatory) and migration corridors (connective).

According to the Protected Areas Act, the structural parts of the natural framework are divided into European, national, regional and local importance.

In the Marine Areas section of the Lithuanian GP, the drawing and text on the ecological balance of the marine area and the preservation of cultural heritage emphasises that the sea, like the land, is shaping the NF.

According to the Lithuanian GP, the marine natural framework, which is formed taking into account the peculiarities of aquatic landscapes, the distribution of the most valuable biodiversity areas, sedimentary and hydrodynamic conditions, is based on 3 geomorphologically distinct zones, characterised by the distinctive nature of natural processes, the distribution and sensitivity of the natural values, which cover 38% of the area of the Lithuanian marine area:

- The Curonian Spit and the mainland coastline – the submarine slope and the shallow part of the sea (up to 20 m deep) – is an important zone of interaction between sea and land, with active hydrodynamic processes and the presence of key natural values.
- Elevations – the Klaipėda-Ventspils elevation, together with the Klaipėda Bank in the northern part bordering Latvia, and the Curonian-Sambian elevation in the south, with relatively shallower sea depths in the more remote parts of the sea basin.
- Depressions and valleys – the Gdansk depression together with the Nemunas valley that flows into it, and the Gotland depression at the border of the EEZ of the Republic of Lithuania with Sweden – are the deepest parts of the Lithuanian Sea, where conditions are favourable for the feeding and growth of certain fish species.

According to the specific solutions of the NF of the Palanga City Master Plan for the adjustment of the municipality's infrastructure development priority areas, the land corridors for the connection of the PEA fall within the areas classified as natural framework complexes: limited (coastal) and weak geoecological pathways of regional significance (A) and migration corridors of weak geo-ecological potential (C) (Fig. 5.5.5).

According to the specific drawing of the natural environment of the Kretinga District territory and its part – the Kretinga Town GP amendment, the planned export cable corridors onshore cross geo-ecological pathways (T) and migration corridors (m) of regional significance, with different potentials and forming directions (Fig. 5.5.6).

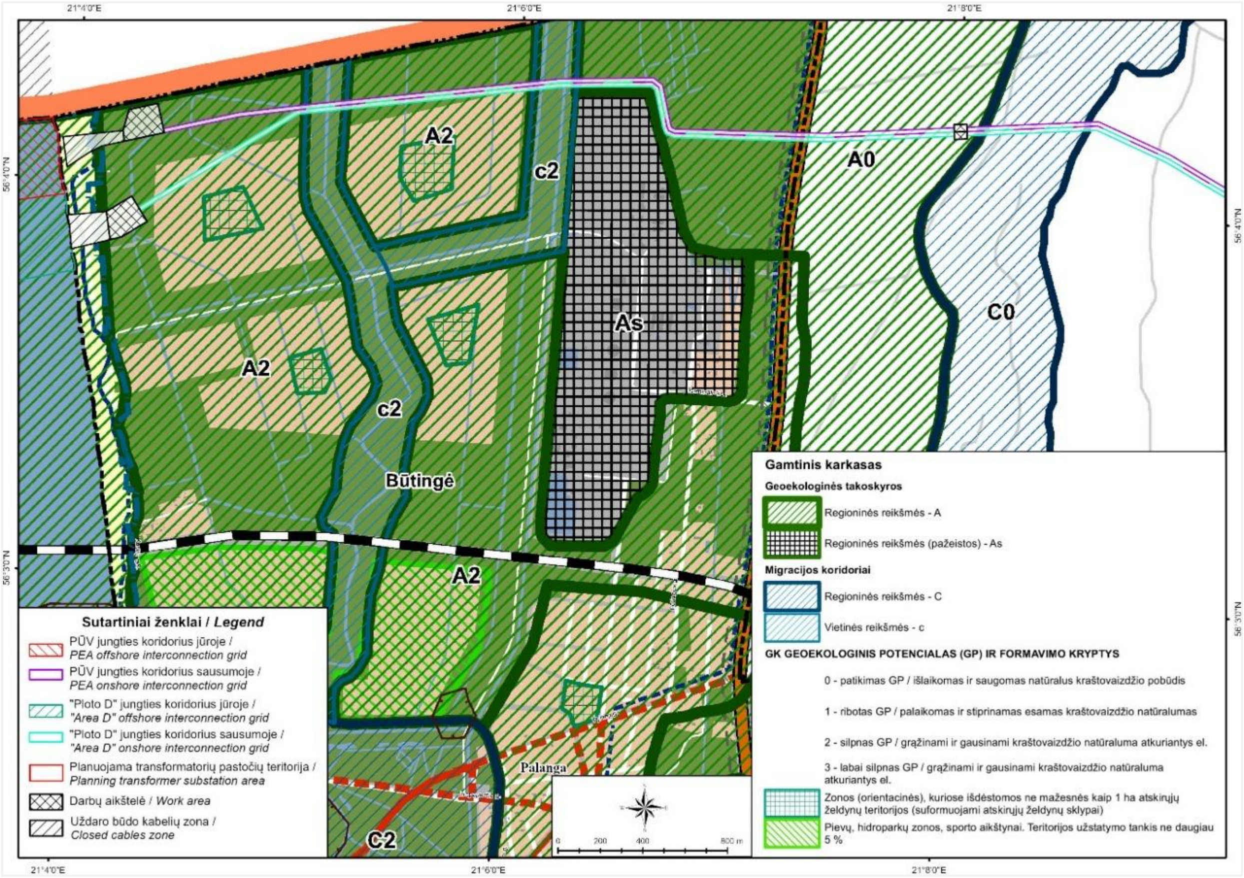


Fig. 5.5.5. Planned territory in relation to the solutions of the NF (basis: extract from the drawing of the specific solutions of the NF of the Palanga City Municipality territory GP).

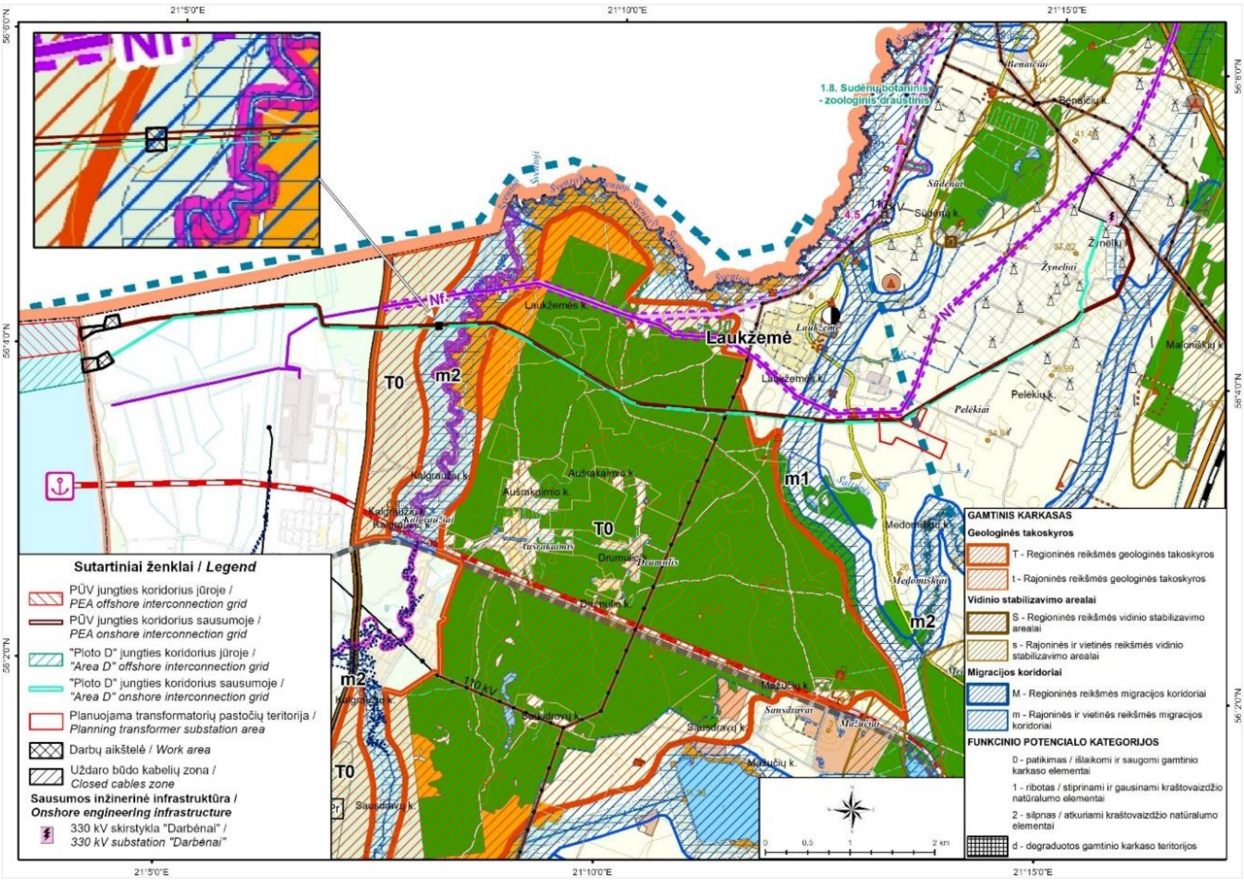


Fig. 5.5.6. Planned territory in relation to the solutions of the NF (basis: extract from the drawing of the solutions of the natural environment of the northern part of Kretinga Municipality).

5.5.3.3. Existing recreational attractions

The high recreational and tourist potential of the Lithuanian seaside is largely due to the fact that the majority of the Lithuanian population lives far from the sea, making visits to the seaside and sea – unlike forests, rivers, and lakes – relatively rare throughout the year or even a lifetime. Coastal recreational areas, beaches (see Fig. 5.5.7), elevated terrain, and viewpoints are highly valued for offering a multifaceted experience of a rare landscape-seascape. This is enhanced by the sense of unexpectedness, as if the 'natural curtain' of forests, reedbeds, and dunes has been drawn back, revealing the flatlands. Observing the dynamic element of the sea becomes a unique ritual not available every day or to everyone. Additionally, Lithuania's Baltic Sea coast faces west, allowing for the viewing of sunsets over the marine horizon under good weather conditions.

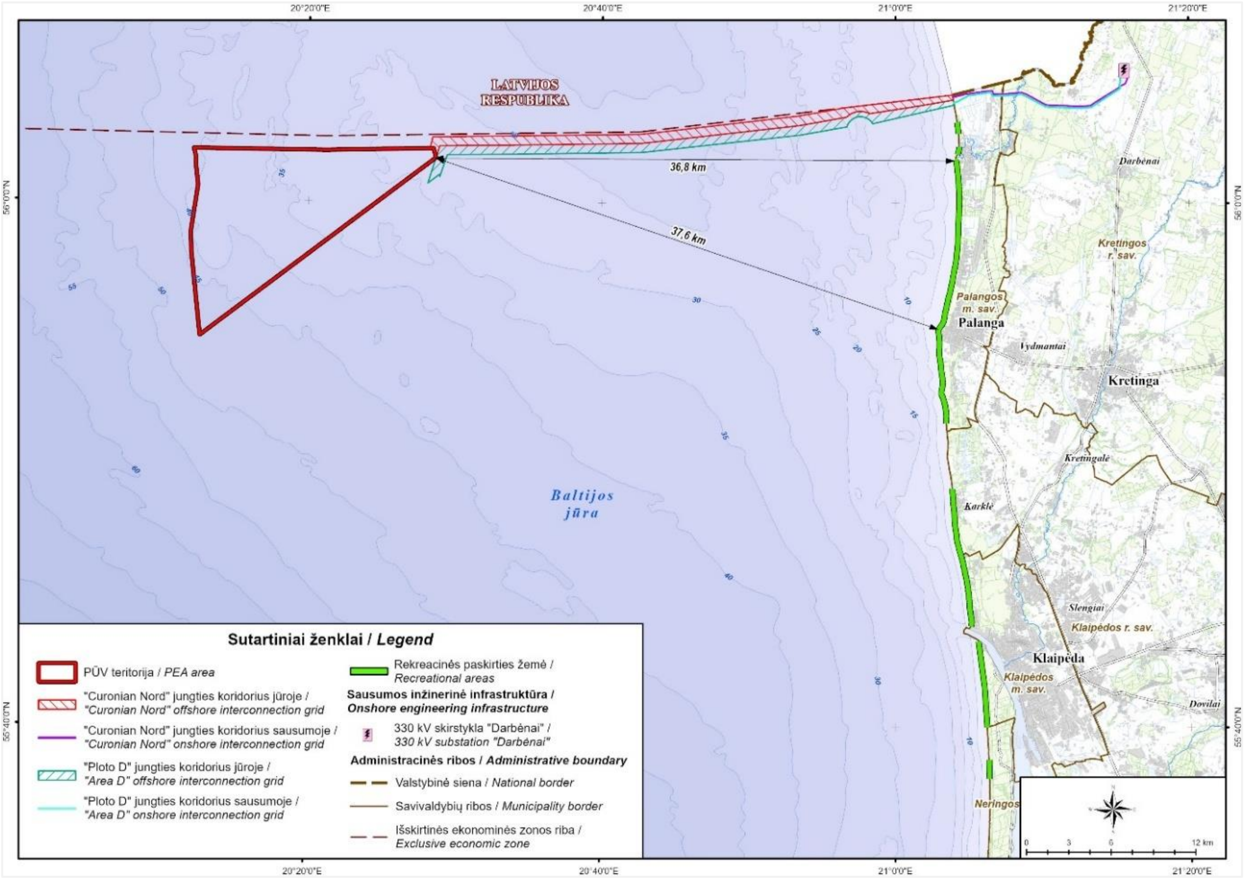


Fig. 5.5.7. The area of the OWF in relation to recreational areas (beaches) along the Lithuanian Baltic Sea coast.

5.5.4. Potential impact on the landscape/seascape

5.5.4.1. Assessment of visual impact on the seascape

Visibility was assessed in terms of the OWF's vertical and horizontal viewing angles. The maximum possible technical parameters of the wind turbines are considered, with a tower height of up to 170 m and a total height of up to 350 m for the planned OWF. Two alternatives for the deployment of the OWF at sea are assessed: the maximum deployment (Alternative 1) and the environmentally friendly/optimal alternative (Alternative 2).

The assessment of the visual impact of the OWF at the nearest observation site (see Table 5.5.3, Fig. 5.5.8, and Fig. 5.5.9) for both alternatives indicates that the potential visual impact, in terms of VVA, ranges from 0.43° to 0.47° and is considered low (VVA 0.21 to 0.49; see Table 5.5.1). Additionally, in accordance with the provisions of Article 49(18) of the Law on Renewable Energy of the Republic of Lithuania, the impact of the OWF's marine solutions on the landscape/seascape is deemed negligible.

It is noted that the CN OWF under consideration is positioned to the west (further away) and partly behind the already planned 700 MW "Area D" OWF, in relation to the Lithuanian Baltic Sea coast. The proximity of future offshore installations to the planned OWF will make identifying the offshore PEAs challenging, as they will merge visually with the already planned technogenic installations. The potential cumulative effects of the PEA and other OWFs on the landscape are described in section 5.5.4.4.

Table 5.5.3. Calculated VVA of the PEA from the key observation sites

No.	Observation site	Minimum distance to OWF, km	Vertical viewing angle, °		Extent of impact
			PEA 1 alt. (maximum)	PEA 2 alt. (optimal)	
1	Pape beach (Latvia)	36.8	0.46	0.44	Small
		Palanga City Municipality			
2	Viewing platform at Fisherman's Daughters	37.4	0.47	0.43	Small
3	Palanga Bridge Observation deck	38.2	0.45	0.43	
4	Palanga Bridge	37.2	0.45	0.43	
		Kretinga District Municipality			
5	Kretinga town surroundings from the railway viaduct	50.0	0	0	No effect
		Klaipėda District Municipality			
6	Dutch cap	45.4	0.34	0.31	Small
		Klaipėda City Municipality			
7	Klaipėda Port northern pier	50.9	0.27	0.26	Small
8	Viewing point on the Smiltynė quay	52.5	0	0	No effect
		Municipality of Neringa			
9	Juodkrantė beach	67.0	0.11	0.11	Very low
10	Viewpoint Nagliai Nature Reserve	75.6	0.16	0.16	
11	Viewpoint on Vecekrugs dune	81.4	0.13	0.13	
12	Nida beach	83.0	0.01	0.01	No effect

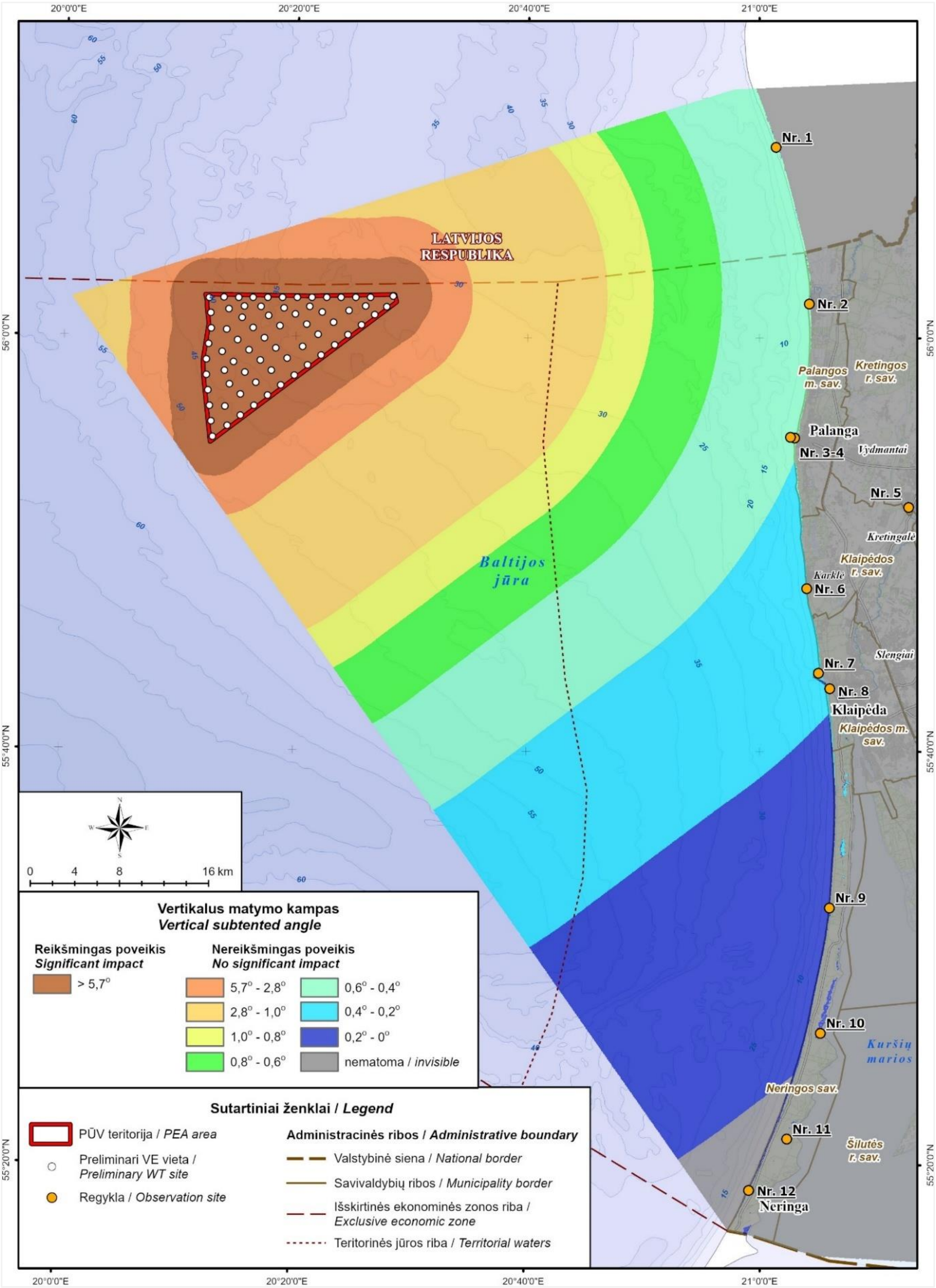


Fig. 5.5.8. Visual impact of 350 m total height WTGs based on the VVA (Alternative 1).

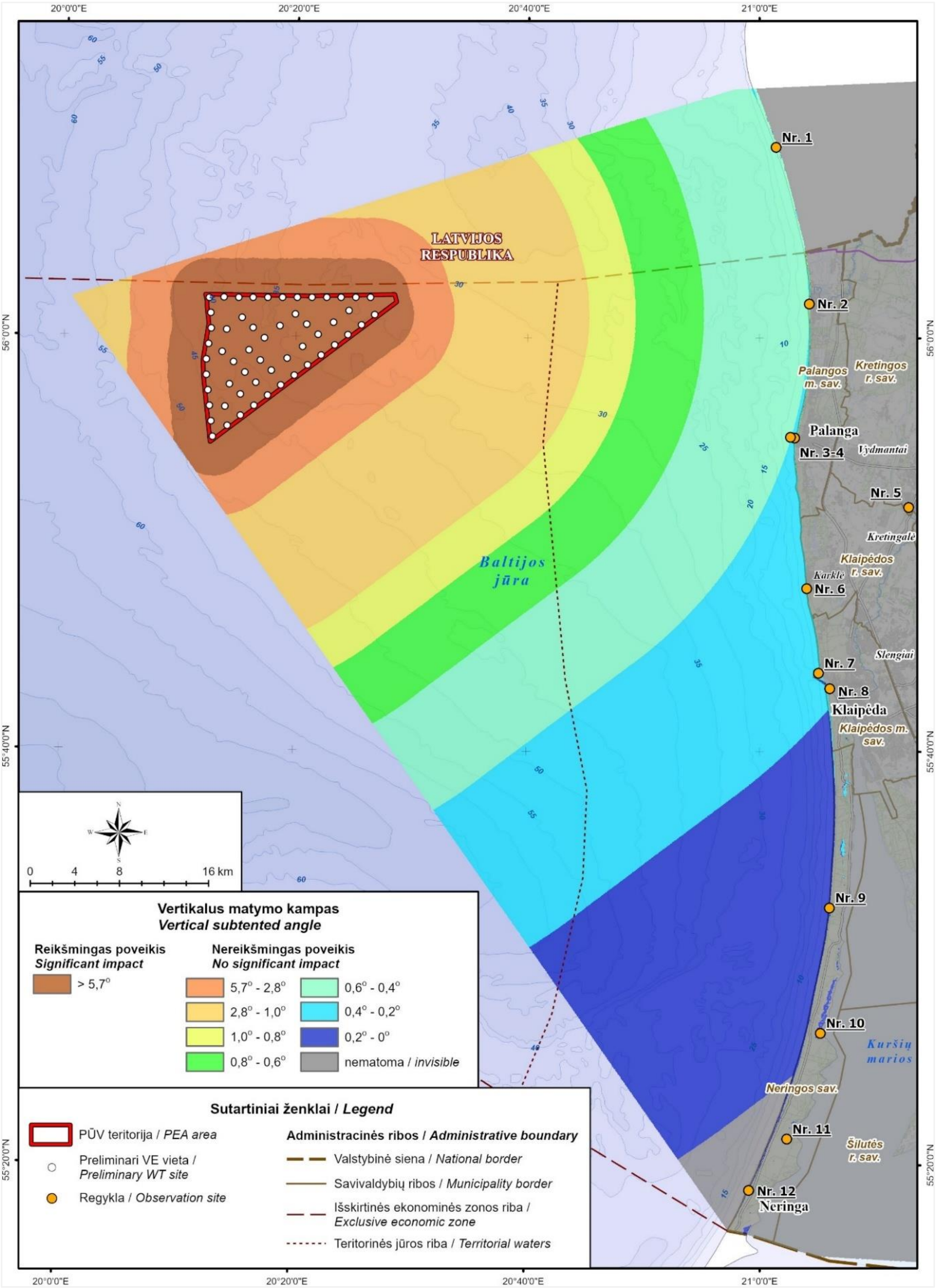


Fig. 5.5.9. Visual impact of 350 m total height WTGs based on the VVA (Alternative 2).

5.5.4.2. Potential impacts on intrinsic values and spatial structure of the local landscape

According to the European Landscape Convention, the landscape encompasses both terrestrial and aquatic spaces, with landscape character representing the intrinsic value of a region's identity. Although landscapes are constantly undergoing dynamic change, alterations due to human activity should not result in the deterioration or loss of the essential relative proportions of individual landscape types. Future generations must be able to experience and utilize all landscape types identified today.

The planned OWF will utilize 119.5 km² of marine area, representing a small portion of the Lithuanian marine territory. However, the OWF installations will notably change the degree of development in this area. The PEA will establish a new technogenic zone in the open Baltic Sea adjacent to the Lithuanian landscape, located in the shallow part of the Baltic Shallow Sea (A) Plateau, within the submarine plateaus of the Southeastern Baltic Sea (AI), specifically the Curonian-Western Samogitian offshore submarine plateaus seascape. This development aligns with the functional land use priorities outlined in the Lithuanian GP under the section 'Marine Areas.'

5.5.4.3. Potential impact on the local natural framework

In assessing the potential impact of the PEA on the territories of the Lithuanian Marine Natural Framework, consideration is given to the Order of the Minister of the Environment of the Republic of Lithuania No D1-96 of 14 February 2007, which defines the permissible density of development for land plots classified for other purposes.

Part of the PEA area (approximately 9,500 ha) falls within the geomorphological upland zone of the Klaipėda-Ventspils Plateau and would encompass about 6.2% of the upland zone of the Baltic Sea within Lithuania. It is important to note that the exact potential seabed area required by the PEA depends on the foundation construction, which will be selected based on prevailing seabed geology and the technical parameters of the WTG model.

Considering that the development density of the planned OWF will not exceed 30% of the geomorphological zones of the Lithuanian Baltic Sea, it can be assumed that the potential impact of the OWF on offshore areas of the NF will be insignificant.

During construction, the installation of cables on land may cause temporary physical and visual impacts on the landscape due to the accumulation of earth spoil and the storage of construction materials, equipment, and machinery in open trenches. Upon project completion, the area will be cleaned, the soil in spoil heap areas will be rehabilitated, and the former landforms will be restored.

For the onshore part of the PEA area, land management focuses on sound geological potential, aiming to maintain and protect the natural character of the landscape. It has been established that about 60% (~8.4 km) of the planned export cable corridors will cross NF areas, with approximately 4.8 km crossing the forests of Būtingė and Laukžemė, classified as areas of reliable geoecological potential. The deforestation and removal of other vegetation, destruction and fragmentation of vegetation habitats, damage and/or destruction of animal habitats, and disruption of their migration may negatively impact the ecological balance of the landscape and its ecological compensation functions, including natural connections between environmentally important areas or habitats and plant and animal migration (see Section 5.4 Biodiversity).

5.5.4.4. Potential cumulative impact on the landscape

When developing the OWF and assessing their impact on the landscape, it is important to consider that similar activities are already planned in the Baltic Sea area approved by Resolution No. 697 of the Lithuanian Government. Additionally, Latvia has foreseen the development of OWF along its northern border with the Republic of Lithuania, in accordance with the Maritime Territories Plan of Latvia, approved on 14 May 2019.

These projects may alter the horizontal viewing angle of the OWF. However, since the size and technical parameters of the OWF planned in Latvia are not known at this stage, a detailed assessment of the cumulative impact is only appropriate if the planned OWF are included (see Fig. 5.5.10).

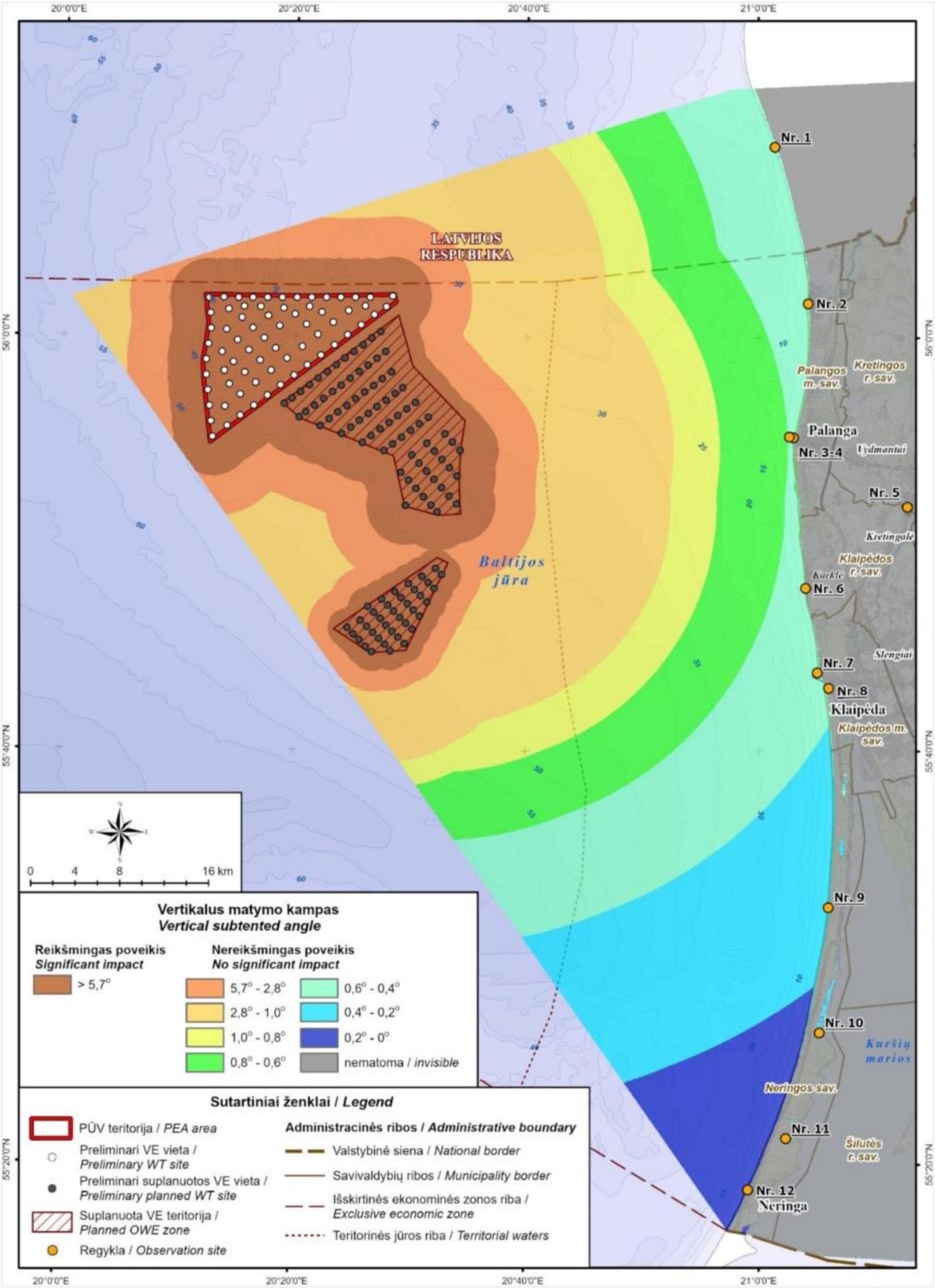


Fig. 5.5.10. Cumulative impact of the planned OWFs in the Curonian-Western Baltic Sea Curonian-Western Samogitian Baltic coastal submarine plateau and lomatic aquatic landscape area.

Currently, the landscape of the Lithuanian Baltic Sea basin is completely open, with existing vertical technogenic landmarks – such as ships – being variable in terms of position and visibility. The already planned construction and operation of the “Area D” OWF will introduce a permanent accumulation of vertical technogenic structures, leading to the emergence of a new type of urbanised marine energy landscape. In terms of landscape character, the area of large open water will become an open-air accumulation of very tall engineering structures, which will be an important part of the technogenic, spatial, and meaningful landscape structure of the Lithuanian water area due to their tower-like shape and height.

To assess the potential impact of the planned development and the PEA on the integrity of the Lithuanian Baltic Sea basin, the HOV of the OWFs was analysed (see Table 5.5.4). This involved evaluating the horizontal composition of the landscape and changes in the visual structure. While this criterion for assessing significance is not regulated by legislation, the HOV criteria indicate the proportion of the open Baltic Sea horizon that will be covered by the OWF areas. It is noted that, due to its position in relation to the already planned OWF, the offshore location of the PEA will appear identical or undifferentiated from the OWF planned closer to the coast for most of the Lithuanian coastline.

Table 5.5.4. Visibility analysis of the planned OWF by HOV

No.	Observation site	Minimum distance to OWF, km	Horizontal angle of view, °		
			PEA 1 alt. (maximum)	PEA 2 alt. (optimal)	Planned OWFs
1	Pape beach (Latvia)	36,8	12,66	12,66	28,46
	Palanga City Municipality				
2	Viewing platform at Fisherman's Daughters	37.4	13.97	13.76	36.69
3	Palanga Bridge Observation deck	38.2	19.7	18.56	42.6
4	Palanga Bridge	37.9	19.87	18.72	43.02
	Kretinga District Municipality				
5	Kretinga town surroundings from the railway viaduct	50.0	0	0	0
	Klaipėda District Municipality				
6	Dutchman's hat	45.4	21.28	19.7	40.06
	Klaipėda City Municipality				
7	Klaipėda Port northern pier	50.9	20.55	18.94	33.45
8	Viewpoint on the Smiltynė quay	52.5	0	0	0
	Municipality of Neringa				
9	Juodkrantė beach	67.0	17.28	15.84	23.11
10	Viewpoint Nagliai Nature Reserve	75.6	15.65	14.32	18.18
11	Viewpoint on Vecekrugs dune	81.4	14.44	13.16	15.53
12	Nida beach	83.0	7.34	7.34	14.35

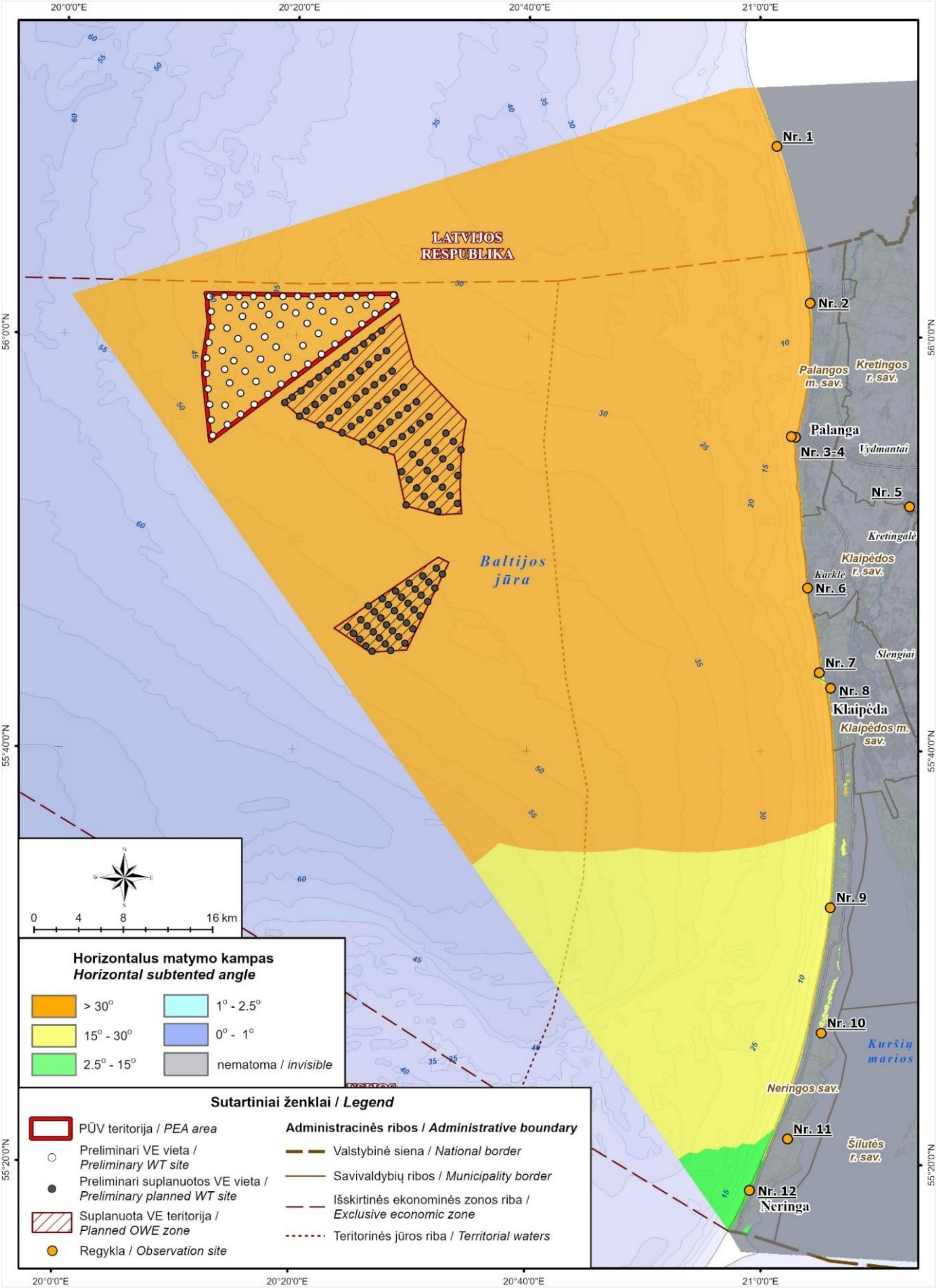


Fig. 5.5.11. Cumulative visual assessment of PEA based on HOV (Alternative 1).

Among all regions selected for analysis, the HOV of the CN OWF will be lower in the northern part of the Lithuanian Baltic Sea coast and at Pape beach in Latvia, compared to the already planned "Area D" and other OWFs. The greatest contrast in meaning is anticipated during the tourist season, particularly when observing the sea horizon at sunset along the coastline of the Municipality of Palanga. Across the rest of the Lithuanian Baltic Sea coast, the cumulative contrast of the OWFs with the contextual seascape will be minimal.

5.5.5. Measures to prevent, mitigate and compensate for landscape impacts

Given the nature of the PEA – namely, the operation of the OWF in an open water landscape where existing vertical and technogenic landmarks are primarily episodic, such as vessels – implementing measures to mitigate or compensate for the impact on the local landscape is challenging.

5.5.5.1. Offshore

To minimise the potential impact on the landscape in the offshore area of the PEA, it is proposed to:

- Paint the WTGs in light colours that create minimal colour contrast, avoiding white, which would result in greater contrast.
- Use a special paint formulation to prevent the structures from glossing and creating reflections.

5.5.5.2. Onshore

To minimise the potential impact on the landscape within the onshore PEA area, it is proposed to:

- Avoid establishing temporary parking areas for construction materials, storage of excavated soil, construction carts, construction equipment, and parking lots within or adjacent to pollution-sensitive areas, such as protected areas, wetlands, coastal protection strips, and surface water body protection zones.
- If tree or vegetation removal is necessary, it is recommended to carefully assess the need during the technical design process and minimise the number of trees to be cut down. Protect existing trees from damage during construction work and rehabilitate disturbed areas after construction.
- Clear areas of spoil heaps and remove stored construction materials, equipment, and machinery resulting from open trenching for cable installation. Reclaim excavated areas using species and tree forms typical of the local environment, sow grasses characteristic of the area, and restore former landforms.

5.6. Cultural Heritage

5.6.1. Survey methods

5.6.1.1. Methods for assessing current state

5.6.1.1.1. Offshore

The condition of underwater cultural heritage in the selected area is assessed from two perspectives: whether there are officially registered cultural heritage objects within the research area and adjacent territories, and whether other sunken objects of possible archaeological value are known. This involves analysing cultural heritage registers to gather information about already identified and evaluated cultural assets and systematizing information about other sunken objects marked on official nautical charts whose historical value may not necessarily have been determined. In addition to sunken objects registered in official sources, it is important to conduct a detailed analysis of literary sources, including notes from individual marine archaeologists that provide information about past sea battles, preliminary locations of potentially sunken ships, and their cultural/historical significance.

Alongside the analysis of literary sources and cultural heritage databases, an archaeological assessment was conducted in the selected offshore area. The following sources and materials were used for this assessment:

- Side-scan sonar data recordings conducted both within the boundaries of the OWF and along the export cable corridor.
- Report on the discovery of a shipwreck – Field Memo 02 BA Wreck 231123" (Annex 7), which provides a description of the wreck and attempts to identify it as the remains of the submarine U-580.
- Videos recorded during the inspection of the wreck using a ROV.
- Online sources used: fishing fleets of communist and post-communist countries[93]; Lithuanian Register of Cultural Properties – The Register of Cultural Property[94].

5.6.1.1.2. Onshore

Registered immovable cultural heritage located in the analysed territory was identified according to the Register of Immovable Cultural Properties.

To ascertain whether unregistered cultural heritage assets may be present along the planned interconnection grid and in its vicinity, an expert assessment was conducted, utilizing official literary sources and background data from scientific research conducted in the area or its surrounding environment.

5.6.1.2. Methods for assessing potential impacts

5.6.1.2.1. Offshore

To establish the assessment criteria, it is essential to consider the recommendations from the 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage, which Lithuania ratified in 2006. Article 1, Paragraph 1(a) of the Convention defines "underwater cultural heritage" as: "all traces of human existence having a cultural, historical, or archaeological character which have been partially or totally underwater, periodically or continuously, for at least 100 years."

This definition includes:

1) Sites, structures, buildings, artefacts and human remain, together with their archaeological and natural context.
2) Vessels, aircraft, other vehicles or any part thereof, their cargo or other contents, together with their archaeological and natural context, and
3) Objects of prehistoric character.

When assessing the value of a sunken vessel, two main criteria are typically considered: (1) whether the vessel sank 100 or more years ago, and (2) whether the object possesses significant cultural, historical, or archaeological value.

The protection of underwater cultural heritage at the national level is governed by the Law on the Protection of Immovable Cultural Heritage, which clearly outlines the conditions under which a submerged object can be classified as cultural heritage and the measures that must be applied to avoid potential adverse impacts. Consequently, the potential impact is assessed only in relation to objects that are deemed valuable for historical or cultural reasons.

[93] Fishing fleets of communist and post-communist countries. Information online: https://soviet-trawler.narod.ru/main_en/list_of_projects.html

[94] Register of Cultural Properties. Available online: https://kvr.kpd.lt/#/static-heritage-search

Objects of anthropogenic origin that are not considered valuable from an archaeological or historical perspective are not subject to impact assessment.

5.6.1.2.2. Onshore

In assessing whether the PEA may affect immovable cultural heritage, it is essential to analyse the alignment of the planned export cable corridors in relation to registered cultural heritage properties and identify areas where archaeological supervision is required during earthworks.

5.6.2. Survey area

5.6.2.1. Offshore

The direct study area at sea includes two zones (Fig. 5.6.11):

1) the 120.9 km² CN OWF zone, where water depths range from approximately 27 m to 49 m below mean sea level; and
2) ~40 km² area or a marine corridor approximately 40 km long and ~1 km wide, where the export cables for the CN OWF and "Area D" OWFs are planned to be installed. These export cables will connect the offshore OSSs with the onshore electricity transmission grid. Water depths in this corridor range from 0 to 39 m.

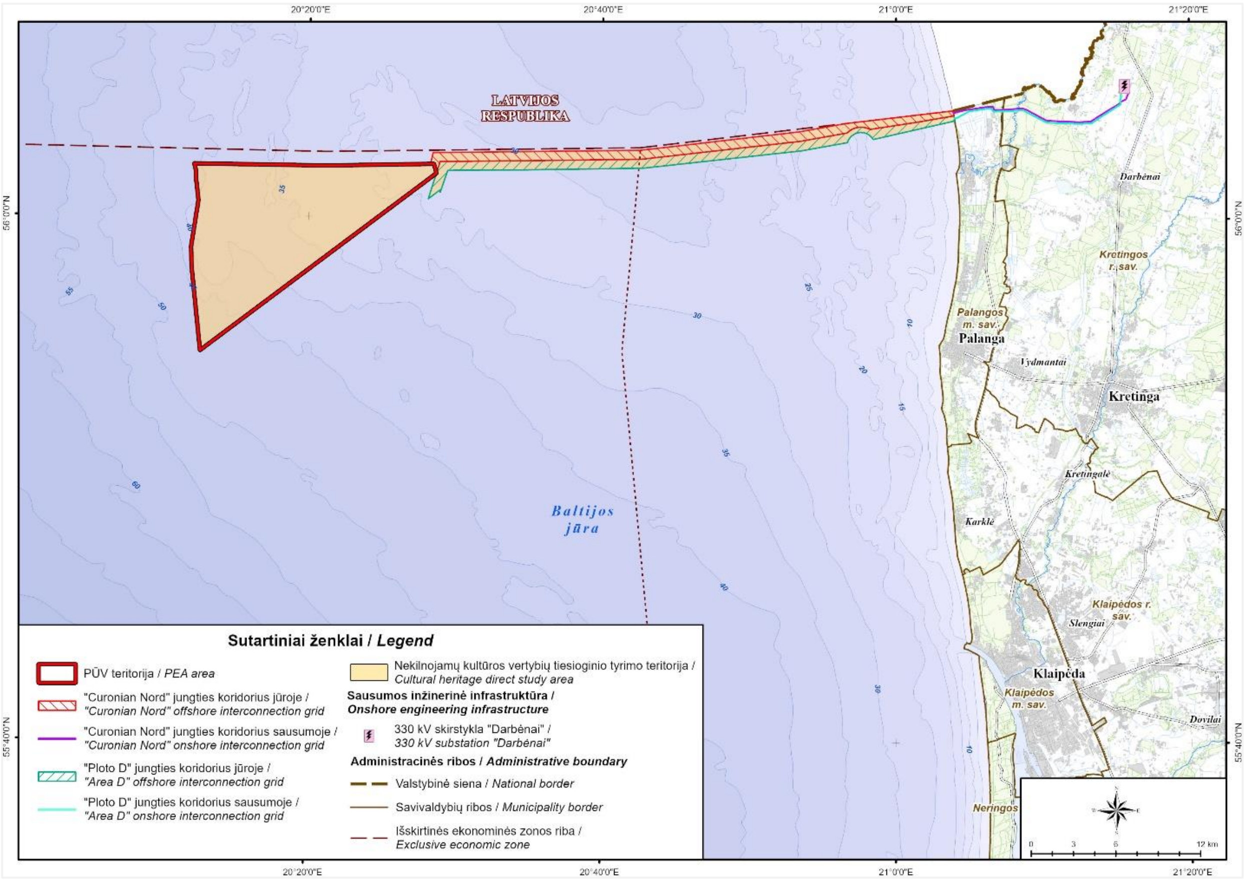


Fig. 5.6. 1. Survey area offshore.

According to the Geophysical Survey Report (Fugro Netherlands Marine BV, 2024), the seabed in the area of the planned OWF has been shaped by glaciers and glacial meltwater. This has resulted in the development of relict seabed features and complex morphological elements, including asymmetric ridges, sand ribbons and ripples, boulder fields, complex seabed structures, straight or meandering ridges, flat seabed with signs of local erosion, linear depressions, sand waves, and scour marks. Detailed geophysical surveys conducted within the planned export cable corridor (PTPI, 2023) revealed that the corridor's topography along its entire profile consists of sediments deposited by glacial and glaciofluvial processes. Apart from the nearshore area, where modern sand deposits and a dynamic shoal zone dominate, its morphology is similarly shaped by glacial and post-glacial processes. Characteristic glacial ridge zones have formed, and a relatively uniform glacial plain extends across the central part of the corridor. Numerous depressions of varying size and shape are present, along with fields of sand and gravel ripples, indicating an active hydrodynamic environment.

5.6.2.2. Onshore

The analysis of registered cultural heritage sites was carried out along the export cable corridor and within the territory in its vicinity extending up to 500 m on either side of the corridor.

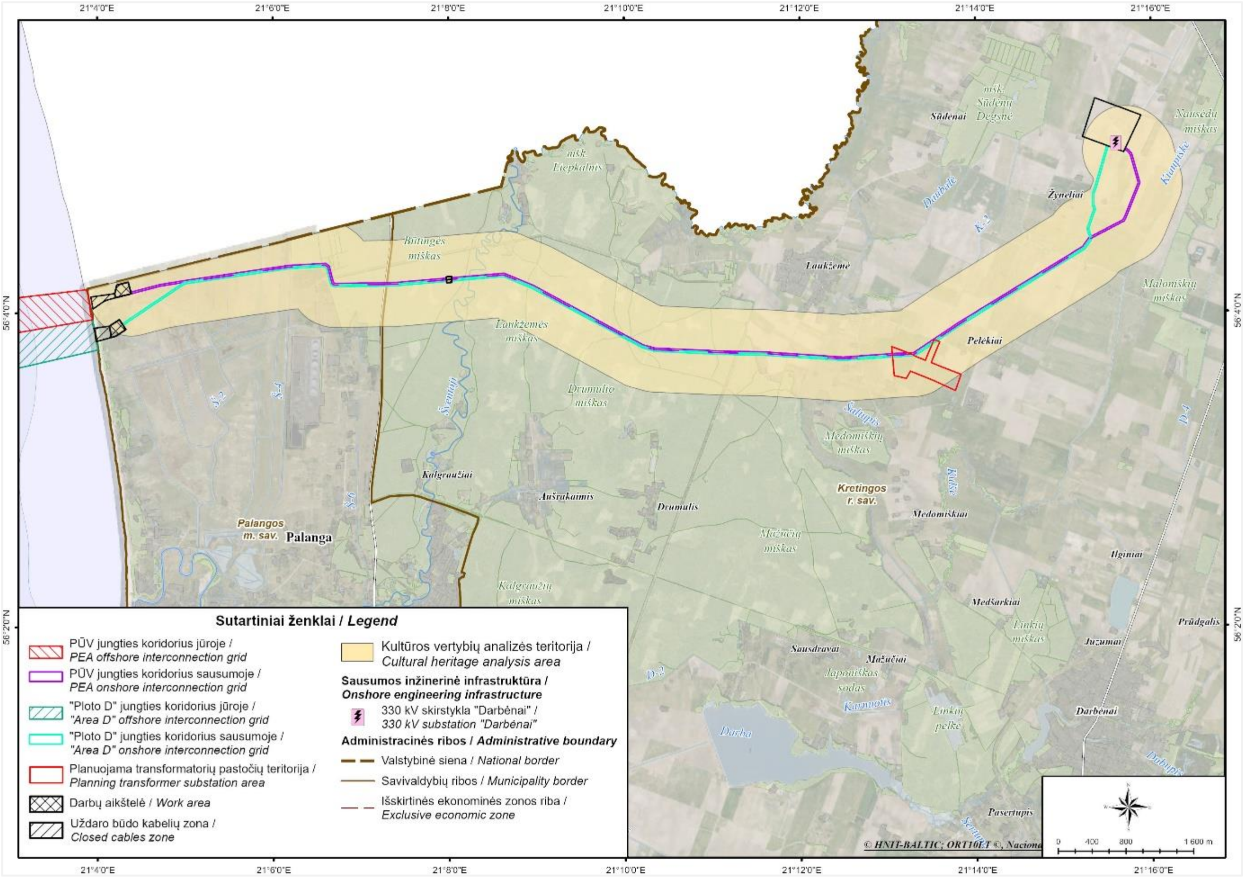


Fig. 5.6.2. Survey area onshore.

5.6.3. Legal regulation

5.6.3.1. Offshore

The most important international legal document related to the use and planning of marine areas is the United Nations Convention on the Law of the Sea (hereinafter – UNCLOS). It is the principal document on which all other international and national regulations regarding the use of marine areas are based. The following articles of the UNCLOS are relevant for the protection of underwater cultural heritage:

- Article 149 (Archaeological and Historical objects): "all objects of an archaeological and historical nature found in the Area to be 'preserved or disposed of for the benefit of mankind as a whole, particular regard being paid to the preferential rights of the State or country of origin, or the State of cultural origin, or the State of historical and archaeological origin. "
- Article 150 (Policies relating to activities in the Area): "activities in the Area shall, as specifically provided for in this Part, be carried out in such a manner as to foster healthy development of the world economy and balanced growth of international trade, and to promote international cooperation for the over-all development of all countries, especially developing States, and with a view to ensuring: (a) the development of the resources of the Area; (b) orderly, safe and rational management of the resources of the Area, including the efficient conduct of activities in the Area and, in accordance with sound principles of conservation, the avoidance of unnecessary waste..../ (i) the development of the common heritage for the benefit of mankind as a whole."
- Article 303 (Archaeological and historical objects found at sea): "(1) States have the duty to protect objects of an archaeological and historical nature found at sea and shall cooperate for this purpose. (2) In order to control traffic in such objects, the coastal State may, in applying article 33, presume that their removal from the seabed in the zone referred to in that article without its approval would result in an infringement within its territory or territorial sea of the laws and regulations referred to in that article."

The UNCLOS divides marine areas into territorial waters, contiguous waters, and EEZs, stipulating that national laws apply to underwater cultural heritage within the first two zones (Article 303, with reference to Article 33 and Article 2 of UNCLOS, which states that “the sovereignty of a coastal State, in addition to its land territory and internal waters and, in the case of an archipelagic State, its archipelagic waters, also extends to the sea zone adjacent to its coasts, which is known as the territorial sea”). In EEZs, only the provisions of UNCLOS apply, alongside salvage rights and other maritime law norms, allowing discoverers almost unrestricted access to underwater cultural heritage.

The protection of underwater heritage is governed by the UNESCO Convention on the Protection of the Underwater Cultural Heritage, ratified by Lithuania on 12 June 2006. This Convention defines underwater cultural heritage as items located underwater that possess historical and cultural significance, bearing witness to human history.

Article 2 of the UNCLOS outlines its objectives to ensure and strengthen the protection of underwater cultural heritage (paragraph 1), obligate States Parties to protect such heritage (paragraph 3), and promote cooperation (paragraph 2). States Parties must take appropriate measures individually or jointly, in compliance with the Convention and international law, using the best practical means available and acting within their capabilities (paragraph 4).

The UNCLOS principles for protecting underwater heritage are detailed in Clauses 5 to 11 of Article 2. It prioritizes in situ preservation of underwater heritage before any activity is allowed (Clause 5) and mandates that recovered heritage be conserved for long-term preservation (Clause 6). Underwater cultural heritage should not be commercially exploited (Clause 7). The Convention does not alter international law and State practices regarding sovereign immunities or rights related to State vessels and aircraft (Clause 8). States Parties must ensure respect for human remains in marine waters (Clause 9). Responsible non-intrusive access for observation and documentation is encouraged to promote public awareness and protection of heritage, unless it conflicts with protection and management (Clause 10). Activities under this Convention shall not be grounds for claiming or disputing national sovereignty or jurisdiction (Clause 11).

The Convention includes Rules that regulate activities directed at underwater cultural heritage, forming an integral part of the Convention. Violations may lead to sanctions imposed by the State Party as per Article 17. Rule 1 emphasizes in situ preservation as a priority and permits activities only if they contribute significantly to the protection, knowledge, or enhancement of underwater cultural heritage.

General principles state that activities should not cause unnecessary adverse impact and should employ non-destructive techniques where possible. Excavation and recovery, when necessary, should use minimally destructive methods to preserve remains, avoiding disturbance of human remains or memorial sites. Activities must be regulated to ensure proper recording of cultural, historical, and archaeological information. Public access to in situ heritage is encouraged unless incompatible with protection and management. International cooperation is promoted to facilitate the exchange and use of archaeologists and relevant professionals.

At the national level, the protection of underwater cultural heritage is regulated by the Law on the Protection of Immovable Cultural Heritage (1994, No. I-733). Article 3 defines archaeological objects, sites, and items of significance under water, reliant on underwater research for scientific data. Article 17 prohibits, without consent from cultural heritage authorities, the use of detectors to search for findings, and the removal or disturbance of underwater objects in inland waters, marine areas, territorial seas, contiguous zones, and EEZs, as defined by Lithuania's international treaties.

5.6.3.2. Onshore

The protection of cultural heritage at the national level is governed by the Law on the Protection of Immovable Cultural Heritage[95] (LRS, 1994-12-22, No. I-733). This law regulates the protection and state management of immovable cultural values located within the territory and territorial waters of the Republic of Lithuania, including those owned by the state, municipalities, religious organizations, and other legal and natural persons.

The Heritage Management Regulation PTR 2.13.01:2022, titled "Management of Archaeological Cultural Heritage,"[96] specifies the mandatory cases for archaeological research, the composition and preparation procedure of an archaeological research project, the methodology for archaeological research, the assessment of archaeological cultural heritage objects and sites, and the procedure for preparing, submitting, considering, and appealing archaeological research reports and certificates. It also includes guidelines for addressing threats, repair, conservation, restoration, and adaptation of archaeological heritage objects.

[95] https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.15165/asr

[96] https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.405666/asr

5.6.4. Current state

5.6.4.1. Cultural heritage values offshore

The Baltic Sea hosts numerous shipwrecks of various types, which form the most common group of finds. However, significant discoveries related to the earliest periods of human habitation in this region are also noteworthy. The geological history of the Baltic Sea suggests that archaeological artifacts from the early Holocene may have survived on its seabed. Mesolithic finds discovered in Denmark, Germany, and Sweden in the last century raise hopes for similar discoveries in other parts of the Baltic Sea. Previously, archaeologists, in collaboration with geologists studying Holocene Sea level changes, attempted to identify Stone Age settlements in Lithuanian waters. Subfossil forest remnants preserved on the seabed serve as key indicators for identifying areas likely to contain relics of Stone Age human activity. The results of previous studies are documented in the works of V. Žulkus and A. Girininkas. [97]

The seabed of the adjacent study area has been mapped to reconstruct the underwater cultural seascape in the eastern part of the Baltic Sea, within Lithuanian waters. This includes remnants of tree trunks, peat sediments, and traces of human activity now submerged. The researchers report: "Based on the latest sediment layer data, palynological and dendrochronological analysis, identified flora species, and radiocarbon dating of wood and peat samples, we determined the dynamics of the Baltic Sea water level during the Yoldia Sea stages of the Early Litorina Period. At depths of 39-43 m, traces of the Yoldia Sea eroded coasts were observed, as well as at depths of 44 and 47 m during the transgression of Ancylus Lake. The Ancylus Lake transgression was marked by an overflow of lagoons and small lakes with a peat layer and surrounding forests. The water level may have been 10-9 m below the current sea level. The Litorina transgression is evidenced by a tree trunk found at a depth of 14.5 m, dated 7,900-7,660 BP." The article indicates that remains of Early Holocene inhabitants are concentrated in the coastline zone, "evidenced by piles driven into the seabed (one dated 9,510–9,460 BP) found at a depth of 11 m, as well as T-shaped collars (dated 9,510–9,460 BP) and T-shaped horn hatches of the Early Neolithic Age washed ashore from coastline Stone Age settlements."

Based on available information from official sources, including the Lithuanian Maritime Safety Administration and the Department of Cultural Heritage, several dozen wreck sites have been identified within the EEZ of the Republic of Lithuania. Some of these sites are listed in the Register of Cultural Properties. Cultural heritage assets are also present along the coastal strip. According to the Lithuanian Register of Cultural Heritage, there are nine registered cultural heritage sites within Lithuania’s marine territory. There are no registered cultural heritage sites in the planned OWF area. The nearest registered cultural heritage site is the wreck of the ship "L-14" (ID 38471), located approximately 33.9 km away (see Figure 5.6.3). Additionally, geophysical seabed surveys conducted in the planned OWF area have identified a previously unrecorded shipwreck (more details in subsection 5.6.4.2).

The analysed area of the connection corridor does not include any registered cultural heritage sites. The nearest registered site is the sunken ship “L-1” (ID 3846657) in the Baltic Sea, located approximately 1.9 km from the connection corridor (see Fig. 5.6.3). The ship “L-1” is protected, and a 500 m safety zone has been established around it.

[97] Žulkus, V, Girininkas, A. The eastern shores of the Baltic Sea in the Early Holocene according to natural and cultural relict data. Geo: Geography and Environment, 2020 https://doi.org/10.1002/geo2.87

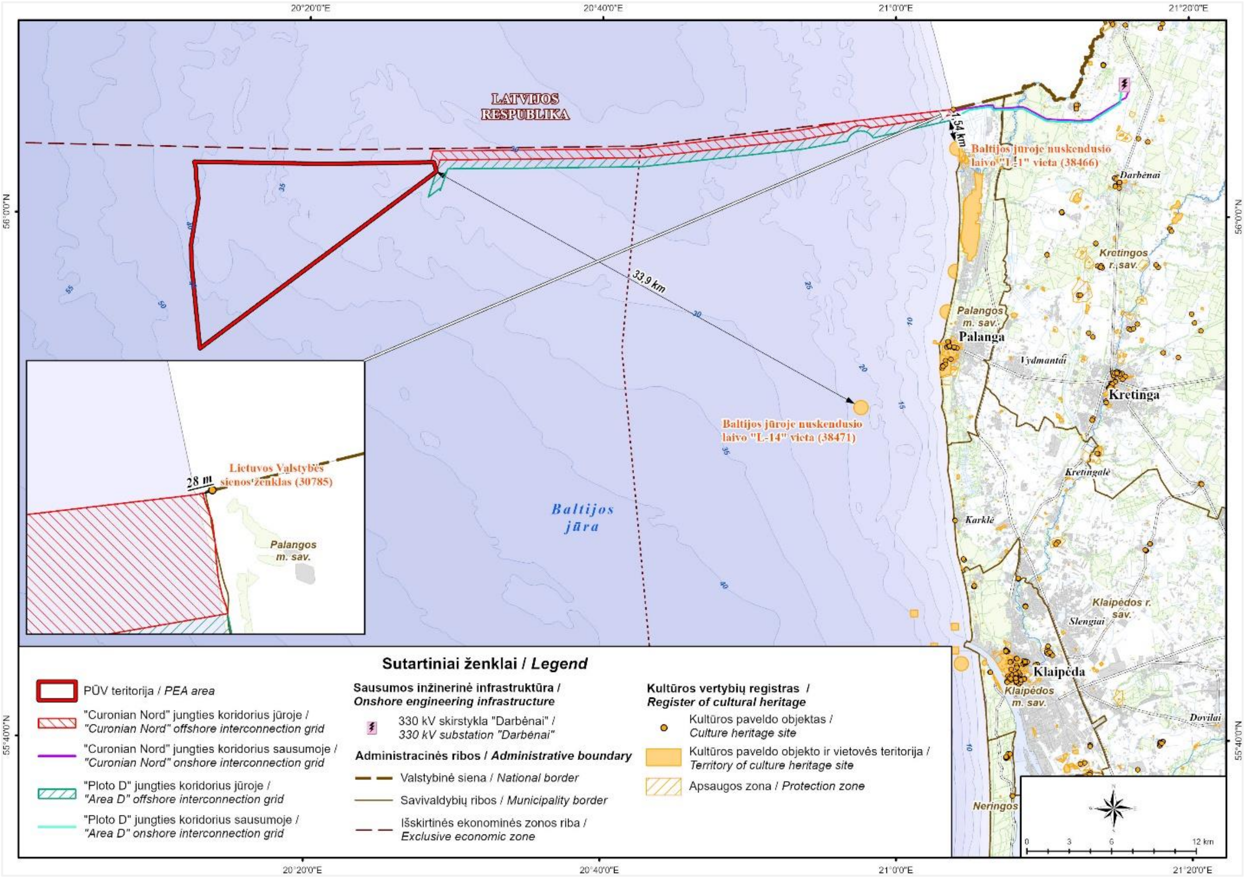


Fig. 5.6.3. Registered cultural heritage sites offshore.

According to the information on the charts of the Lithuanian Transport Safety Administration, several dozen wrecks not included in the Cultural Heritage Register are marked in the EEZ of the Republic of Lithuania (Fig. 5.6.4).

The majority of the wrecks are industrial-type vessels; however, remains of wooden ships of significant scientific value have also been discovered. Additionally, several valuable underwater cultural landscape areas containing natural relics and remains of trees have been identified.

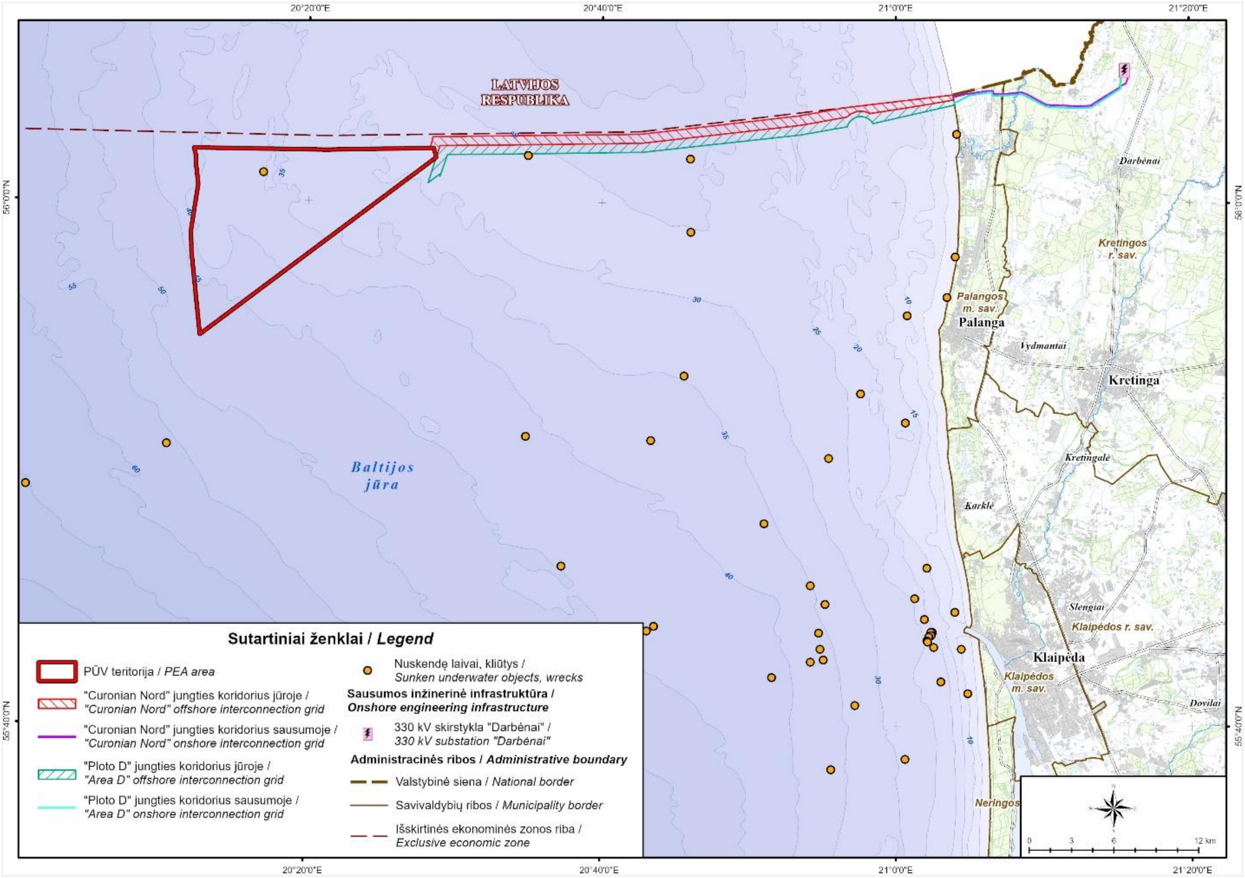


Fig. 5.6.4. Identified locations of wrecks.

5.6.4.2. Archaeological investigations in the offshore area of CN OWF and export cable corridors

Given the depth and distance from the coast of the PEA area, the likelihood of detecting settlement remains has been ruled out. Potential heritage objects in this area are likely to be wrecks of vehicles such as ships or aircraft. Due to the characteristics of the bottom sediments, ship structures should be clearly visible in sonar imagery. The geophysical survey report (Fugro Netherlands Marine BV, 2024) identifies 5,783 magnetic anomalies. Although a portion may correspond to man-made items like anchors, ordnances, cargo, or equipment from sunken vessels – the great majority are considered to be geological of origin, such as magnetite-bearing erratic boulders or other naturally magnetised seabed features.

During the analysis, only one object was identified that may have archaeological or cultural value: an identified sunken ship (see Fig. 5.6.5), to which the authors who conducted the initial research assigned the ID 231123. Other objects are natural, including individual boulders and boulder fields, bottom morphological structures, trawling marks, and individual wrecks of various origins, which lack historical or cultural significance and do not pose a serious threat to the implementation of the PEA in the research area. Additionally, several anthropogenic objects were identified, such as remnants of ropes, which are not of significant importance for the research, and possibly one explosive (see Fig. 5.6.5), which is recommended to be investigated using the available means of the military fleet.

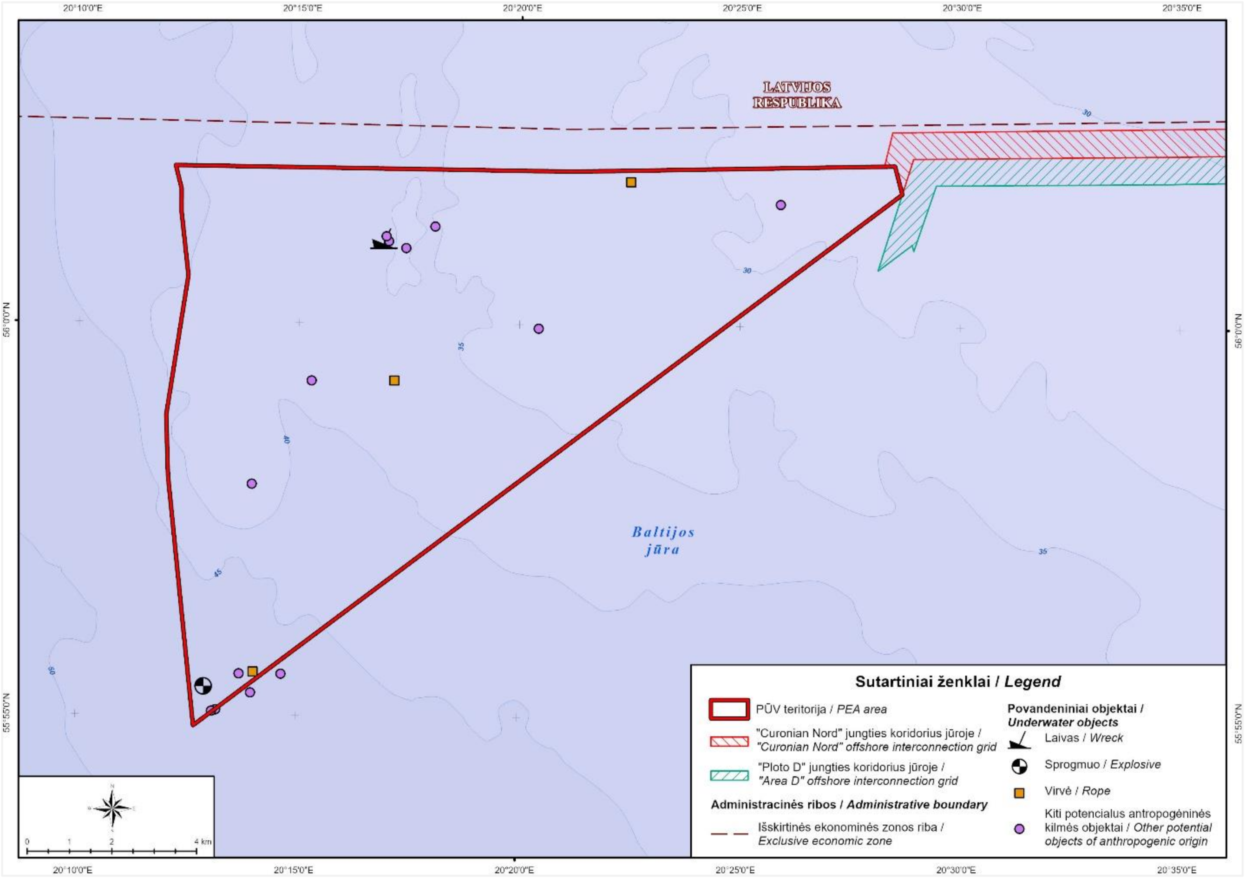


Fig. 5.6.5. Identified anthropogenic objects.

Following an archaeological assessment, it was determined that the sunken object (ID 231123) does not possess archaeological value; however, it presents a significant obstacle to the installation of foundation structures nearby. A detailed report on the investigation of the sunken object and the conclusion of the underwater cultural heritage expert are provided in Annex 7.

The entire export cable corridors were also surveyed using side-scan sonar (PTPI, 2023). Due to the widespread fluvioglacial and moraine deposits in the cable corridor, the main objects on the seabed are naturally occurring individual boulders, boulder fields, and moraine ridges. The boulder fields follow the erosional boundaries of zones affected by glacial erosion and intense glacial meltwater action, concentrated in the western and eastern zones of the surveyed area, while the remaining part is dominated by single larger boulders. In total, over 4,500 natural objects (boulders) and several hundred moraine ridges were identified. Additionally, two linear anthropogenic features roughly corresponding to telecommunication cables marked on navigational charts and clearly visible in some sonar images were detected. No other objects potentially possessing historical or cultural value were found within the export cable corridor.

5.6.4.3. Cultural heritage values onshore

The export cable corridors do not cross registered cultural heritage sites, but in 3 cases they pass nearby: Laukžemė Burial Ground II (ID 37960), the Lithuanian State Border Marker (ID 30785), and Būtingė Discovery Site 7 (unregistered object).

5.6.4.3.1. Laukžemė Cemetery II

The CN OWF export cable corridor is located closest, within 3 m to the south, to the southwestern corner of the Laukžemė Cemetery II (ID 37960) territory (see Fig. 5.6.6). The cemetery is not clearly distinguished in the terrain (see Fig. 5.6.7), which may lead to inaccuracies in determining its boundaries.

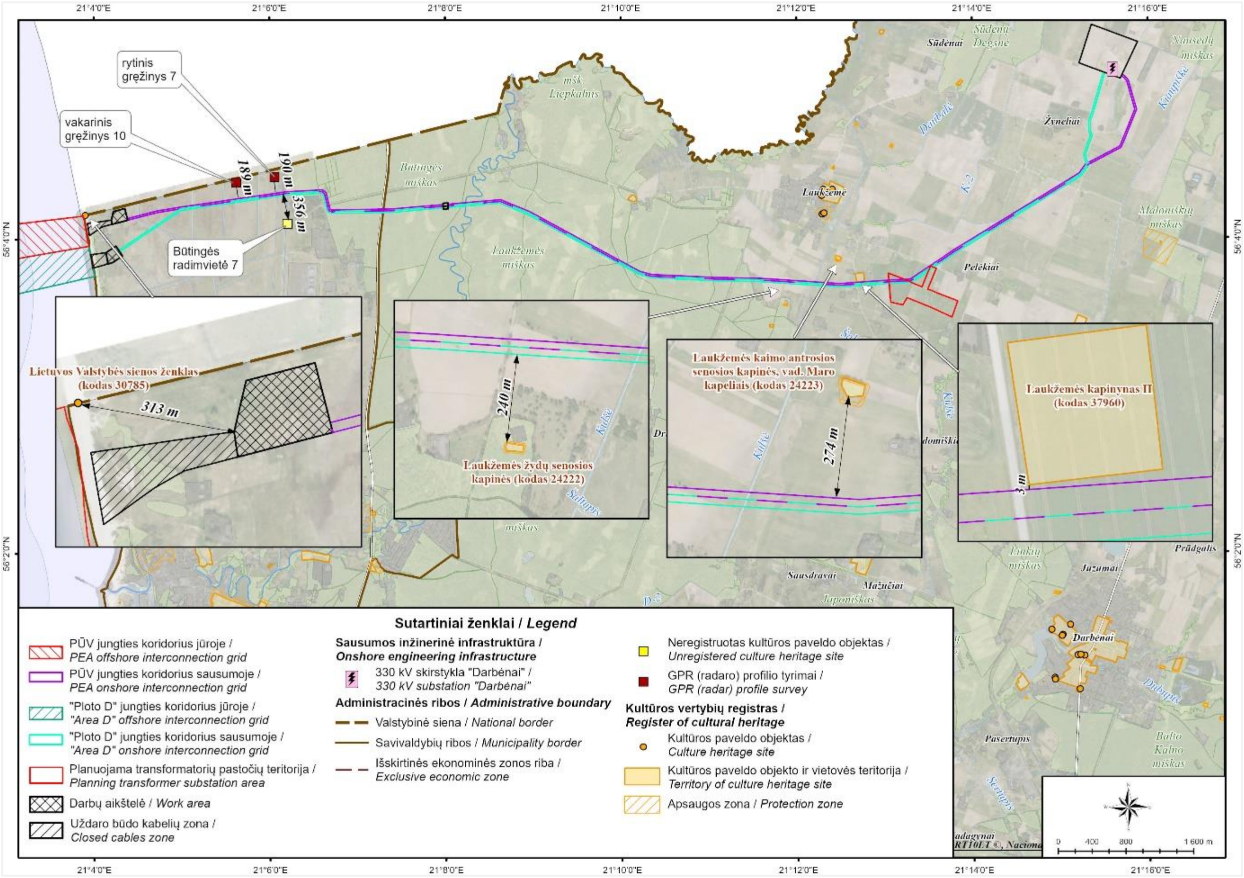


Fig. 5.6.6 Registered cultural heritage sites onshore.

Table 5.6.1. Information about Laukžemė Cemetery II

Unique object code (ID)	Full name	Address	The nature of valuable properties	Area of the territory
37960	Laukžemė Cemetery II	Kretinga District Municipality, Darbėnai eldership, Medomiškė village	Archaeological (determining significance);	9,969.00 m^2

Valuable features include land and its surface elements – relief characterized by a flat field with a barely noticeable shallow elevation on the western side, bordered by the Laukžemė-Darbėnai road and cultivated fields on other sides. The territory has been altered by long-term ploughing and during the construction of an oil pipeline at the end of the 20th century; it is currently being ploughed. Graves – incidental archaeological finds from disturbed cremated human graves, which were uncovered during various earthmoving activities. In 2011, incidental archaeological finds were collected within the territory.

Fig. 5.6.7. Cultural heritage areas (with valuable features) identified in the vicinity of the planned export cable corridor (Laukžemė Cemetery II site, northwest).

5.6.4.3.2. Lithuanian state border mark (ID 30785)

The Lithuanian state border sign is located within the municipal boundaries of Palanga city at the state border with Latvia. The distance from the planned CN OWF export cable landfall to this cultural heritage site is approximately 313 m.

The nature of the valuable features is historical, with important determining significance. Valuable features include:

- Sites: a concrete platform formed on a dune.
- Niches: a niche in the southern wall intended for a wall marking board (the board itself has not survived).
- Structures: made of reinforced concrete.
- various forms of expression: a pointed four-sided pillar.

Fig. 5.6.8. Border sign of the Republic of Lithuania (photo authors: on the left V. A. Spudas, 2006-08-08; on the right A. Zokaitis, 2011-04-28, https://kvr.kpd.lt/).

5.6.4.3.3. Būtingė site 7

In 2013, archaeologist G. Piličiauskas discovered an unregistered cultural heritage site in the Būtingė area – Būtingė site 7 – located approximately 356 m south of the planned "Area D" OWF export cable corridor. The site lacks precise localization; the research report provides only the coordinates of flint finds: 6218706.13; 319659.92; 6218705.94; 319660.41; 6218711.47; 319654.96. The site is considered unprotected, and research should be conducted only if construction or similar activities are planned there (Piličiauskas G. Report on the archaeological exploratory research of the ancient settlement of Šventoji (1813) and its surroundings in 2013, Manuscripts of the Lithuanian Institute of

History, vol. 1, vol. 6748, pp. 195–196, 200, 212, 242–243; Piličiauskas G., Kurilienė A., Vengalis R. Exploratory research in Šventoji, Archaeological research in Lithuania in 2013. Vilnius, 2014, pp. 37, 39).

Approximately 200 m north of the route, a GPR (ground-penetrating radar) profile was made, and boreholes 7–13 were drilled in an almost northeast-southwest direction (coordinates of the edge boreholes: eastern (borehole 7) – 6219268.76; 319527.47, western (borehole 10) – 6219221.29; 319072.89). In all boreholes, yellowish sand was found beneath 35–45 cm of dark peaty soil (Piličiauskas G. Report on the archaeological exploration of the ancient settlement of Šventoji (1813) and its surroundings in 2013, Manuscripts of the Lithuanian Institute of History, f. 1, b. 6748, pp. 11, 13–14).

The 2013 investigations determined that Būtingė shows "signs of a significant presence of a valuable archaeological layer or structures." Given the potential for archaeological findings, exploratory archaeological research should be conducted before implementing large construction or infrastructure development projects (Piličiauskas G. Report on the 2013 Archaeological Exploratory Research of the Ancient Settlement of Šventoji (1813) and its Environment, Manuscripts of the Lithuanian Institute of History, f. 1, b. 6748, p. 200).

5.6.5. Potential impact on cultural heritage values

5.6.5.1. Offshore

Offshore, export cable corridors will not be laid in the territories of registered cultural heritage values, they will not affect cultural heritage, and no negative consequences are expected.

The majority of the sunken objects known in the Lithuanian waters are industrial-type vessels; however, remains of wooden ships of high scientific value have also been discovered. Based on the locations of registered cultural properties, known shipwreck sites, and the data from conducted investigations, no negative impacts – such as the destruction of heritage or reduction of its valuable attributes – are anticipated for cultural properties in the marine area.

5.6.5.2. Onshore

Onshore, the installation of export cable corridors and the Pelėkiai Transformer Substation will involve earthworks that may potentially affect registered and unregistered cultural heritage properties. The planned export cable corridors will not cross the territory of any registered cultural heritage properties but will pass near the territory of the registered cultural heritage site Laukžemė Cemetery II (ID 37960), and approximately 340 m away from the unregistered cultural heritage site Būtingė Site 7.

To ensure that the planned export cable corridors do not damage potential cultural heritage properties, particularly archaeological heritage, archaeological investigations must be conducted during the design phase of the export cable corridors. The type and scope of these investigations shall be determined by the responsible archaeologist (or team of archaeologists) in the archaeological investigation project, in accordance with the requirements of the Heritage Management Regulation PTR 2.13.01:2022 "Management of Archaeological Cultural Heritage".

Since the construction activities of the export cable will cover an area larger than 5 hectares, archaeological investigations will be required in the areas where topsoil removal is planned, in accordance with paragraph 7.8 of the Heritage Management Regulation PTR 2.13.01:2022 "Management of Archaeological Cultural Heritage".

5.6.6. Measures for the protection of cultural heritage values

5.6.6.1. Offshore

The protection of marine cultural heritage is important when planning activities in the marine area. The main sources were related to maritime navigation and disasters in the Baltic Sea. No objects with cultural value and/or monument status were found in the study area. The only wreck discovered – No. 231 123 – is not an archaeological artifact. During the study, it was not possible to determine what kind of ship it was and when it sank. Despite the fact that the shipwreck is not a monument/object of underwater cultural heritage, it is an obstacle to the planned PEA. Therefore, it is recommended to establish a protective zone (protective buffer) of at least 50 meters around the wreck, measured from the outer points of the shipwreck, determined based on sonar surveys. This will allow for safe planning of the placement of the OWF and the construction of cable infrastructure. It will also protect the wreck itself from accidental destruction.

The protection of marine cultural heritage is a crucial consideration when planning activities in marine areas. The primary sources of information pertained to maritime navigation and disasters in the Baltic Sea. No objects with cultural value or monument status were identified in the study area. The sole wreck discovered – ID 231123 – is not classified as an archaeological artifact. During the study, it was not possible to determine the type of ship or the date of sinking. Although the shipwreck is not a designated monument or object of underwater cultural heritage, it poses an obstacle to the planned PEA. Therefore, it is recommended to establish a protective zone (buffer) of at least 50 ms around the wreck, measured from the outer points identified through sonar surveys. This measure will facilitate safe planning for the placement of the OWF and the construction of export cable infrastructure, while also protecting the wreck from accidental damage.

5.6.6.2. Onshore

To avoid negative impacts on cultural values, the export cable corridors have been selected to steer clear of valuable cultural heritage territories or objects. Activities that might physically damage the valuable properties of cultural heritage objects or obstruct their view are not planned within these zones.

When carrying out cable installation works for connections involving earthworks, if archaeological finds or valuable features of an immovable property are discovered, the owners or persons performing the works must notify the municipal heritage protection unit, which in turn informs the Department of Cultural Heritage, as stipulated in Article 9(3) of the Law on the Protection of Immovable Cultural Heritage of the Republic of Lithuania. The Department of Cultural Heritage may suspend the works for 15 days. Within this period, together with the municipal heritage protection unit, it must verify the notification and decide whether or not to initiate the registration of the discovered immovable cultural property, the designation of the cultural heritage object as protected, or the disclosure of the discovered valuable features and clarification of the protection requirements.

Table 5.6.2. Potential impact of the OWF on cultural values offshore and summary of mitigation measures

Stage	Impact	Nature	Scale	Duration	Significance	Measures
Construction	Impact on the seabed during the installation of WTG foundations, inter array cables and export cables	Direct, if cultural values are discovered in the affected seabed area	Local at the installation site of WTG foundations and cable laying corridors	Long-term	Impact is of little significance	During the planning stage, the locations and export cable corridors were selected by retreating from registered offshore underwater objects. It is recommended to establish a safety zone of at least 50 m around wreck ID 231123.
Operation and maintenance	Impact not expected				Insignificant	Not applicable.
Decommissioning	Impact not expected				Insignificant	Not applicable.

Colour code

(light green)	Positive impact
(light blue)	No impact or impact insignificant (not to be considered, no measures are applicable)
(blue)	Minor impact: decisions during design, preventive or mitigation measures
(light orange)	Moderate impact: addressed by mitigation measures
(orange)	Significant impact: mitigation and/or compensation measures are necessary.

Table 5.6.3. Potential impact of the installation of the export cables on cultural assets onshore and summary of mitigation measures

Stage	Impact	Nature	Scale	Duration	Significance	Measures
Construction	Earthmoving works	Direct, if unregistered cultural property is discovered along the export cable corridor and in the territory of the Pelėkiai Transformer Substation	Local	Long-term	Impact is of minor significance	During the planning stage, the export cable corridors were selected by retreating from cultural heritage territories or objects. During the technical design, it is necessary to conduct archaeological research at the Laukžemė Cemetery II (ID 37960) and the Būtingė site-7 territories. During the installation of export cables that involve excavation works, any archaeological finds must be promptly reported to the municipal heritage protection unit. This unit will then inform the Cultural Heritage Department, in accordance with Article 9, Part 3 of the Law of the Republic of Lithuania on the Protection of Immovable Cultural Heritage.
Operation and maintenance	Impact not expected				Insignificant	Not applicable.
Decommission	Impact not expected				Insignificant	Not applicable.

Colour code

(light green)	Positive impact
(light blue)	No impact or impact insignificant (not to be considered, no measures are applicable)
(blue)	Minor impact: decisions during design, preventive or mitigation measures
(light orange)	Moderate impact: addressed by mitigation measures
(orange)	Significant impact: mitigation and/or compensation measures are necessary

5.7. Public health

Article 18 of the Law on Public Health Care of the Republic of Lithuania mandates that the environment be improved to promote human health, reduce the negative impact of human activities on health, and eliminate environmental damage caused by such activities. Furthermore, before initiating or expanding economic activities that may pose a threat to human health, an assessment of the impact on public health must be conducted.

The purpose of the public health impact assessment is to identify, describe, and evaluate the potential impact of the PEA on public health and to propose appropriate measures to eliminate or reduce harmful effects.

5.7.1. Survey methods

5.7.1.1. Offshore area

The planned economic activity area is located far from the shoreline zone and residential areas. Since the PEA will take place in a marine environment, where there are no residential, public, or sensitive receptors, no impacts on such environments are expected. Therefore, in the offshore territory, potential impacts on residential areas are not assessed, and the application of research methods is considered irrelevant.

5.7.1.2. Onshore area

For the analysis of the current state of public health, demographic and morbidity indicators have been used, based on data from the Health Information Centre on the website of the Institute of Hygiene (https://sveikstat.hi.lt/, July 2025).

According to the data of the Real Property Register database of the State Enterprise Centre of Registers, the nearest residential houses, public-purpose areas, and other important territories located at a certain distance from the planned onshore connection corridor have been identified.

The dispersion of noise generated by the planned ONS in the analysed area was calculated using CadnaA software. CadnaA (Computer Aided Noise Abatement) is a tool designed for the calculation, visualization, assessment, and prediction of noise impact. Within CadnaA, all sources of acoustic pollution are evaluated in accordance with Directive 2002/49/EC[98], applying relevant methodologies and standards that are valid in the European Union and Lithuania, including industrial noise assessments based on ISO 9613.For the assessment of the electromagnetic field, data obtained from measurements carried out in a transformer substation of an economic activity with an analogous purpose were used.

5.7.2. Survey area

5.7.2.1. Offshore

In terms of public health impact, the closest residential and public areas located near the Baltic Sea are examined: Klaipėda City, Klaipėda District, Palanga City Municipality. The shortest distance to Palanga City Municipality from OWF is 36.8 km.

5.7.2.2. Onshore

The impact of PEA on public health is analysed within the area where activity-related impacts are possible: in the adjacent area of the export cable corridors and in the Pelėkiai Transformer Substation, located within the municipalities of Palanga City and Kretinga District. The activity-related impacts and their health risk factors are identified in the nearest residential and public areas to the PEA, which are located at a distance of 75 to 732 m from the planned onshore section of the export cable corridor and 117 to 293 m from the boundary of the planned Pelėkiai Transformer Substation area.

[98] Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise

5.7.3. Analysis of the current public health state

5.7.3.1. Offshore

The analysed PEA territory is located in the Baltic Sea, within the EEZ and territorial waters of the Republic of Lithuania (see Fig. 5.7.1). The electricity generated by the OWF is planned to be transmitted to transmission grid via onshore substation.

The nearest residential and public areas along the Baltic Sea coast are within the municipalities of Klaipėda City, Klaipėda District, and Palanga City. The shortest distance to Palanga City Municipality is approximately 36.8 km. The distances from the PEA area to onshore residential and public areas are detailed in Table 5.7.1 and shown in Figure 5.7.1.

Table 5.7.1. Distances from the PEA site to residential and public areas

Territory	Distance from PEA
Residential	
Palanga, Palanga City Municipality	36.8 km
Karklė village, Klaipėda District Municipality	41.0 km
Klaipėda, Klaipėda City Municipality	46.8 km
Public objects	
No. 1 – Palanga Rehabilitation Hospital, Public Institution (Palanga, Vytautas st. 153)	38.7 km
No. 2 – Palanga Šventoji Primary School (Palanga, Mokyklos st. 10)	37.8 km

The recreational areas designated by the Coastal Strip Mainland Management Plan, approved by the Minister of Environment of the Republic of Lithuania on July 28, 2011, by Order No. D1-601, are depicted in Fig. 5.7.1. The examined PEA area is situated outside the boundaries of these recreational areas, approximately 36.8 km from the shore.

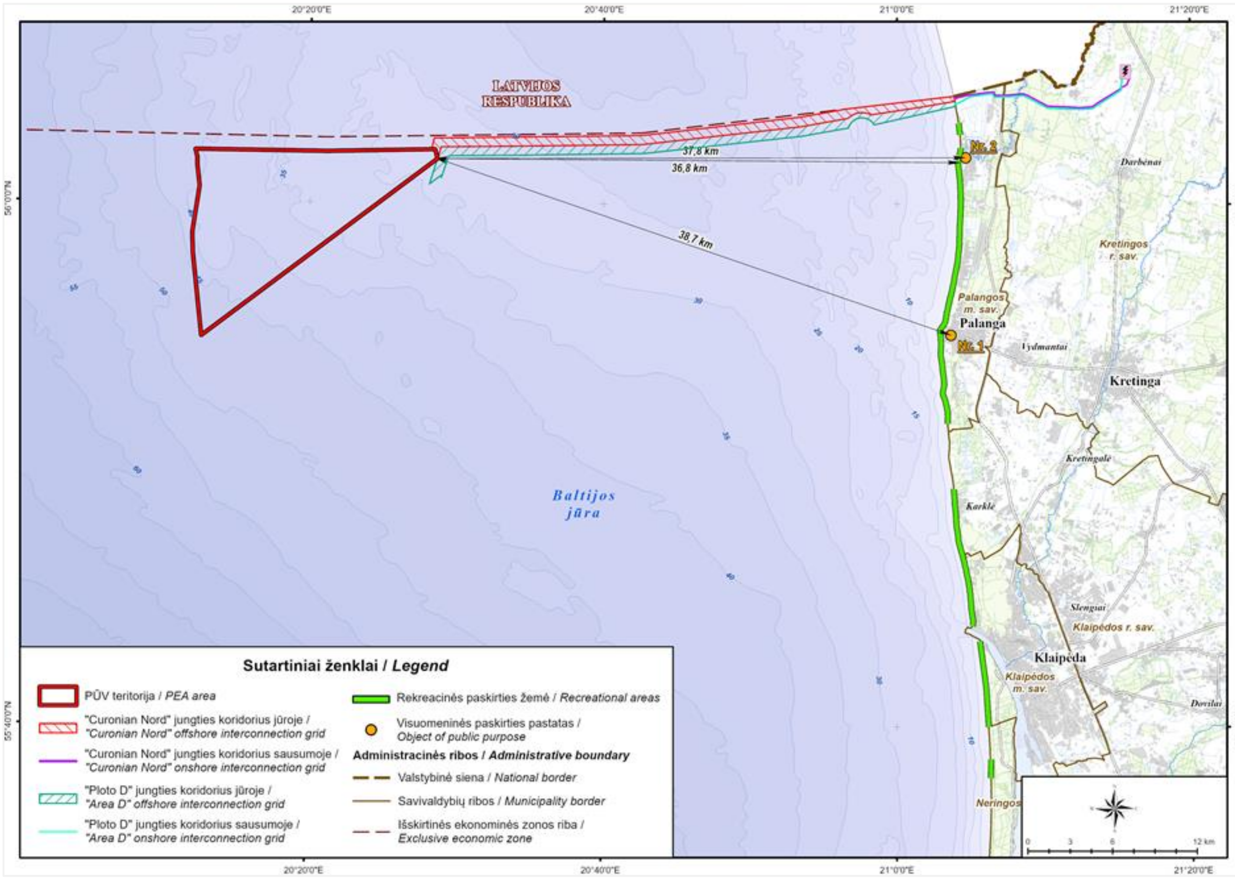


Fig. 5.7.1. Residential, public and recreational areas closest to the shore within the area of CN.

5.7.3.2. Onshore

The onshore section of the export cable corridors is planned to be located within the territories of Palanga City and Kretinga District Municipality (see Fig. 5.7.1), specifically connecting the OWF to the onshore electricity transmission grid at the 330 kV "Darbėnai" switchyard area (Kretinga District Municipality, Darbėnai township, Žyneliai village 9). The EIA report further examines the current state of public health in the affected municipalities.

5.7.3.2.1. Demographic situation of the region's population

The planned installation of the export cables and the Pelėkiai Transformer Substation is associated with noise, electromagnetic radiation, ambient air pollution, which, depending on the magnitude and duration of the exposure, may be potential aetiological factors for various diseases of the central nervous system, circulatory, respiratory and digestive systems. The analysis of public health indicators is carried out in the light of these diseases, which are relevant to the economic activity under consideration.

In the absence of availability of health indicator data below the municipal level (due to data protection requirements, the Institute of Hygiene does not receive the full address of the residence, only the municipal code), the smallest territorial unit for which the morbidity indicators are calculated is the municipality.

To characterise the population health status, the following public health indicators have been selected:

- demographic indicators: average population, birth rate, death rate, natural increase rate,
- population morbidity rates: number of individuals with certain diseases (morbidity) (by disease group and age).

The tables below show the demographic indicators for the most recent 10 years for the municipalities of Palanga City Municipality, Kretinga District Municipality, and the Republic of Lithuania (for comparison). Data from the Institute of Hygiene, Health Information Centre (https://sveikstat.hi.lt/, July 2025).

In 2023, the average annual population of Palanga City Municipality was 17,954 inhabitants, while that of Kretinga District Municipality was 37,498. That year, Kretinga District Municipality accounted for a larger share of Lithuania's total population (1.3 %) compared to Palanga City Municipality (0.63 %) (Table 5.7.3).

Compared to the previous year (2022), the population of Palanga City Municipality increased by 541 residents, whereas Kretinga District Municipality experienced a smaller increase of 19 residents. Over the same period, the total population of the Republic of Lithuania grew by 39 946 residents.

In the Municipality of Palanga, the Municipality of Kretinga District, and in Lithuania overall, the share of women was higher than that of men. In 2023, the proportion of women of reproductive age (15–49 years) in the Municipality of Palanga was 34.9%, in the Municipality of Kretinga District – 38.9%, and in Lithuania – 39.4%. According to the age structure, in the Municipality of Palanga the largest share of the population was aged 45–64 – 30.9%, while in the Municipality of Kretinga District the largest share was aged 18–44 – 31.9%, as was the case in the country overall – 33.4%.

Table 5.7.2. Population composition of regions in 2023

Indicator	Palanga City Municipality	Kretinga District Municipality	Lithuania
Average annual population	17,954	37,498	2,871,585
Share of Lithuania’s population, %	0.63	1.32	100
Percentage of men, %	44.8	47.0	47.0
Percentage of women, %	55.2	53.0	53.0
Share of women of reproductive age (15–49 years), %	34.9	38.9	39.4
Share of population aged 0–17 years, %	15.8	18.3	17.6
Share of population aged 18–44 years, %	28.5	31.9	33.4
Share of population aged 45-64, %	30.9	29.7	28.8
Share of population aged 65 years and older, %	24.9	20.2	20.2

Over the period 2014–2023, despite fluctuations, birth rates in Palanga City Municipality and Kretinga District Municipality remained below the corresponding rates in Lithuania, except in Kretinga District Municipality in 2017, 2018, 2019 and 2023 *(Table 5.7.3, Fig. 5.7.2)*.

Table 5.7.3. Birth rate per 1,000 inhabitants 2014–2023

Years	Palanga City Municipality	Kretinga District Municipality	Lithuania
2014	8.1	9.6	10
2015	9.4	9.3	10.3
2016	9.6	9.7	10.3
2017	8.1	10.3	9.8
2018	9.1	9.7	9.5
2019	8.5	9.6	8.9
2020	8.1	8.3	8.4
2021	5.9	8.0	8.3
2022	6.1	7.8	7.8

Years	Palanga City Municipality	Kretinga District Municipality	Lithuania
2023	6.2	7.5	7.2

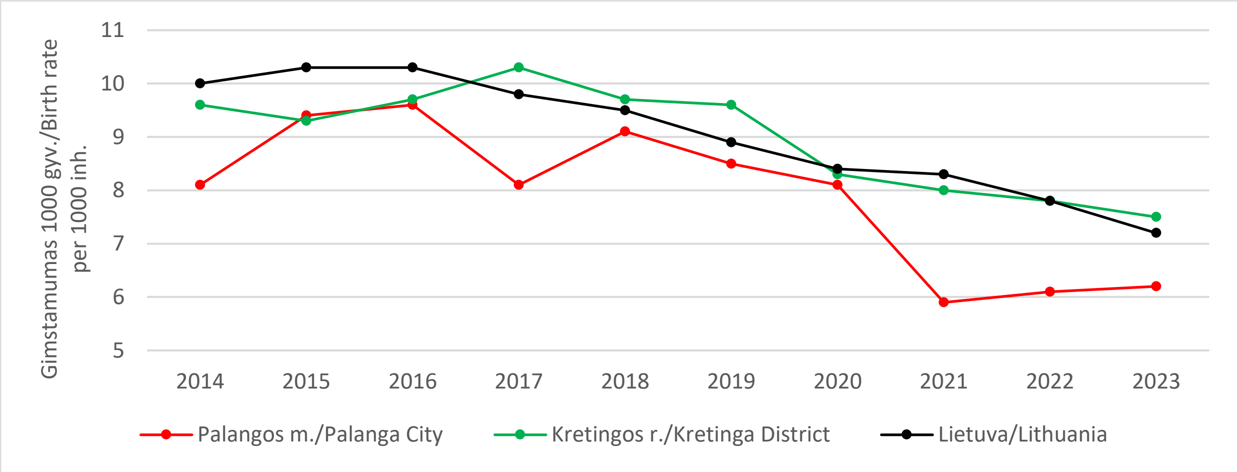


Fig. 5.7.2. Birth rate per 1000 inhabitants in Palanga City Municipality, Kretinga District Municipality and Republic of Lithuania, 2014-2023.

In the period 2014–2023, the number of mortality rates per 1,000 inhabitants in Kretinga District Municipality was lower than in Lithuania, except for 2016, 2019 and 2021, while in Palanga City Municipality the indicator was variable (Table 5.7.4, Fig. 5.7.3). In 2021, Kretinga District Municipality had the highest mortality rate, with 17.1 deaths per 1,000 inhabitants.

Table 5.7.5. Mortality rate per 1,000 inhabitants 2014–2023

Years	Palanga City Municipality	Kretinga District Municipality	Lithuania
2014	14.6	12.6	13.7
2015	15.1	13.3	14.4
2016	14.5	14.5	14.3
2017	15.1	13.9	14.1
2018	14.0	13.5	14.0
2019	13.4	13.8	13.6
2020	16.3	14.8	15.5
2021	16.7	17.1	17.0
2022	14.6	14.8	15.1
2023	13.2	12.6	12.9

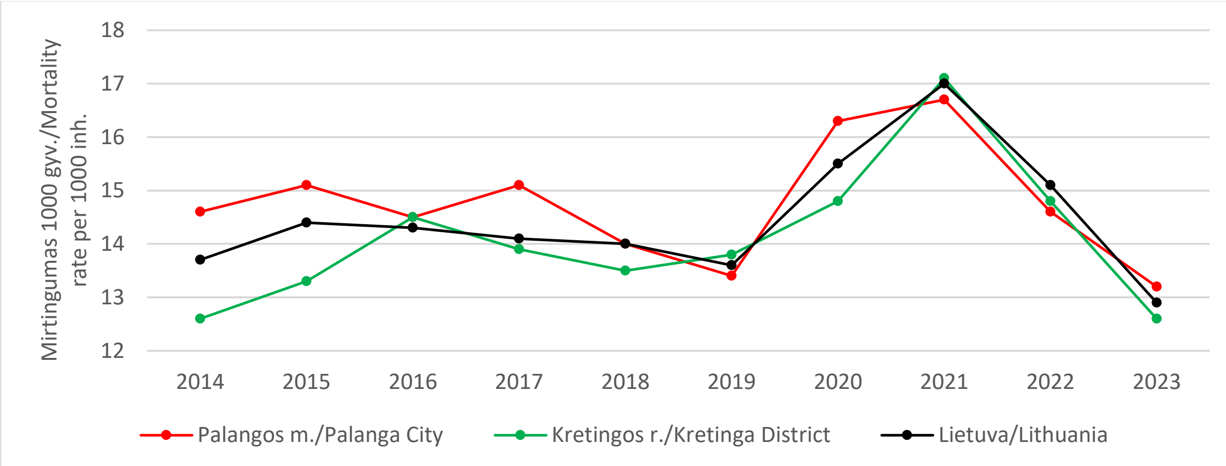


Fig. 5.7.3. Mortality rate per 1000 inhabitants in Palanga City Municipality, Kretinga District Municipality and Republic of Lithuania, 2014-2023.

During the period from 2014 to 2023, the natural population growth per 1,000 inhabitants in Lithuania remained negative, meaning that more people died than were born (Table 5.7.5, Fig. 5.7.4). Over the decade, the natural population growth rate in Palanga City Municipality was higher than that of Lithuania as a whole.

Table 5.7.5. Natural population change per 1,000 inhabitants 2014–2023

Years	Palanga City Municipality	Kretinga District Municipality	Lithuania
2014	-5.8	-2.5	-3.4
2015	-4.9	-3.5	-3.5
2016	-4.5	-4.3	-3.6
2017	-6.6	-3.3	-4.0
2018	-4.6	-3.4	-4.1
2019	-4.1	-3.5	-3.9
2020	-7.3	-6.2	-6.5
2021	-10.8	-9.1	-8.7
2022	-8.4	-7.0	-7.4
2023	-13.2	-12.6	-12.9

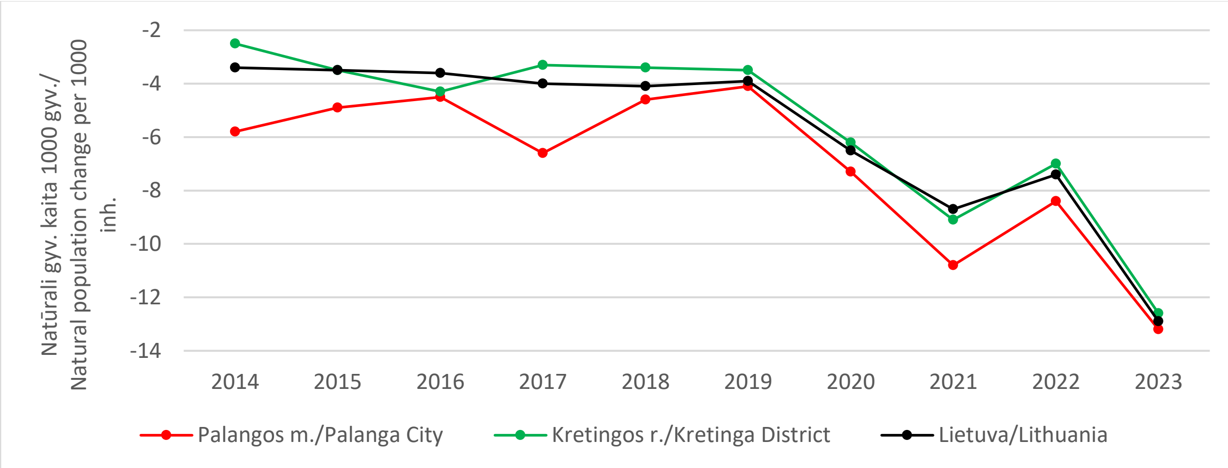


Fig. 5.7.6. Natural population change per 1000 inhabitants in Palanga City Municipality, Kretinga District Municipality and Republic of Lithuania, 2014-2023.

5.7.3.2.2. Analysis of population morbidity rates

The main impact on morbidity rates is due to the higher proportion of older people in the population and, to some extent, poorer access to primary care. The current age structure of the population must be considered when assessing morbidity rates.

It should be noted that the occurrence of circulatory diseases is mainly due to risk factors related to human behaviour (unhealthy diet and lifestyle): smoking, alcohol abuse, overweight, lack of physical activity.

The analysis focuses on relevant morbidity indicators of the population in Palanga City and Kretinga District Municipality – specifically, morbidity related to the nervous, respiratory, circulatory, hypertensive, and digestive systems – which may be associated with the planned export cable corridor. The Health Statistics Data Portal of the Institute of Hygiene provides statistical information on morbidity based on International Classification of Diseases (hereinafter – ICD) codes for the period 2014–2023.

Sick individuals (morbidity) – the number of individuals for whom at least one illness or injury from individual diseases or groups of diseases is registered in in ambulatory or stationary personal health care facilities (according to ICD codes).

In the period 2014–2023, the number of individuals with diseases of the nervous system per 1,000 inhabitants has been increasing unevenly in the whole country, as well as in Palanga Municipality and Kretinga District Municipality (Table 5.7.6).

Table 5.7.6. Number of individuals with diseases of the nervous system (G00-G99) per 1,000 inhabitants

Years	Palanga City Municipality	Kretinga District Municipality	Lithuania
2014	133.68	106.54	130.37
2015	140.35	110.03	135.37
2016	147.45	113.6	136.89
2017	149.15	116.64	140.23
2018	120.32	117.03	141.41
2019	122.89	122.75	145.07
2020	102.41	103.6	132.23
2021	110.14	108.44	143.63
2022	125.25	111.26	152.38
2023	134.12	113.95	159.78

During the period from 2014 to 2023, the number of individuals with circulatory system diseases per 1,000 inhabitants increased in Lithuania. In 2014, this indicator was highest in Palanga City Municipality (368.22), while in 2023 it was highest in Kretinga District Municipality (334.95) and in Lithuania overall (338.74) (Table 5.7.7).

Table 5.7.7. Number of individuals with circulatory diseases (I00-I99) per 1000 inhabitants

Years	Palanga City Municipality	Kretinga District Municipality	Lithuania
2014	368.22	312.6	304.78
2015	362.94	312.35	307.55
2016	358.68	313.28	309.7
2017	360.04	320.02	312.15
2018	365.57	324.35	319.75
2019	366.51	328.48	326.8
2020	346.01	311.64	312.59
2021	357.69	323.47	325.38
2022	361.87	324.9	330.32
2023	362.48	334.95	338.74

During the period from 2014 to 2023, the number of individuals with hypertensive diseases per 1,000 inhabitants increased in Palanga City Municipality, Kretinga District Municipality and Lithuania. During the analysed period, this indicator in Palanga City Municipality was higher than the corresponding indicator in Kretinga District Municipality and in Lithuania overall (Table 5.7.8).

Table 5.7.8. Number of individuals with hypertension diseases (I10-I15) per 1,000 inhabitants

Years	Palanga City Municipality	Kretinga District Municipality	Lithuania
2014	299.22	251.04	252.17
2015	292.93	253.15	253.87
2016	288.46	254.29	257.07
2017	294.4	262.26	264.36
2018	302.76	269.48	272.59
2019	304.17	270.88	278.44
2020	292.75	265.43	273.37
2021	300.04	274.06	280.88
2022	303.69	276.18	284.62
2023	309.91	286.18	291.96

During the period from 2014 to 2023, the number of individuals with gastrointestinal diseases, excluding dental diseases per 1,000 inhabitants increased unevenly across the regions. During the analysed period, this indicator in Kretinga District Municipality was lower than the corresponding indicator in Lithuania overall (Table 5.7.9).

Table 5.7.9. The number of individuals with digestive system diseases, excluding dental diseases (K09–K93), per 1,000 inhabitants

Years	Palanga City Municipality	Kretinga District Municipality	Lithuania
2014	139.76	127.64	133.49
2015	152.45	131.16	136.75
2016	146.18	133.78	139.05

Years	Palanga City Municipality	Kretinga District Municipality	Lithuania
2017	139.00	129.73	139.71
2018	146.57	136.54	147.59
2019	150.44	141.18	154.9
2020	111.79	112.31	124.83
2021	139.14	121.5	142.09
2022	147.54	130.69	158.67
2023	159.74	139.37	168.64

Between 2014 and 2023, the morbidity rate for ear diseases 1,000 inhabitants in the analysed regions fluctuated – at times increasing, at times decreasing. For several years, the rate in Kretinga District Municipality was lower than the corresponding rate in Lithuania (Table 5.7.10).

Table 5.7.10. Number of individuals with ear and mastoid process diseases (H60-H95) per 1,000 inhabitants

Years	Palanga City Municipality	Kretinga District Municipality	Lithuania
2014	65.32	56.74	68.23
2015	64.12	54.74	69.93
2016	57.67	52.73	70.1
2017	56.14	56.8	73.6
2018	61.74	59.76	75.56
2019	65.08	62.87	80.37
2020	51.87	43.1	58.97
2021	59.9	49.94	68.87
2022	71.33	71.91	86.65
2023	80.15	74.83	96.71

5.7.3.2.3. Analysis of the population in risk groups

The most important risk group consists of residents who live in the area 24/7 and could be exposed to excessive environmental impact. The most sensitive groups of the population include children, the sick, pregnant women, and the elderly. Representatives of these groups are more sensitive to increased air pollution, noise, and other changes in environmental or lifestyle indicators. There are no residential or public buildings within the excessive impact zone for the planned export cable corridors and Pelėkiai Transformer Substation, so the residents are not considered part of the risk groups. Furthermore, if the general and specific environmental pollution indicators do not exceed the threshold values, there should be no negative health impact on people.

To avoid workplace accidents, safety regulations should be followed, and workers should be properly instructed. The impact on employees is assessed within the scope of occupational risk evaluation.

5.7.3.2.4. Assessment of the PEA location considering residential, social and recreational environment

The installation of export cables and two ONS is planned at a sufficient distance from residential, public-use, and recreational areas. The planned electricity interconnection grids will not intersect with these zones.

Based on the data from the Real Property Register database of the State Enterprise Centre of Registers, the nearest residential houses (Table 5.7.11, Fig. 5.7.5–7) have been identified at the distances ranging from 55 m to 732 m from the planned onshore interconnection grid and from 117 m to 293 m from the planned ONS area boundaries. The nearest public-use facility – Laukžemė the Holy Apostle Andrew Church – is located 812 m from the interconnection grid.

According to the database of territorial planning documents prepared and registered by the State Territorial Planning and Construction Inspectorate under the Ministry of Environment, in the vicinity (38 m north of the planned interconnection grid boundary) there is a planned area (designation SG01) intended for selecting a location for a farmstead (land plot, cadastral No. 5647/0004:0017), located in Medomiškiai village, Darbėnai eldership, Kretinga district municipality, Klaipėda county).

Information on the nearest residential and public use areas is provided in Table 5.7.11, Fig. 5.7.5–7

Table 5.7.11. Distances to the nearest residential and public areas

No.	Address	Distance	
		To the onshore export cable corridors	To the Pelėkiai TS land plot
	Living environment		
G01	Palanga, Kuršių Path 62	211 m	-
G02	Kretinga District. Municipality, Darbėnai Parish, Laukžemė Village, Malūno Street 5	672 m	-
G03	Kretinga District. Municipality, Darbėnai Parish, Laukžemė Village, Malūno Street 3	623 m	-
G04	Kretinga District. Municipality, Darbėnai Parish, Laukžemė Village, Malūno Street 1	732 m	-
G05	Kretinga District. Municipality, Darbėnai Parish, Laukžemė Village, Miško Street 16	155 m	-
G06	Kretinga District. Municipality, Darbėnai Parish, Laukžemė Village, Miško Street 18	238 m	-
G07	Kretinga District. Municipality, Darbėnai Parish, Laukžemė Village, Miško Street 14	551 m	--
G08	Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village, Laukžemės Street 25	264 m	-
G09	Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village, Laukžemės Street 29	97 m	-
G10	Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village, Laukžemės Street 27	216 m	-
G11	Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village, Laukžemės Stree. 31	55 m	-
G12	Kretinga District. Municipality, Darbėnai Parish, Laukžemė Village, Ilgoji Street 1	128 m	-
G13	Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village, Laukžemės Street 26	-	117 m
G14	Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village, Miško Street 2	-	195 m
G15	Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village, Miško Street 4	-	293 m

No.	Address	Distance	
		To the onshore export cable corridors	To the Pelėkiai TS land plot
G16	Kretinga District. Municipality, Darbėnai Parish, Pelėkiai Village 4	-	244 m
G17	Kretinga District. Municipality, Darbėnai Parish, Pelėkiai Village 1	199 m	233 m
G18	Kretinga District. Municipality, Darbėnai Parish, Žyneliai Village 2	334 m	
G19	Kretinga District. Municipality, Darbėnai Parish, Žyneliai Village 7	109 m	
G20	Kretinga District. Municipality, Darbėnai Parish, Žyneliai Village 8	207 m	-
	Planned residential areas		
SG01	Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village	38 m	193 m
	Public facilities		
V01	Laukžemė the Holy Apostle Andrew Church (Kretinga District. Municipality, Darbėnai Parish, Laukžemė Village., Ilgoji Street. 12)	812 m	-

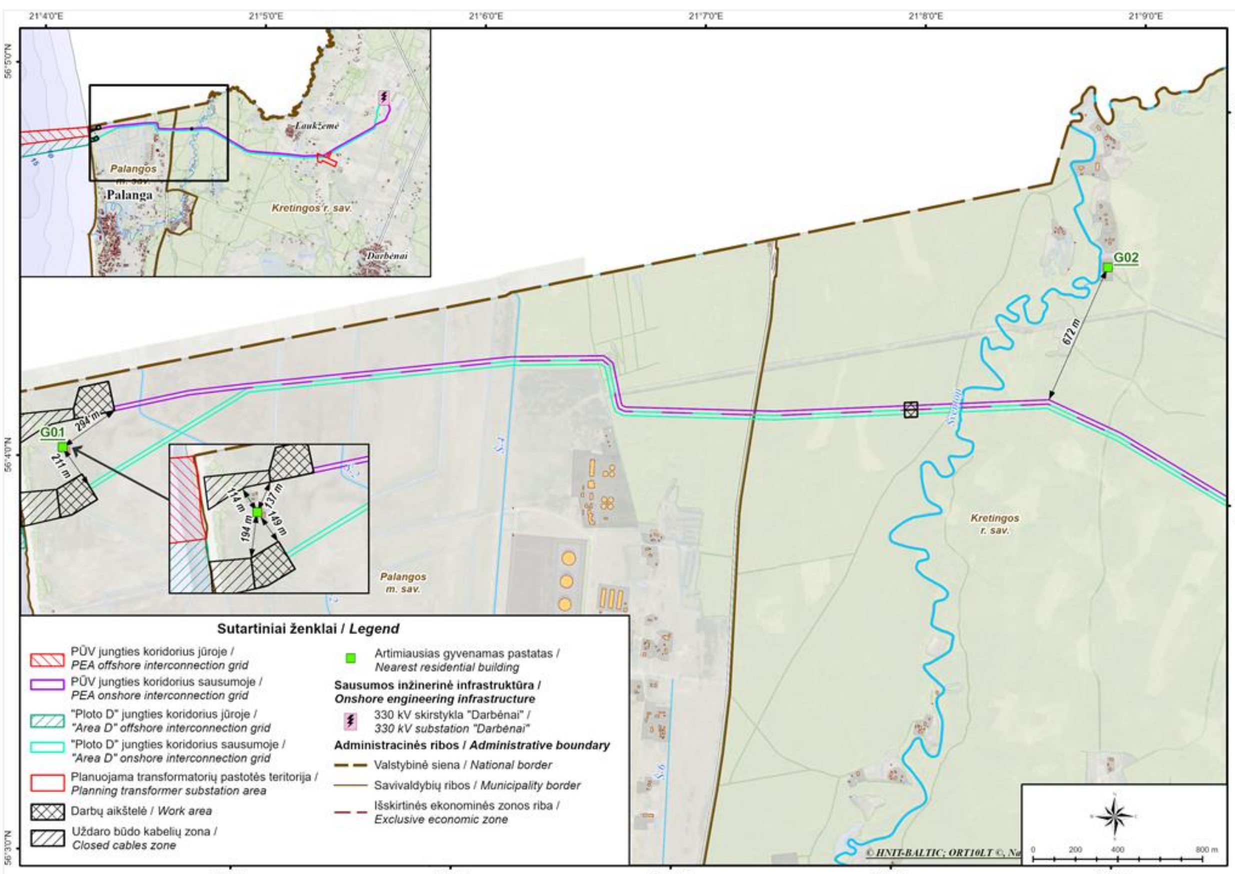


Fig. 5.7.5. Proximity of the nearest residential and public areas to the planned export cable corridors (1 of 3).

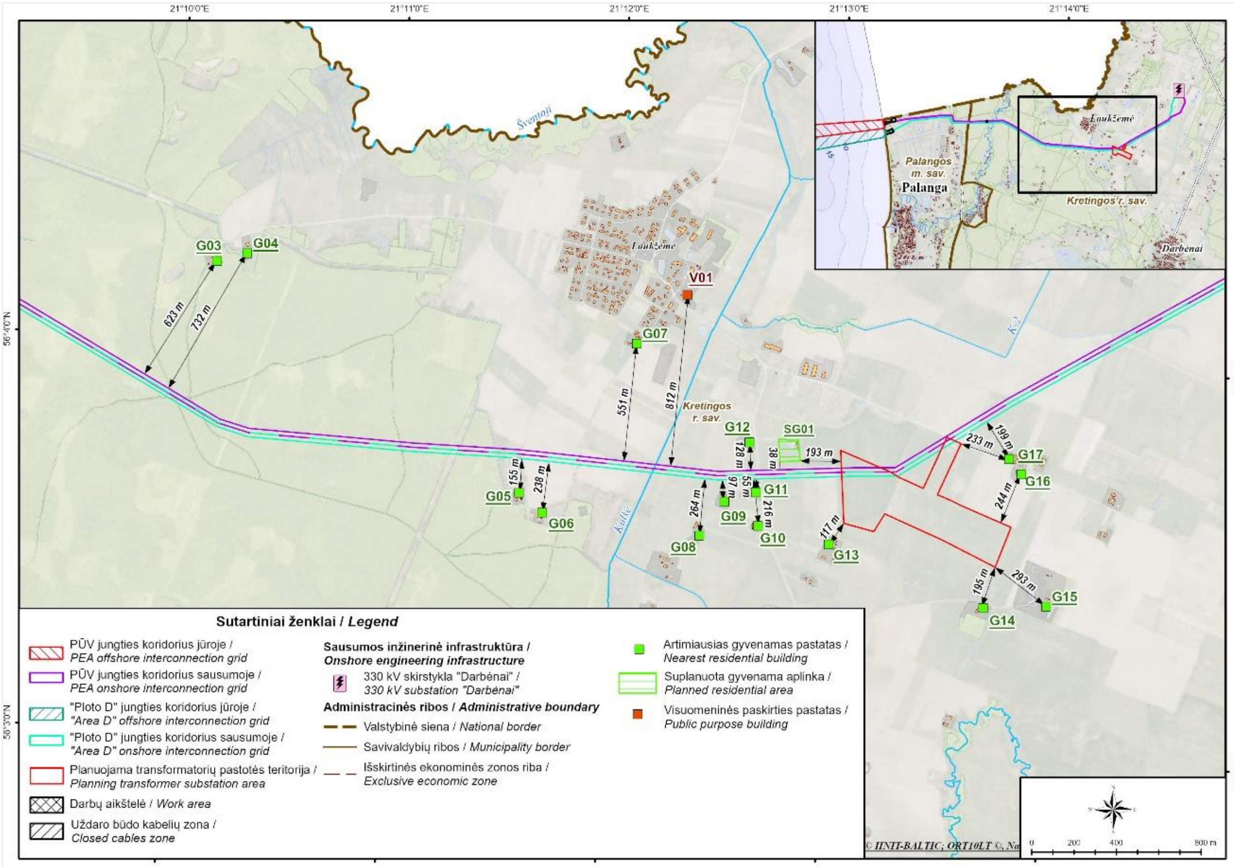


Fig. 5.7.6. Proximity of the nearest residential and public-use areas to the planned export cable corridors (2 of 3).

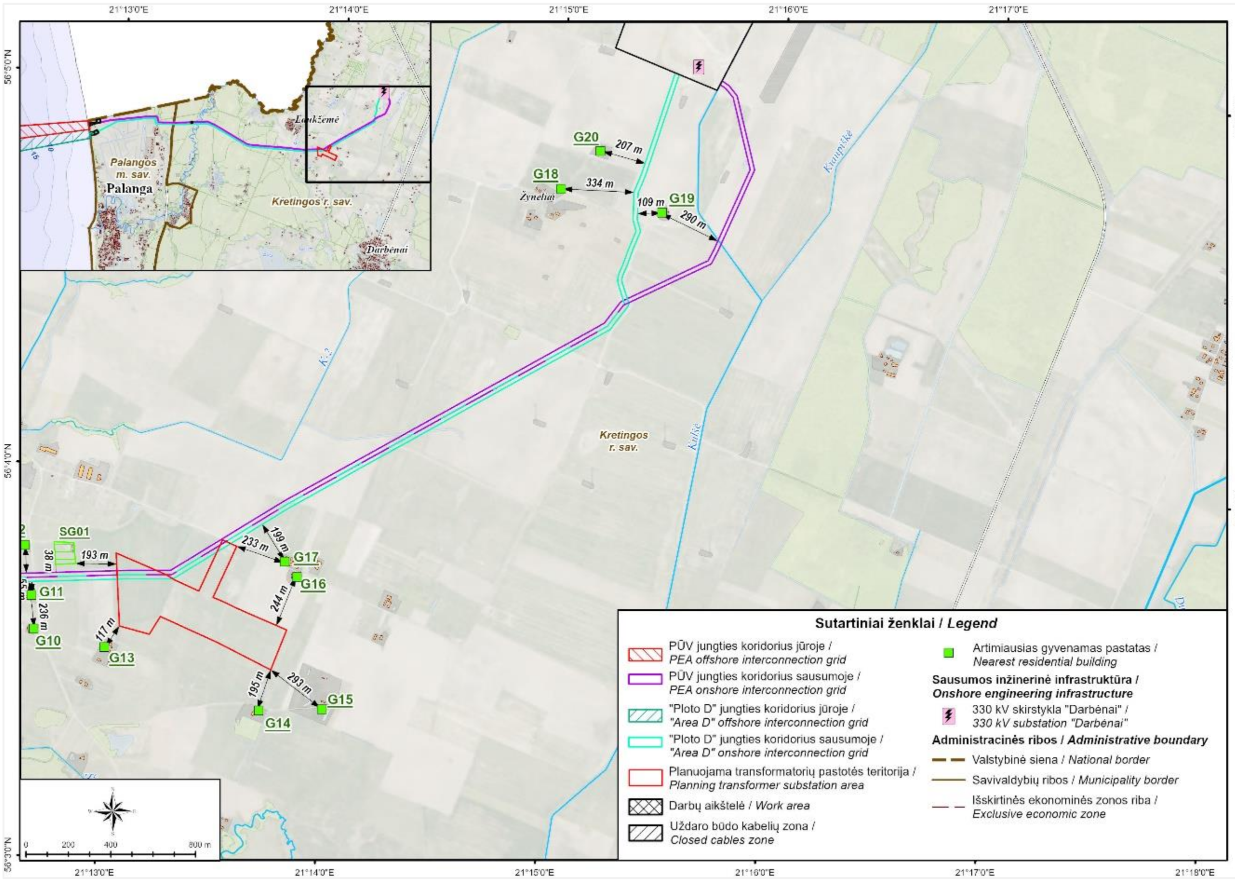


Fig. 5.7.7. Proximity of the nearest residential and public-use areas to the export cable corridor (3 of 3).

5.7.4. Potential impact on public health

5.7.4.1. Offshore

During construction, only short-term, localised and insignificant emissions to ambient air from internal combustion engines of vehicles and machinery used for construction activities are possible. The works will be carried out in compliance with all requirements applicable to such operations. The offshore environment, away from the coast and residential and public areas, is favourable for the dispersion of pollutants, so that emissions will be readily dispersed and will not have an impact on the residential environment on the shore.

During construction, there may be a temporary and localised increase in noise due to the installation of the OWF and the construction of the export cable corridors in the offshore section of OWF, and therefore no health effects due to physical pollution are expected.

5.7.4.2. Onshore

Having examined the information on the installation of the planned export cables and the Pelėkiai Transformer Substations, in terms of its nature and scale, the technological processes, and the literature, it can be concluded that the physical factors associated with the planned export cable corridors and the two Transformer Substations, which may have an impact on health, are:

- air pollution,
- noise,
- electromagnetic fields.

5.7.4.2.1. Health effects of ambient air pollutants

The impact of the planned installation of export cable corridors and two ONS on ambient air related to mobile sources of pollution.

Carbon monoxide. A colourless and odourless gas produced during combustion when fuel is incompletely burned. Carbon monoxide, after passing through the lungs into the bloodstream, combines with haemoglobin to form the highly persistent compound carboxyhaemoglobin. As a result of this reaction, haemoglobin is unable to supply oxygen to the tissues and tissue hypoxia develops. Carbon monoxide is 200 times more likely to bind to haemoglobin than to oxygen, so that even small concentrations in the environment have adverse health effects and can be dangerous. The central nervous system, vision, respiratory and cardiovascular systems may be affected.

Nitrogen oxides. Health effects of nitrogen oxides: irritating to the eyes and respiratory tract mucous membranes, high concentrations cause mucosal swelling and oedema, toxic to the lungs. Nitrogen oxides are one of the most important components of acid precipitation. They react with water to form nitric acid. In sunlight, NOX reacts with other active atmospheric constituents, mostly hydrocarbons, to form photochemical oxidants (including ozone) through complex reactions. These highly unstable compounds damage plants and irritate the human respiratory and visual organs.

Particulate matter. The most common sources of fine particulate matter pollution are fossil fuel boilers (emitting ash and soot), industrial processes (metal dust, fabric dust), soil erosion and transport. Particulate matter from combustion is smaller than 1 micrometre, while industrial and soil particles are larger than 1 micrometre. Particulate matter ("fine dust") is a pollutant of major health concern. They have a wide range of effects, including exacerbations of bronchial asthma, the development of chronic bronchitis, impaired lung function, eye irritation and reduced life expectancy. Long-term exposure to higher concentrations of particulate matter has a significant impact on the incidence of respiratory diseases.

Hydrocarbons*.* Hydrocarbons irritate the respiratory tract, causing vomiting, dizziness, drowsiness, respiratory and circulatory problems.

Sulphur dioxide. The effects of sulphur dioxide on human health depend on the concentration of the pollutant in ambient air. Adverse effects include irritation of the respiratory tract, eye mucosa and reflex coughing. At very high concentrations, even brief exposure can be dangerous. The most sensitive groups are the elderly and children with cardiovascular diseases.

The installation of export cables by open trenching may have a short-term temporary impact on air pollution levels. The impact is assessed as localised, short-term and insignificant.

5.7.4.2.2. Health effects of noise

The main noise sources in the area of the planned export cable corridors and two ONS are mobile and stationary noise sources.

Intense acoustic stimuli induce stress reactions in the body, with different phases ranging from the compensatory stage of adaptation to the non-compensatory stage. Stress affects the human body in many ways, ranging from inducing functional damage to cerebrovisceral regulation to marked degenerative changes in the morphology of organs and systems.

The places most sensitive to noise (according to the World Health Organisation (hereinafter – WHO) are residential areas, recreational areas, health resorts, schools, pre-schools and medical facilities. The groups most vulnerable to noise are children, the sick, the disabled, shift workers, the elderly, people who spend long periods of time in noise, etc.

Diseases relatively related to noise exposure: diseases of the circulatory system, nervous system, digestive system.

5.7.4.2.3. Noise during construction work

The export cables will be laid using the open trench method, while in designated locations – at the landfall (see Fig. 2.1.12, detailed description in Section 2), at the intersections with the A13 Klaipėda–Liepāja highway and the Šventoji

River – trenchless technologies will be utilised. Additionally, electrical equipment for the two ONS will be installed. As a result, a temporary and localized increase in noise levels is possible due to the use of machinery and equipment (earthworks, transportation, construction, etc.) at the work site. This increase in noise will be short-term (approximately 3 months), episodic (only during construction activities), and will not have a significant impact on public health.

If, during construction works, noise levels exceeding the limit values established in legislation (HN 33:2011) are identified, appropriate mitigation measures will be implemented. Such measures may include the installation of noise barriers, restrictions on working hours, optimization of equipment use, and informing local residents about planned noisy activities, among others.

Construction works will be carried out in accordance with the Construction Technical Regulation STR 1.06.01:2016 'Construction Works. Construction Supervision[99]' and the provisions of the Noise Management Law[100]. The construction works are planned to be carried out using only technically sound machinery, with noise levels not exceeding the permissible sound power levels for outdoor equipment as defined in STR 2.01.08:2003 'Noise Emission to the Environment by Equipment for Use Outdoors' (approved by the Order No. 325 of the Minister of Environment of the Republic of Lithuania dated 30 June 2003).

5.7.4.2.4. Noise assessment of a transformer substation

Noise levels in residential and public buildings and their surroundings are assessed by comparing the results obtained through modelling with the corresponding maximum permissible noise limit values specified in the Lithuanian hygiene standard HN 33:2011 'Noise limit values in residential and public buildings and their surroundings', approved by the Order No. V-604 of the Minister of Health of the Republic of Lithuania on 13 June 2011 'on the approval of Lithuanian hygiene standard HN 33:2011 'Noise limit values in residential and public buildings and their surroundings' (later in text – HN 33:2011) (Table 5.7.12).

Table 5.7.12. Maximum permissible noise limit values in residential and public buildings and their surroundings, as set out in HN 33:2011

Title of the object	Time of day*	Equivalent sound pressure level (L_{AeqT}), dBA	Maximum sound pressure level (L_{AFmax}), dBA
In the environment of residential buildings (houses) and public buildings (excluding catering and cultural buildings), excluding noise from transport	day	55	60
	evening	50	55
	night	45	50

* The start and end hours of the times of day (daytime, evening, and night-time) are understood as defined in Article 2, Sections 3, 9, and 28 of the Law on Noise Management of the Republic of Lithuania, in the definitions of the day noise indicator (L_{day}), evening noise indicator ($L_{evening}$), and night noise indicator (L_{night}).

According to Section 1, Point 2 of HN 33:2011, noise levels were assessed in the vicinity of residential buildings, including land plot boundaries within a maximum distance of 40 m from the facade of the residential building experiencing the highest noise level.

The projected noise from the two planned ONS is assessed based on the maximum permissible noise limit values regulated by HN 33:2011 for the surroundings of residential and public-use buildings (excluding catering and cultural buildings), except for traffic-induced noise.

In the territory of the two ONS, there are preliminary planned to install power transformers (4 units), shunt reactors (4 units), static synchronous compensators (4 units) and other necessary electrical equipment. Operating time – 24 hours. According to preliminary noise calculations, the sound pressure level from all equipment at a distance of 2 m is estimated to be 75 dBA. The layout of the preliminary equipment is shown in Fig. 5.7.8. Technical solutions will be

[99] Order No. D1-848 of the Minister of Environment of the Republic of Lithuania of 2 December 2016 “On the Approval of the Construction Technical Regulation STR 1.06.01:2016 ‘Construction Works. Supervision of Building Construction’.

[100] Law on Noise Management of the Republic of Lithuania No. IX-2499 of 26 October 2004.

chosen by the developer, which could depend on the specific location shape of the land, which affects the layout of the station.

During the design and implementation stages, the developer will be required to ensure that all necessary measures are implemented to comply with the noise limit values established in legislation (according to HN 33:2011), considering the technical characteristics of the selected equipment, their layout in the environment, local conditions, and possible noise reduction solutions.

An example of a preliminary equipment layout is shown in Fig. 5.7.8. Technical solutions will be selected by the contractor, considering the shape of the specific land parcel, which may affect the layout of the substation.

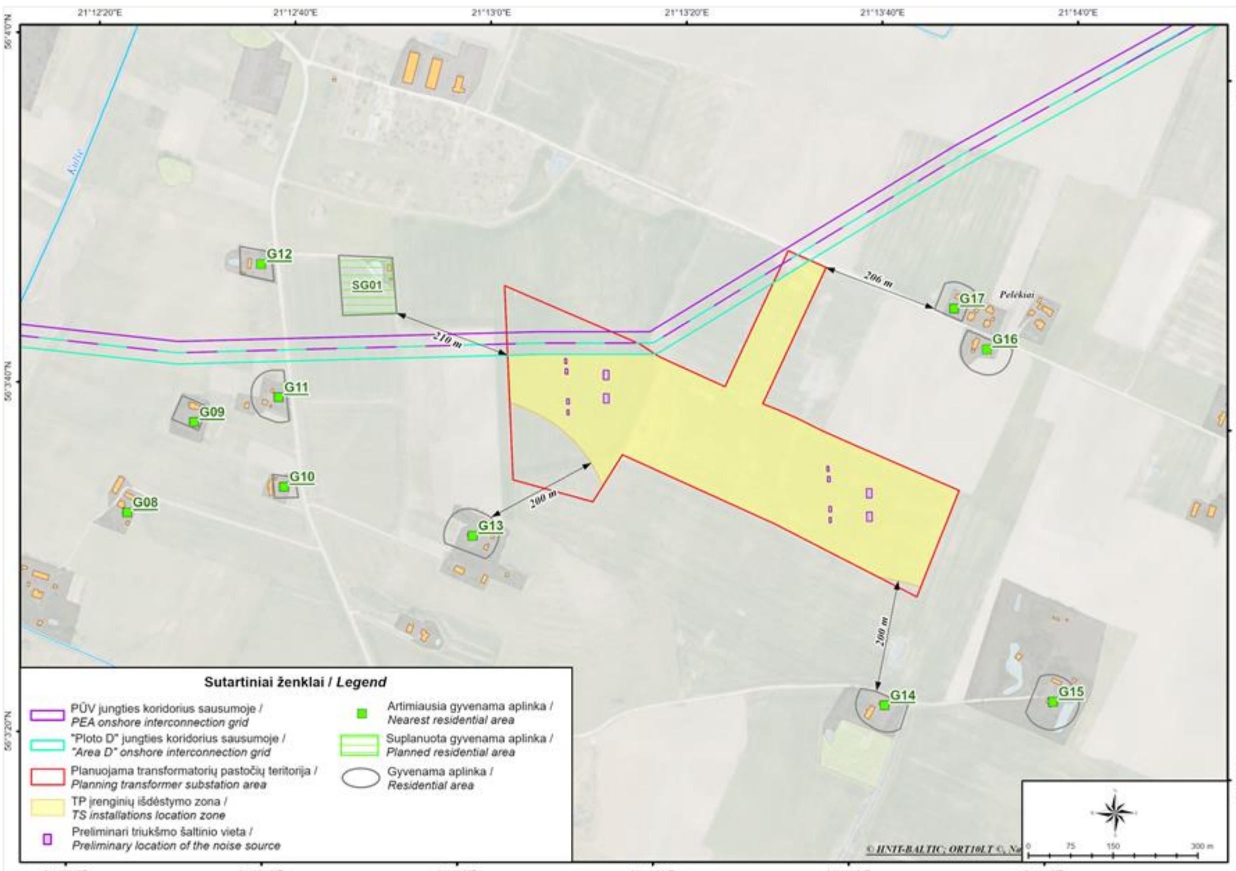


Fig. 5.7.8. Preliminary example of location of noise generating installations in the two ONS area.

The assessment conditions and parameters applied in the noise dispersion modelling:

- noise level calculation height 4 m, receiver grid step 2 m
- air temperature +10 °C, relative humidity 70%
- ground surface type (sound absorption coefficient) 0,8
- projected noise levels were calculated at a distance of 40 m from existing and planned residential environment.

The results of the noise dispersion modelling do not depend on the time of day, meaning the calculated noise level remains the same during daytime, evening, and nighttime. The results of the noise dispersion assessment are compared with the lowest regulated nighttime noise limit value, which is 45 dBA.

The results of the noise dispersion modelling are presented in Table 5.7.13 and Fig. 5.7.9.

Table 5.7.13. Calculated noise levels from ONS in the nearest residential environment (within land plot boundaries not exceeding 40 m from the residential building facade)

Living environment, address	Estimated maximum noise figure for the planned ONS, dBA
G10 (Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village, Laukžemė Street 27)	41
G11 (Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village, Laukžemė Street 31)	42
G12 (Kretinga District. Municipality, Laukžemė Village, Ilgoji Street 1)	39
G13 Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village, Laukžemė Street 26	49
G14 (Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village Miško Street 2)	46
G15 (Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village Miško Street 4)	42
G16 (Kretinga District. Municipality, Darbėnai Parish, Pelėkiai Village 4)	49
G17 (Kretinga District. Municipality, Darbėnai Parish, Pelėkiai Village 1)	46
SG01 (Kretinga District. Municipality, Darbėnai Parish, Medomiškiai Village)	44
HN 33:2011 limit value at night	**45**

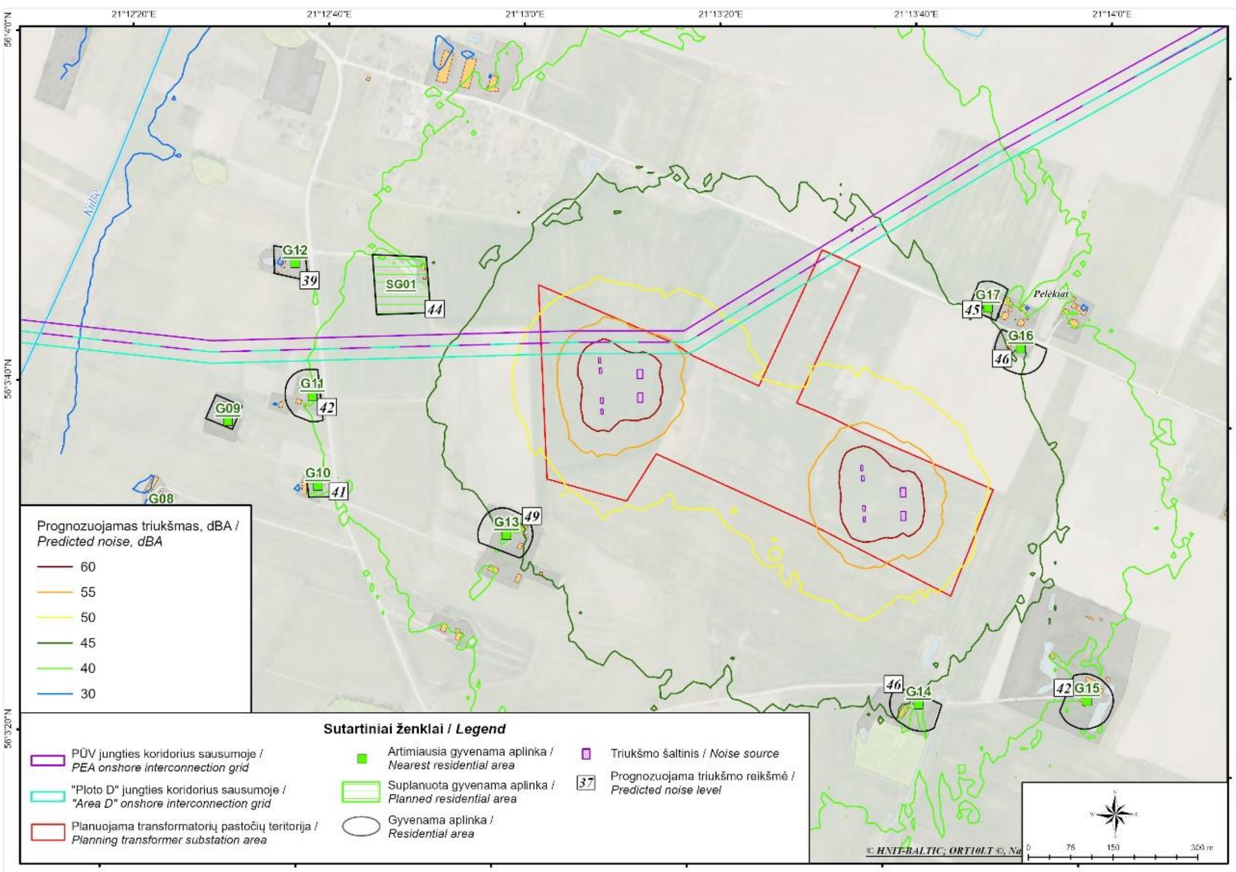


Fig. 5.7.9. Predicted noise from the planned ONS.

According to the modelling results, the projected noise level caused by the two planned ONSs in residential and planned development areas may reach 33–49 dBA. The assessment determined that the noise level from both ONS at the nearest residential environment, location G13, G14, G16, G17 will exceed the HN 33:2011 maximum permissible nighttime noise limits.

To mitigate the potential noise impact from the planned two ONS on the surrounding residential environment, it is proposed to implement noise reduction measures by installing noise-absorbing walls. A total of 9 barriers were assessed, positioned adjacent to preliminary equipment 4 shunt reactors, 2 power transformers, and 3 static synchronous condensers. Each barrier is 35–40 m long and 6 m high. The sound absorption rating (DLα, dB), in accordance with LST EN 1793-1:2017, is assumed to be no less than 8 dBA. Calculations also assume a barrier density exceeding 10 kg/m², which complies with the noise barrier criteria specified in ISO 9613-2:2024, „Acoustics Attenuation of sound during propagation outdoors. Part 2: Engineering method for the prediction of sound pressure levels outdoors". Final technical solutions will be chosen by the developer, which could depend on the specific location shape of the land, and can affect the layout of the ONS and equipment.

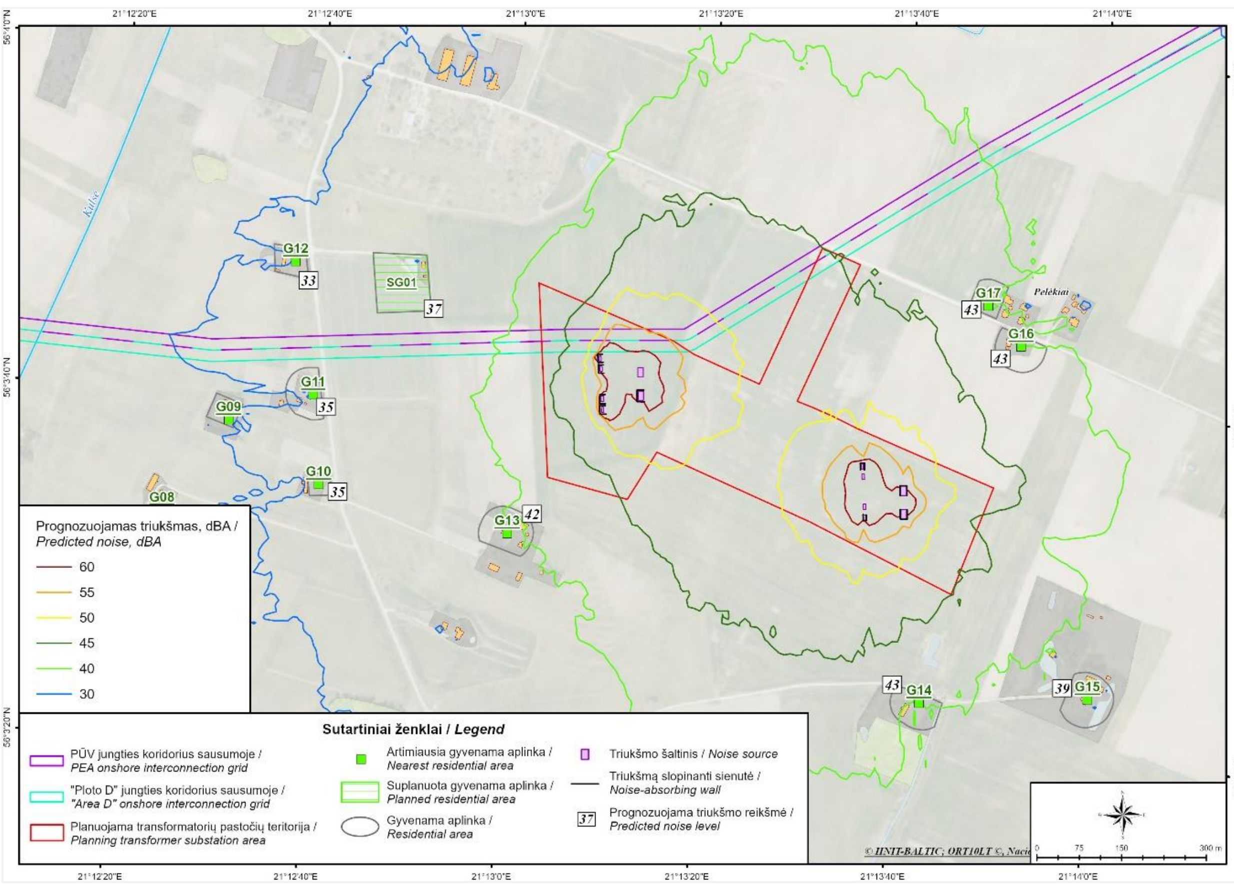


Fig. 5.7.10. Predicted noise from the planned ONSs, considering noise abatement measures.

According to the modelling results, the projected noise level from the two planned ONSs, considering the noise reduction measures, may reach 33–43 dBA near residential buildings and planned residential areas. This level will not exceed the maximum permissible noise limits set by the Lithuanian hygiene norm HN 33:2011 "Noise limit values in residential and public buildings and their surroundings" during any time of day.

During the building design phase, the number of installed units, their layout, and noise characteristics may be revised. Therefore, recalculations of the predicted noise levels will be carried out. If necessary, additional noise mitigation measures will be implemented to ensure compliance with the maximum permissible noise levels established by

Lithuanian Hygiene Standard HN 33:2011 “Noise limit values in residential and public buildings and their surroundings” for all times of day in the vicinity of residential and public-use buildings.

5.7.4.2.5. Health effects of electromagnetic fields

During the operation of the OWF, an electromagnetic field (hereinafter – EMF) (industrial frequency, >0–300 Hz) is generated only near high-voltage electrical transformation and transmission equipment, as well as near the electrical generator. The electricity produced by the OWF is transmitted via export cable lines on land to the 220/330 kV Pelėkiai Transformer Substations and from there further into the transmission network.

An EMF, also referred to as electromagnetic radiation, is a physical field created by moving electric charges, consisting of interrelated and time-varying electric and magnetic fields. A time-varying electric field creates a magnetic field, which also changes over time and, in turn, generates an electric field. Electric and magnetic fields cannot exist independently of each other. This mutual variation creates EMF fields.

Sources of EMF fields can be both natural and human made. Natural sources of EMF fields and waves are found in nature – these include the Earth’s atmospheric electric field and magnetic field, electromagnetic waves generated by atmospheric discharges, and electromagnetic radiation emitted by the Sun and other celestial bodies.

It is very difficult to prove the non-specific effects of electromagnetic radiation on human health, as it is virtually impossible to carry out scientific studies isolating their effects from other possible influences. The effects of strong fields are more clearly defined, while the consequences of low intensity but long-term exposure are assessed quite critically. Electric fields are usually generated in the environment of high-voltage power lines.

The intensity of the EMF is inversely proportional to the square of the distance from the source – that is, as the distance from the source increases, electromagnetic radiation disperses and weakens. As the distance from an EMF source increases, both electric and magnetic fields decrease proportionally: within several tens of meters from high-voltage power transmission lines, the EMF reduces to insignificant levels[101] (.

Humans do not have a specific sensory organ that directly responds to electromagnetic radiation. It is believed that the central nervous system, cardiovascular, endocrine, and reproductive systems are the most sensitive to electromagnetic fields.

The magnetic field generated by underground power lines depends on the current flowing through the cable and the depth at which the cable is buried. The magnetic field is uniform along the length of the line, except at cable joints or where the burial depth changes.[101]

To ensure physical protection from damage, as well as to reduce electromagnetic radiation and field interference, underground electrical cables are shielded and laid below ground, and therefore no impact on public health is anticipated.

ONSs include high- and low-voltage switchyards, along with the power transformers and autotransformers that connect them.

According to the SLUC Article 24(6), the protection zone of ONSs, switchyards, and current conversion stations corresponds to the built-up area and the airspace above the structures and equipment of the substation, switchyard, or current conversion station.

The Lithuanian hygiene norm HN 104:2011 “Safety of the population from the electromagnetic field generated by overhead power lines”, approved by Order No. V-552 of the Minister of Health of the Republic of Lithuania on May 30, 2011, "On Approval of the Lithuanian Hygienic Standard HN 104:2011 "Safety of the Population from Electromagnetic Fields Generated by Power Lines" (HN 104:2011) establishes the permissible values for EMF parameters and general EMF measurement requirements for 330 kV and higher voltage overhead power lines and related equipment operating

[101] Model for the Assessment and Management of Electromagnetic Fields Emitted by Power Transmission Lines, National Public Health Surveillance Laboratory, 2013.

at an industrial frequency of 50 Hz, in residential and public building interiors and surrounding environments (Table 5.7.14).

Table 5.7.14. Permissible values of EMF

No.	Name of the object	Permissible values of electromagnetic field parameters *(not to exceed)*		
		Electric field strength (E), kV/m	Magnetic field strength (H), A/m	Magnetic flux density (B), µT
1.	Residential and public buildings	0.5	16.0	20.0
2.	Living environment	1.0	32.0	40.0

Assessment of the EMF generated by the ONSs: to evaluate the potential impact of the CN OWF and the "Area D" OWF ONSs on public health, the EMF measurement results from the existing 330/110/10 kV Klaipėda ONS are analysed and compared with the permissible EMF parameter values established in public health safety legislation, which are considered safe for human health.

The EMF measurements of the existing 330/110/10 kV Klaipėda ONS were carried out by the accredited National Public Health Surveillance Laboratory. Measurements were taken at a height of 1.5 meters. The results of the EMF investigations are presented in Table 5.7.15. (see Annex 9 for the measurement protocols).

Table 5.7.15. Results of EMF studies

	Measurement points	EMF strength (E), kV/m	Magnetic field strength (H), A/m	Magnetic flux density (B), µT
T1	At the boundary of the ONSs area	0.049	0.082	0.103
T2	30 m from the boundary of the ONSs area	0.058	0.244	0.307
T3	At the boundary of the ONSs area	0.036	0.318	0.399
T4	At the boundary of the ONSs area	0.019	0.243	0.305
HN 104:2011 Permissible values	**Residential and public buildings**	**0.5**	**16.0**	**20.0**
	Living environment	**1.0**	**32.0**	**40.0**

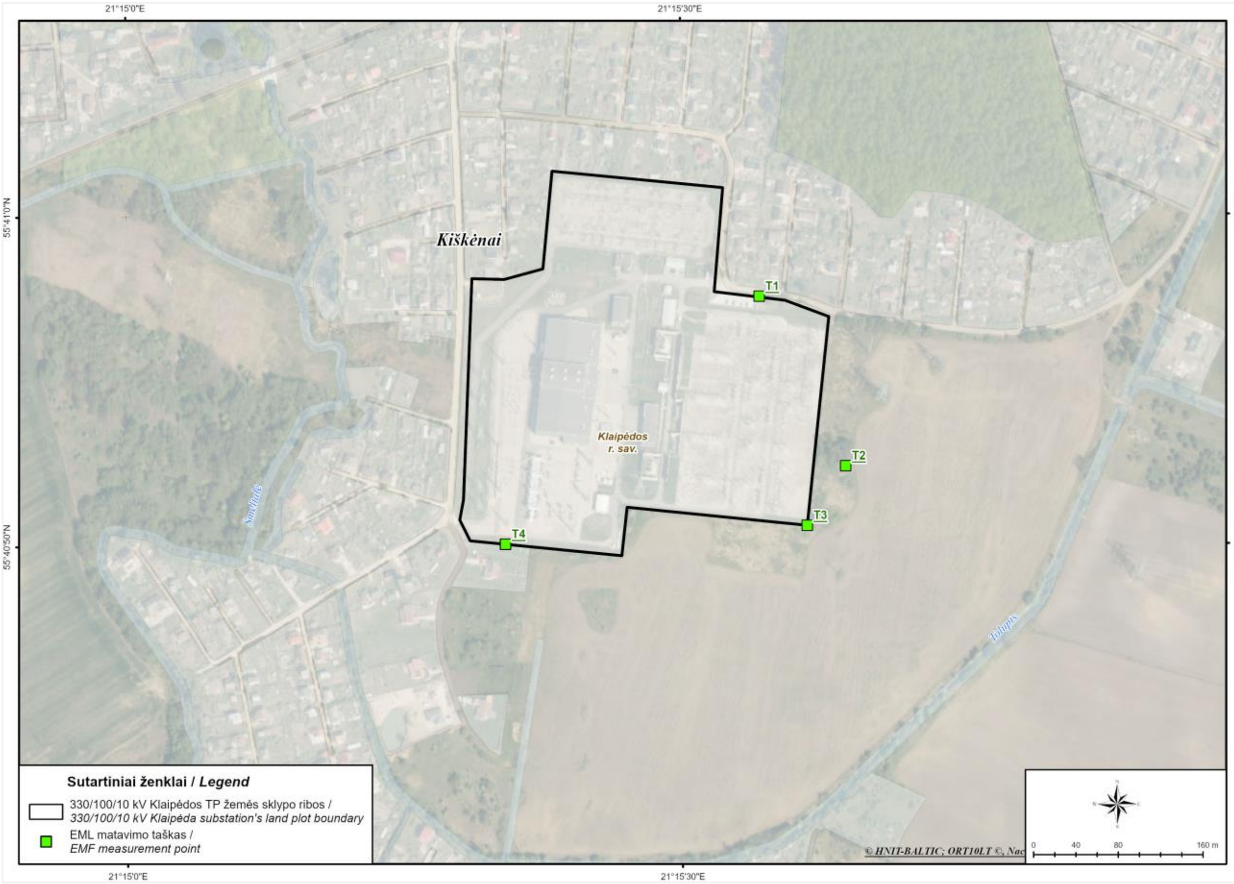


Figure 5.7.14. Measurement points for EMF.

The measured electric and magnetic field parameters at and beyond a distance of 30 m from the boundaries of the 330/110/10 kV Klaipėda ONS do not exceed the permissible values set by Lithuanian hygiene norm HN 104:2011 for residential and public buildings and living environments.

Based on literature sources, as the distance from the EMF source increases, both electric and magnetic fields decrease proportionally with distance. Considering the EMF measurements conducted near the existing 330/110/10 kV Klaipėda ONS (evaluated as an analogue), it can be concluded that at the boundary of the ONSs for the CN OWF and the "Area D" OWF, the EMF parameters will not exceed the permissible values set by the Lithuanian hygiene norm HN 104:2011, "Safety of the Population from the Electromagnetic Field Generated by Overhead Power Lines," for residential and public buildings and living environments. Therefore, no impact on human health is anticipated.

5.7.5. Measures to prevent, reduce and compensate for public health impacts

5.7.5.1. Offshore

Planned PEA is located at a considerable distance from the coastal zone and residential, public, and recreational areas, therefore, physical pollution in these areas due to the operation of the OWF is not anticipated, and no environmental impact avoidance, reduction, or compensation measures are required.

5.7.5.2. Onshore

To ensure the lowest possible impact of the PEA on public health, the following proposed environmental and health impact avoidance and/or mitigation measures are presented:

- If, during construction works, noise impact exceeding the limit values established by legislation (according to HN 33:2011) is identified, appropriate mitigation measures will be applied, such as noise barriers, restrictions on working hours, optimization of equipment use, or informing local residents about planned noisy activities, among others.

- To mitigate the potential noise impact from the planned installation of two ONS on the surrounding residential environment, it is proposed to implement noise reduction measures by installing noise-absorbing walls. A total of 9 barriers were assessed, positioned adjacent to preliminary equipment 4 shunt reactors, 2 power transformers, and 3 synchronous condensers. Each barrier is 35–40 m long and 6 m high. This solution was assessed as one of the possible noise mitigation methods, demonstrating that by applying appropriate noise reduction measures, it is possible to ensure that noise levels in the residential environment do not exceed the legal limit values.

Final noise mitigation solutions will be specified during the technical design phase, considering the technical characteristics of the selected equipment and the actual modelled noise levels.

Table 5.7.16. Potential public health impacts of the OWF and summary of mitigation measures

Phase	Impact	Nature	Scale	Duration	Relevance	Protective measures
Construction	Noise and air pollution from ship movements	Direct	Local, on site	Short-term	There will be no impact on the quality of the residential environment	Not applicable.
Exploitation	Noise	Direct	Local, adjacent to OWF	Long-term, during exploitation	There will be no impact on the quality of the residential environment	Not applicable.
	Shadowing	Direct	Local, adjacent to OWF	Long-term, during exploitation	There will be no impact on the quality of the residential environment	
	Infrasound	Direct	Local, adjacent to OWF	Long-term, during exploitation	There will be no impact on the quality of the residential environment	
	Electromagnetic field	Direct	Local, adjacent to OWF	Long-term, during exploitation	There will be no impact on the quality of the residential environment	
	Energy production from renewable sources	Indirect	Country/Global	Long-term, during exploitation	Positive	Not applicable.
Decommissioning	Noise	Direct	Local, on site	Short-term (only during works)	There will be no impact on the quality of the residential environment	Not applicable.

Colour code

Light green	Positive impact
Light blue	No impact or impact insignificant (not to be considered, no measures are applicable)
Blue	Minor impact: decisions during design, preventive or mitigation measures
Light orange	Moderate impact: addressed by mitigation measures
Orange	Significant impact: mitigation and/or compensation measures are necessary.

Table 5.7.17. Potential impact of onshore section of the export cable corridors on public health and summary of mitigation measures

Phase	Impact	Nature	Scale	Duration	Relevance	Protective measures
Construction	Noise and air pollution from construction machinery	Direct	Local	Temporary	Minor impact	Impact mitigation measures will be applied as needed. Construction works will be carried out in accordance with the Construction Technical Regulation STR 1.06.01:2016 “Construction Works. Supervision of Building Construction” and the provisions of the Law on Noise Management and STR 2.01.08:2003 "Control of environmental noise emitted by equipment used outdoors”.
Exploitation	Noise	Direct	Local, adjacent to ONSs	Long-term, during exploitation	Significant impact	Due to the potential impact of noise from the planned two TS on the residential environment, noise mitigation measures are foreseen, such as the installation of noise-reducing walls (one of the possible noise reduction methods) or other measures available on the market that would ensure compliance with the limit values. The specific noise mitigation measures will be selected during the technical design stage, based on the chosen technical characteristics of the equipment.
	Electromagnetic field	Direct	Local, adjacent to ONSs	Long-term, during exploitation	There will be no impact on the quality of the residential environment	Not applicable.
Decommissioning	Noise and air pollution from construction machinery	Direct	Local	Temporary	Minor impact	Impact mitigation measures will be applied as needed. Construction works will be carried out in accordance with the Construction Technical Regulation STR 1.06.01:2016 “Construction Works. Supervision of Building Construction” and the provisions of the Law on Noise Management and STR 2.01.08:2003 "Control of environmental noise emitted by equipment used outdoors".

Colour code

	Positive impact
	No impact or impact insignificant (not to be considered, no measures are applicable)
	Minor impact: decisions during design, preventive or mitigation measures
	Moderate impact: addressed by mitigation measures
	Significant impact: mitigation and/or compensation measures are necessary.

5.8. Material assets

5.8.1. Survey methods

5.8.1.1. Methods for assessing the current state

To assess the current condition, a comprehensive review of all relevant cartographic marine and land use materials, including nautical charts and pertinent land maps, was conducted. Feasibility studies related to the object, prepared special planning documents, materials from the Lithuanian GP 2030, and sectoral strategic documents were utilized. These resources pertain to the values described and assessed below, providing a foundation for the current condition assessment.

5.8.1.2. Methods for assessing potential impacts

The potential impact is assessed by analysing potential conflicts and spatial and functional compatibility between the assessed activities and values. A key consideration is the extent to which the emerging offshore wind energy sector will influence existing traditional maritime activities, whether it might create obstacles to their further development, and the extent to which it could potentially alter established procedures. Additionally, the assessment examines the potential impact on inter-sectoral relations both at sea and on land. Understanding the spatial relationship between planned and existing sea and land users, as well as identifying adjacencies and potential conflicts (and, where applicable, mutual benefits or synergies), is crucial for a comprehensive impact assessment.

5.8.2. Survey area

The survey area covers both marine and onshore zones designated for OWF development and related engineering infrastructure. It is located within the territorial waters and EEZ of the Republic of Lithuania, including the coastal strip and the land areas of Palanga City and Kretinga District Municipalities.

In the marine part of the territory, where the CN OWF is planned, various economic activities take place, including fishing (both offshore and coastal), shipping, dumping of dredged material, sand extraction, and recreation (diving). The area also hosts existing engineering infrastructure such as pipelines and electricity and communication cables. In addition, restricted-use and hazardous zones (e.g., former minefields), cultural heritage objects, and potential resource extraction areas have been identified.

The onshore section of the survey area includes the planned export cable corridors, extending across the territories of Palanga City and Kretinga District Municipalities up to the Darbėnai 330 kV switchyard. This area encompasses existing and planned land uses, recreational zones, forests, cultural heritage sites, engineering and transport infrastructure, protected natural areas, as well as zones of national security importance.

This complex territory has been selected to ensure that the proposed wind energy development can be harmonized with other land- and sea-use interests, minimize impacts on the environment and stakeholders, and comply with the requirements of national and international legislation. The survey area has been defined with consideration of the potential impacts of OWF construction, operation, and decommissioning on the natural, social, and economic environment.

5.8.3. Current state: sectors of the economy that may be affected by the development of OWF

The possibilities for developing offshore wind energy are directly related to other activities already underway in the marine area. The following takes place offshore:

- fishing
- shipping (shipping routes)
- dumping of dredged materials
- sand extraction (including sand for beach nourishment)
- recreation (diving sites)
- engineering installations (electrical, communication lines, pipelines, etc.) and their safety zones at sea
- restricted-use areas (military training areas, sunken ships, dangerous objects, cultural heritage sites)
- other potential activities (prospective areas of useful resources).

Onshore:

- agricultural and other purpose territories
- recreation.

To rationally utilise marine territories and resources, it is essential to harmonize existing and planned activities with the interests of sea users. The functional priorities for marine territory, along with existing and planned uses, are detailed in the marine territories section of the National Plan of the Republic of Lithuania. It is important to note that the construction of OWFs will significantly contribute to achieving the objectives of Lithuania's energy independence strategy.

5.8.3.1. Fishing sector

One of the most significant activities that the planned OWF may directly impact over the long term is marine and coastal fishing.

According to the International Council for the Exploration of the Sea (hereinafter – ICES) classification, Lithuanian marine territory falls within statistical rectangles 40H10, 40G9, and 39H10 of Fishing Area 26, where fish are caught using trawling and set nets. The area of the planned OWF will occupy approximately 1.66% of ICES statistical rectangle 40H10 and about 1.82% of rectangle 41H10 (see Figure 5.8.1).

Based on data from 2013–2018, fishing in the planned area during 2014–2015 was conducted using set gillnets (hereinafter – GNS). Due to unsuitable seabed substrate, bottom otter trawl (hereinafter – OTB) fishing was not conducted in the area, and midwater otter trawl (hereinafter – OTM) fishing was also not carried out in the planned area during 2013–2022.

Since 2019, following the EU ban on commercial cod fishing in parts of the Baltic Sea (ICES sub-areas 24–26), fishing intensity in the planned area has further decreased. According to the latest ICES assessment (ICES 2023), there is almost no likelihood that eastern Baltic cod stocks will recover to a level that would allow the ban on commercial cod fishing to be lifted in the medium term (approximately until 2030). Therefore, set net fishing in the open Baltic Sea is also not expected to resume during this period.

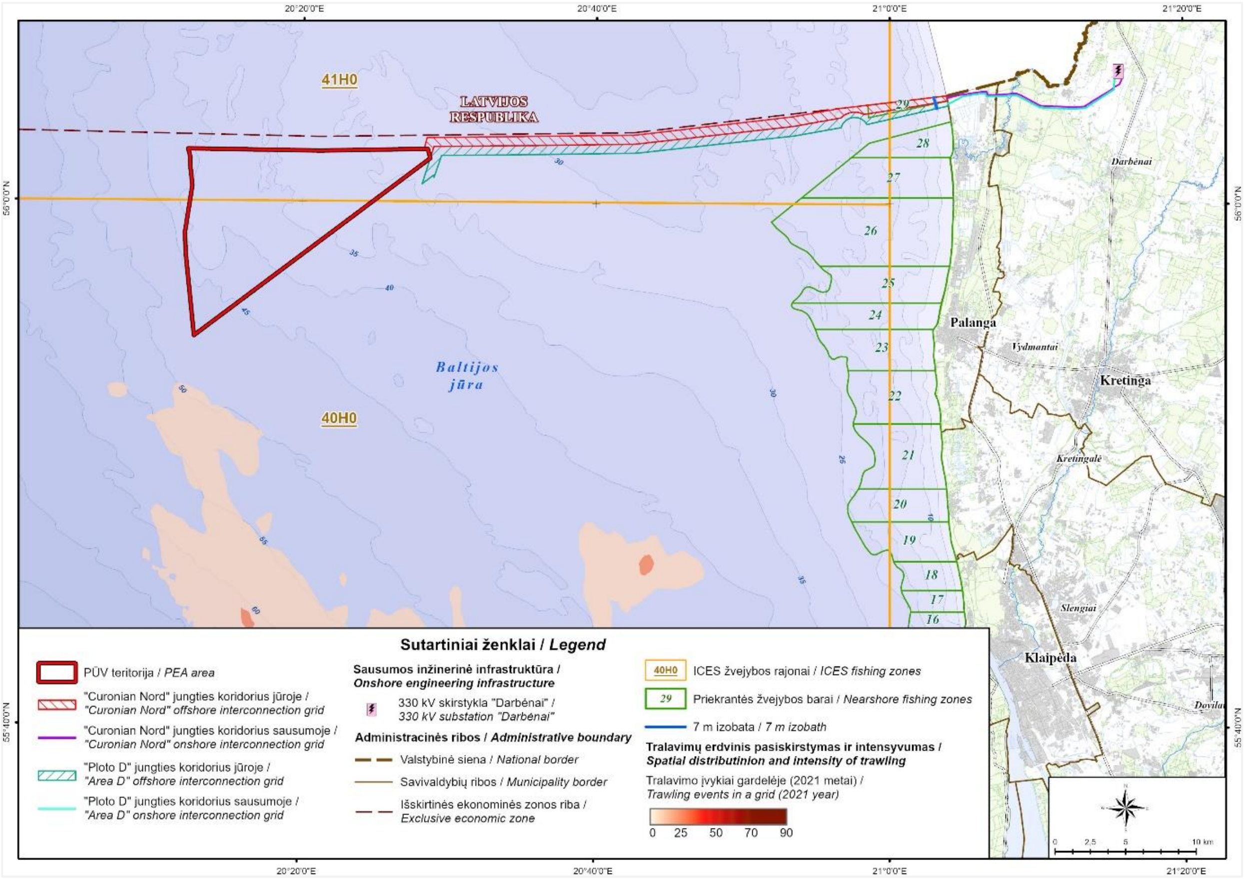


Fig. 5.8.1. Fishing areas and coastal fishing bars.

The boundary of the coastal fishing zone, delineated along the 20-meter isobath, defines a coastal area of variable width – north of Klaipėda, this zone extends up to 7 nautical miles in some places. The Lithuanian coastal zone is divided into 29 fishing sectors, allocated to fishing companies. Trawls, pair trawls, and other trawling or dragging nets are prohibited in waters shallower than 20 meters. Fishing is conducted using nets and traps for species such as Baltic herring, smelt, and round goby.

The export cable corridors for the OWFs crosses the 29th coastal fishing sector. On average, about 40 tons of fish are caught annually in this sector, with the catch predominantly consisting of round goby (>60%), Baltic herring, and European smelt, alongside garfish and Atlantic sprat.

In addition to these species, other typical marine fish are caught, including common halibut, Atlantic cod, European flounder, and migratory species like river lamprey and sea trout. Facultative migratory species that move between inland or transitional waters and the Lithuanian Baltic Sea coast, such as ide, asp, bream, zander, European perch, and gudgeon, are also present.

The species composition (ichthyocenosis) of the Baltic coastal waters exhibits significant variation and seasonality, influenced by fish spawning migrations, feeding patterns, and winter migrations between different water bodies. This seasonality is evident in the 29th coastal fishing sector, as reflected in fluctuations in annual catch value.

The catch value was calculated based on data from the European Market Observatory for Fisheries and Aquaculture Products (EUMOFA), using average first-sale prices (see Fig. 5.8.2). The diagram illustrates the variability in both catch volumes and commercial value. Over the evaluated decade (2012–2022), income from fish caught in the 29th coastal sector ranged from approximately €3,000 in 2014 to €22,000 in 2017.

If there is a need to restrict coastal fishing in the 29th sector, Lithuania has established clear methodologies for calculating compensation and payout procedures for affected fishermen, which are regularly updated by the Ministry of Agriculture.

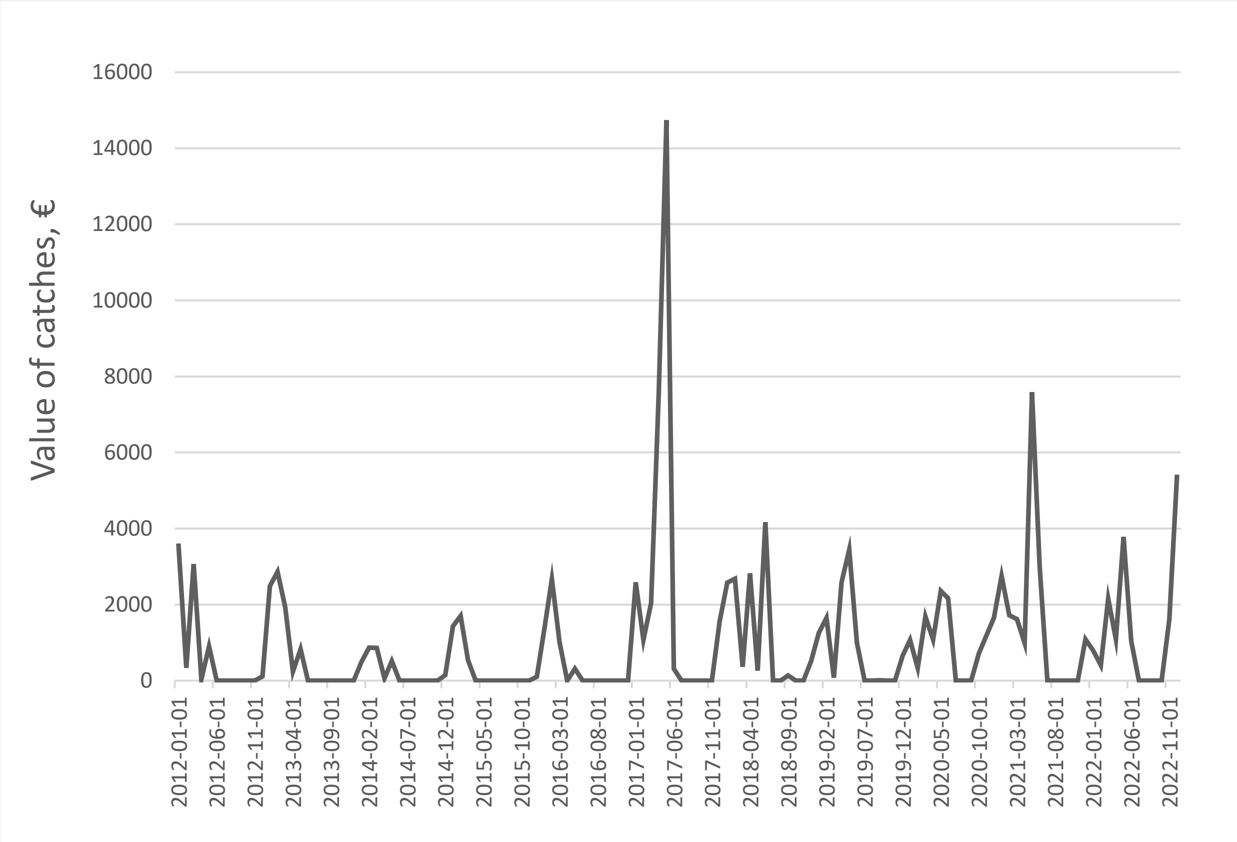


Figure 5.8.2. Change in catch value in 29th fishing sector of the Baltic Sea in 2012–2022.

5.8.3.2. Shipping

Lithuania has two main 4-nautical-mile navigation routes, approved in the 2001 HELCOM Copenhagen Declaration[102] and officially mapped. The primary shipping routes in the Lithuanian sea area are most intensively used: the navigation line to and from the port of Klaipėda and to and from the Būtingė oil terminal. About 7,000 ships visit the port of Klaipėda annually, with 6,453 in 2020. The Būtingė terminal exclusively serves tankers, with approximately 90–100 ships annually, compared to the larger number at Klaipėda port.

[102]Declaration on the Safety of Navigation and Emergency Capacity in the Baltic Sea Area (HELCOM Copenhagen Declaration adopted on 10 September 2001 in Copenhagen by the HELCOM Extraordinary Ministerial Meeting

The OWF installation area does not fall within established international shipping lanes, port raids, or anchorage areas. The nearest international shipping corridor is approximately 340 m from the eastern boundary of the OWF area. The export cable corridors cross existing shipping lanes, but no additional restrictions or conflicts are expected during exploitation.

For bringing export cables ashore, the most relevant locations are the tanker anchorage of the Būtingė oil terminal and the Šventoji port roadstead with its marked anchorage.

The CN OWF area, along with the established water areas, ship anchorages, and shipping corridors of Klaipėda State Seaport, Šventoji Port, and Būtingė Terminal, is presented in Fig. 5.8.3.

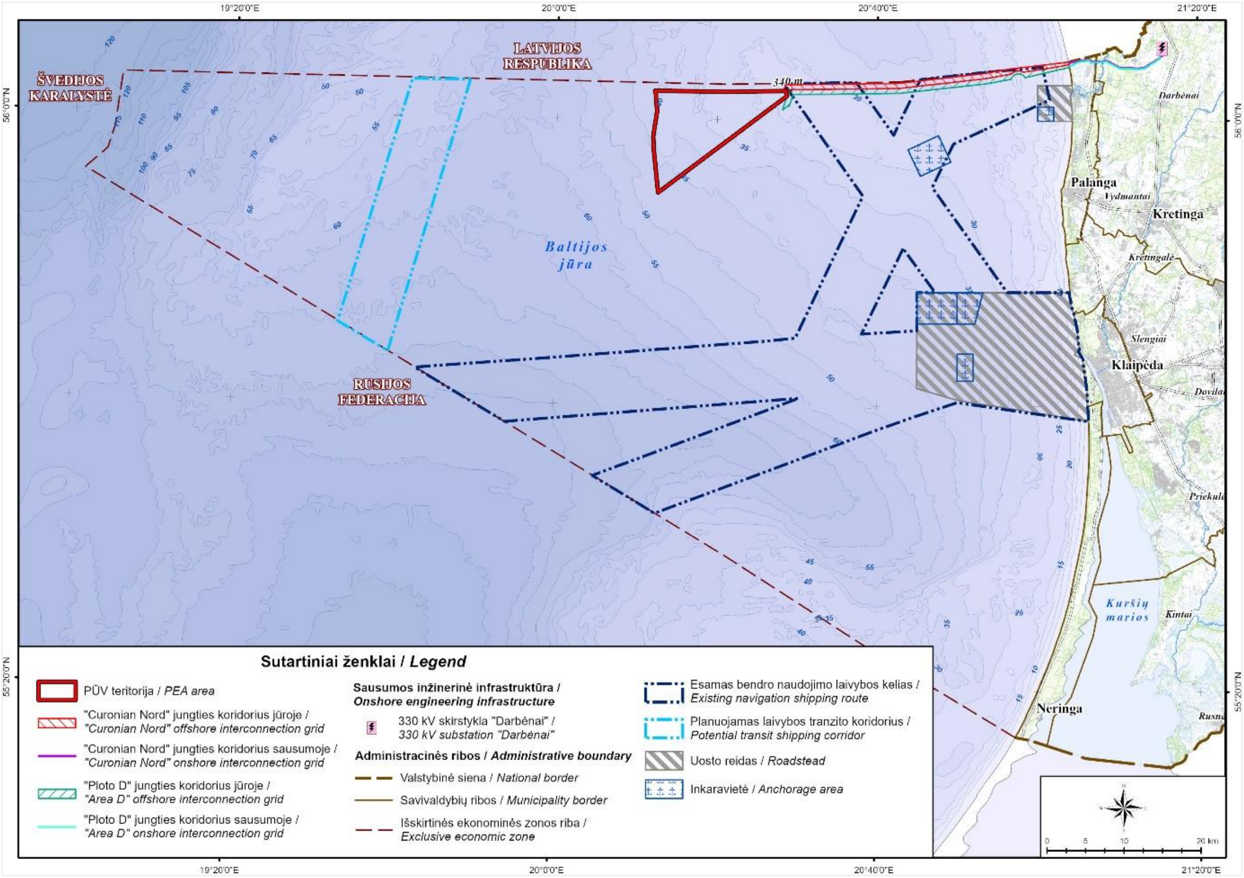


Fig. 5.8.3. Scheme of the layout of the PEA territory in terms of shipping lanes, port roads and anchorages (GIS data: Baltic Sea-Central Baltic Sea-Southeast Baltic Sea Lithuanian Coast and EEZ Sea Chart. Lithuanian Transport Safety Administration; 2022).

5.8.3.3. Dumping of dredged material at sea

Several marine dumping sites have been designated and assessed during the 2014 EIA for depositing dredged material from the Klaipėda Port water area.

The deep-water dumping site, covering an area of 4 square nautical miles (approximately 13.87 km²), is situated about 11 nautical miles (approximately 20.37 km) southwest of the port entrance, at a depth of 43–48 meters. Operation of this site began in 1987, and it accommodates all types of dredged materials, including sand, silt, and moraine soil.

Another dumping site, designated for sandy material disposal (fine sand and silty sand), is located 6 nautical miles (approximately 11.11 km) northeast of the port entrance, at a depth of 25–30 meters.

Since 2001, coastal nourishment with sand has been conducted near Palanga, within the coastal strip between coordinates 55°47’00’’ and 55°45’20’’. Sand is deposited at a depth of approximately 5 meters, with around 400,000 m³ of sand having been placed in this area.

The existing marine dumping sites are located more than 38 km away from the PEA area (see Fig. 5.8.4).

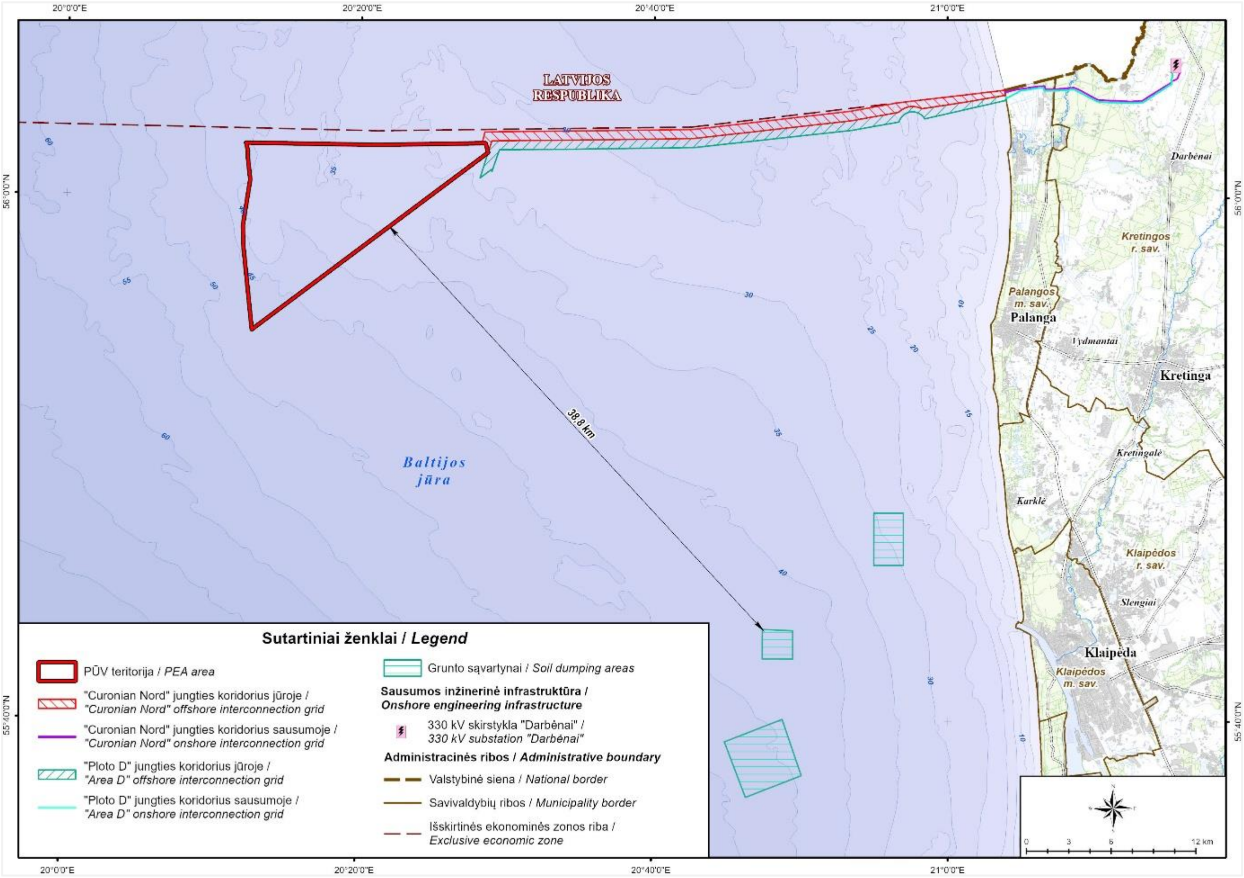


Fig. 5.8.4. Existing offshore dumping sites.

5.8.3.4. Recreational resources

Along the Baltic Sea coastline lies a shoreline relief zone formed by the sea – the beach. By order of the Director of the Palanga City Municipality Administration, No. A1-174 dated February 8, 2022, titled “On the Designation of Bathing Area Territories on the Beaches of Palanga City,” the bathing areas of the beaches in the settlement of Šventoji and Palanga City have been officially established.

The nearest recreational zones and beaches under the jurisdiction of Palanga City Municipality are located approximately 36.8 km from the OWF area (see Figure 5.8.5).

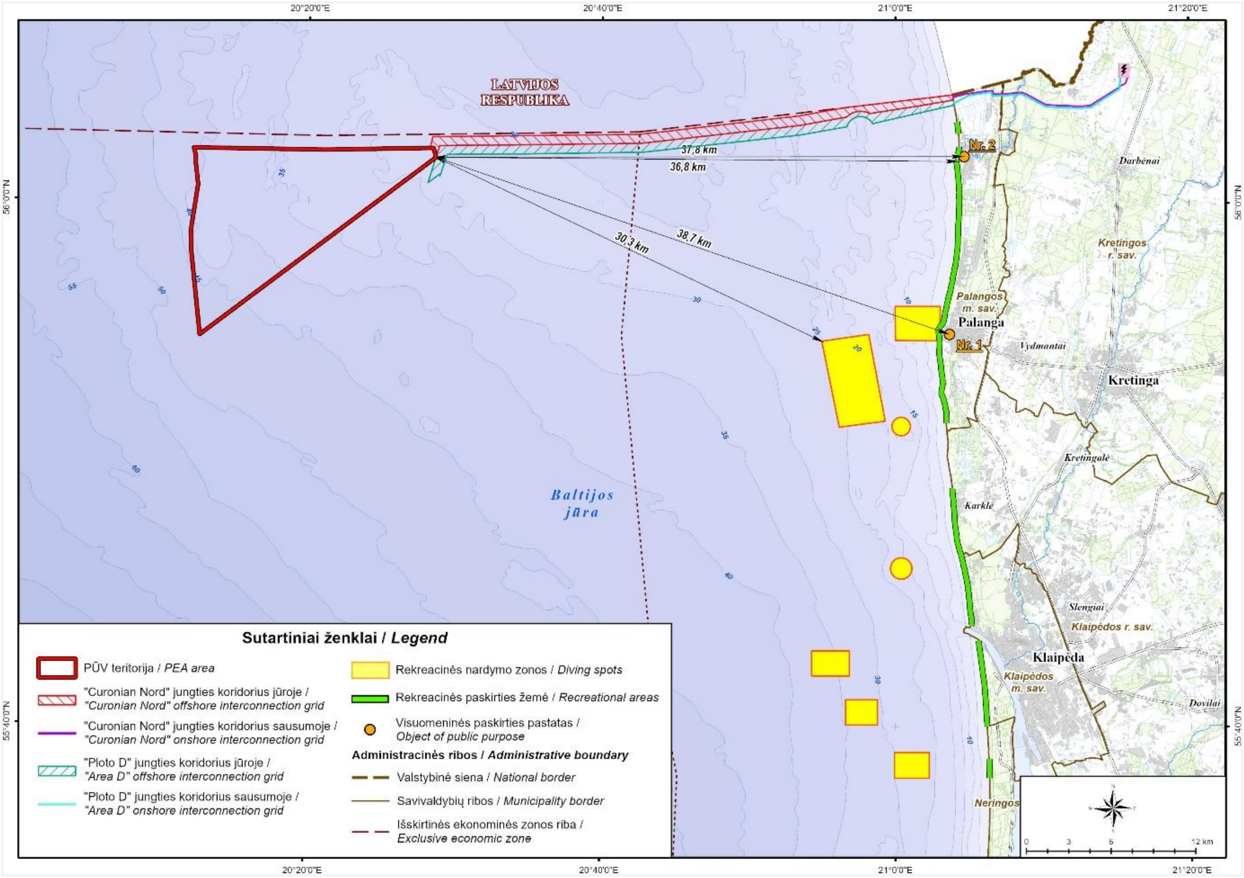


Figure 5.8.5. Residential and recreational areas in coastal municipalities (according to the solutions of the Special Plan for the Management of the Continental Part of the Coastal Belt [103]).

Marine tourism services are emerging along the Lithuanian coast, defined as independent, fee-based services for organizing boat trips for tourists. These services require specific infrastructure, including adapted quays, roads, pedestrian and bicycle paths, designated tourist areas, buildings, equipment, and other facilities to cater to inbound, outbound, and domestic tourism within the territorial waters of the Republic of Lithuania and adjacent areas with marine tourism infrastructure.

Based on this definition, the most common marine tourism services along the Lithuanian coast include cruise shipping, inland waterway tourist boating, recreational fishing, and diving services.

In the Klaipėda region, several diving clubs offer recreational diving services in the Baltic Sea, with the most attractive sites being shipwrecks and fields of prominent seabed elevations, such as moraine ridges. According to data from the "OCTOPUS" diving club, divers frequently dive in coastal waters, with the most popular diving zones situated more than 20 km from the PEA area (see Fig. 5.8.5).

According to the Engineering Infrastructure Development Plan, trenchless cable-laying technology will be employed to bring the export cables ashore, ensuring that recreational areas – bathing sites, beaches, and dunes – will not be affected or damaged.

5.8.3.5. Engineering infrastructure

Two types of engineering infrastructure facilities have been identified in the Baltic Sea waters of the Republic of Lithuania: a pipeline complex with a Būtingė terminal buoy (hereinafter – SPM buoy) and submarine cables.

The 7.3 km long pipeline of the Būtingė oil terminal, connecting the underground shore pipeline with the tanker mooring buoy, is used for loading oil products by AB Orlen Lietuva. The coordinates for the location of the Būtingė terminal oil pipeline, the SPM buoy, and the safety area are specified in the Būtingė oil terminal navigation rules[104]. The water area

[103] Main solutions of the explanatory note of the management plan for the continental part of the coastal strip . Approved by Order No. D1-601 of the Minister of the Environment of the Republic of Lithuania of 28 July 2011.

[104] Patvirtintos Lietuvos Respublikos susisiekimo ministro 2000 m. rugsėjo 18 d. įsakymu Nr. 248 „Dėl Būtingės naftos terminalo laivybos taisyklių patvirtinimo".

assigned to the terminal is within a radius of 1,000 m around the SPM buoy, and the safety zone extends 300 m in both directions from the oil pipeline.

The EEZ is crossed by two telecommunications cable routes, originating from Šventoji and owned by AB "TeliaSonera," according to the International Cable Protection Committee:

- 218 km long BCS East-West interlink route (in use since 1997), connecting Šventoji with Katthammarsvik in Sweden (Gotland island)
- The 97.8 km long BCS East (ready for use since 1995), connecting Šventoji with Liepaja in Latvia.

Another cable from Kaliningrad to Kingisepp (Russia) runs parallel to the western boundary of the CN OWF but does not intersect the OWF and its associated offshore cables (see Fig. 5.8.6).

In the central part of the water area, extending from Klaipėda through the Curonian Spit and further towards the Swedish EEZ, the NORDBALT connection has been established – a 450 km long, 700 MW high-voltage direct current submarine and underground cable.

On 21 December 2018, the heads of the Lithuanian and Polish transmission system operators signed an agreement to commence the new Lithuanian-Polish maritime high-voltage direct current (HVDC) cable construction project "Harmony Link." The Government of the Republic of Lithuania, by Resolution No. 720[105] of 1 September 2021, approved the engineering infrastructure development plan for the electricity system synchronization project of special national importance "Construction of the Harmony Link connection and the 330 kV switchyard 'Darbėnai'," which outlines the route for the planned "Harmony Link" maritime connection.

The export cable corridors bypass the SPM buoy and its pipeline complex, as well as the existing and planned submarine cable routes from the north but intersects the previously mentioned telecommunications cables of AB TeliaSonera.

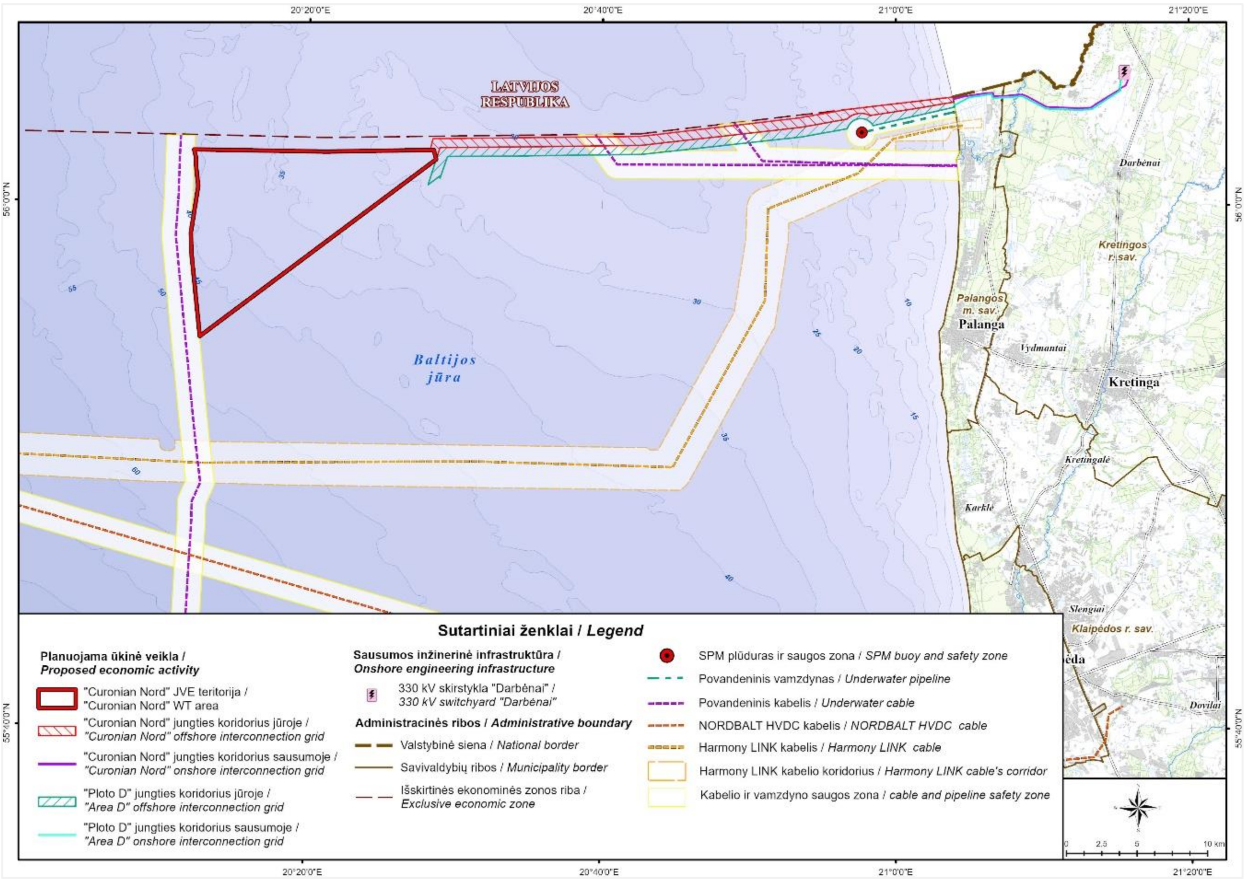


Fig. 5.8.6. Existing and planned engineering facilities offshore.

[105] Lietuvos Respublikos vyriausybės 2021 m. rugsėjo 1 d. nutarimas Nr. 720 „Dėl ypatingos valstybinės svarbos elektros energetikos sistemos sinchronizacijos projekto „Harmony link jungties ir 330 kV skirstyklos „Darbėnai" statyba" inžinerinės infrastruktūros vystymo plano patvirtinimo".

5.8.3.6. Restricted and hazardous areas at sea

Part of the OWF territory falls within a hazardous maritime area, specifically a zone of former minefields (see Fig. 5.8.7).

In the Lithuanian territorial sea and EEZ, there are several restricted-use areas, such as military training ranges, as well as parts of the water area containing sunken World War II weapons and former minefields, which cover a considerable expanse. While economic activities can be implemented in these territories, it is crucial to conduct thorough bottom surveys to identify and, if necessary, decontaminate dangerous objects prior to implementing technical project solutions.

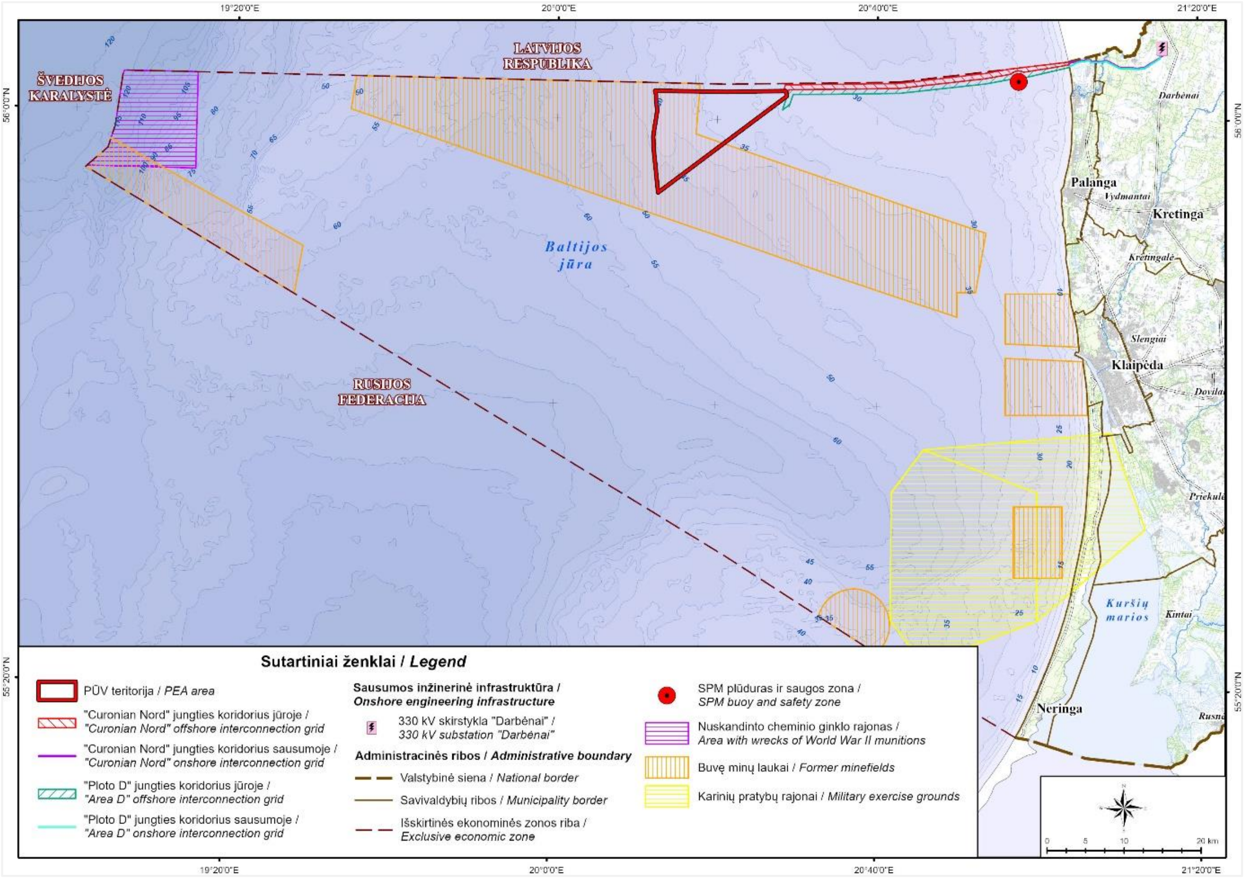


Fig. 5.8.7. Restricted use and hazardous areas (according to the charts of the Lithuanian coast and EEZ of the Baltic Sea-Central Baltic Sea-Southeastern Baltic Sea. Lithuanian Transport Safety Administration; 2022).

5.8.3.6.1. Chemical weapon sunk in Lithuanian waters

After World War II, more than 40,000 tons of chemical warfare materials were dumped in the Baltic Sea, including aviation bombs, artillery shells, mines, and smoke grenades containing toxic chemicals such as mustard gas, adamsite, chloroacetophenone, tabun, tear gas, phosgene, arsenic compounds, and others.

In official nautical charts, updated annually by the Water Transport Department of the Lithuanian Transport Safety Administration, a designated area in the westernmost part of Lithuania's EEZ, approximately 70 nautical miles away in the Gotland Deep, is marked as a chemical weapons dumping site. In this zone, anchoring and bottom trawling are not recommended. It is believed that munitions containing mustard gas, tear agents, choking agents, and other chemicals are buried there (HELCOM, 1995). Since this chemical munition dumping area is quite far from the PEA site, no direct threat is anticipated during the development of the PEA.

According to data from the Ministry of Environment of the Republic of Lithuania, monitoring stations have been established in the chemical weapons dumping area, and environmental monitoring is being carried out. Key studies include:

- 2002–2004: the EPA conducted seabed research and identified 39 objects. Elevated arsenic concentrations were detected at the dumping site. Sediment and bacteriological samples were taken, and hydrochemical indicators were analysed. Results indicated that in Lithuania's EEZ, the chemical impact (e.g., arsenic) on the marine environment is minimal or non-existent due to natural self-purification processes.

- 2011–2014: the CHEMSEA project (Chemical Munitions Search and Assessment), with participation from EPA, collected sediment and benthic samples. A significant decline in Macrozoobenthos species was observed compared to earlier studies (from 10 species in 1981–1993 to 3 in 2013). Chemical munitions components were detected in sediments. Arsenic concentrations in Lithuanian marine waters ranged from 1.9 to 15.9 mg/kg (dry weight). No live benthic fauna was found at the Lithuanian EEZ study sites, except for a few empty shells of the bivalve Macoma balthica.
- 2013–2015: the MODUM project (Towards the Monitoring of Dumped Munitions Threat), funded by NATO's Science for Peace and Security (SPS) programme, aimed to develop a long-term monitoring network at chemical munitions sites in the Baltic Sea using autonomous and remotely operated underwater equipment.
- 2015–2019: the DAIMON project (Decision Aid for Marine Munitions) evaluated the condition of chemical weapons dump sites, modelled the potential release of chemical components into the environment, analysed sediment and water pollution, impact on biota, and assessed risk. Benthic samples showed no living microorganisms at chemical munitions dump sites. The widely distributed mollusc Limecola balthica was found in only one out of five sampling locations. Arsenic concentrations were measured.
- 2019–2020: the DAIMON 2 project aimed to apply and further optimize tools developed under DAIMON. During this phase, the decision support system was enhanced and integrated into the Ammunition Cadastre Sea platform (AmuCad.org). Trainings and seminars were organized for environmental agencies, maritime authorities, military personnel, spatial planners, coast guards, and marine investors.

5.8.3.6.2. Territories important for ensuring national security requirements

According to the methodology for preparing the map of territories in the Republic of Lithuania, where restrictions on the design and construction of OWF projects may apply based on national security requirements, a map has been compiled and approved indicating territories where OWF projects involving tall structures may face restrictions (see Figure 5.8.8).

As per this map, the planned OWF's area falls within a territory where the location of OWF structures must be coordinated, provided that the wind farm developer enters into an agreement with the Lithuanian Armed Forces concerning a share of investment and other costs.

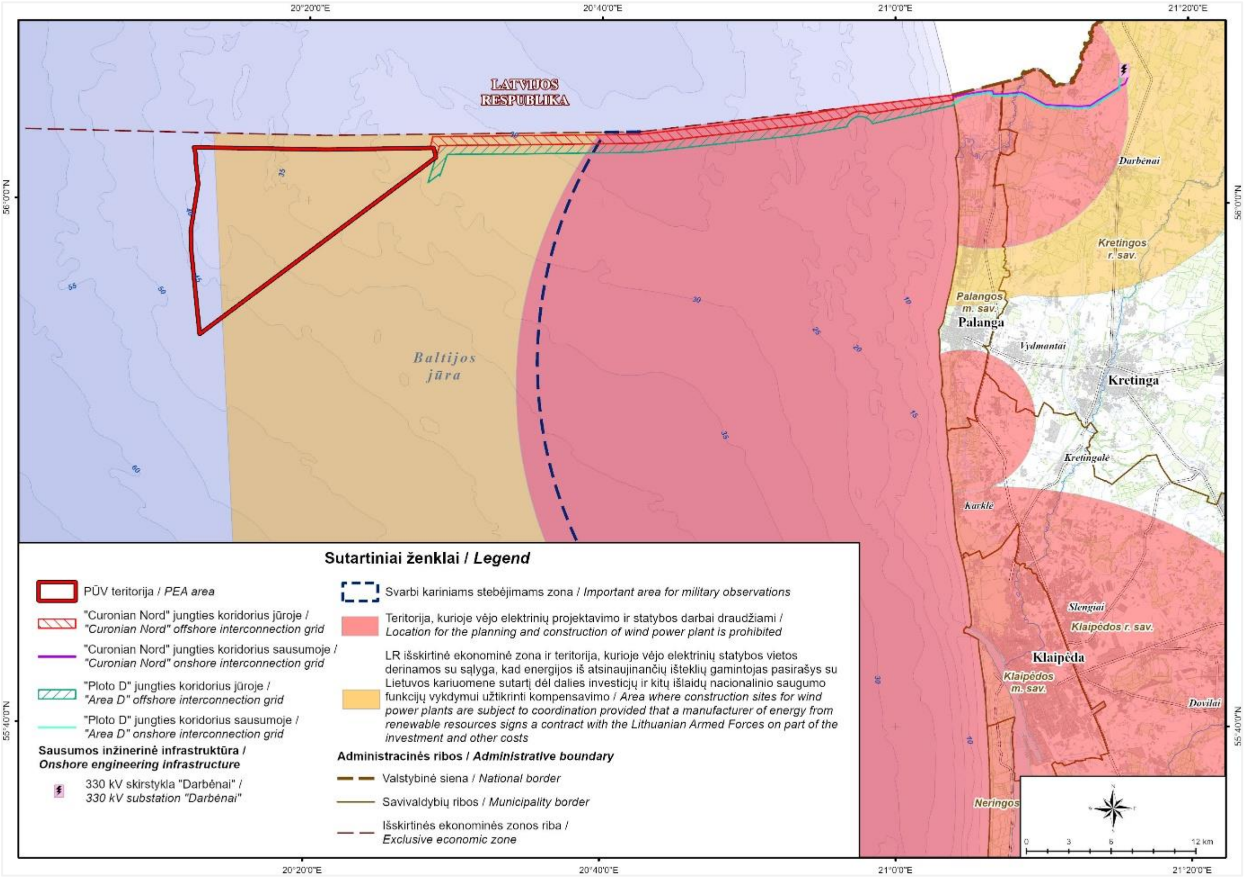


Fig. 5.8.8. Layout of the PEA area in relation to territories subject to national security requirements (based on: the map of the Republic of Lithuania's territories where the design and construction of OWF (tall structures) may be restricted, approved by Order No. V-217 of the Commander of the Lithuanian Armed Forces on February 15, 2016).

According to Article 49, Part 19 of the Law on Renewable Energy of the Republic of Lithuania, locations for the construction of WTGs in territories subject to SLUC – based on national security concerns outlined in the Law on SLUC – must be coordinated in advance with the Commander of the Lithuanian Armed Forces and other relevant institutions, following the procedure established by laws and other legal acts. This coordination must occur during the territorial planning process or, if no such planning document is prepared, before the issuance of a construction permit, within the time limits set out in Article 10, Part 4 of the Law on Public Administration.

If it is determined that the interference caused by the planned WTGs can be mitigated through additional measures, the construction site may be approved on the condition that the developer submits an approved construction project and signs an agreement with the designated institution – prior to receiving the construction permit – on the compensation for a portion of investments and other costs necessary to ensure national security functions. The developer must also provide a guarantee for fulfilling this obligation.

However, OWF sites may be coordinated without requiring a compensation agreement if the developer includes additional technical measures (e.g., radars, electro-optical devices, communication and data transmission systems) in the construction project that are coordinated with the Lithuanian Armed Forces and/or other national security institutions, in accordance with the procedure established by the Government of the Republic of Lithuania.

In November 2022, a draft order by the Commander of the Lithuanian Armed Forces was prepared (but as of September 22, 2025, is still not approved), titled "On the Approval of Maps of Territories Where, Based on National Security Requirements, Construction Restrictions Apply, and of Military Radar Protection Zones." This draft order is intended to approve maps of territories subject to construction restrictions and military radar protection zones.

The analysed OWF area does not fall within the designated military radar protection zone (see Fig. 5.8.9), but it does fall within the designated territories where construction restrictions apply due to national security requirements (see Fig. 5.8.10).

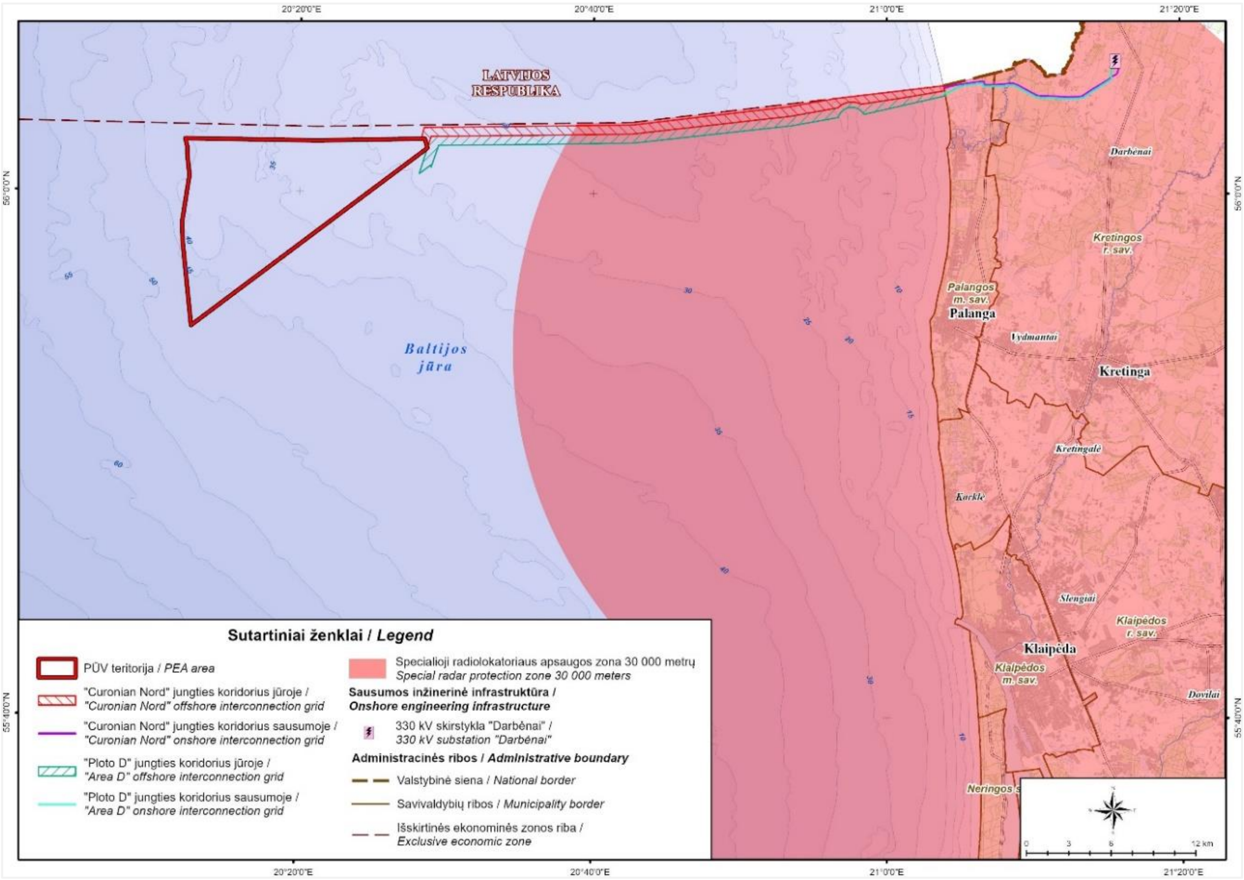


Fig. 5.8.9. Layout of the OWF territory in relation to the planned radar protection zones (based on: Radar Protection Zone Map (not approved)).

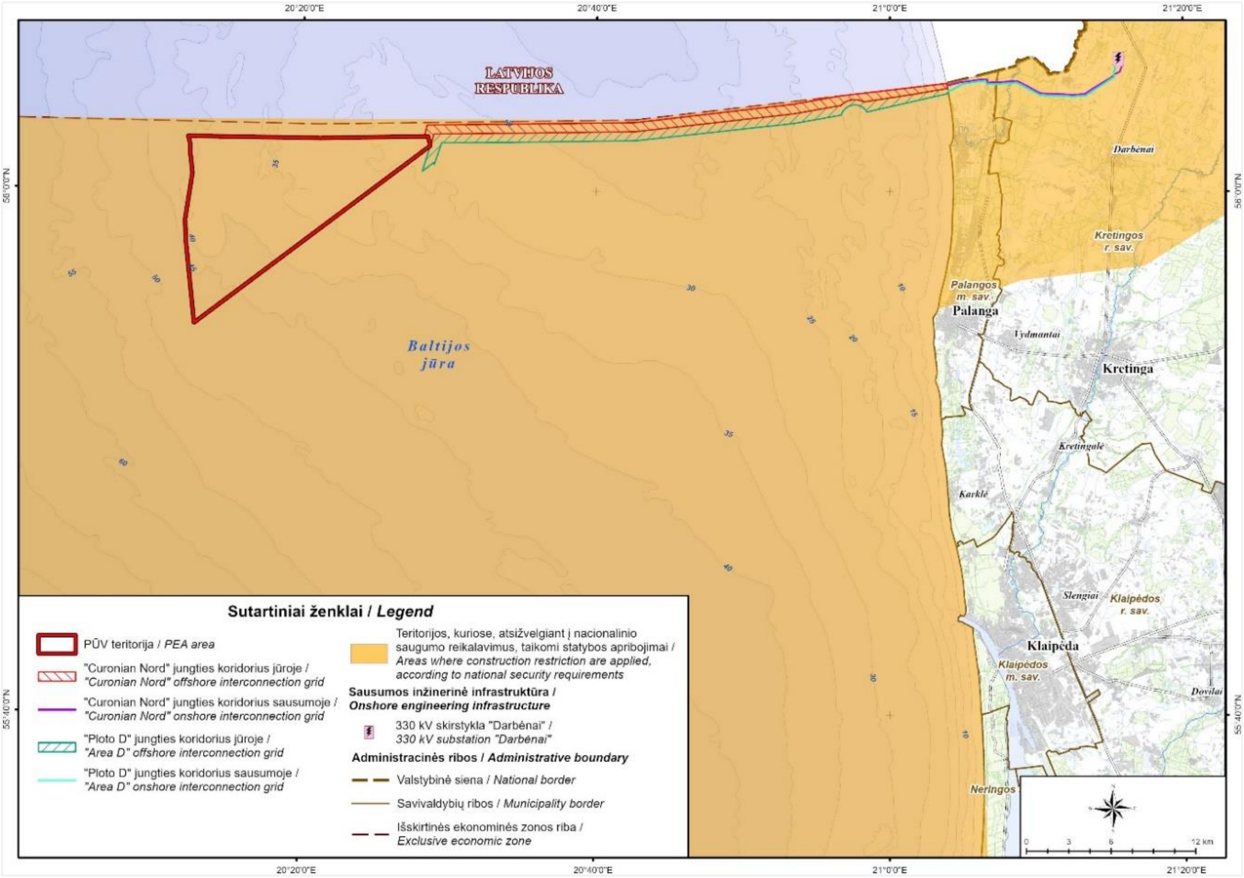


Fig. 5.8.10. Layout of the OWF territory with planned areas where construction restrictions apply, considering national security requirements (basis: map of areas where construction restrictions apply, taking into account national security requirements (unapproved)).

5.8.3.7. Current use of the onshore section of the PEA area

Onshore, it is planned to install the ONSs necessary for the OWF and to lay export cables to the Darbėnai 330 kV switchyard. An Engineering Infrastructure Development Plan has been prepared for selecting the export cable corridors. Based on its concept and specified solutions, connection routes have been planned for the CN and "Area D" OWFs, which are further analysed in the EIA report.

The onshore length of the CN OWF export cable corridor (from the sea landfall point) is approximately 13.5 km, with about 3.2 km located within the territory of Palanga City Municipality and the remaining 10.3 km within Kretinga District Municipality. Similarly, the onshore length of the "Area D" export cable corridor is approximately 13.6 km, with about 3.5 km within Palanga City Municipality and the remaining 10.1 km within Kretinga District Municipality.

5.8.3.7.1. Engineering infrastructure

The transportation network in Palanga City Municipality comprises state-level and local roads (see Fig. 5.8.11). There are no existing railway lines within the municipality; however, a new railway is planned in Būtingė to connect to a future deep-water port. The Palanga International Airport is in the central part of the municipality, near the settlements of Kunigiškiai and Užkanavė, while the Šventoji State Seaport is situated at the mouth of the Šventoji River by the Baltic Sea in the northern part. The entire territory of Palanga City has developed public water supply and centralized domestic wastewater systems, an electricity supply network, and a natural gas distribution pipeline system. In the northern part of the municipality, near the border with Latvia, oil terminal pipelines connect the offshore pipeline with the oil storage tank park in Būtingė. Additionally, the northeastern part of this area contains a segment of the main oil pipeline leading to the Mažeikiai oil refinery.

The transport infrastructure of Kretinga District Municipality includes state roads, main roads, regional roads, and local district roads. The district is supported by a well-developed electricity supply network, ensuring reliable and high-quality electricity for consumers (see Fig. 5.8.12). Two broad-gauge railway sections pass through Kretinga District, and the Kartena airfield is located within the district. Kretinga District also has a centralized water supply and domestic wastewater treatment system, developed communications infrastructure, and main gas pipeline networks. When evaluating the export cable corridors of the OWFs in the EIA report, both existing and planned infrastructure in Kretinga District – based on valid spatial planning documents – are considered.

Fig. 5.8.11. Planned export cable corridors in relation to the district's engineering infrastructure (map basis and legend: drawing of solutions for the adjustment of the Palanga City GP, determining priority municipal infrastructure development territories, www.tpdr.lt).

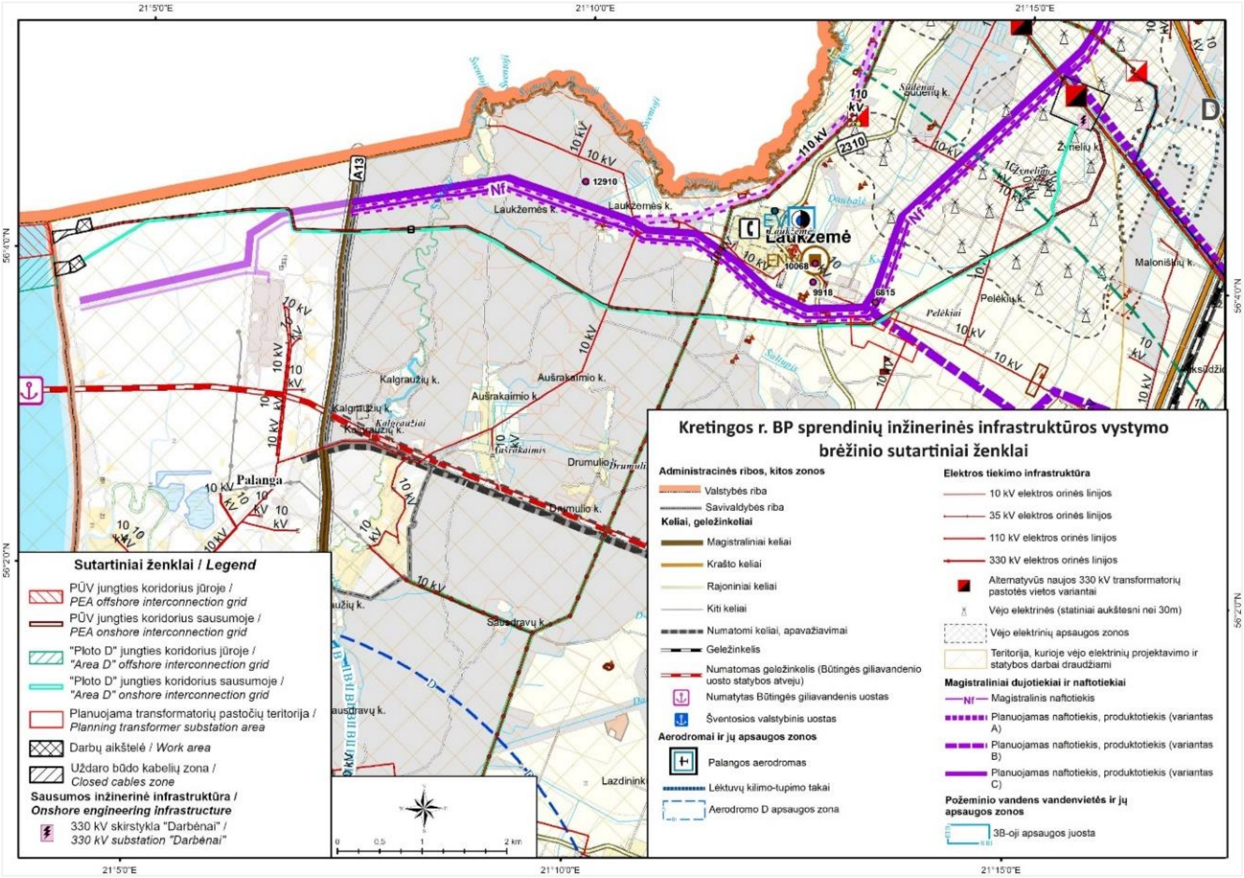


Fig. 5.8.12. Planned export cable corridors in relation to the existing engineering infrastructure of Kretinga District Municipality (map base and legend: excerpt from the engineering infrastructure solution drawing of the Kretinga district municipality and its part of the Kretinga city general plan, www.tpdr.lt).

5.8.3.7.2. Protected areas

Within or near the connection corridor area, there are "Natura 2000" network sites and other protected territories. In the territory of Palanga City Municipality, the export cable corridor will cross the boundaries of the Būtingė Geomorphological Reserve using trenchless underground cable-laying technology. In the territory of Kretinga District Municipality, the route will cross the Baltic Šventoji River, which is part of the "Natura 2000" site (see Section 5.4.1).

5.8.3.7.3. Forests

In Palanga City Municipality, forests and forest land constitute approximately 41% of the city's land area and about 90% of all protected areas. All forests here are of state importance and classified as Group II special-purpose forests.

In Kretinga District Municipality, forest land covers about 35% of the district's total area, with Group IV commercial forests being predominant. Some of these forests are state-owned, while others are privately owned.

The export cable corridors will traverse special-purpose forests (Group II), protective forests (Group III), and commercial forests (Group IV). The forests located within the study area in Palanga City and Kretinga District Municipalities are depicted in Fig. 5.8.13.

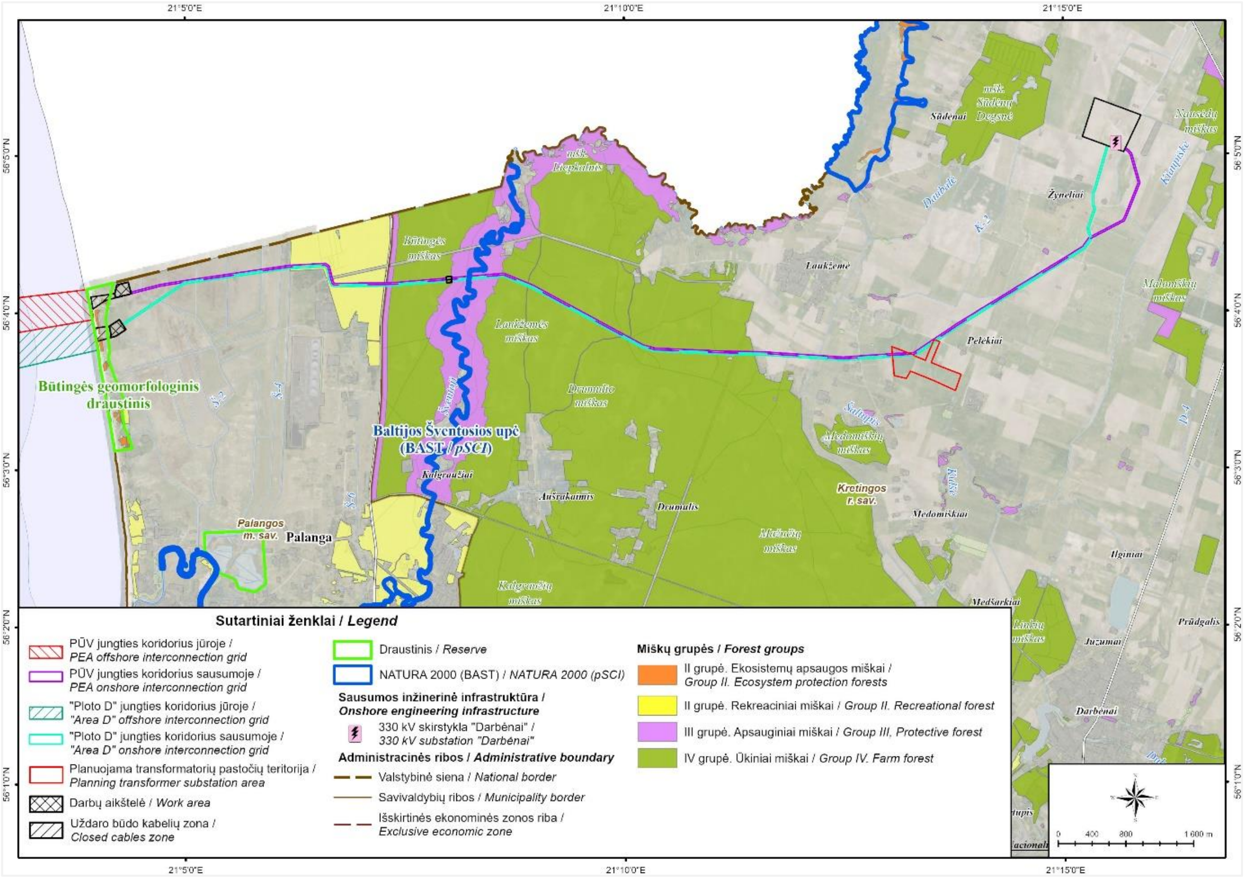


Fig. 5.8.13. Forests in the analysed area in Palanga city and Kretinga District Municipalities.

5.8.3.7.4. Mineral deposits

The export cable corridors within the boundaries of Palanga City Municipality cross the periphery of the Šventoji oil prospective resource area (see Fig. 5.8.14).

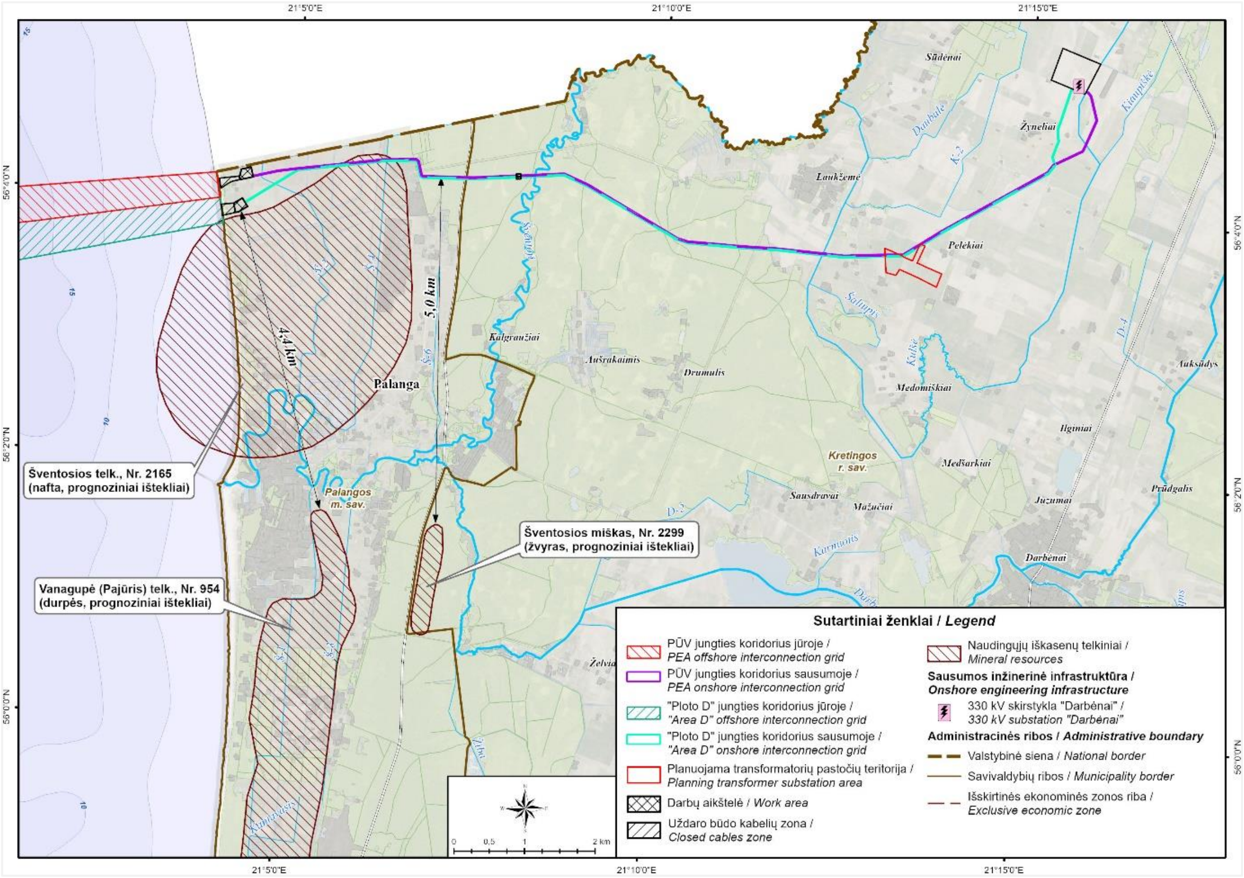


Figure 5.8.14. Deposits of useful resources in the analysed area (source: www.lgt.lt).

5.8.3.7.5. Cultural heritage

In the territory of Kretinga District Municipality, there are numerous archaeological heritage sites, sacred groves, and significant stones. The area also contains many heritage sites of historical importance, such as old cemeteries and small architectural monuments, including chapels and wayside shrines.

Within the boundaries of Palanga City, near the export cable corridors, there is a registered cultural heritage site – the Lithuanian State Border Marker (ID 30785). In Kretinga District, near the route, there is Laukžemė Cemetery II (ID 37960) (see Fig. 5.8.15).

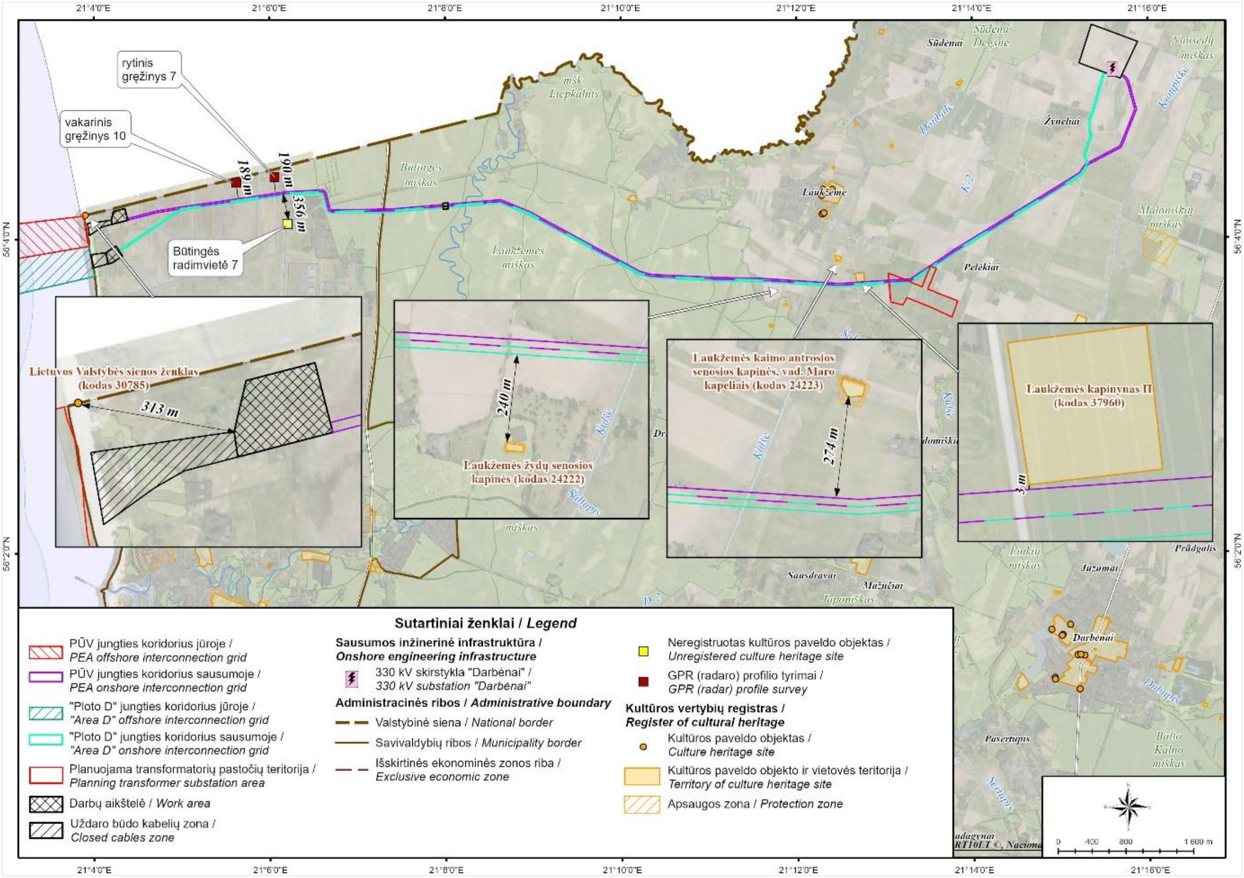


Fig. 5.8.15. Registered cultural heritage values in the vicinity of the export cable corridors (source: Cultural Heritage Register, https://kvr.kpd.lt).

5.8.3.7.6. Recreation, tourism

Palanga is one of the most important resorts in Lithuania, classified as a national-level recreation service centre.

In the territory of Kretinga District Municipality, two recreational directions are significant based on the geographical situation: firstly, exploring the continental part of the district municipality and utilizing its recreational resources; secondly, using the seaside zone to develop a resort-type environment.

5.8.4. Potential impact on material assets

5.8.4.1. Potential impacts on fisheries and fishing during the construction, operation and decommissioning phases of the OWF, including export cables

5.8.4.1.1. OWF area

Potential impacts on fisheries and fishing include a reduction in fishing areas and deterioration of fishing conditions due to possible restrictions in the OWF area.

The implementation of the PEA may have some economic impact on the fishing industry due to restrictions applied in the OWF area. Once the OWF is installed, active fishing methods (such as trawling) will become impossible due to the risk of damaging export cable corridors located on the seabed. However, fishing with passive gears will be permitted only through agreements between the developer and the fishing community.

It is important to note that the analysed territory covers open sea fishing areas that are not assigned to specific enterprises. Therefore, if restrictions are imposed during the construction and operation of the OWF, fishing can continue in adjacent areas, and fishermen will not incur losses. The OWF area covers 119.5 km², representing only a few hundredths of a percent of the quota resource area, meaning that the restriction of fishing in the OWF area does not significantly reduce fishing opportunities in the open Baltic Sea.

If fishing is restricted throughout the OWF area, according to Article 7, Part 1, Point 3 of the Law on Fisheries of the Republic of Lithuania, users of fish resources have the right to receive compensation for losses if the opportunity to fish is lost (including for a limited period) due to the economic activities of government institutions, state or municipal enterprises or institutions, as well as due to work carried out on their orders. Part 2 of the same article notes that the procedure for calculating losses incurred and the rates in marine waters shall be established by the Ministry of Agriculture. If fishermen file a claim for compensation related to the loss of fishing areas, the procedure for compensation shall be determined by the Ministry of Agriculture.

In the PEA area, pelagic and bottom trawl fishing has not been conducted in the last decade, except for a few trawling trips crossing the area. Due to the characteristics of the bottom and substrate, fishing in the PEA area is conducted solely using set nets. In 2014, this area was an intensive fishing ground for cod, but since 2017, catches have significantly decreased, and the area has lost its significance as a fishing ground. Despite fishing bans introduced in 2019 to protect cod, the Eastern Baltic cod population shows no signs of recovery. This is primarily linked to the collapse of cod stocks in the Baltic Sea and changing environmental conditions. Recovery is believed to be hindered by the lack of food sources and increasingly warm Baltic Sea waters in the summer. Currently, there are no clear forecasts for the possible recovery period of the Baltic cod population. According to the latest assessments (ICES, 2023), it is unlikely that the eastern Baltic cod stock will recover sufficiently to lift the ban on directed cod fishing by 2030. Following the collapse of Atlantic cod off the coast of Newfoundland in 1991, their stock has still not recovered in the long term. Meanwhile, specialized fishing for European plaice is unprofitable due to low primary purchase prices.

The simulation results show that the noise from pile driving will have the greatest impact on herring (*Clupeidae*) fish, in particular herring and sprat. Some impact on fish behaviour is possible up to 33 km from the noise source. Considering that the main fishing period for pelagic species in the Lithuanian EEZ is September–April, it is recommended to plan the installation of the OWF, if practicable, so that the pile installation is carried out in May–August, when the impact distance is halved, and fishing for pelagic species is reduced to a minimum or does not occur at all.

The construction of the OWF may also positively impact fish stocks. According to the study "Impacts of Wind Energy on Marine Organisms" prepared by the Swedish Environmental Protection Agency (Bergström et al., 2012), the foundations of WTGs can function as artificial reefs, attracting various fish species. Initially, fish are drawn from adjacent areas to the WTGs foundations, but over time, an increase in fish productivity within the OWF is possible if the OWF is sufficiently large and fishing intensity is low. OWF areas typically create favourable conditions for the formation of a food base and fish spawning, leading to increased biodiversity (Leonhard et al., 2011). This, coupled with fishing restrictions in park areas, may contribute to the conservation and enhancement of fish stocks.

A balanced approach to protecting and enriching fish stocks, along with implementing necessary restrictions and compensations, can significantly mitigate negative impacts on the fishing industry and reduce potential conflicts between the fishing business and wind energy.

5.8.4.1.2. Nearshore export cable corridors

Restrictions on coastal fishing are expected during export cables installation work.

During the operation phase, restrictions on fishing nets should be applied to the connection cable locations in coastal fishing areas due to the risk of damage to the cables by anchors.

According to Article 7, Part 1, Item 3 of the Law on Fisheries of the Republic of Lithuania, users of fish resources have the right to receive compensation for losses if the possibility of fishing is lost (including temporarily) due to the economic activities of government institutions, state or municipal enterprises, or institutions, as well as due to work carried out on their behalf. Part 2 of the same article notes that the procedure for calculating losses incurred and the rates in marine waters shall be established by the Ministry of Agriculture.

5.8.4.2. Sizes and regulations of protection zones established for electricity transmission cables offshore and onshore, requirements set out in the Law on Special Land Use and Conditions

According to Article 24 of Section 4 of the Law on SLUC of the Republic of Lithuania:

- Item 3 stipulates that the protection zone for underground cable lines is a strip of land along the cable line, with boundaries 2 meters on each side from the outermost cables, including the airspace above this strip.
- Item 5 defines the protection zone for underwater cable lines as a 100-meter-wide strip of seabed on each side from the external boundaries of the engineering structure of the cable line (or from the outermost cables if no structure is present), including the water column above.
- Item 6 states that the protection zone for ONSs, switchyards, and converter stations corresponds to the built-up area occupied by these facilities and the airspace above it. No protection zones are designated for enclosed transformer substations.
- Item 7 provides that the protection zone for a transformer unit or switching point is a 5-meter-wide strip of land around it, including the airspace above. No protection zones are established for ONSs integrated into buildings.

Prohibited activities within electrical grid protection zones:

1) Construction of residential, cultural, scientific, medical, dining, service, commercial, administrative, hotel, transportation, or sports buildings under 110 kV and higher voltage overhead line protection zones.
2) Construction or installation of stadiums, sports or playgrounds, markets, hazardous materials tanks or storage, landfills, and public transport stops.
3) Construction or installation of parking or storage areas for all types of vehicles or machinery under overhead lines.
4) Organizing events involving public gatherings.
5) Blocking, damaging, or obstructing access roads to electrical grids.
6) Flying kites, model aircrafts, or any flying objects below 30 meters above the highest overhead line wire (except drones used for grid maintenance).
7) Parking any type of vehicle or machinery under 330 kV or higher voltage lines.
8) Spraying fertilizers or chemicals from aircraft onto 35 kV+ lines, substations, switchyards, or converter stations.
9) Using fire or performing hot works, including setting campfires, using barbecues, portable stoves, or outdoor saunas – except as allowed under Item 8, Part 2 of this Article.
10) Storing any materials, except those used for construction of the electrical grid.

Activities prohibited without prior approval from the grid owner or operator (as per the Construction Law, Territorial Planning Law, or procedure established by the Minister of Energy):

1) Constructing buildings or installing equipment, unless otherwise prohibited in Part 1.
2) Changing the use or function of buildings, premises, or engineering structures.
3) Reconstructing, demolishing, or dismantling buildings or equipment.
4) Installing animal pens, wire fences, or metal fences.
5) Conducting mining, seabed dredging, excavation, blasting, land reclamation, or flooding.
6) Planting, growing, or cutting vegetation, except shrubs and herbaceous plants.
7) Mechanized irrigation of crops.
8) Using fire or hot works in technological processes.
9) Installing parking areas for vehicles or machinery within underground cable protection zones.
10) Using impact or vibration-generating machinery within underground cable zones.
11) Changing the land surface elevation by more than 0.3 meters (digging or filling) in underground or underwater cable protection zones.
12) Dropping anchors or sailing with dropped anchors or bottom-touching gear in underwater cable zones.
13) Driving vehicles or machinery exceeding 4.5 m in height (with or without cargo) in overhead line protection zones.

The dimensions of the offshore and onshore export cable corridors protection zones for the OWF connections, as well as the SLUC regulations applicable within them, are defined in the prepared Engineering Infrastructure Development Plan.

5.8.5. Preventive, mitigation and compensatory measures for the impact on material assets

5.8.5.1. Support for local communities

Support for local communities is provided for in the legal acts of the Republic of Lithuania. In 2022, a Description of Requirements for Persons Seeking or Having Acquired the Right to Develop and Operate Power Plants Using Renewable Energy Sources in Maritime Territory, and Compensation for the Costs of Research and Other Actions in Maritime Territory, was prepared. Chapter IV of this document outlines the requirements related to support for local communities:

- Point 13 states that the winner of the tender, conducted in accordance with Article 221 of the Law on Renewable Energy, is obliged to support local communities – as defined in this section – within the municipalities adjacent to the maritime territory where power plants using renewable energy sources are installed. Similarly, the winner of the tender under Article 22 of the same law must support communities within municipalities whose coastal land strip is parallel to the part of the maritime territory where the power plants are located. In determining which municipalities are considered to have a parallel coastal strip, lines are drawn perpendicularly from the northern and southern corners of the power plant site to the shoreline.

- Point 14 provides that the tender winner, following the procedure set by the Government of the Republic of Lithuania (LRV) and in accordance with Article 13(4) of the Law on Renewable Energy, must pay a levy to the levy administrator appointed by the Government upon the proposal of the Ministry of Energy. This levy is €1 per 1 MWh, and is due by January 31st of the current year, but only if the hourly price on the Lithuanian electricity market for the next day exceeds €1 per 1 MWh. The levy is paid from the date the electricity generation permit is issued to the tender winner and continues until the permit expires. The levy amount is calculated based on the amount of electricity produced and supplied to the grid in the previous calendar year.
- Point 15 stipulates that the levy administrator must distribute the collected funds – in accordance with the procedure and conditions set by the Government – to the municipalities identified in Point 13. If the power plants are installed in accordance with Article 221, the amount paid to each municipality is proportional to the length of that municipality's coastal land strip along the Baltic Sea. If installed under Article 22, the payment amount is proportional to the municipality's share of the designated coastal strip interval defined in Point 13.

Each municipal council then determines, according to its own procedures, how to allocate the funds to meet the social, economic, and environmental needs of local communities and residents.

5.8.5.2. Recommendations on compensation for losses to fishermen.

According to Lithuanian and EU legislation related to financial support for fisheries, quota-based fishing opportunities are assessed solely based on the value of the catch, not the area fished. This implies that if annual catches of quota-managed stocks remain within total allowable catches (TACs), fishing opportunities are not considered lost, even if fishing occurs in a smaller area. Spatial restrictions on fishing grounds that help ensure TACs are not exceeded are viewed as beneficial to the goals of the EU Common Fisheries Policy.

Thus, a Member State may require developers to pay compensation for losses related to reduced access to quota-based fishing only if the annual catch is significantly lower than the allocated quota, and this decrease is directly attributable to the inability to fish in the OWF area (Bučas et al., 2023). In this context, the only relevant example of such a resource is eastern Baltic cod, which is currently subject to fishing bans.

Although guidelines for calculating compensation for businesses operating in the open Baltic Sea have been developed (Bučas et al., 2023), the latest revision (as of 2025-01-01) of the Order No. 3D-695 by the Minister of Agriculture of the Republic of Lithuania, dated December 3, 2008, titled "On the Approval of Rules for the Calculation and Valuation of Losses Due to Loss of Fishing Opportunities Caused by Third Parties", does not provide for compensation for lost fishing opportunities in the open Baltic Sea.

The above-mentioned guidelines propose that:

- During periods of direct cod fishing bans, compensation should be calculated based on the average annual catch over at least five years during the ban (e.g., 2020–2025) in the area where fishing access was restricted.
- After the ban is lifted, compensation should be calculated using 2013–2018 data, determining average annual catches in the area where fishing access was limited.

However, the spatial distribution of fish stocks is uneven, and fishing effort varies by area, meaning that even in relatively small areas, significant catches generating substantial revenue may occur in certain years. Thus, the guidelines propose two possible approaches to calculating compensation:

1) Annual assessment of the OWF area's impact on the exploitation level of quota stocks, with compensation calculated separately for each fish species.
2) A predefined assumption that over the lifetime of the OWF, a certain proportion of quota resources will not be exploited due to limited access, and a lump-sum compensation is paid accordingly.

Until 2017, fishing in the 29th coastal sector was primarily conducted using gillnets, with fishing lasting 4–6 months per year. Since 2017, the use of fish traps has intensified across the coastal zone, significantly improving round goby catches, extending the fishing season to 7–9 months, and increasing the value of catches.

Despite changes in fishing activity and intensity in the Baltic Sea coastal area due to new fishing gear, fishing in the 29th coastal sector is minimal or absent during the summer (July–August) and autumn (September–October). Therefore, cable-laying activities during this period would not have a direct impact on fishing activity. Otherwise, losses from lost fishing opportunities must be calculated and compensated in accordance with the procedure and rates set out in the rules approved by Order No. 3D-695 of the Minister of Agriculture, specific to Coastal Zone IV of the Baltic Sea.

5.8.5.3. Dangerous areas offshore

Part of the territory of the Baltic Sea of the Republic of Lithuania has been identified as dangerous. Former minefields have been identified as potentially dangerous. A prerequisite is to conduct detailed seabed surveys to search for dangerous objects and, if necessary, to carry out decontamination work on dangerous objects before starting design work.

5.8.5.4. Land use onshore

Compensation for easements for land plots falling within planned export cable corridors must be paid in accordance with the procedure established by the Government.

6. RISK ANALYSIS AND ASSESSMENT

The risk analysis (hereinafter – RA) of the development of an OWF in Lithuania is designed to assess the risk of emergency situations and incidents arising during the PEA and the dangers these situations pose to the social and natural environment.

The risks posed by the PEA to people and the social environment in the offshore part are related to the rotating blades of the WTG, considering the possibility of their partial or complete ejection, the collapse of towers, the impact of electrical voltage on service personnel. Collision risks arise for aircraft, ships moving near the WTGs or OWFs at sea. The risks posed by emergency situations to the natural environment in the offshore part are potentially related to minor oil leaks from the rotors, fuel leaks from ships and oil leaks from OSS.

Onshore, risks to the social and natural environment are related to accidents in export cable corridors, transformer oil leaks from and fires in ONSs.

6.1. Recommendations for PEA RA and its assessment in the normative documents of the Republic of Lithuania

The requirements for the PEA EIA report and its individual parts are specified in the Description of the Procedure for Preparing Environmental Impact Assessment Documents for Planned Economic Activities, approved by Order No. D1-885 of the Minister of the Environment of the Republic of Lithuania of 31 October 2017. The requirements for RA are set out in Section 9 of Chapter III of Annex 1 to this Description – RA.

The RA must provide information about hazardous objects, objects of state importance, engineering networks, plots or territories located in the immediate vicinity of the PEA, considering the possible impact of extreme events, zones of natural events (e.g. earthquakes, karst phenomena, landslides, landslides, floods), residential areas, enterprises and organizations, and places of mass public gatherings.

When assessing the risks of developing a wind farm in Lithuania, the following factors are important in the offshore part:

- OWFs planned nearby
- Existing shared shipping lanes and planned shipping transit corridors
- Marine facilities of the Būtingė terminal, underwater pipelines and anchorage for incoming tankers
- Coastal fishing sectors in the Būtingė-Šventoji area, located in the immediate vicinity of the export cable corridors
- Residential and recreational areas in Palanga and Kretinga municipalities (and waterfront facilities)
- Underwater pipelines and cables in the vicinity of the OWF and connection corridors
- Dangerous sea areas – zones of former minefields and a part of the water area with sunken World War II weapons
- An area where national security requirements are in place and construction restrictions may apply
- Palanga International Airport, special radar protection zone
- Other potentially dangerous areas of the PEA.

Onshore:

- Structure of the transport network of the Palanga city municipality territory
- The planned railway (in the case of the construction of the Būtingė deep-water port) is in accordance with the Kretinga district municipal plan
- Palanga International Airport
- In the northern part of the territory of Palanga City Municipality, public water supply and centralized domestic wastewater management systems, an electricity supply system, a communication infrastructure system, a natural gas distribution pipeline system has been developed, which are crossed or located in the close vicinity of export cable corridors
- Connecting pipelines of the Būtingė oil terminal with the offshore part and the main oil pipeline to the Mažeikiai oil products processing plant
- Palanga City and Kretinga District Municipalities' national highways, regional and district roads crossed by or adjacent to the power transmission cable

- Kretinga District Municipality has a developed electricity supply system, communication infrastructure system, natural gas distribution pipeline system, centralized water supply and wastewater treatment systems, which are crossed or located in the immediate vicinity of export cable corridors
- Recreational and residential territories of Palanga City and Kretinga District Municipalities
- The nearest public facilities, places of large gatherings of people
- Industrial areas, chemical storage areas
- Other potentially dangerous locations that may be at risk from the PEA.

The RA must include the assessment of significant impacts on environmental elements and public health due to potential events, major industrial accidents, nuclear or radiological accidents, accidents, emergencies and/or potential emergencies during the PEA. It also assesses the impact of objects or natural, social, ecological or biological phenomena outside the boundaries of the planned activity on the PEA and its continuity.

The RA is guided by:

- The List of Extreme Event Criteria (hereinafter – the List of Extreme Event Criteria) provided in Annex 2 to the Description of the Procedure for Notification and Exchange of Information about an Event, Extreme Event, Special Event, Emergency Situation or Crisis, approved by the Resolution of the Government of the Republic of Lithuania of 29 December 2022 No. 1317 "On the Implementation of the Law of the Republic of Lithuania on Crisis Management and Civil Protection".
- Indicators of natural, catastrophic meteorological and hydrological phenomena, approved by Order No. D1-870 of the Minister of the Environment of the Republic of Lithuania of 11 November 2011 "On the Approval of Indicators of Natural, Catastrophic Meteorological and Hydrological Phenomena" (hereinafter – the Indicators of Natural, Catastrophic Meteorological and Hydrological Phenomena).
- Methodological recommendations for the analysis of potential hazards and emergency situations of an economic entity or other institution, approved by Order No. 1-189 of the Director of the Fire and Rescue Department under the Ministry of Internal Affairs of 2 June 2011 (hereinafter – the Hazard and Emergency RA Recommendations).

RA examines:

- Individual PEA objects – in this RA are the OWF and its constituent elements: foundation, tower, nacelle, rotor, inter array and export cables, OSS, transitional connection to the mainland, onshore electricity transmission cables, ONSs, connection to the AB Litgrid transmission network.
- Operations (activities) carried out at risk facilities related to the threat of possible hazardous events (production, transmission, transformation).
- Hazardous factors that may be associated with the threat of potential events, major industrial accidents, other accidents, mishaps, emergencies and/or potential emergencies:
  - Use of hazardous chemicals (rotor oil, transformer oil).
  - Generation, storage, use, disposal, management of hazardous and other waste (waste during construction and dismantling).
  - Technical, technological conditions that affect the loss of tightness of technological equipment, fire, collapse of structures due to technological failures, personnel errors, erosion and/or corrosion, mechanical damage, ship traffic accidents, terrorism and/or sabotage, etc.
  - Organization of transport (in the mainland – road, railway, in the maritime – water, air) and its intensity during the implementation of the PEA, as well as incidents caused by external transport, collisions with WTGs of passing ships.
  - Possibility of terrorism, sabotage, criminal activity or other events of social origin.
  - Extreme geological, meteorological or hydrological phenomena.
  - Unplanned interruption of energy and communication services.
  - Other factors and conditions established in accordance with the List of Criteria for Extreme Events and Indicators of Natural, Catastrophic Meteorological and Hydrological Phenomena.
- The worst-case scenarios (causing the greatest, most severe consequences) and typical (causing medium or small, most likely consequences) of possible events are examined.
- It examines what events, major industrial accidents, other accidents, mishaps, emergencies and/or potential emergencies (explosion, fire, release of hazardous substances into the environment, uncontrolled chemical

reactions, uncontrolled energy release, collapse) can be caused by individual hazardous factors or in combination with other hazardous factors, including those that may be caused by climate change.

- It examines the impact that events caused by the PEA may have on dangerous and vulnerable objects in the immediate vicinity (roads, railways, shipping corridors and seaports, residential buildings, industrial facilities, infrastructure, groundwater and surface water, gas and oil pipelines, storage facilities (reservoirs), enterprises and organizations located and carrying out economic activities in the territory under consideration), environmental elements and public health.
- It examines how environmental objects, elements and phenomena can affect planned economic activities.
- Considering the analysed risk objects, operations (activities) and hazardous factors, the zones (expansion) and probability of potentially dangerous consequences (impact) of possible dangerous events, accidents, incidents, emergency events and/or potential emergency situations are determined.
- The risk of possible hazardous events, accidents, incidents, emergencies and/or potential emergencies is determined based on the magnitude of impact and probability.
- The acceptability of the risk of possible hazardous events, accidents, incidents, emergencies and/or potential emergencies is determined.

After conducting a PEA RA, measures must be provided to avoid, reduce and compensate for significant negative environmental impacts:

- Preventive and mitigation measures planned to be taken to avoid, reduce or, if possible, compensate for the anticipated significant adverse impact.
- A description of measures related to emergency preparedness and proposed response is provided.
- It is indicated whether the PEA economic entity will meet the criteria for facilities whose managers must organize the preparation, coordination and approval of emergency management plans; whose managers must establish an emergency operations centre and must prepare an emergency management plan.

At the EIA stage, there is often insufficient information to provide specific risk reduction and impact compensation measures. Therefore, it is indicated at what planning stage such measures are envisaged (usually during the preparation of the technical design) and implemented (during construction).

6.2. RA and its assessment methodology

The description of the procedure for preparing EIA documents indicates that when conducting PEA RA for objects that have not been granted the status of a higher-level hazardous object, the recommendations for the analysis of risks of hazards and emergencies are followed. Considering the specifics of PEA, specialized assessment methods and methodologies from literary sources are used for the RA of the marine part.

The information sources used in this report are risk assessment methodologies and reviews of already operating OWFs, databases of international organizations such as the Maritime Injury Centre , G+ Global Offshore Wind Health and Safety Organization , as well as scientific articles that provide information based on publicly available statistics of accidents and incidents in OWFs (Chou et al., 2021) [106] or a review of applied methodologies (Mou et.al., 2021) [107]. In individual cases, recognized and applied methodologies are used, the descriptions of which are provided either in the EIA or risk assessment reports of individual facilities or as separate methodological instructions.

The recommendations for hazard and emergency RA provide for three stages of RA:

1) Identification of potential hazards.
2) Risk assessment of identified hazards.
3) Determining the level of risk and its acceptability.

The identification of potential hazards is carried out using a standard Hazard Identification (hereinafter – HAZID) procedure, which must examine risk factors and vulnerable objects and assess the probability and consequences of accidents related to these factors for people, nature and material values (property) and the company's reputation. The RA must identify existing and potential hazards and indicate:

1. risk objects where a dangerous event is possible
2. risk sources in risk objects

[106]Chou J.-S., Liao, P.-C., Yeh, C.-D. RA and Management of Construction and Operations in Offshore Wind Project. S ustainability 2021, 13, 7473. htTSs://doi.org/10.3390/su13137473 .
[107]Mou J., Jis, X., Chen, P., Chen, L. Research on Operation Safety of OWFs. Journal of Marine Science and Engineering. 2021,9,881. htTSs://doi.org/10.3390/jmse9080881 .

3. the nature of the hazardous events
4. potentially vulnerable objects
5. consequences of dangerous events
6. the estimated probability of hazardous events
7. factors that increase risk.

When conducting a RA, it is important to clarify, and it is recommended to specify:

1. information sources (methodology, literature, computer programs, etc.)
2. maps and other information material about the PEA environment, infrastructure facilities, residential areas and public facilities
3. strategic planning in the area surrounding the PEA
4. nearby protected and cultural values
5. possible emergency situations and their probability
6. companies and organizations located and operating in the area under consideration
7. hazardous substances used in PEA
8. traffic intensity
9. existing safety and rescue plans
10. data on accidents and their statistics
11. information about the number of people (residents and employees).

In all cases, the following hazards and risks are considered in risk analyses:

1. potential risks to people and the social environment
2. emerging or increasing dangers and risks to the natural environment
3. risk to property
4. risk to business continuity and company reputation.

During the EIA stage, a qualitative risk assessment is performed using a risk matrix.

A register of hazardous events is created during the assessment of risk and its acceptability, and the significance of the risk and its potential impact on objects within the risk zone are evaluated. For events with increased risk, a causality analysis is conducted, and risk mitigation measures are recommended.

6.3. Incidents and hazardous events in OWFs with the potential for major accidents

Prior to analysing the risk receptors and hazardous factors associated with OWFs, a brief overview of accident and emergency statistics relating to OWF installation and operation is provided.

The Global Offshore Wind Health and Safety Organisation (hereinafter – G+), whose membership includes leading offshore wind developers, compiles and analyses incident data across the sector. Established in 2011, G+ also develops good practice guidance, conducts *Safe by Design workshops*, and delivers Learning from Incidents seminars. Regional working groups have been established in Europe, Asia-Pacific (South Korea and Taiwan), and North America.

The G+ dataset covers activities reported by member companies across the full project lifecycle, from development through to decommissioning. Both onshore and offshore activities are included where they are directly associated with OWF projects, while activities outside contractual scope (e.g. manufacturing of turbines or fabrication of foundations) fall under suppliers' health and safety management systems and are not reported. Similarly, certain marine incidents may not be captured by G+ if they occur outside the project scope, although such incidents may be recorded in other industry databases such as that of the International Marine Contractors Association (IMCA).

For the purpose of risk assessment, incidents within OWFs are categorised according to project phase:

- Planned projects – site selection, planning and coordination activities, including EIA, research, and permitting.
- Projects under construction – site preparation, permitting, and execution of construction works.
- Operational projects – active electricity generation. A transitional "mixed" phase may occur, where some parts of the OWF are operational while others remain under construction. Incident classification is phase-specific.
- Projects in a decommissioning phase – as of 2024, G+ members have not reported any incidents in decommissioning phases, as such works have not yet commenced.

The G+ 2024 Offshore Wind Energy Incidents Data Report provides an overview of recorded incidents between 2020 and 2024, alongside associated operational hours.

Table 6.3.1. Table of recorded incidents in G+ organization's OWF's and OWF operating hours 2020–2024

Actual consequence	2020	2021	2022	2023	2024
Fatality	0	0	0	1	1
Lost workday injury	43	45	46	65	99
Restricted workday injury	30	20	36	33	57
Medical treatment day injury	22	31	44	70	74
First aid injury	197	283	246	374	442
Asset damage	148	85	157	390	375
Hazard (without damage or injury)	106	81	70	401	498
Near hit/miss*	193	221	268	344	421
Total reports	**739**	**766**	**867**	**1679**	**1967**
OWF parks work hours, mln.	**25,3**	**31,3**	**44,6**	**61,9**	**78,8**
TRIR, n1/mln.h**	3,76	3,07	2,82	2,73	2,93
LTIF, n2/mln.h***	1,70	1,44	1,03	1,07	1,27

*A near-miss or near-miss incident is considered a precursor to an actual incident or event and should be reported regardless of whether or not there was an injury. When this occurs, it is necessary to complete an incident and near-miss/near-miss report. *recordable* injury rate (fatalities, injuries, lost-time injuries, work-related injuries, medically-required injuries) per million hours worked.

**TRIR – *total recordable injury rate*, the number of fatalities, lost workday incidents, restricted workday incidents and medical treatment injuries per million hours worked.

***LTIF – *lost time injury frequency*, the number of fatalities and lost workday incidents per million hours worked.

In 2024, the G+ database recorded a significant increase in reported data compared to previous years. This growth reflects both the expansion of offshore wind development activity and the inclusion of additional reporting countries. Reported operating hours for offshore wind farms reached 78.8 million hours.

A total of 1,967 incidents were recorded across the project lifecycle, distributed as follows:

- Planning and coordination stages – 166 incidents
- Construction activities – 1,174 incidents
- Operational facilities – 627 incidents
- Decommissioning activities – no incidents reported

Of these, 245 incidents were classified as high risk.

Injury outcomes included:

- 1 fatality
- 99 lost-time injuries (LTIs)
- 57 restricted workday (RWD) injuries
- 74 medical treatment injuries (MTIs)
- 48 emergency response and medical evacuation cases of varying severity.

Main process areas associated with incidents:

- Lifting operations – 282 cases
- Routine maintenance – 178 cases
- Manual lifting of loads – 140 cases.

Comparative trends (2023–2024):

- Total hours worked increased by 27% (61.9 million to 78.8 million).
- Total Recordable Incident Rate (TRIR) increased by 7%, from 2.73 to 2.93.
- Lost Time Injury Frequency (LTIF) increased by 19%, from 1.07 to 1.27.

The increase in TRIR and LTIF was primarily driven by:

- A 73% rise in injuries resulting in lost work hours or capacity.
- A 52% rise in lost-day injuries.

- A 6% increase in injuries requiring medical treatment, which was proportionally lower than the increase in hours worked.

For the second time since the reporting began, G+ recorded a fatality in 2024.

Overall, the majority of reported injuries were classified as first aid cases (66%), which is broadly consistent with the 2023 proportion (69%) (Figure 6.3.1).

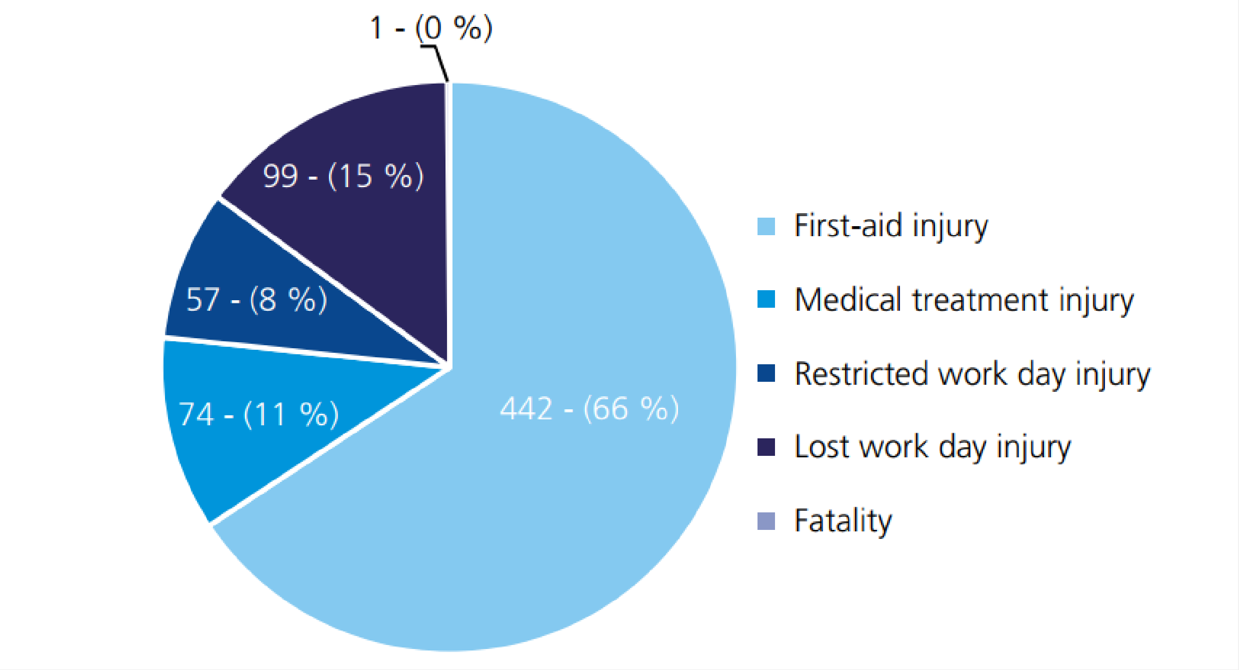


Fig. 6.3.1. Incidents that resulted in an injury, by actual consequence (2024).

In 2024, the proportion of lost workday cases increased slightly, representing 15% of all injuries, compared with 12% in 2023. Medical treatment cases accounted for 11%, down from 13% in 2023, while restricted workday cases rose to 8%, compared with 6% in the previous year.

The seven most common incident locations in 2024, together with a statistical comparison to 2023, are presented in Figure 6.3.2.

The most frequent location for injuries was jack-up vessels and barges, which accounted for 14% of all injuries (92 incidents). Other significant incident locations included:

- WTG nacelles – 55 incidents (+2% compared to 54 in 2023)
- Onshore civil construction works – 50 incidents (+138% compared to 21 in 2023)
- CTVs – 50 incidents (+108% compared to 24 in 2023)
- SOVs – 44 incidents (–30% compared to 63 in 2023).

Together with jack-up vessels and barges, these areas represented 43% of all reported injuries in 2024.

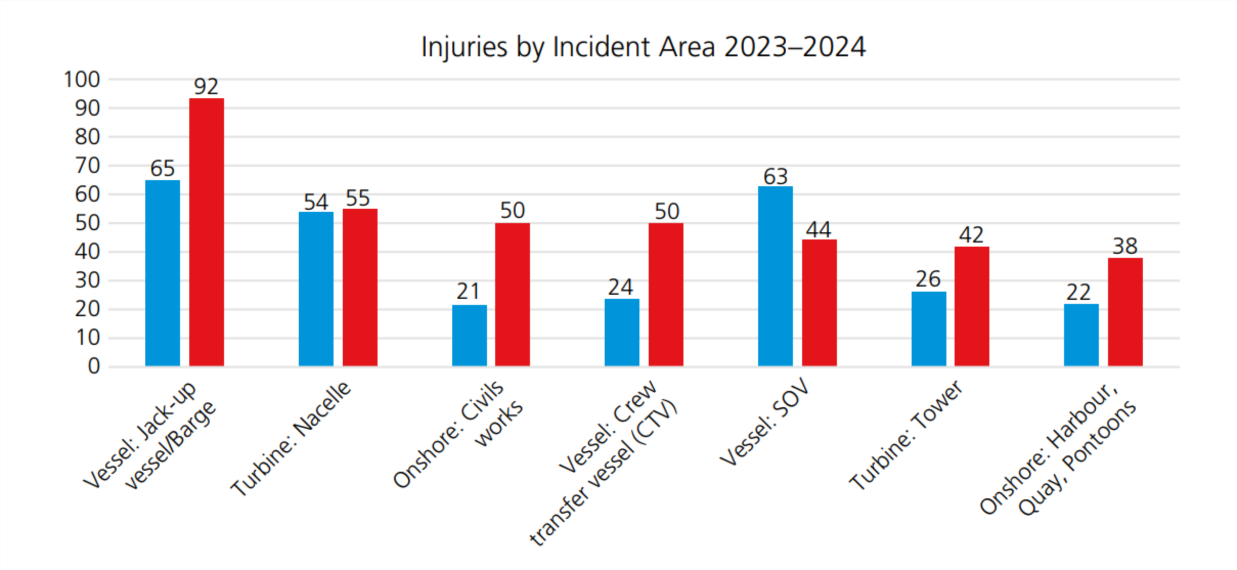


Fig. 6.3.2. Injuries by reported work area (top seven), 2023 and 2024.

In 2024, OWF WTGs accounted for 42 injury incidents, compared with 26 in 2023, while onshore sites such as ports, quaysides, and pontoons recorded 38 incidents, an increase from 22 in 2023.

Other incident locations with notable increases in 2024 included:

- Survey vessels – 30 incidents (+150%, up from 12 in 2023)
- Cable installation vessels – 25 incidents (+108%, up from 12 in 2023)
- Onshore warehouses and workshops – 24 incidents (+100%, up from 12 in 2023)
- Turbine hubs and blades – 23 incidents (+109%, up from 11 in 2023).

Conversely, decreases were observed in:

- Onshore turbine assembly – 17 incidents (-35%, down from 26 in 2023)
- OSS HV areas – 17 incidents (-15%, down from 20 in 2023).

The distribution of reported injury incidents by project development phase in 2024 was as follows:

- Construction – 403 incidents (60%)
- Operations – 228 incidents (34%)
- Planning – 42 incidents (16%).

Figure 6.3.3 illustrates the seven most common work processes associated with injury incidents in 2024, together with a comparison to 2023 data.

Manual handling was the leading cause of injuries in both 2023 and 2024, with 121 incidents reported in 2024 (+26%, up from 96 in 2023). This process consistently represented 18% of all OWF injury incidents across both years.

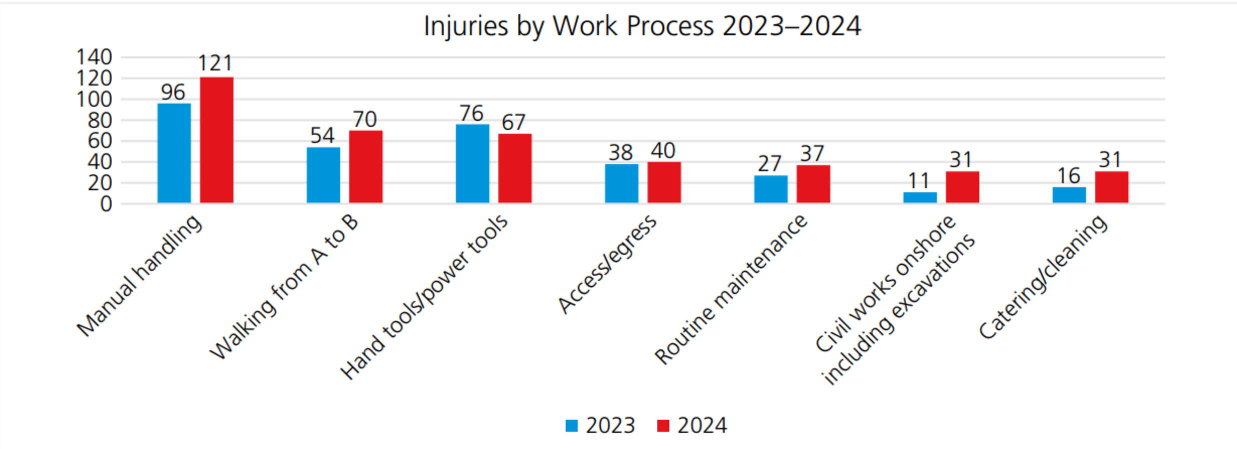


Fig. 6.3.3. Incidents reported by work process (top seven), 2024. In 2024, several work processes were identified as leading causes of incidents:

- Walking from A to B – 70 incidents (+30%, up from 54 in 2023)
- Working with hand or power tools – 67 incidents (-12%, down from 76 in 2023)
- Embarkation/disembarkation – 40 incidents (+5%, up from 38 in 2023)
- Routine maintenance – 37 incidents (+37%, up from 27 in 2023).

In addition, several hazardous processes within OWF development continue to pose risks to worker health and safety, according to G+ recorded injury statistics. These include:

- Onshore civil works (including excavation)
- Catering and cleaning services
- Electrical system works
- Vessel operations.

Statistical analysis from the G+ group indicates that as the number of operating hours in OWFs increases the total number of hazardous events also rises. However, the proportion of incidents with the potential to cause major accidents decreases significantly.

To address the highest-risk activities, a good practice guide has been developed under the section "Risk Mitigation Measures", covering the five most hazardous activities:

- Lifting operations
- Embarkation/disembarkation of personnel and loading/unloading of cargo
- Vessel operations (including jack-ups and barges)
- Working at height
- Electrical works in low- and medium-voltage OSSs108.

For the planned Lithuanian OWFs, it is recommended that particular attention is paid to the construction phase and the five most hazardous work activities. Preventive measures should be prioritised, especially for events with the potential to escalate into major accidents.

The Maritime Injury Centre (updated April 26, 2024) provides a causal analysis of accidents during 2022 offshore wind incidents. The key findings are summarised as follows:

- On vessels and craft used in OWF construction and operation, the main causes of incidents include:
  - Severe weather conditions
  - Equipment failures
  - Inadequate staff training
  - Operator errors
  - Insufficient adherence to safety procedures and poor preparation
  - Poorly secured cargo
- On WTG platforms and rooms, the leading causes of worker injuries are:
  - Inadequate staff training
  - Human error
  - Failure to follow safety procedures and insufficient preparation
  - Adverse weather conditions
  - Structural failures
  - Faulty equipment
  - Exposure to toxic substances or oxygen deficiencies in confined spaces
  - Ergonomically poor or uncomfortable working positions
- For offshore divers, frequent (and often fatal) injuries are linked to:
  - Defective diving equipment
  - Unsuitable weather conditions
  - Inadequate maintenance of diving equipment
  - Other operational causes.

[108] Good practice guidelines. G+ Offshore Wind Health and Safety Organisation.

Finally, in recognition of the impact of climate change on the performance and safety of offshore and onshore wind farms, design and manufacturing standards for wind turbines are being progressively tightened. The International Electrotechnical Commission (IEC) and the global certification body DNV GL are responsible for coordinating and implementing these international design standards.

In global offshore wind practice, dangerous events related to soil liquefaction have been recorded. In Lithuania, dusty sands and loams with thixotropic properties are present within glacial, pre-glacial, and post-glacial lake sediments (limnoglacial sediments), interbedded with moraine loams. These soils are particularly sensitive to dynamic loads. Consequently, if the presence of dusty sands or loams is identified during geological surveys at the planned OWF foundation sites, the risk of liquefaction under dynamic loads should be considered highly probable.

According to the PMBOK® Guide109 (Section 2.8.5.1), a risk or threat is defined as an uncertain event or condition that may negatively affect the progress or objectives of a project. Five alternative strategies for managing risks may be considered during the planning stage of the PEA, including the preparation of the EIA:

1. Avoidance – eliminating the threat or protecting the project from its impact.
2. Escalation – recognising that the risk is beyond the scope, competence, or authority of the project team, and transferring it to higher-level decision-making.
3. Transfer – assigning ownership of the threat to a third party, which assumes responsibility for managing and addressing its impact.
4. Mitigation – taking action to reduce the likelihood and/or potential impact of a threat. Proactive mitigation is generally more effective than reactive measures once an incident occurs.
5. Acceptance – acknowledging the existence of the threat without proactive intervention. In some cases, active acceptance may involve developing a contingency plan to be implemented should the risk materialise.

For the planned CN OWF, geotechnical and operational risks will be addressed through a structured risk assessment process. This includes analysing the main causes of OWF failures, preparing a dedicated risk assessment report, and integrating its findings into the technical design. These results will also inform the prioritisation of construction and operational measures, with the dual aim of avoiding and mitigating risks throughout the project lifecycle.

6.4. PEA adjacencies and activities within them

The risk assessment objects in the offshore section of the OWF are:

- economic activities carried out in and near the territory of the OWF
- ships sailing in shipping channels, anchorages, external port facilities
- infrastructure (including strategic) objects (cables, pipelines)
- territories important for state security (naval and air force training ranges, military aircraft flight routes, etc.)
- existing archaeological objects, including UXO sites of World War II.

The PEA onshore:

- infrastructure facilities (oil, gas pipelines, roads, electric cables)
- natural objects (rivers, marshes, coastal sandbanks, etc.)
- territories important for state security (testing grounds), airports, roads
- economic activities with the status of hazardous facilities (chemical storage facilities, factories, etc.).

Vulnerable objects in OWFs can also serve as risk factors. For example, ships navigating shipping corridors may cause OWF accidents, and their crews may be injured during such events, thus becoming vulnerable objects. Sunken explosives are both a risk factor and a vulnerable object, as they could detonate if damaged during OWF construction. These and other objects are examined in the risk assessment from both perspectives.

Many other activities occur in the sea near the PEA, including shipping, fishing, recreational activities, dredging, ports, the Būtingė terminal, engineering facilities, and designated restricted-use and dangerous areas or territories important for national security. A summary representation of all these activities, as well as potentially vulnerable objects and objects that may pose a risk to the OWF, is presented in Fig. 6.4.1.

109 A Guide to the Project Management Body of Knowledge, Project Management Institute, PMBOK® - Guide to the Project Management Body of Knowledge.

The territory of the planned OWF does not fall within or border any established international shipping lanes, port roadsteads, or anchorage areas. The minimum distances to established shipping lanes, port roadsteads, anchorage areas, and the Būtingė terminal buoy are:

- shipping lane to Latvia – 340 m to the east (low-medium intensity traffic – large ships, tankers)
- shipping lane to Šventoji and the anchorage of the Būtingė terminal – 16.9 km in the east-southeast (low-intensity traffic – small ships, tankers)
- shipping lane to Sweden – 20.3 km to the west (medium intensity traffic – large ships, tankers)
- planned shipping transit corridor – 24 km to the west
- tanker anchorage in the Būtingė terminal – 17.2 km to the east-southeast
- anchorage of the Šventoji port – 32.6 km to the west
- Būtingė terminal buoy – 30.1 km to the west.
- Klaipėda port liquefied natural gas terminal ship anchorage – 40.1 km, the anchorages of other ships are 30.6 km away in the southeast direction.

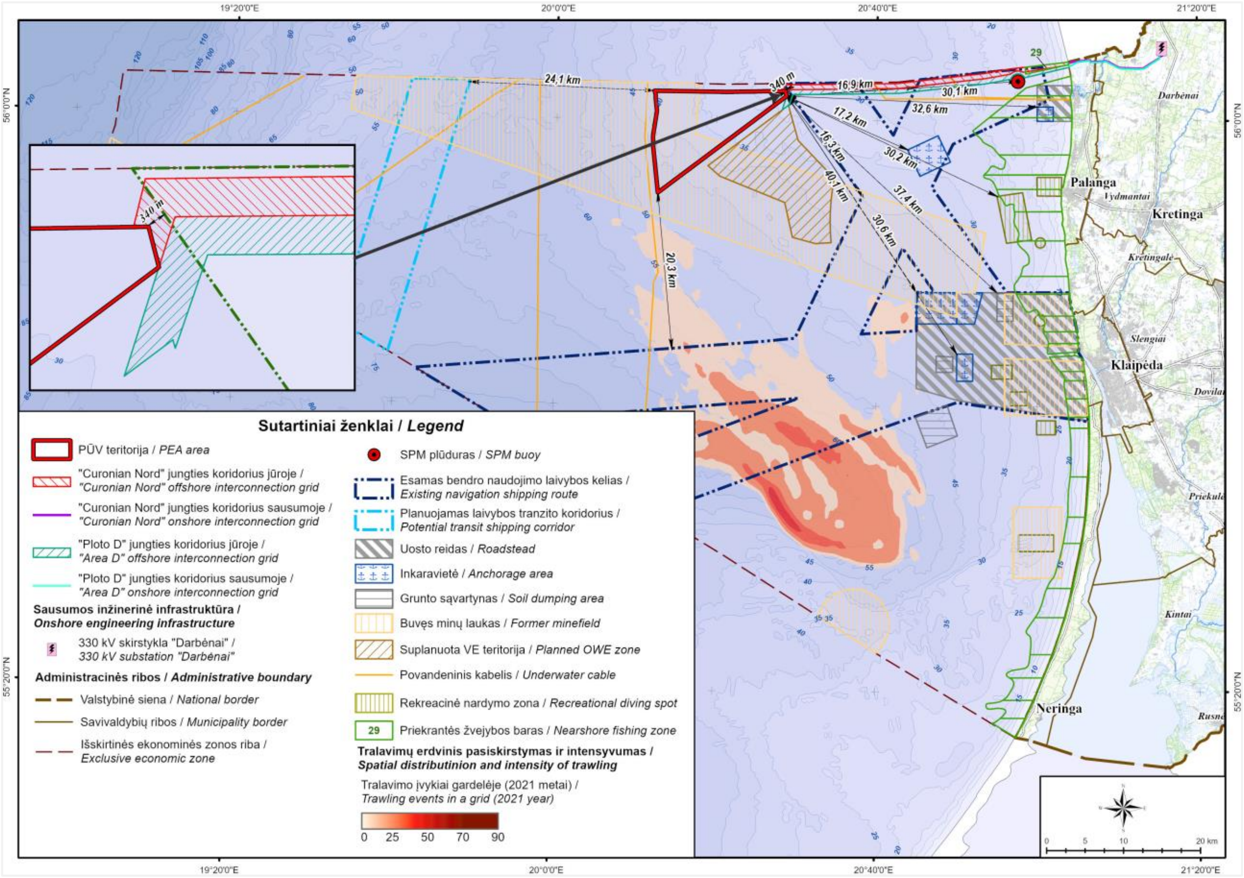


Fig. 6.4.1. Proximity of the planned OWF to the sea.

6.4.1. Engineering infrastructure

Two types of engineering infrastructure facilities have been identified in the Lithuanian Baltic Sea – a pipeline complex with a SPM buoy and export cables.

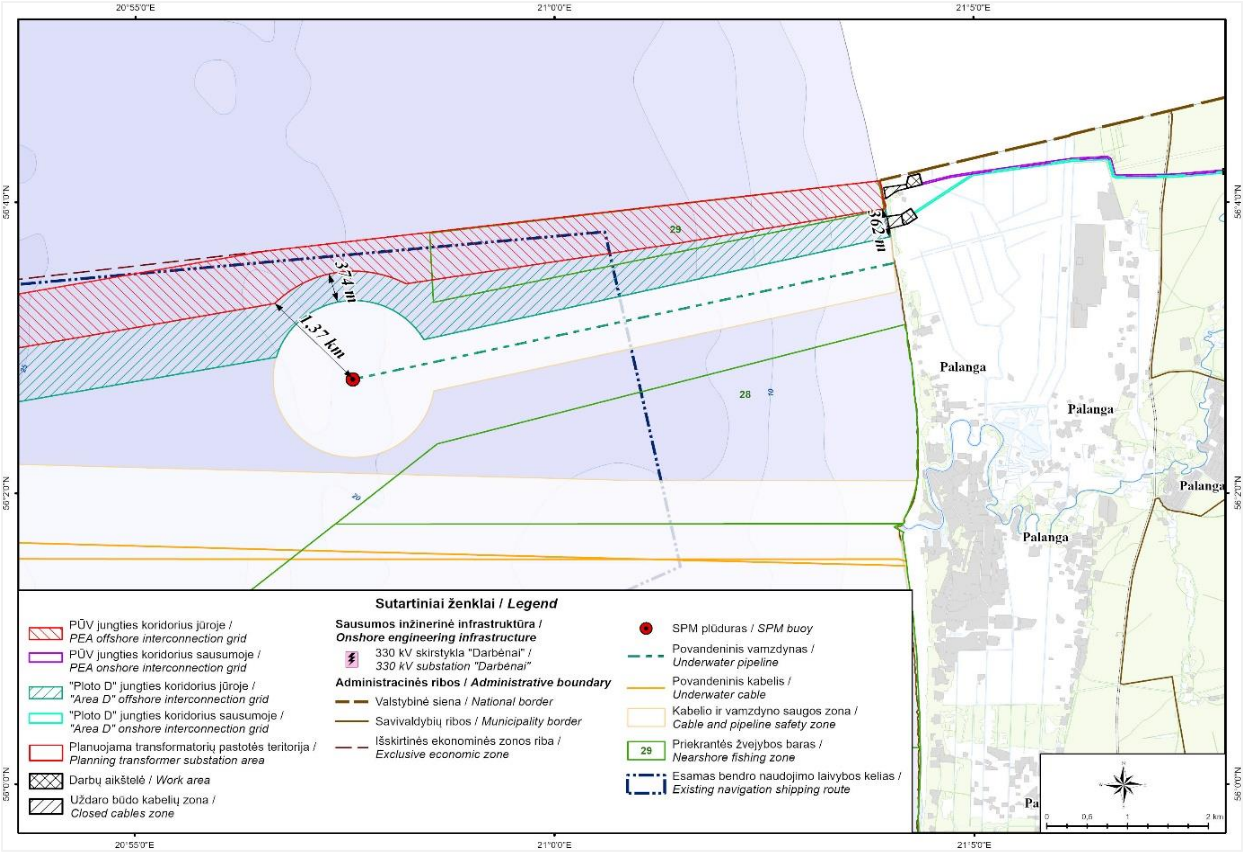


Fig. 6.4.2. PEA export cable corridors and distances from the SPM buoy protection zone.

The Būtingė terminal is designated with a 1,000 m radius water area around the SPM buoy and a 300 m safety zone extending in both directions along the 7.3 km offshore oil pipeline. The distance from the boundary of the export cable corridors to the SPM buoy safety zone is 374 m, while the distance to the oil pipeline safety zone near the shore is 362 m (see Fig. 6.4.2). The SPM buoy is located 30.1 km from the boundary of the OWF territory.

Four underwater cable lines cross the Lithuanian EEZ. Two of these lines intersect the planned OWF export cable corridors (see Fig. 5.8.6, Section 5.8.3.5). These are telecommunication cable routes, originating in Šventoji and owned by AB TeliaSonera, according to the International Cable Protection Committee (ICPC[110]):

- The 218 km long BCS East-West interlink route (in use since 1997), connecting Šventoji with Katthammarsvik in Sweden (Gotland Island).
- The 97.8 km long BCS East (ready for use since 1995), connecting Šventoji with Liepaja in Latvia.

Two cable routes, which do not affect the PEA but cross the Lithuanian EEZ from south to north and southwest to northeast, are marked on the ICPC map and run from Kaliningrad, Russia to Kingi Sepp, Russia. Additionally, a cable of unknown origin passes near the western boundary of the planned OWF, with the OWF boundary coinciding with the boundary of the cable safety zone.

Klaipėda is connected to Sweden by the 450 km long, 700 MW high-voltage DC underwater and underground NORDBALT interconnector cable. This cable is situated away from the PEA territory, and no mutual impact is expected.

A corridor has also been reserved in the Lithuanian maritime territory for the planned Lithuanian-Polish offshore high-voltage direct current (HVDC) "Harmony Link" cable. No intersection with the planned offshore HVDC cable corridor is anticipated.

6.4.2. Commercial fishing areas

According to ICES data, the Lithuanian maritime territory falls within statistical squares 40H10 and 41H10 of fishing area 26, where fish are caught by trawling and set nets. The trawling fishing areas start 2 km south of the planned OWF, and the intensive trawling areas are located about 20 km south of the OWF (Fig. 5.8.1).

[110] https://www.iscpc.org/ - International Cable Protection Commitee.

The planned OWF export cable corridors crosses 29 coastal fishing grounds located near Latvian territorial waters. Commercial fishing areas are described in more detail in Section 5.8.3.1 of this EIA report.

6.4.3. Dredged material dumping sites

There are several dumping sites in the sea where soil excavated in the Klaipėda port water area is dumped. The existing dredged material dumping sites in the sea are more than 40 km away from the PEA territory to the east (Fig. 5.8.4). This activity does not pose a threat to the operation of the OWF and does not fall within the potential impact zone in the event of accidents in the OWF.

The dumping area is described in more detail in Section 5.8.3.3 of this EIA report.

6.4.4. Recreational areas

The beginnings of maritime tourism services are observed on the Lithuanian coast. This is an independent, paid service for organizing boat trips for tourists, which requires a certain infrastructure. The following maritime tourism services are most often provided to tourists on the Lithuanian coast: cruise shipping, inland water tourist shipping and amateur fishing, diving services in the sea. Inland water shipping is offered to Palanga vacationers during the season, there is no official data on shipping routes, as well as on amateur fishing sites.

There are several diving clubs in the Klaipėda region that provide recreational diving services in the Baltic Sea. The most attractive places for diving in the Baltic Sea are the remains of sunken ships, excursions to fields of expressive bottom elevations (moraine ridges). According to the data provided by the diving club "OCTOPUS", divers mostly dive in coastal waters. The nearest diving zone is more than 30 km from the territory of the PEA.

Recreational areas are described in more detail in Section 5.8.3.4 of this EIA report.

6.4.5. Restricted and hazardous areas

There are several areas of limited use (military training ranges) and parts of the water area with sunken World War II munitions and former minefields in the Lithuanian territorial waters and EEZ. Part of the territory of the PEA falls into a dangerous sea area – a zone of former minefields.

6.4.6. Territories important for ensuring national security requirements

According to the methodology for mapping the territories of the Republic of Lithuania where, considering national security requirements, restrictions on the design and construction of OWFs may be applied[111] A map of the territories of the Republic of Lithuania where design and construction works of WTGs (tall buildings) may be restricted has been compiled and approved[112]. According to this map, the planned OWF area falls within the territories where construction sites for WTGs are coordinated on the condition that the developer of the OWF signs an agreement with the Lithuanian Armed Forces for part of the investments and other costs.

6.4.7. Adjacent PEA areas onshore

The export cables corridors onshore will be installed from the Baltic Sea coast to the 330 kV “Darbėnai” switchyard in Darbėnai Eldership, Kretinga District Municipality. The export cables will be installed combining open trenching method or trenchless method in the planned onshore zones of the export cable corridors. The adjacencies and intersections of these planned corridors with natural and infrastructural objects that may be potentially vulnerable or pose a risk to the PEA are shown in Fig. 6.4.3 A–C.

[111]Approved by Order No. V-921 of the Minister of National Defence of the Republic of Lithuania of 22 August 2012 “On approval of the methodology for compiling a map of the territories of the Republic of Lithuania where, taking into account national security requirements, restrictions on the design and construction of wind farms may be applied”.

[112]Approved by the Commander of the Lithuanian Armed Forces of 15 February 2016. Order No. V-217 “On approval of the map of the territories of the Republic of Lithuania where the design and construction work of wind farms (tall buildings) may be restricted”.

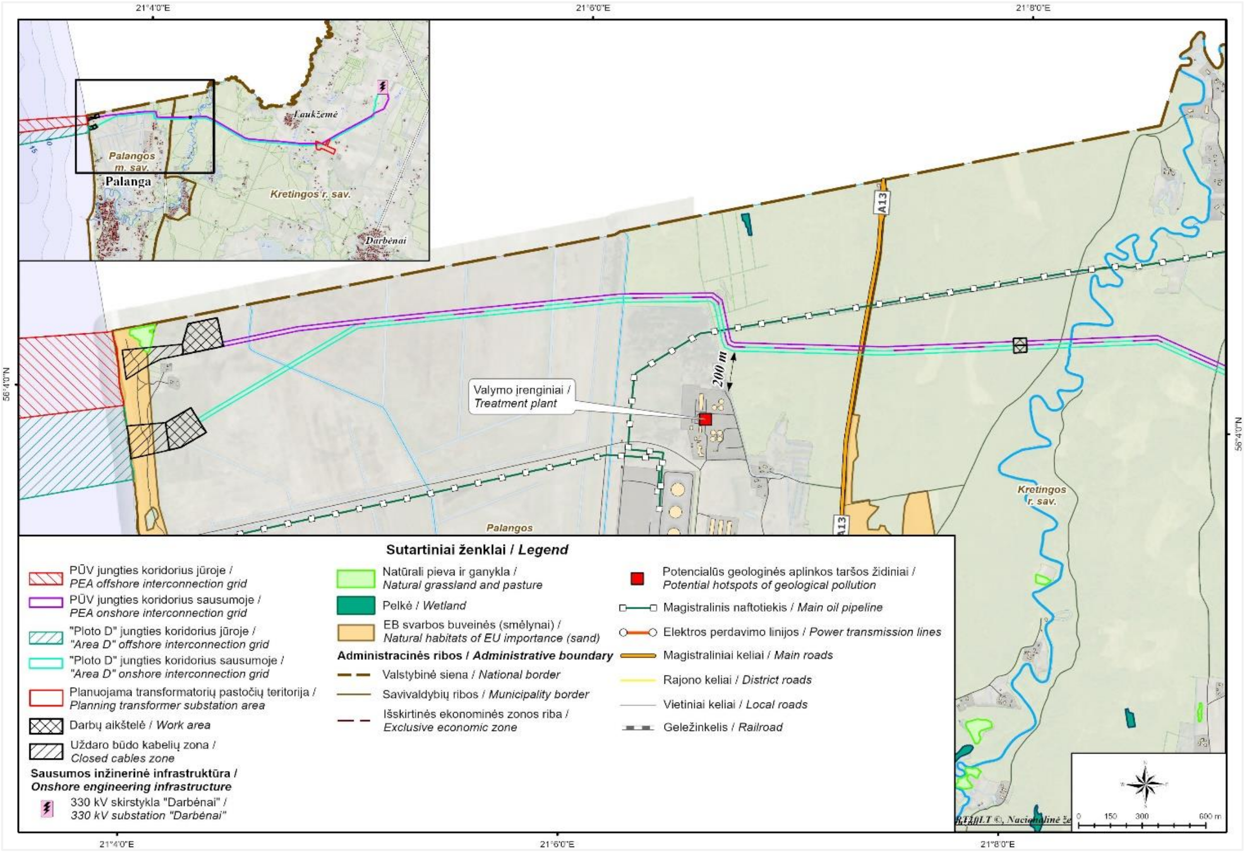


Fig. 6.4.3A. PEA adjacencies onshore.

The planned OWF export cable corridors onshore within the territory of Palanga City Municipality intersect with the protection zone of the existing underground oil pipeline Būtingė–Mažeikiai (see Fig. 6.4.3A) and the protection zone of the main road No. A13 Klaipėda–Palanga–Liepaja. The nearest export cable corridor, designated to the "Area D", is located approximately 200 m from the boundary of the Būtingė oil terminal treatment facilities. Within the territory of Darbėnai Eldership, Kretinga Municipality, the export cable corridors cross the Šventoji River. Deforestation will be required in the forested section to enable the installation of PEA export cables.

Another infrastructure facility whose protection zone will be intersected by the planned export cable corridors is the AB Litgrid 110 kV electricity transmission overhead line Palanga–Skuodas (see Fig. 6.4.3B). A 220/330 kV Pelėkiai ONS is planned in proximity to the village of Pelėkiai. The planned Pelėkiai ONSs and the export cable corridors will remain outside the protection zone of the adjacent main oil pipeline.

The nearest agricultural or farm-related facility to the connection corridors is a warehouse located approximately 180 m away. The potential risk of flooding of the Šventoji River, as well as smaller streams and drainage channels, affecting the PEA electricity export cable corridors are considered negligible and therefore has not been assessed further. Where trenchless installation methods are employed, the cables will be installed at a depth of no less than 1 m below the bed of the watercourse[113].

[113]Law of the Republic of Lithuania on Special Land Use Conditions, 2019. June 6. No. XIII-2166, Section IV, Article 24, Item 3.

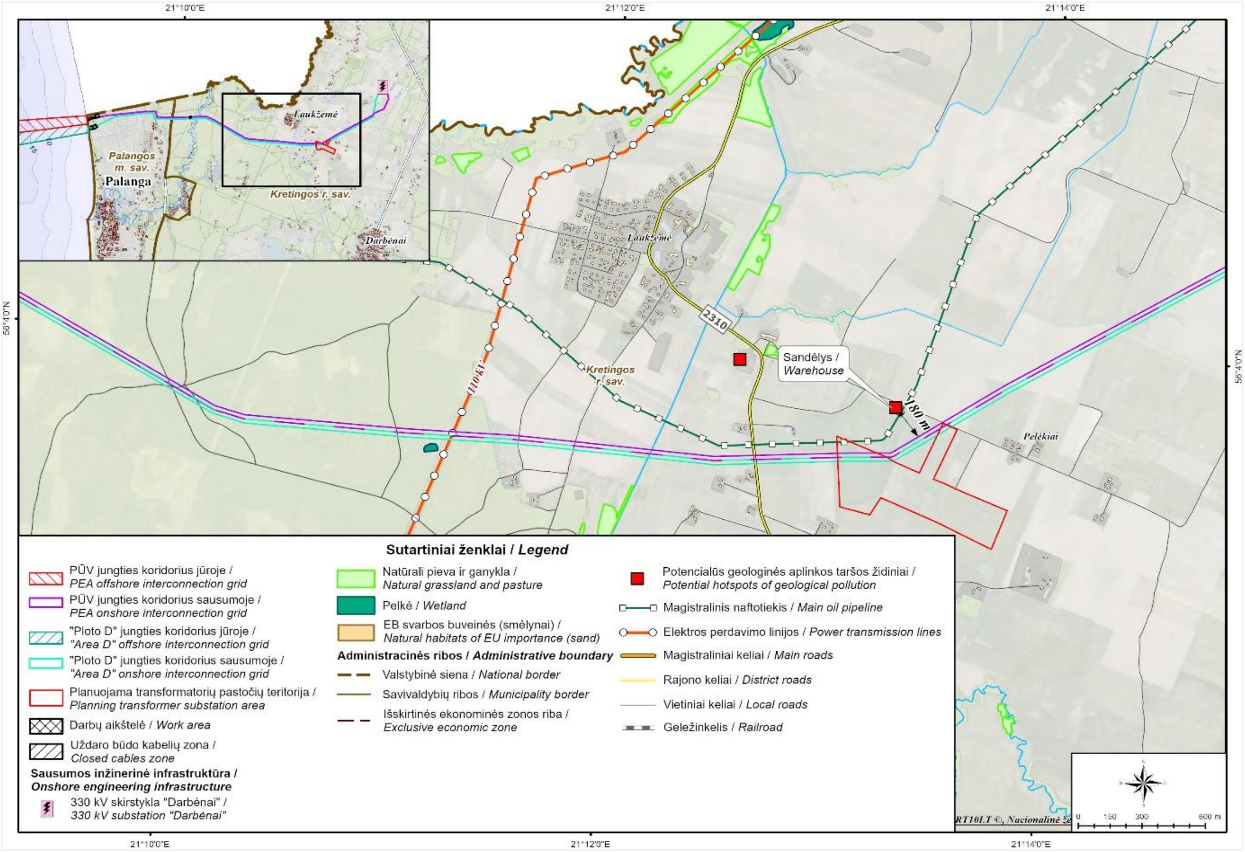


Fig. 6.4.3B. PEA adjacencies onshore.

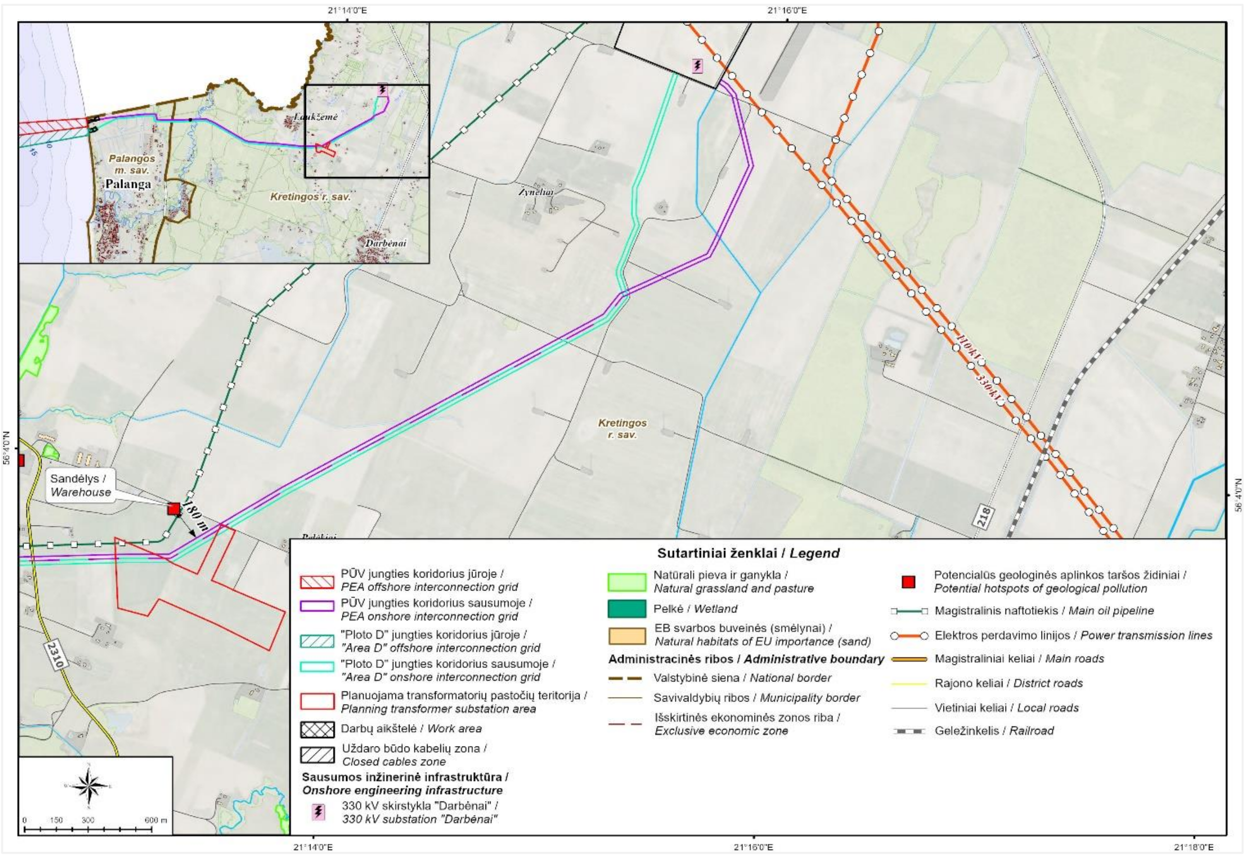


Fig. 6.4.3C. PEA adjacencies onshore.

The nearest warehouse is located approximately 180 m from the export cable corridors. According to 2008 data from the Registry Centre, this facility, identified under pollution source No. 6510, was classified as medium hazardous; however, it has since been demolished and is no longer in operation.

During the design phase, the crossing of the main oil pipeline protection zone within the land export cable corridors will be coordinated with AB Orlen Lietuva. Similarly, the crossing of the 110 kV overhead line protection zone and the connection works to the “Darbėnai” switchyard will be coordinated with AB Litgrid. All works will be executed in compliance with applicable construction regulations and occupational health and safety requirements, thereby minimising potential risks during both construction and operational phases.

The risk assessment for the identified hazards is provided in Section 6.9, Table 6.9.8.

6.5. Natural and catastrophic meteorological phenomena offshore and onshore

According to the Indicators of Natural, Catastrophic Meteorological and Hydrological Phenomena approved by Order No. D1-870 of the Minister of the Environment of the Republic of Lithuania (11 November 2011, as amended on 5 November 2024), the following wind speed thresholds are applicable:

- In the municipalities of Klaipėda City, Klaipėda District, Kretinga District, Palanga City, Neringa and Šilutė District, winds reaching ≥ 28 m/s at a height of 10 m above ground level are classified as storm-force or natural phenomena, while winds exceeding 33 m/s are considered hurricane-force or catastrophic.
- Within the territorial sea of the Republic of Lithuania and the Klaipėda State Seaport, winds of ≥28 m/s measured at 24 m above sea level are classified as storm-force or natural phenomena, while those exceeding 33 m/s are considered hurricane-force or catastrophic.

Storms, hurricanes and associated large waves represent the most significant meteorological hazards to the OWF. These phenomena may impede the navigation of vessels transiting near the OWF or engaged in operational activities and can also adversely affect the service life and structural integrity of OWF components.

A detailed long-term statistical analysis of wind speeds along the Klaipėda coast and within the port area (covering the period 1961–2008) is provided in the Summary Report of Research Study on Navigational Conditions and Parameters for Proposed LNG Import Terminal in Lithuania (2011) by Prof. Habil. Dr. Capt. Vytautas Paulauskas.

Based on this analysis, the Klaipėda coast experiences, on average, 73 days per year with wind speeds exceeding 15 m/s at the time of measurement (see Table 6.5.1). Although storm-force winds are recorded in all months over a multi-year period, their highest probability occurs between October and January.

Table 6.5.1. Maximum wind speed and duration in number of days per month in the Klaipėda region in 1961–2008 (V. Paulauskas, 2011)

Wind speed, m/s	Months												Total per year
	1	2	3	4	5	6	7	8	9	10	11	12	
≥8	24.3	18.4	20.4	18.3	17.8	18.2	20.9	20.1	21.3	24.6	22.8	24.9	252
>10	21.4	13.9	14.9	11.7	8.5	8.4	12.7	13.7	18.0	19.6	18.4	20.0	181
>15	12.1	5.0	5.7	2.4	0.6	1.5	2.6	3.9	8.2	10.5	9.0	11.3	73
>20	3.9	1.3	1.7	0.2	0.1	0.2	0.2	0.3	2.2	3.2	2.9	3.0	20
>30	0.1										0.1	0.1	0.3

Table 6.5.2 presents the maximum westerly wind speeds recorded at the port of Klaipėda between 1947 and 2008. These data are of relevance for ship navigation and cargo handling operations. Long-term statistics indicate that hurricane-force winds predominantly occur from the west, north-west and south-west directions. The information provided in the table is used to assess potential risks to maritime operations in the vicinity of the PEA area.

Table 6.5.2. Maximum westerly wind speed (m/s, per month of the year) in Klaipėda Port from 1947 to 2008 (V. Paulauskas, 2011)

Wind direction	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
SW	34	29	28	20	20	18	20	23	23	34	27	26
W	34	28	25	20	20	20	20	28	28	34	30	**38**

Wind direction	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
NW	29	24	26	20	24	18	23	23	23	27	23	27

Long-term observations indicate that an average of 35 storm and hurricane-force wind events occur annually, each typically lasting 20–30 hours. The highest recorded wind speeds in the region were 38 m/s in Klaipėda and 40 m/s in Nida, both measured during the December 1999 storm (hurricane "Anatolijus").

Hurricane-force winds represent a critical factor in the structural resistance and long-term durability of OWF infrastructure. During 2022–2024, a comprehensive programme of hydrometeorological measurements was undertaken in the Baltic Sea, approximately 30 km offshore near Palanga. The maximum wind speeds recorded at various elevations above sea level are directly relevant to the assessment of OWF operational resilience and structural safety.

The research campaign was conducted using two floating LiDAR systems supplied by EOLOS Floating Lidar Solutions SL (Spain). A detailed dataset is available via the "Research Data" section of https://offshorewind.lt/lt/. Selected results are summarised in Tables 6.5.3 and 6.5.4.

Table 6.5.3. Maximum recorded wind speed at measured heights during the observation period

2022.07–2023.07	Maximum wind speed (m/s) / Height (m)										
	12	40	50	100	125	150	175	200	220	250	280
Lidar E01	19.6	22.1	22.3	26.8	27.9	28.6	29.4	34.0	33.8	**34.9**	35.3
Lidar E06	19.3	21.8	22.7	26.6	28.5	29.6	30.7	32.7	33.0	33.3	**34.9**

According to the data received, the maximum recorded wind speed in one year reached 35.3 m/s at an altitude of 280 meters. The maximum wind speed for actual ship navigation at 12 meters above the sea surface reached 19.6 m/s.

Table 6.5.4. Maximum recorded wind speed at measured heights during the observation period

2024.02.20–2024.08.20	Maximum wind speed (m/s) / Height (m)										
	20	40	100	120	140	155	160	175	190	250	280
Lidar	27.5	26.2	31.6	31.8	32.7	32.5	32.8	33.2	33.7	36.1	**37.8**

During the period February–August 2024, the maximum recorded wind speed reached 37.8 m/s at an altitude of 280 meters. At 20 meters above sea level, the maximum wind speed reached 27.5 m/s.

Table 6.5.5. Extreme factors that have a significant impact on PEA

No.	Phenomenon	Units	Critical limit	Potential impact
		Natural meteorological phenomena		
1	Very strong winds in the Lithuanian Baltic Sea PEA territories	Maximum wind speed at 24 m height (m/s)	≥28–<33	Disruption of shipping. Risk of collision with an OWF. Recovery of unmanned ships. OWF rotor blade damage
2	Very strong winds in the Lithuanian PEA territory onshore	Maximum wind speed at 10 m height (m/s)	≥28–<33	Disruption of ONSs
3	Very severe compound frost	Icing thickness/ diameter on the wires of the rain with frost or bald ice stand (mm)	≥35	Icing of the OWF blades. Icing of OSS external structures
4	Very strong wind		≥20	
5	Very thick fog	Visibility (m) duration (hours)	100 ≥12	Impact on navigation of service vessels in the OWF

No.	Phenomenon	Units	Critical limit	Potential impact
6	Very severe storm (a complex of dangerous meteorological phenomena: thunderstorm and heavy rain, and (or) squall, and (or) hail)	Fact precipitation amount (mm), duration (hours) maximum wind speed (m/s) ice cube diameter (mm)	Occurs ≥15 ≤12 ≥15 ≥6	and on navigation of all vessels near the OWF and adjacent facilities of the PEA
	Catastrophic meteorological events			
7	Hurricane in the Lithuanian onshore PEA territories	Maximum wind speed at 10 m height (m/s)	≥33	Disruption of ONSs
8	Hurricane in Lithuanian Baltic Sea PEA territories	Maximum wind speed at a height of 24 m (m/s)	≥33	Damage to WTG blades, impact on navigation near OWF
	Natural hydrological phenomena			
9	Very severe icing of ships in the Baltic Sea, Curonian Lagoon, and Klaipėda State Seaport water area	Ice layer (cm) duration (hours)	≥0.7 ≥1	Impact on navigation of service vessels in the OWF and on navigation of all vessels near the OWF and adjacent facilities of the PEA
10	Very strong waves in the Baltic Sea	Wave height at sea (m)	≥6	Impact on the foundation of the OWF; damage to the export cables at landfall due to the erosion of coastal sand
11	Very high flood onshore	Flooded area (ha)	≥60,000	Damage to the export cables
	Other extreme events that resulted in human casualties			
12	Death or injury due to a terrorist act	Number of victims	≥1	Terrorist act at OWF or mainland facilities
13	Death or injury due to fire Health damage due to fire	Number of victims	≥5 ≥10; or ≥5 and there are fatalities	Fire in the OWF nacelle, smoke in the WTG tower and nacelle, poisoning, burns, fatal injuries
	Other extreme events that could have an impact on the environment			
1 4	Transformer oil leaking to the surface and/or deeper layers of the earth	Quantity, t	≥5	Leakage in ONSs
15	Transformer oil leaking to the onshore water bodies	Quantity, t	≥1	Leakage in ONSs
16	Transformer oil leaking to the sea	Quantity, t	≥1	Leakage in OSS
	Other natural events that could cause incidents with the potential for major accidents in the OWF			
17	Earthquake in the OWF region	Local earthquakes up to 4–5 on the Richter scale have been recorded (Koningsberg)	≥6	Severe (irreparable) damage to OWF structures, collapse of individual structures
18	Liquefaction of thixotropic soils from dynamic loads	Interlayers in moraine soils	-	Severe (irreparable) damage to structures, collapse

6.6. Risk objects and hazardous factors

Table 6.6.1 summarizes the PEA risk objects and the most typical hazardous factors and possible external impacts that may cause emergency situations, indicating at what stage of the OWF they are important, significant or insignificant.

Table 6.6.1. Hazardous factors of risk objects

Risk objects	Hazardous factors	Stages	
		Construction	Operation
	Internal factors		
OWF	Construction and service vessels WTGs OSS Inter array cables	Important	Important
OWF	Rotor blades WTGs Nacelles Rotor oil Electrical installations Fires Foundations	Important	Important
OSS	Electrical installations Transformer oil Foundations	Significant Important Important	Significant Important Important
Marine cables	Electrical voltage	Significant	Significant
Landfall	Electrical voltage	Significant	Significant
Onshore export cables	Electrical voltage	Significant	Significant
ONSs	Electrical installations Transformer oil	Significant Important	Significant Important
Staff	Personnel training Human error Deliberate activity (diversion)	Important	Important
	External activities, objects and factors		
Shipping routes (corridors)	Distance from the PEA Traffic intensity Ship size	Important	Important
Passing ships	Cargo hazard Oily waters Fuel Probability of tower damage	Important Significant Significant Important	Important Significant Significant Important
Existing underwater cables	Electrical voltage	Important	Important
Būtingė oil pipeline to the shore	Location (remote)	Important	Important
Būtingė buoy	Location (remote)	Important	Important
Fishing areas	Fishing spot Fishing intensity Size of ships Human error	Important Important Significant Significant	Important Significant Significant Significant
Dredged material dumping sites	Dumping site (remote) Ships	Insignificant	Insignificant
Tourism activities	Boat routes (remote) Diving locations (remote)	Important Insignificant	Insignificant Insignificant
Restricted use areas	Sunken explosives	Important	Important

Risk objects	Hazardous factors	Stages	
		Construction	Operation
	Minefields offshore National Defence Territories	Important Important	Important Important
Accidental detonation of UXO	Impact on the ecosystem Impact on the foundations Damage to the WTGs Human injuries and deaths	Significant Important Important Important	Significant Important Important Important
Aircraft flying over	Aviation fuel Possibility to damage blades Possibility to damage WTG tower	Significant	Important
Birds	Bird deaths Rotor damage	Insignificant	Significant
Extreme hydrometeorological conditions and other extreme events	Icing Hurricane, severe storm Earthquake	Important Important Significant	Important Important Significant

6.7. Vulnerable objects and possible consequences

When planning and constructing OWFs, direct impacts on surrounding residents and public facilities are avoided, but vulnerable objects remain.

Table 6.7.1. Possible consequences for vulnerable objects

Vulnerable objects	Consequences
People	
During construction:	
builders	Injuries and injuries of varying degrees, accidental deaths
During operation:	
service staff	Injuries and injuries of varying degrees, accidental deaths
accident and emergency responders	Injuries and injuries of varying degrees, accidental deaths
crews of passing ships	Collision with OWF, spillage of flammable materials, fire, injuries of varying degrees, accidental deaths
passengers of passing passenger ships and ferries	Collision with OWF, spillage of flammable materials, fire, injuries of varying degrees, accidental deaths
aircraft pilots	Collision with rotating blades of the OWF, spillage of flammable materials, fire, explosion, serious injuries, deaths
During disassembly:	
construction workers-demolition workers	Injuries of varying degrees, accidental deaths.
Environmental components	
During construction:	
sea area	Water pollution – spills of hazardous materials and fuel from construction machinery and ships Environmental pollution – the entry of assembly materials and construction waste into the water area
terrestrial water bodies and groundwater	Water pollution – spills of hazardous materials and fuel from construction machinery
soil and ground	Pollution – spillage of hazardous materials and fuel from construction machinery
ambient air	Air pollution due to malfunctioning internal combustion engines Pollution by combustion products during a fire
During operation:	

Vulnerable objects	Consequences
sea area	Water pollution – spillage of hazardous materials from OWF facilities Water pollution – small spills of hazardous materials and fuel from ships Water pollution – fuel spills from aircraft
birds	Bird deaths due to collision with rotating blades Impact of oil spills and other hazardous substances on flying birds
marine life	Impact due to spilled hazardous materials
ambient air	Pollution by combustion products during a fire
terrestrial water bodies and groundwater	Water pollution – spillage of hazardous materials from ONSs
soil and ground	Pollution – spillage of hazardous materials from ONSs
During disassembly:	
sea area	Water pollution – spills of hazardous materials and fuel from construction machinery and ships Environmental pollution – assembly materials, construction waste
terrestrial water bodies and groundwater	Water pollution – spills of hazardous materials and fuel from construction machinery
ambient air	Air pollution due to malfunctioning internal combustion engines Pollution by combustion products during a fire
Property	
WTGs	Failures of various scales, collapse of towers, blade blowout
passing ships	Mechanical damage to ship hulls
fishing and recreational vessels	Mechanical damage to ship hulls Fuel leaks into the water area Injuries and deaths of sailors and holidaymakers
offshore infrastructure facilities	Damage to cables
existing underground communications onshore	Damage to existing communications during the laying of onshore export cables
passing aircraft	Aircraft crash Major mechanical damage to the aircraft body

6.8. Description of possible hazardous events

According to methodological recommendations for the assessment of potential hazards and emergency situations applicable to economic entities (e.g. the PMBOK® Guide), a potential hazard is defined as a threat to human life or health, property and/or the environment arising from possible events, incidents or emergencies.

First, all possible natural and human-induced (technical, ecological and social) hazards are identified due to:

- geographical location
- technological processes or failures
- employee errors (human factor)
- design, construction or equipment of the building(s) (physical factor).

Subsequently, hazards are identified that may arise outside the boundaries of the economic entity or other institution but have consequences (impact) on the life or health of residents, property, the environment, the continuity of the economic entity's or other institution's activities and cause an emergency situation.

The risks arising from the geographical location are related to natural and catastrophic hydrometeorological phenomena and other extreme external factors of natural origin that may arise in the PEA area.

Natural and catastrophic hydrometeorological phenomena, approved by Order No. D1-870 of the Minister of the Environment of the Republic of Lithuania of 11 November 2011, are presented in Table 6.5.5 of this chapter. The greatest danger is posed by storms, hurricanes and large waves – dangerous phenomena that complicate the navigation of vessels passing near the OWF and servicing its activities.

Extreme external factors causing hazardous events include possible earthquakes, as well as failure to remove thixotropic soils in the foundations. The probability of earthquakes and thixotropic or other weak soil inclusions in the foundations of planned OWFs is assessed during the design phase and therefore is considered as a physical factor. The same situation is with chemical munition sunken during World War II and former minefields – migrating explosives are classified as external factors, as they cannot be accurately assessed during the design phase and research.

The assessment of possible hazardous events is carried out during the construction, operation and decommissioning periods of the OWF.

Hazardous events occurring during construction and dismantling of the OWF are related to accidents involving construction machinery and ships, personnel errors during the installation of OWF towers and lifting of rotors, and connection of electrical equipment:

- accidents involving machinery and ships, accompanied by small spills of oil products into the water area
- failures of lifting mechanisms, resulting in the collapse or fall of assembled structures
- collapse or fall of mechanisms being installed due to employee errors
- electricity leakage due to employee errors when connecting WTGs and checking their electrical equipment.

OWF are related to failures of power plants and infrastructure equipment, personnel errors during maintenance, and activities of third parties. External and third-party activities include possible attacks, sabotage, and theft from facilities. Among natural factors, the impact of migratory birds and extreme hydrometeorological phenomena should be noted.

The following emergencies are possible during the operation of the OWF:

- fall of service personnel from a great height while performing inspection or repair work
- throwing of an incorrectly attached rotor blade or other parts when the rotor is rotating
- ejection of the entire rotor due to installation errors
- collapse of a WTG tower due to a poorly designed foundation, a defect in the tower's structural design, or blade impacts.

The main incidents caused by external factors are:

- Collision of ships with OWF during a storm, due to fog, failure of positioning or control equipment. The WTG tower may be demolished, blades may be broken, the ship's hull may be damaged, fuel or transported materials may spill. In exceptional cases, passengers may be injured.
- Aircraft collisions with WTGs, when a small, low-flying aircraft, not noticing the tower, crashes into the rotating blades or the tower. The WTG may be demolished or damaged, the blades and rotor may break, the aircraft may crash, and pilots and passengers may be killed.
- Detonation of a migrating submerged explosive or mine upon impact with the underwater part of a OWF under construction or operation.

Potential hazardous events are analysed separately in the offshore section of the PEA – the OWF, the planned marine export cable corridors, and the onshore part – export cable connections, the conduits, and the ONSs.

The identified potential hazardous events are presented in Table 6.8.1. The safety measures commonly used to protect against the effects of the identified potential hazardous events of natural origin are presented in Table 6.8.2. The causes of the identified potential hazardous events of non-natural origin and the safety measures commonly used are presented in Table 6.8.3.

Table 6.8.1. Description of identified potential hazardous events

No.	Factor	A dangerous event has been identified.	The zone of consequences (impact) of the identified potential hazard and the potential spread of the hazard	Vulnerable objects
1	**Geographical hazards**			
The offshore section of the PEA, the OWF and the export cable corridors Construction, operation and decommissioning stages				
G1	Natural and catastrophic meteorological phenomena	A natural meteorological phenomenon – a wind with a speed of ≥28–<33 m/s at a height of 24 metres.	The entire EEZ and surrounding waters. Emerging risks: • disruption of shipping, collision of ships with WTGs and OSS • uncontrolled ships in the OWF and collisions with WTGs and OSS • Damage to the blades of the operating WTGs, possible blade breakage and ejection	WTGs OSS Construction and service vessels Builders-installers Ship crews Cargo handling workers Offshore divers Adjacent, already built OWFs Passing ships
G8		Catastrophic phenomenon – hurricane, max. wind speed at a height of 24 m >33 m/s.		
G3	Natural meteorological phenomenon	Very severe compound frost, when the frost thickness on the wires exceeds 35 mm.	The entire EEZ and surrounding waters. Emerging risks: • icing of operating WTGs blades • icing of OSS external structures	WTGs OSS Construction and service vessels Construction workers, ship crews Cargo handling workers Offshore divers
G4	Natural meteorological phenomenon	Very severe frost occurs when the frost thickness exceeds 20 mm.	The entire EEZ zone and surrounding waters. Emerging risks: • icing of operating WTGs blades • icing of OSS external structures	
G5	Natural meteorological phenomenon	Very dense fog with visibility ≤100 m, duration ≥12 hours.	The entire EEZ and surrounding waters. Emerging risks: • impact on the navigation of service vessels in the OWF and all vessels near the OWF and adjacent objects of the PEA	WTGs OSS Construction and service vessels Nearby, already built OWFs Passing ships Ship crews
G6	Natural meteorological phenomenon	Very severe storm (a complex of dangerous meteorological phenomena: thunderstorm and heavy rain, and (or) squall, and (or) hail).	The entire EEZ and surrounding waters. Emerging risks: • impact on the navigation of service vessels in the OWF and vessels near the OWF and adjacent objects of the PEA	WTGs OSS Construction and service vessels Adjacent, already built OWFs Passing ships

No.	Factor	A dangerous event has been identified.	The zone of consequences (impact) of the identified potential hazard and the potential spread of the hazard	Vulnerable objects
				Builders-installers Ship crews
G9	Natural hydrological phenomenon	Very severe icing of ships in the Baltic Sea, Curonian Lagoon, Klaipėda State Seaport water area, ice layer ≥0.7 cm, duration ≥1 hour	The entire territory of the PEA (OWF and export cable corridors). Emerging risks: • impact on the navigation of service vessels in the OWF and passing vessels near the OWF and adjacent objects of the PEA	WTGs OSS Construction and service vessels Builders-installers Ship crews Cargo handling workers Offshore divers Adjacent, already built OWFs Passing ships
G10	Natural hydrological phenomenon	Very strong waves in the Baltic Sea, with wave height ≥6 m	The entire EEZ and surrounding waters. Emerging risks: • impact on the navigation of service vessels in the OWF and passing vessels near the OWF	Construction and service vessels Builders-installers Ship crews Cargo handling workers Offshore divers Passing ships
G11	Extreme natural event	Earthquake in the OWF offshore area (local earthquakes up to 4–5 on the Richter scale were recorded in Königsberg)	The entire territory of the PEA (OWF and export cable corridors). Emerging risks: • Severe (irreparable) damage to WTG towers and OSS, collapse of individual structures • Breakages of underwater cables due to seabed displacements	WTGs OSS Offshore divers Construction and service vessels Passing ships
G12	Extreme natural event	Liquefaction of thixotropic soils from dynamic loads	OWF territory. Emerging risks: • Severe (irreparable) damage to individual OWF structures, possible collapse	WTGs OSS
The onshore section of the PEA, landfall, the onshore export cables and ONSs Construction, operation and decommissioning stages				
G2	Natural and catastrophic meteorological phenomena (onshore)	A natural meteorological phenomenon is a wind with a speed of ≥28–<33 m/s at a height of 10 m	The entire territory of the PEA in the mainland (land cable corridor and land transformer substations).	

No.	Factor	A dangerous event has been identified.	The zone of consequences (impact) of the identified potential hazard and the potential spread of the hazard	Vulnerable objects
G7		Catastrophic phenomenon – hurricane, max. wind speed at 10 m, height >33 m/s.	Emerging risks: • Risk of damage to the ONS's external structures	ONSs
G13	Natural meteorological phenomenon (onshore)	Very severe compound icing, when the icing thickness on the wires exceeds 35 mm	The entire territory of the PEA onshore (export cable corridors and ONSs). Emerging risks: • Risk of damage to the ONS's external structures	ONSs (external structures)
G14	Natural meteorological phenomenon (onshore)	Very severe storm (a complex of dangerous meteorological phenomena: thunderstorms and heavy rain, squalls, hail)	The entire territory of the PEA onshore (export cable corridors and ONSs). Emerging risks: • Risk of damage to the ONS's external structures	ONSs (external structures)
2	**Hazards due to technological processes or failures, materials used, errors by designers and personnel, and activities carried out in the vicinity**			
The offshore section of the PEA, the OWF and the export cable corridors Construction and decommissioning stages				
2.1	Vessels and machinery serving construction and decommissioning works	Fuel spillage from a vessel or machinery involved in construction work	The entire territory of the PEA (OWF and the export cable corridors, the navigational route between the service vessel port and the OWF, and the designated export cable corridors)	Marine ecosystems Property (fuel loss)
2.2	Vessels and machinery serving construction and decommissioning works	Collision and damage to service vessels	The entire territory of the PEA (OWF and the export cable corridors, the navigational route between the service vessel port and the OWF, and the designated export cable corridors)	Ship crews and people being transported Marine ecosystems Property (collision ships and cargo carried) Disruption of operations
2.3	Vessels and machinery serving construction and decommissioning works	Personnel injuries while transporting workers and cargo to vessels serving the construction of the OWF	The entire territory of the PEA (OWF and the export cable corridors, the navigational route between the service vessel port and the OWF, and the designated export cable corridors)	Ship crews and people being transported Ownership (cargo transported)
2.4	Vessels and machinery serving construction and decommissioning works	Collision of service vessels with OWFs under construction, critical damage	OWF offshore section	Ship crews and people being transported Builders-installers Marine ecosystems Property (WTGs and OSS, collided ships and transported cargo)

No.	Factor	A dangerous event has been identified.	The zone of consequences (impact) of the identified potential hazard and the potential spread of the hazard	Vulnerable objects
				Disruption of operations in the vicinity of a damaged WTGs or OSS
2.5	OWF construction and decommissioning processes	Falling of lifted objects, damage to the ship, serious injuries	OWF offshore (installation site)	Construction workers, ship (lift, barge) crew, cargo handling workers Marine ecosystems Property (damage to the installed wind turbine tower, nacelle, blades)
2.6	OWF construction and decommissioning processes	Collapse of WTG towers being installed	OWF offshore (installation site)	Builders-installers By ship (lift, barge) crew Crews of nearby service vessels Property (damage to the foundations, tower, nacelle, blades of the installed OWF) Property (damage to nearby vessels)
2.7	OWF construction and decommissioning processes	Installation worker falling from a great height	OWF offshore (installation site)	Builders-installers
2.8	External hazards, passing ships	Collision of passing vessels with service vessels, critical damage	The boundaries of the OWF offshore area located adjacent to existing shipping corridors, as well as the navigational route between the service vessel port and the OWF, and the designated export cable corridors	Crews of serving and passing vessels and people being transported Marine ecosystems Property (serving vessels, passing vessels, their cargoes)
2.9	External hazards, passing ships	Collision of passing ships with WTGs under construction, critical damage	The boundaries of the OWF offshore area located adjacent to existing shipping corridors	Crews of passing ships and people being transported Builders-installers Property (damage to the foundations, tower, nacelle, blades of the installed WTGs, passing ships, their cargo)
2.10	Laying of export cables	Collision of ships participating in the works near the offshore section of	A section of the export cable corridors adjacent to the Būtingė terminal	Offshore facilities of the Būtingė terminal Tanker at the Būtingė terminal

No.	Factor	A dangerous event has been identified.	The zone of consequences (impact) of the identified potential hazard and the potential spread of the hazard	Vulnerable objects
		the Būtingė terminal and the port of Šventoji, critical damage		
2.11	External hazards, nearest cable of unknown origin	Accidental damage to an existing underwater cable during ground surveys for a planned OWF due to incorrect coordinates	Eastern section of the OWF offshore area, protection zone of a cable of unknown origin	The nearest cable of unknown origin, the boundary of which coincides with the boundary of the OWF Workers performing drilling operations
2.12	External hazards, sites of UXOs and former minefields	Damaged UXO during foundation installation or construction	Part of the OWF that falls within the area of former minefields and UXOs	Crews of foundation installation vessels (pile drivers, barges, etc.) and construction workers Offshore divers Marine ecosystems Property (critical damage to ships, installed foundation structures) Disruption of operations
2.13	External hazards, sites of UXOs and former minefields	Damaged UXO during cable laying	The part of the OWF that falls within the area of former minefields and UXOs, the section of the export cable corridors adjacent to the area of former minefields and UXOs	Crews of cable-laying and support vessels and workers carrying out cable laying Offshore divers Marine ecosystems Property (critical damage or destruction of ships, part of a laid cable) Disruption of operations
2.14	External hazards, passing aircraft	Collision with high-rise OWF structures	OWF offshore area, WTG towers, nacelles, blades.	Pilots of passing aircraft Construction workers (inside the nacelle) Marine ecosystems Property (WTG towers, nacelles, blades)
Construction and decommissioning stages, construction and decommissioning works of OSS				
2.15	Filling of transformer oil in an OSS	Transformer oil spill into the water	OWF offshore section (OSS area).	Marine ecosystems Property (transformer oil loss)

No.	Factor	A dangerous event has been identified.	The zone of consequences (impact) of the identified potential hazard and the potential spread of the hazard	Vulnerable objects
2.16	OSS's connection to the network, testing	Electrical leakage	OWF OSS	Personnel performing the work Marine ecosystems
The onshore part of the PEA, export cables and ONSs Construction phase, laying of export cables and installation of ONSs				
2.17	Laying of land cables from the coast to Darbėnai Switchyard	Violation of export cables	Export cable corridors	Cable laying workers Underground communications being crossed
2.18	Installation and preparation of the ONSs for operation	ONS oil spillage during filling	Location of the ONSs	Soil and aeration zone soil Groundwater Nearest surface water bodies
The offshore section of the PEA, the OWF and the export cable corridors Operation phase, operation of OWFs and related infrastructure				
2.19	OWF operation: rotor blades	Rotor blade ejection	The offshore of the OWF, one of the operating WTGs	Service staff Property (OWF, service vessels, service aircraft) Disruption of operations (damaged OWF)
2.20	OWF operation: towers	Tower collapse	The offshore of the OWF, one of the operating WTGs	Service staff Property (OWF, service vessels, service aircraft) Disruption of operations (damaged OWF)
2.21	OWF operation: nacelle	Fire	The offshore of the OWF, one of the operating WTGs	Service staff Ownership (OWF) Disruption of operations (damaged OWF)
2.22	OWF operation: rotor oil	Rotor oil spill	The offshore of the OWF, one of the operating WTGs	Marine ecosystems Disruption of operations (damaged OWF)
2.23	OWF operation: electrical equipment	Electrical leakage	The offshore of the OWF, one of the operating WTGs	Service staff Marine ecosystems
2.24	OWF operation: electrical equipment	Fire in electrical equipment	The offshore of the OWF, one of the operating WTGs	Service staff Ownership (OWF)

No.	Factor	A dangerous event has been identified.	The zone of consequences (impact) of the identified potential hazard and the potential spread of the hazard	Vulnerable objects
				Disruption of operations (damaged OWF)
2.25	OWF operation: tower foundation structures	Foundation settlement, loss of tower stability	The offshore section of the OWF, one of the operating WTGs	Ownership (OWF) Disruption of operations (damaged OWF)
2.26	OSS operation	Fire in OSS facilities	OWF offshore, OSS	Service staff Property (OSS) Disruption of operations (OWF or part thereof)
2.27	OSS operation	Transformer oil spill	OWF offshore, OSS	Marine ecosystems Disruption of operations (OWF or part thereof)
2.28	OSS operation, foundation construction	Foundation settlement, loss of stability of the OSS platform	OWF offshore, OSS	Ownership (OWF) Disruption of operations (OWF or part thereof)
2.29	OSS operation	Electrical leakage	OWF offshore, OSS	Service staff Marine ecosystems
2.30	Connecting cables from the OWF to the transformer stations	Electrical leakage	OWF offshore	Service personnel (divers) Marine ecosystems
2.31	Export cables	Electrical leakage	Export cable corridors	Marine ecosystems Disruption of operations (OWF or part thereof)
Operational phase, hazards posed by activities carried out in the vicinity of OWFs and infrastructure.				
2.32	External threats, shipping corridors	Collision of passing passenger ships with WTGs, critical damage.	The edges of the OWF offshore section adjacent to existing shipping corridors	Ship crews and passengers Marine ecosystems Ownership (OWF and passenger ships) Disruption of operations (damaged OWF)
2.33	External threats, shipping corridors	Collision of passing passenger ships with WTGs, critical damage.	The edges of the OWF offshore section adjacent to existing shipping corridors	Ship crews and passengers Marine ecosystems

No.	Factor	A dangerous event has been identified.	The zone of consequences (impact) of the identified potential hazard and the potential spread of the hazard	Vulnerable objects
				Ownership (JVs and passenger ships) Disruption of operations (damaged OWF)
2.34	External threats, shipping corridors	Collision of passing tankers with OWF, critical damage, oil spill	The edges of the OWF water area are adjacent to existing shipping corridors.	Ship crews Marine ecosystems Seaside area, beaches Ownership (OWF and cargo ships) Disruption of operations (damaged OWF)
2.35	External threats, shipping corridors	Discharge of bilge water	OWF offshore section and OWF responsibility area	Marine ecosystems
2.36	External hazards, underwater cables	Damage to the export and inter array cable	The protection zones of external underwater cables outside the PEA offshore section are not considered, as there is no possibility of damage during the operation of the OWF	No vulnerable objects
2.37	External hazards, Būtingė terminal facilities	Damage to Būtingė terminal facilities and underground oil pipeline	Underwater power transmission cables are laid outside the terminal and oil pipeline protection zones are not considered as there is no possibility of damage during the operation of the OWF	No vulnerable objects
2.38	External hazards, fishing areas	Collision of fishing vessels with WTGs and OSS	The OWF offshore section adjacent to the marine areas designated for fishing	Fishing vessel crews Marine ecosystems Property (OWF, fishing boats and equipment)
2.39	External hazards, dumping areas: soil subsidence	Barge collision with OWF	Remote objects, no possibility of damage during operation of the OWF	No vulnerable objects
2.40	External hazards, tourism activities, pleasure boat routes	Recreational vessel's collision with OWF	There is no data that recreational boat routes reach the PEA territory, the objects are remote, and there is no possibility of damaging during the operation of the OWF	No vulnerable objects
2.41	External hazards, tourism activities, diving sites	Collision of divers' boats with OWF	Remote objects, no possibility of damage during operation of the OWF	No vulnerable objects
2.42	External hazards, restricted areas, areas	OWF violation during military training	Remote objects, no possibility of damage during operation of the OWF	No vulnerable objects

No.	Factor	A dangerous event has been identified.	The zone of consequences (impact) of the identified potential hazard and the potential spread of the hazard	Vulnerable objects
	designated for national defence			
2.43	External hazards, sites of UXOs and former minefields	UXO exposed by underwater currents	Part of the OWF offshore section, which falls within the territory of former minefields	Offshore divers Marine ecosystems OWF, OSS, export cables Disruption of operations (damaged WTGs)
2.44	External hazards, sites of UXOs and former minefields	Accidental detonation of UXO exposed by underwater currents upon impact with subsea structures	The part of the OWF offshore section that falls within the territory of former minefields and the adjacent surrounding area	Offshore divers Marine ecosystems OWF, OSS, export cables Disruption of operations (damaged WTGs)
2.45	External hazards, coastal flying, air force exercises	Damage to WTG blades by military aircraft during exercises	OWF offshore section	Aircraft pilot Marine ecosystems Property (OWF, military aircraft) Disruption of operations (damaged WTGs)
2.46	External hazards, coastal flying, border service helicopters	Damage to the blades of the WTG by a passing helicopter	OWF offshore section	Aircraft pilot Marine ecosystems Property (OWF, helicopters) Disruption of operations (damaged WTGs)
2.47	External hazards, coastal flying, unmanned aircraft flight	Damage to the WTG blades caused by uncontrolled or lost control of the aircraft	OWF offshore section	Aircraft pilots Marine ecosystems Property (OWF, balloons, gliders) Disruption of operations (damaged WTGs)
2.48	External hazards, flying in the coastal zone, unauthorized entry into the PEA territory	A stray, unknown aircraft entered and collided with the blades of the WTG	OWF offshore section	Aircraft pilots Marine ecosystems Property (OWF, military aircraft) Disruption of operations (damaged WTGs)

No.	Factor	A dangerous event has been identified.	The zone of consequences (impact) of the identified potential hazard and the potential spread of the hazard	Vulnerable objects
2.49	External hazards, bird intrusion into the PEA territory	Bird entry into the blade rotation zone	OWF offshore section	Birds (multiple deaths) Property (damage to WTG blades) Disruption of operations (damaged WTGs)
The onshore section of the PEA, export cables and ONSs Operational phase, export cables and ONSs				
2.50	Export cables exploitation	Cable damage during earthworks, electrical leakage	Export cable laying site	Earthmoving workers
2.51	ONSs exploitation	Transformer oil spill	Location of the ONSs	Soil and aeration zone soil Groundwater Nearest surface water bodies
2.52	ONSs exploitation	Electrical leakage	ONSs	Repairmen Random animals, birds From the property (damage to transformer equipment)

Table 6.8.2. Standard safety measures typically employed to mitigate the impact of identified natural hazards

No.	Factor	Hazard	Potential impact	Safety measures
G1	Natural meteorological phenomenon	Very strong wind in the Lithuanian Baltic Sea EEZ	• Disruption of shipping • Risk of collision with a WTG • Drifting of uncontrolled vessels • Damage to WTG blade	1) The project will assess the maximum values of wind speed and other maximum meteorological parameters at which the OWF can operate. 2) The service personnel are trained to carry out activities during extreme hydrometeorological events. 3) The values of wind speed, waves, and visibility defined in regulatory documents, after which ship navigation is prohibited, will be included in the project. 4) It is recommended to prepare an emergency management plan, even if the facility does not meet the established criteria, for economic entities and other
G3		Very severe compound frost	• Icing of the WTG blades • Icing of OSS external structures	
G4		Very strong wind		
G5		Very thick fog	Impact on navigation of service vessels in the OWF and all vessels near the OWF and adjacent facilities of the PEA	
G6		Very severe storm		
G8	Catastrophic meteorological phenomenon	Hurricane in the Lithuanian Baltic Sea EEZ	Damage to the WTG blades, impact on navigation near the WTGs and adjacent facilities of the PEA	
G9	Natural hydrological phenomenon	Very severe icing of ships in the Baltic Sea		

No.	Factor	Hazard	Potential impact	Safety measures
G10	Natural hydrological phenomenon	Very strong waves in the Baltic Sea	Impact on navigation of service vessels in the OWF and all vessels near the WTGs and adjacent facilities of the PEA	institutions whose management is responsible for organising, coordinating and approving emergency management plans.
G11	Other natural events	Earthquake in the OWF water area	• Severe (irreparable) damage WTGs, collapse of individual structures • Potential seabed mass movements resulting in subsea cable breakage • Potential onshore slope failures resulting in damage to export cables	1) Local earthquakes of up to 4–5 on the Richter scale have been recorded in the Königsberg region, therefore the impact of a possible 4–5 magnitude earthquake will be assessed in the project. Considering the probability of such an event, it is recommended to strengthen the structures of the OWF towers and foundations and the OSS platform and foundations. 2) It is proposed to assess the possibility of a tsunami effect when preparing the project. There is no data on tsunami waves caused by local earthquakes recorded in Königsberg.
G12	Other natural events	Liquefaction of thixotropic soils from dynamic loads	Loss of stability of WTG due to weakening of foundations, possible collapse	MP foundations to be installed to the depth of Cretaceous-period metamorphosed bedrock
G2	Natural meteorological phenomenon	Very strong winds onshore	• Disruption of the operation of ONSs • Tearing off structural elements of ONSs	1) The project will assess maximum values of wind speed and other maximum meteorological parameters. 2) It is recommended to prepare an emergency management plan, even if the facility does not meet the established criteria, for economic entities and other institutions whose management is responsible for organising, coordinating and approving emergency management plans.
G7	Catastrophic meteorological phenomenon	Hurricane onshore		
G13	Natural meteorological phenomenon	Very severe compound frost, when the frost thickness on the wires exceeds 35 mm	• Disruption of the operation of ONSs • Tearing off structural elements of ONSs	
G14	Natural meteorological phenomenon	Very severe storm (a complex of dangerous meteorological phenomena).		

Table 6.8.3. Identified potential anthropogenic hazards and the standard safety measures typically employed to mitigate them

No.	Factor	Hazard	Reasons	Safety measures
1	**Hazards arising from operational processes or equipment failures, materials used, and errors by designers or personnel**			
The offshore section of the PEA, the OWF and the export cable corridors Construction and decommissioning stages				
1	Vessels and machinery supporting construction and decommissioning works	Fuel spillage from a vessel or machinery	1) Loss of fuel tank integrity on vessels (or equipment) due to corrosion 2) Damage to fuel tanks on vessels (or equipment) during operation 3) Fuel spillage during filling of vessel or equipment tanks	The ship's crew and machinery service personnel are trained and instructed, ready for refuelling at sea. Technically sound vessels and machinery. If fuel is delivered to the work site, this is done by special vessels. A minimum amount of oil spill response equipment is kept on service vessels operating at the construction site.
2	Vessels and machinery serving construction and dismantling works	Collision, damage to service vessels	1) Helmsman error, leading to close approach to another vessel in high seas 2) Technical failure resulting in an uncontrolled vessel due to a malfunctioning steering mechanism or engine stoppage 3) High wind speeds, rough seas, and poor visibility	Compliance with safe shipping rules, working only in acceptable meteorological conditions. Shipping speed in the OWF territory is limited, and the wave height at which work is permitted is limited. Trained and experienced ship captain and crew. Instruction on specific works in the OWF.
3	Vessels and machinery supporting construction and decommissioning works	Personnel injuries during transport by vessels delivering workers and cargo to vessels supporting OWF construction	1) Inadequate personnel training 2) Insufficient adherence to safety procedures and preparedness 3) High wind speeds, rough seas, and poor visibility 4) Improperly secured cargo 5) Equipment failures	Compliance with safe shipping rules, working only in acceptable meteorological conditions. Shipping speed in the OWF territory is limited, and the wave height at which work is permitted is limited. Trained and experienced ship captain and crew. Instruction on specific works in the OWF. Instructions for employees brought to the OWF.
4	Vessels and machinery supporting construction and decommissioning works	Collision of service vessels with WTGs under construction, critical damage	1) Helmsman error, resulting in close approach to another vessel in rough seas 2) Technical failure leading to an uncontrolled vessel due to a malfunctioning steering mechanism or engine stoppage 3) High wind speeds, rough seas, and poor visibility	Compliance with safe shipping rules, working only in acceptable meteorological conditions. Shipping speed in the OWF territory is limited, and the wave height at which work is permitted is limited. Trained and experienced ship captain and crew. Instruction on specific works in the OWF.

No.	Factor	Hazard	Reasons	Safety measures
5	Operational processes associated with OWF construction and decommissioning	Hazards including falling objects, damage to vessels, and severe injuries	1) Personnel (crane operator) error, non-compliance with safety regulations, fatigue due to improper work schedule 2) Failure of a worn crane lifting cable 3) Load exceeding the crane's lifting capacity 4) Loss of power supply to the mechanism or slippage of the braking system during lifting	Compliance with safe work rules, compliance with weight, lifting speed, meteorological conditions restrictions applicable to a specific lifting mechanism, trained and instructed personnel. A checked and technically sound rope without any damage. Neat and maintained equipment, periodic technical inspections and daily inspections before the start of the shift.
6	Operational processes associated with OWF construction and decommissioning	Collapse of WTG towers under construction	1) Manufacturing defects, use of inappropriate materials 2) Design errors or errors in engineering and geological investigations 3) Installation errors, lack of quality control 4) Non-compliance with restrictions on working under adverse weather conditions 5) Collision of large vessels with the structures under installation 6) Collision of large aircraft	Structures are manufactured in OWF factories and purchased only from licensed suppliers. Contracts for design and construction are concluded with reliable and experienced companies. Prohibitions on performing work in extreme and catastrophic hydrometeorological conditions. The distances from the edge of the nearest approximately 8 km wide shipping corridors are more than 1 km, and to their middle – about 6 km. A no-fly zone is recommended for recreational aircraft and aircraft without their own propulsion systems (gliders, balloons).
7	Operational processes associated with OWF construction and decommissioning	Fall of installation personnel from height	1) Personnel (crane operator) error, non-compliance with safety regulations, or fatigue due to improper work conditions 2) Violation of work discipline, including unfastened safety ropes 3) Improperly maintained equipment, worn attachment ropes, or incorrectly fastened carabiners	Compliance with safe work rules, compliance with meteorological conditions restrictions applicable to work at high altitudes, trained and instructed personnel. Certified, well-maintained, regularly inspected safety ropes and snap hooks.
8	External hazards: passing ships	Collision of passing vessels with service vessels, critical damage	1) Poor visibility and challenging hydrometeorological conditions	A safety zone of at least 1,000 m from OWF assets is recommended during construction and operation.

No.	Factor	Hazard	Reasons	Safety measures
9		Collision of passing ships with WTGs under construction, critical damage	2) Error by the passing vessel's captain or helmsman, including non-compliance with safe navigation rules	According to the lighting and marking plan, information buoys marking the safety zone near the nearest shipping corridors are planned.
10	Export cables installation	Collision of vessels involved in the works near the offshore part of the Būtingė terminal and the port of Šventoji; critical damage	1) Helmsman error, resulting in close approach to another vessel in rough seas 2) Technical failure leading to an uncontrolled vessel due to a malfunctioning steering mechanism or engine stoppage 3) High wind speeds, rough seas, and poor visibility	Compliance with safe shipping rules, working only in acceptable meteorological conditions. Shipping speed in the work area is limited, and the wave height at which work is permitted is limited. Trained and experienced ship captain and crew. Instruction on specific work and special requirements when working in the security zone of the Būtingė terminal and near the Šventoji port roadstead and anchorage.
11	External hazards: nearest cable of unknown origin	Accidental damage to an existing underwater cable during ground surveys	1) During the initial stage of the OWF development, borehole locations may be inaccurately determined while conducting investigations involving drilling operations	It is forbidden to work in the cable protection zone. Well locations are compatible, precise coordinates are determined using GPS equipment. If there is any doubt about the accuracy of the selected location, an on-site inspection of the bottom borehole is performed.
12	External hazards: UXOs and minefields	Damaged UXO during foundation installation or construction	1) Detonation of damaged submerged, sand-covered explosive devices (mines) may occur during investigations or foundation construction 2) Storms and currents may cause UXOs to migrate and roll into the OWF area	It is recommended to conduct UXO surveys prior to the installation of OWF foundations and WTGs. Once a suspicious object is detected, the contractor will provide for the identification and liquidation of explosives on site or safe removal to disposal sites.
13	External hazards: UXOs and minefields	Damaged UXO during cable installation	1) Detonation of a damaged, submerged, and sand-covered explosive device (mine) may occur during investigations or foundation construction	Before installation of cables, it is recommended to conduct UXO) surveys on the sections of the OWF connecting cables and connection corridors adjacent to former minefields and buried explosives. Once a suspicious object is detected, the contractor will provide for the identification and liquidation of explosives on site or safe removal to disposal sites.

No.	Factor	Hazard	Reasons	Safety measures
14	External hazards: passing aircraft	Collision with high-rise OWF structures	1) Fog, poor visibility, challenging flight conditions, and inexperienced aircraft pilot 2) Aircraft malfunction, failure of navigation instruments, communication system failures, or loss of orientation	Permits to fly are issued only to aircraft in good condition, flown by or under the supervision of experienced pilots. At the beginning of construction, air traffic control services, the Lithuanian Armed Forces, the Border Guard Service, and other interested institutions are informed about the work area. Commercial and recreational flights are prohibited within the OWF territory and safety zone.
Construction and decommissioning stages, construction and decommissioning works of OSS				
15	Transformer oil spillage in an OSS	Transformer oil spill into the marine environment	1) Integrity breach of the OSS during installation 2) Spillage during filling operations	The staff is trained, instructed, and experienced. The OSS is new, tested, without defects. It is recommended to have a minimum amount of marine spill response equipment (containment booms, collection equipment or sorbents) at the construction site. It is recommended to use a rapidly degrading oil.
16	Connecting the OSS to the network	Electrical leakage	1) Violation of safety regulations. 2) Use of unsuitable materials.	The staff is trained, instructed, and experienced. Supervision of project implementation, use of equipment and materials with appropriate safety levels.
The onshore section of the PEA, landfall, export cables and the ONSs Construction phase, export cables and ONSs installation				
17	Export cables installation from the coast to Darbėnai Switchyard	Transformer oil spills into the natural environment	1) Integrity breach of the ONSs during installation 2) Spillage during filling operations	The staff is trained, instructed, and experienced. The ONSs are new, tested, without defects. It is recommended to have a minimum amount of marine spill response equipment (containment booms, collection equipment or sorbents) at the construction site. It is recommended to use a rapidly degrading oil.
18	Connecting the ONSs to the network	Electrical leakage	1) Violation of safety regulations 2) Use of unsuitable materials	The staff is trained, instructed, and experienced. Supervision of project implementation, use of equipment and materials with appropriate safety levels.
2	**Hazards due to technological processes or failures, materials used, errors by designers and personnel**			
The offshore section of the PEA, the OWF and the export cable corridors Operational phase, operation of OWF and related infrastructure				
19	OWF operation: rotor blades	Damage and/or ejection of rotor blades	1) Manufacturing defect, improper fasteners	Structures are manufactured in OWF factories and purchased only from licensed suppliers.

No.	Factor	Hazard	Reasons	Safety measures
			2) Extreme meteorological phenomena (strong storm, hurricane, tornado) 3) Collision with passing aircraft 4) Lightning discharge to the blade when the grounding is not properly installed	The project assessed the maximum wind speed values at which the WTG can operate, and designed grounding circuits of the required impedance. Measures for visibility of the OWF even in poor visibility conditions. A no-fly zone is recommended for recreational aircraft and aircraft without their own propulsion systems (gliders, balloons).
20	OWF operation: towers	WTG collapse	1) Manufacturing defect, unsuitable materials 2) Errors in design, engineering geological surveys 3) Installation errors, lack of quality control 4) Failure to comply with restrictions on working in unacceptable weather conditions 5) Collision of large ships into prefabricated structures 6) Collision of large aircraft	Structures are manufactured in OWF factories and purchased only from licensed suppliers. Contracts for design and construction are concluded with reliable and experienced companies. Prohibitions on performing work in extreme and catastrophic hydrometeorological conditions. Distances from the edge of the nearest approximately 8 km wide shipping corridors are more than 1 km, to the middle about 6 km. A no-fly zone is recommended for recreational aircraft and aircraft without their own propulsion systems (gliders, balloons).
21	OWF operation: nacelle	Fire	1) Rotor oil overheating 2) Ignition of connecting cables due to excessive resistance or connection 3) Lightning discharge when grounding fails 4) Failure to comply with fire regulations	The required amount of primary fire extinguishing agents. Temperature sensors, automatic control system, remote video camera surveillance system. The nacelle is not a structure, therefore, when preparing the technical design, additional measures are selected to prevent losses due to fires (automatic gas extinguishing systems, fire insurance, other measures).
22	OWF operation: rotor oil	Rotor oil spill	1) Integrity breach of the OSS during installation 2) Aircraft impact with OWF structures 3) Manufacturing defect, installation error	The personnel are trained and instructed on how to act in the event of an accident. It is recommended to have a minimum amount of spill response equipment (containment booms, collection equipment or sorbents) at the selected location of the OWF (OSS). It is recommended to use a fast-degrading oil. In case of fire, the required amount of primary fire extinguishing agents is stored in the OSS. Temperature sensors, automatic control system, remote video camera surveillance system.

No.	Factor	Hazard	Reasons	Safety measures
23	OWF operation: electrical equipment	Current leakage	1) Mechanical damage to internal cables during maintenance work 2) Insufficient level of protection of the cables used 3) Violation of safety regulations	The staff is trained, instructed, and experienced. Equipment, cables and materials of an appropriate level of security are used. Periodic inspection and maintenance are carried out in accordance with the requirements of regulatory documents and the approved plan.
24		Fire in the electrical equipment of the OWF tower		
25	OWF operation: foundation structures	Settlement of the foundations, weakening and loss of stability of the tower, possible collapse	1) Design errors 2) Errors at the stage of foundation installation 3) Inclusions of thixotropic soil, which can liquefy under dynamic loads, in areas where limnoglacial, silty-dusty sediments are widespread 4) Detonation of a migrating explosive device (mine) after hitting a OWF underwater structures 5) Assessment of the potential impact of an earthquake when preparing a technical project	Before preparing the project, the contractor conducts detailed engineering and geological surveys. The foundations are installed in pre-Quaternary rock soils with sufficient bearing capacity. Maintenance is required at all stages of construction, including the installation of foundation structures. The area is surveyed and buried explosives and mines found are detonated on site (or safely removed) before work begins. Since UXOs may appear in the area cleared of explosives due to wave action and bottom erosion and migration of sandy debris, periodic bottom surveys are recommended, involving the demining units of the Lithuanian Armed Forces or third parties with expertise in such work, in coordination with the Lithuanian Armed Forces.
26	OSS operation	Fire in TS electrical equipment	1) Failure to comply with fire regulations 2) Equipment wears and tear and failure to perform scheduled inspections and maintenance on time 3) Lightning discharge and damaged grounding circuit 4) Ship collision and damage to electrical equipment 5) Aircraft impact with the OSS hull and damage to it 6) Water entering the OSS during extreme swell	The personnel are trained and instructed on how to act in the event of an accident. It is recommended to have a minimum amount of spill response equipment (containment booms, collection equipment or sorbents) at the selected location of the OWF (OSS). It is recommended to use a fast-degrading oil. In case of fire, the OSS stores the necessary amount of primary fire extinguishing agents. Temperature sensors, automatic control system, remote video camera surveillance system. When preparing the technical design, automatic fire detection and extinguishing systems are provided for, if the size of the OSS regulates the installation of such systems. When preparing the technical design, extreme hydrometeorological phenomena are assessed, including maximum wave height, solar radiation, temperature, wind speed, etc.
27		Transformer oil spill into the water area		

No.	Factor	Hazard	Reasons	Safety measures
28	OSS operation	Foundation settlement, loss of stability of the OSS platform, possible collapse	1) Design errors 2) Errors at the stage of foundation installation 3) Inclusions of thixotropic soil, which can liquefy under dynamic loads, in areas where limnoglacial, silty-dusty sediments are widespread 4) Detonation of a stray sunken explosive after hitting a WTG underwater structure 5) Failure to assess the potential impact of an earthquake when preparing a technical design	Before preparing the project, the contractor conducts detailed engineering and geological surveys. The foundations are installed in pre-Quaternary rock soils with sufficient bearing capacity. Maintenance is required at all stages of construction, including the installation of foundation structures. The area is surveyed for UXOs and found UXOs are detonated on site (or safely removed) before work begins. Since UXOs may appear in the area cleared of explosives due to wave action and bottom erosion and migration of sandy debris, periodic bottom surveys are recommended, involving the demining units of the Lithuanian Armed Forces or third parties with expertise in such work, in coordination with the Lithuanian Armed Forces.
29	OSS operation	Electrical leakage	1) Failure of OSS electrical equipment due to corrosion, high waves, aggressive seawater environment and other reasons 2) Detonation of a migrating UXO or mine 3) Mechanical damage to the OSS input or output cables 4) Extreme hydrometeorological conditions 5) Deliberate actions (sabotage)	Constant maintenance. Automatic OSS electricity transmission and process control. Fault alarm. Trained maintenance personnel. Control over the implementation of regulatory requirements. Job instructions for employees performing the work, technical regulations for work performance and supervision, good practice guides, and other company safety and health documents.
30	OWF export cables	Cable damage, current leakage	1) Underwater drilling, seabed excavation, and other activities requiring coordination are carried out in the cable protection zone 2) Detonation of a migrating UXO or mine 3) Cable damage during military exercises 4) Deliberate actions (sabotage)	Armoured cables are used, protected from external influences. Any actions not coordinated with the owner of cables are prohibited in the protection zone. Since UXOs may appear in the area cleared of explosives due to wave action and bottom erosion and migration of sandy debris, periodic bottom inspection is recommended, involving the demining units of the Lithuanian Armed Forces. The Ministry of Defence is informed about all infrastructure elements in territories important for national defence and does not plan actions that could damage them. If unexploded explosives are found during demining, they are not detonated in the cable safety zone.
31	Export cables			

No.	Factor	Hazard	Reasons	Safety measures
				The Border Guard Service is monitoring the EEZ territory. As the threat of intentional damage to energy infrastructure facilities increases, it is necessary to strengthen their protection measures, including military structures.
32; 33	External threats, shipping corridors	Collision of passing passenger and large cargo ships with OWF facilities; critical damage	1) Poor visibility, difficult hydrometeorological conditions 2) Error by the captain (navigator) of a passing vessel, failure to comply with the rules of safe navigation 3) Ship failure, steering gear or engine failure 4) Carrying a drifting ship into the waters of the OWF	Large vessels, the collision of which with objects of the OWF fleet may cause damage to them, shall be equipped with navigational instruments, radio radars, etc. necessary equipment. Distance from the nearest edge of the approximately 8 km wide shipping corridor are 350 m, traffic flow is not intense. The nearest anchorage is 17 km away from the OWF, the drifting time to the OWF is sufficient to start the ship's engines.
34	External threats: shipping corridors	Collision of passing tankers with OWF fleet facilities, critical damage, oil spill		Tankers are equipped with navigational instruments, radars, and other necessary equipment. The distances from the most likely edge of the tanker route to Būtingė are more than 5 km, and the WTGs of the nearest OWF are located between the tankers of this shipping corridors. The nearest anchorages are 17 km away from the OWF, the drifting time to the OWF is sufficient to start the ship's engines.
35	External threats: shipping corridors	Discharge of bilge water	1) Malicious activity	Vessels that commit such a violation are tracked and the captain is held accountable. If the OWF is included in the list of facilities required to prepare a local plan for responding to marine pollution incidents, it shall be obliged to procure the necessary pollution containment equipment and implement measures to manage pollution incidents at sea within its area of responsibility. Should the available resources prove insufficient, the OWF must notify the Lithuanian Navy Maritime Rescue Coordination Centre (LNMRCC).
36	External hazards: nearest cable of unknown origin	Accidental damage to an existing underwater cable	1) Possibility of damage to external cables during repairs of OWF's export cables at intersections	Any repair works within the protection zone of a crossing cable are prohibited without coordination with the organisation operating the cable.
37	External hazards: Būtingė terminal facilities	Possibility of damage to Būtingė terminal facilities	Possible damage to the Būtingė terminal equipment during operation: • The OWF is less than 15 km from the nearest Būtingė facilities	The export cables are installed outside the terminal and oil pipeline protection zones, and there is no possibility of damage to Būtingė terminal's equipment.

No.	Factor	Hazard	Reasons	Safety measures
			• Export cables are laid within the boundaries of the terminal and oil pipeline protection zones	
38	External hazards: fishing areas	Collision of trawlers with OWF objects	1) Poor visibility, difficult hydrometeorological conditions 2) Error by the captain of the fishing vessel 3) Failure to comply with the requirements of the established safety zone 4) Ship failure, engine or steering mechanism failure, the ship becomes uncontrollable	In the OWF, the distances between WTGs are planned to be about 1 km, therefore the decision on the permit to fish in the OWF's water area is made by the contractor before the facility begins operation. It is recommended that the OWF fleet establish a safety zone and provide for activities that will be permitted and prohibited, as well as objects that will be permitted and prohibited from carrying out these activities (ship size, speed, other parameters, traffic safety requirements, etc.).
39	External hazards: dumping areas	Collision of a barge transporting dredged material with a WTG	1) Remote objects, there is no data on planned dumping areas in the vicinity of the OWF	There is no possibility of barges transporting soil colliding with the OWF facilities and damaging these facilities.
40; 41	External threats: tourism activities	Collision of recreational and diving vessels with OWF	1) Remote objects, there is no data on planned pleasure boat routes or diving sites in the vicinity of the OWF	There is no possibility of recreational and diving boats colliding with the OWF facilities and damaging these facilities.
42	External hazards: restricted use zones, national defence territories	WTG damage during military exercises	1) Remote objects, no possibility of damage during operation of the OWF	There are no vulnerable objects.
43; 44	External hazards: unexploded explosives and minefields	Detonation of a migrating explosive device (mine) in the vicinity of the WTG	1) Due to storms and currents, the UXOs migrate and roll into the OWF area, hit the WTG structures and detonate 2) Damage caused by detonating an UXO when it is impossible to retrieve it to a safe distance from OWF	It is recommended to conduct UXO surveys. If a suspicious object is observed, the contractor shall provide for the identification and liquidation of explosives on site or safe removal to disposal sites. Since UXOs may appear in the area cleared of explosives due to wave action and bottom erosion and migration of sandy debris, periodic bottom inspections are recommended, involving the mine clearance units of the Lithuanian Armed Forces.
45; 46	External hazards: coastal flying, air force aircraft and	Damage to OWF turbine blades caused by military aircraft during exercises	1) Due to extreme meteorological conditions, a military aircraft hit the blades of the WTG	The Air Force and Border Guard were informed of the heights and coordinates of the OWF. The Air Force and Border Guard provide information about ongoing exercises.

No.	Factor	Hazard	Reasons	Safety measures
	border guard helicopters		2) Due to extreme meteorological conditions, a Border Guard helicopter crashed into a WTG during exercises or rescue operations 3) Failure of a passing aircraft, loss of control, impact with an OWF	During rescue flights, pilots are informed and additionally instructed about the possibilities of flying into the OWF's offshore area. Flight routes and altitudes in the vicinity of OWF are strictly recommended.
47; 48	External hazards: flying in the coastal zone, flying an unmanned aircraft without an engine, and unauthorized entry into the wind farm	Damage to WTG blades caused by an aircraft in an uncontrolled or loss-of-control situation	1) Sudden increase in wind speed, gusts of wind 2) Inexperienced aircraft pilot 3) Poor visibility, fog, heavy rain 4) Malicious third-party activity, sabotage, attack	Strict rules for issuing permits for unpowered aircraft (balloons, gliders) to fly. Strict wind speed and visibility requirements when issuing permits. Non-powered aircraft training, competency testing. Restriction of commercial and sightseeing flights in the area of the OWFs and their safety zones.
49	Birds	Bird deaths, rotor damage	1) A large flock of migratory birds entering the WTG blade rotation zone in poor visibility conditions	Measures to increase the visibility of blades in fog (bright colours, sound signals, etc.).
The onshore part of the PEA, the landfall, The export cables, ONSs Operational phase, operation of the landfall, export cables and ONSs				
50	Export cables execution	Cable damage during earthworks, electrical leakage	1) Unauthorized excavation work in the land cable protection zone	The location of the cable and the safety zone are indicated on the plans and marked with signs in visible places indicating the distance of the cable from the sign, direction and depth. Strict requirement to carry out all work in the cable protection zone only after obtaining approval from the operating organization. When crossing a cable through a trench, it is mandatory to invite a representative of the operating organization.
51	Operation of ONSs	Transformer oil spill	1) Breach of transformer oil system integrity during installation 2) Spillage during periodic oil replenishment 3) Theft from a substation	The staff is trained, instructed, and experienced. The ONSs are new, tested, without defects. It is recommended to have a minimum amount of marine spill response equipment (containment booms, collection equipment or sorbents) at the construction site. It is recommended to use a fast-degrading oil.
52	Operation of ONSs	Electrical leakage	1) Violation of safety regulations 2) Use of unsuitable materials	The staff is trained, instructed, and experienced. Technical maintenance, using equipment and materials of an appropriate level of security.

No.	Factor	Hazard	Reasons	Safety measures
			1) Failure due to improperly selected security level, unauthorized attempt to enter the transformer stations, or other reasons 2) Untimely or poor-quality maintenance	Alarms and intrusion protection measures.

6.9. Qualitative risk assessment of predicted hazardous events

As specified in the Description of the Procedure for Preparing Environmental Impact Assessment Documents for Planned Economic Activities, qualitative risk assessment is conducted in accordance with the methodological recommendations for the analysis of potential hazards and emergency situations of an economic entity or other institution (hereinafter – FRD recommendations), approved by the Fire and Rescue Department Order No. 1-189 of 2 June 2011.

During the risk assessment, both the probability and the potential consequences of predicted hazardous events are evaluated.

The probability (T) of each identified potential hazard is scored in points according to the criteria for assessing the likelihood of potential hazards provided in the FRD recommendations (Table 6.9.1).

The potential consequences (impacts) of a hazardous event are assessed using the criteria set out in the FRD recommendations. The criteria for evaluating potential impacts on human life and health (P1), property and the environment (P2), and business continuity (P3) are presented in Table 6.9.2.

Table 6.9.1. Criteria for assessing the probability (T) of possible hazardous events according to the FRD recommendations

Assessment of the probability (T) of a potential hazard	Level of probability of potential hazard	Evaluation scores
May occur more than once a year	very high probability	5
May occur once every 1–10 years	high probability	4
May occur once every 10–50 years	average probability	3
May occur once every 50–100 years	low probability	2
May occur less than once every 100 years	very low probability	1

Table 6.9.2. Criteria for assessing potential impacts

Assessment of potential consequences (impacts) on the life and health of the population (P1)	Level of potential consequences (impact)	Assessment scores
There are no deaths or injuries and/or no need to evacuate residents	insignificant	1
1–5 residents injured and/or up to 50 residents evacuated	limited	2
No more than 5 residents were killed and/or 5 to 10 residents were injured and/or 50 to 100 residents were evacuated	large	3
No more than 20 residents died and/or 10 to 50 residents were seriously injured and/or 100 to 200 residents were evacuated	very large	4
More than 20 residents killed and/or more than 50 residents injured and/or more than 200 residents evacuated	catastrophic	5
Assessment of potential consequences (impacts) on property and the environment (P2)		
For economic entities and other institutions – less than 5% of the asset value	insignificant	1
For economic entities and other institutions – from 5 to 10% of the property value	limited	2
For economic entities and other institutions – from 10 to 30% of the asset value	large	3
For economic entities and other institutions – from 30 to 40% of the asset value	very large	4
For economic entities and other institutions – more than 40% of the asset value	catastrophic	5

Assessment of potential consequences (impacts) on the life and health of the population (P1)	Level of potential consequences (impact)	Assessment scores
Assessment of potential consequences (impact) on business continuity (P3)		
When activity is disrupted for up to 6 hours	insignificant	1
When activity is disrupted for 6 to 24 hours	limited	2
When activity is disrupted for 1 to 3 days	large	3
When activity is disrupted for 3 to 30 days	very large	4
When activities are disrupted for more than 30 days	catastrophic	5

The probability of a hazardous event, determined in accordance with the recommendations of the National Hydrometeorological Service, is presented in Table 6.9.3. The likelihood of events of natural origin, given the geographical location of the facility, was assessed based on information provided by the Lithuanian Hydrometeorological Board.

The probabilities of hazardous events arising from technological processes or failures, employee errors (human factors), and design, structural, or equipment-related issues (physical factors) were calculated using statistical data and information from various literature sources concerning extreme natural and technogenic events, risk assessment guidelines and procedures (HAZID, HAZOP), shipping studies in the Baltic Sea, and other relevant materials.

In cases where statistical data are insufficient, the HAZID methodology is applied to estimate the frequency of predicted hazardous events using the following probability scale:

A. **Very rare event –** predominantly theoretical, with no known occurrences in global practice within the industry (during construction, operation, or decommissioning of OWFs) or sufficiently mitigated by accepted prevention measures to preclude such an emergency (e.g., an LNG carrier explosion in collision with an WTG tower); equivalent to very low probability according to FRD recommendations – 1 point.
B. **Rare event –** events that have occurred in the industry but are very infrequent (once in 50–100 years) and require a highly unlikely combination of circumstances; equivalent to low probability according to FRD recommendations – 2 points.
C. **Possible event –** emergency situations that occur infrequently but regularly, at least once a year worldwide, or recorded at least once at a OWF within a region or by an individual developer; equivalent to average probability according to FRD recommendations – 3 points.
D. **Probable event –** emergency situations that have occurred at least once in the region or occur regularly at one of the OWFs operated by the developer; equivalent to high probability according to FRD recommendations – 4 points.
E. **Frequent event –** emergency situations and incidents that occur regularly during the operation of OWFs; equivalent to very high probability according to FRD recommendations – 5 points.

Table 6.9.3. The probability of a hazardous event (in points) calculated according to the FRD recommendations

No.	Potential hazard identified	Event probability [points]
Geographical hazards		
Baltic Sea area		
G1	Natural meteorological phenomenon: wind with a speed of 28–33 m/s	5
G3	Natural meteorological phenomenon: very severe compound frost, when the frost thickness on the wires exceeds 35 mm	4
G4	Natural meteorological phenomenon: very severe frost when frost thickness exceeds 20 mm	5
G5	Natural meteorological phenomenon: very dense fog with visibility ≤100 m, duration ≥12 hours.	4

No.	Potential hazard identified	Event probability [points]
G6	Natural meteorological phenomenon: Very Severe Storm (a complex of dangerous meteorological phenomena)	5
G8	Catastrophic meteorological phenomenon: hurricane, wind speed >33 m/s	4
G9	Natural hydrological phenomenon: very severe icing of ships in the Baltic Sea	4
G10	Natural hydrological phenomenon: very strong waves in the Baltic Sea	5
G11	Other extreme event: earthquake in the OWF area	2
G12	Other extreme event: liquefaction of thixotropic soils from dynamic loads	1
Geographical hazards Onshore		
G2	Natural meteorological phenomenon: very strong wind with a speed of 28–33 m/s	5
G7	Natural meteorological phenomenon: hurricane, wind speed >33 m/s	4
G13	Natural meteorological phenomenon: very severe compound frost, when the frost thickness on the wires exceeds 35 mm	4
G14	Natural meteorological phenomenon: very severe storm (a complex of dangerous meteorological phenomena)	4
Hazards due to technological processes or failures, materials used, design and personnel errors Offshore section of the PEA, OWF and export cable corridors Construction and decommissioning stages		
1	Fuel spillage from a vessel or machinery	3
2	Collision, damage to service vessels	2
3	Personnel injuries during the delivery of workers and cargo to vessels serving the construction of the OWF by transport vessels	3
4	Collision of service vessels with WTGs under construction, critical damage	2
5	Falling of lifted objects, damage to the ship, serious injuries	3
6	Collapse of WTGs towers under construction	1
7	Installer falls from a great height	2
8	Collision of passing vessels with service vessels, critical damage	2
9	Collision of passing vessels with WTG under construction, critical damage	2
10	Collision of vessels involved in the works near the offshore part of the Būtingė terminal and the port of Šventoji, critical damage	1
11	Accidental damage to an existing underwater cable during ground surveys	2
12	Damaged UXOs during foundation installation or construction	1
13	Damaged UXOs during cable installation	1
14	Collision of a passing aircraft with high-rise OWF structures	1
15	Transformer oil spill into the water area during OSS filling	2
16	Electrical leakage in an OSS	4
Onshore section of the PEA, export cables and ONSs Construction phase, installation of export cables and ONSs		
17	Transformer oil spill	2
18	Electrical leakage in a ONSs	4
The offshore section of the PEA, OWF and the export cable corridors Operational phase, operation of an OWF and infrastructure		
19	Damage and/or ejection of WTG rotor blades	2
20	WTG collapse	2

No.	Potential hazard identified	Event probability [points]
21	Fire in the WTG nacelle	2
22	Rotor oil spillage in WTG	2
23	Current leakage in WTG electrical installations	3
24	Fire in WTG electrical equipment	2
25	Settlement of the WTG foundations, weakening and loss of tower stability, possible collapse	1
26	Fire in OSS electrical equipment	2
27	Transformer oil spills into the water during operation	2
28	Settlement of the substation foundations, loss of stability of the transformer platform, possible collapse	1
29	Electrical leakage in a marine transformer substation	3
30	Damage to the OWF electrical cable to ONS, current leakage	2
The offshore part of the PEA, the OWF and the export cable corridors		
Operation phase, operation of wind farms and infrastructure		
31	Damage to the export cable, current leakage	2
Operational phase, activities carried out in the vicinity of OWF and infrastructure		
32	Collision of passing passenger ships with OWF facilities, critical damage	1
33	Collision of passing cargo ships with OWF objects, critical damage	2
34	Collision of passing tankers with OWF facilities, oil spill	2
35	Discharge of bilge water	3
36	Accidental damage to an existing underwater cable	1
37	Damage to the marine equipment of the Būtingė terminal	1
38	Collision of trawling fishing vessels with OWF objects	2
39	Collision of ships bringing soil with OWF	0
40	Pleasure boat collision with OWF	1
41	Diving boats collide with OWF	1
42	OWF damage during military exercises	1
43	A migrating UXO spotted in the OWF	2
44	A migrating UXO rolled into the OWF detonates near the WTG	1
45	Damage to WTG by military aircraft during exercises	1
46	Damage to WTG by border service helicopters during exercises	1
47	Damage to the blades of a WTG aircraft due to uncontrolled or lost control	2
48	Unmanned aircraft without engine and unauthorized entry into the OWF fleet	2
49	Death of birds due to birds colliding with blade, rotor damage	4
Onshore section of the PEA, export cables and ONSs		
Operational phase, operation of export cables and ONSs		
50	Damage to export cable during earthworks, electrical leakage	3
51	Transformer oil spillage during ONSs operation	2
52	Electric current leakage in an ONSs during operation	3

The potential impact of a hazardous event on human life and health (P1) determined in accordance with the FRD recommendations is presented in Table 6.9.4. The criteria are presented in Table 6.9.2.

Table 6.9.4. Impact on human life and health (P1) calculated according to the FRD recommendations

No.	Potential hazard identified	Number of victims (FRD criterion)	Scores
Geographical hazards Baltic Sea area			
G1	Natural meteorological phenomenon: wind with a speed of 28–33 m/s	Injured 1–5 people.	2
G3	Natural meteorological phenomenon: very severe compound frost, frost thickness on wires exceeds 35 mm	No injuries, no evacuation required	1
G4	Natural meteorological phenomenon: very severe frost when frost thickness exceeds 20 mm	No injuries, no evacuation required	1
G5	Natural meteorological phenomenon: very dense fog, visibility ≤100 m, duration ≥ 12 hours.	Injured 1–5 people.	2
G6	Natural meteorological phenomenon: very severe storm	Injured 1–5 people.	2
G8	Natural meteorological phenomenon: hurricane, wind speed >33 m/s	1–5 people died. 5–10 people injured.	3
G9	Natural hydrological phenomenon: very severe icing of ships in the Baltic Sea	No injuries, no evacuation required	1
G10	Natural hydrological phenomenon: very strong waves in the Baltic Sea	Injured 1–5 people.	2
G11	Other extreme event: earthquake in the OWF area	Injured 1–5 people.	2
G12	Other extreme event: liquefaction of thixotropic soils from dynamic loads	Injured 1–5 people.	2
Geographical hazards Onshore			
G2	Natural meteorological phenomenon: very strong wind with a speed of 28–33 m/s	Injured 1–5 people.	2
G7	Natural meteorological phenomenon: hurricane, wind speed >33 m/s	1–5 people died. 5–10 people injured.	3
G13	Natural meteorological phenomenon: very severe compound frost, thickness on wires > 35 mm	No injuries, no evacuation required	1
G14	Natural meteorological phenomenon: very severe storm	Injured 1–5 people.	2
Hazards due to technological processes or failures, materials used, design and personnel errors Offshore section of the PEA, OWF and export cable corridors Construction and decommissioning stages			
1	Fuel spillage from a vessel or machinery	No injuries, no evacuation required	1
2	Collision, damage to service vessels	Injured 1–5 people.	2
3	Personnel injuries during the delivery of workers and cargo to vessels serving the construction of the OWF by transport vessels	Injured 1–5 people.	2
4	Collision of service vessels with WTGs under construction, critical damage	Injured 1–5 people.	2
5	Falling of lifted objects, damage to the ship, serious injuries	5–10 people injured.	3
6	Collapse of WTG towers under construction	5–10 people injured.	3
7	Installer falls from a great height	1 person died.	3

No.	Potential hazard identified	Number of victims (FRD criterion)	Scores
8	Collision of passing vessels with service vessels, critical damage	5–10 people injured.	3
9	Collision of passing ships with WTGs under construction, critical damage	Injured 1–5 people.	2
10	Collision of ships involved in the works near the offshore part of the Būtingė terminal and the port of Šventoji, critical damage	Injured 1–5 people.	2
11	Accidental damage to an existing underwater cable during ground surveys	No injuries, no evacuation required	1
12	Damaged UXO during foundation installation or construction	1–5 people died. 5–10 people injured.	3
13	Damaged UXO during cable installation	1–5 people died. 5–10 people injured.	3
14	Collision of a passing aircraft with high-rise OWF structures	1 person died.	3
15	Transformer oil spill into the water area during OSS filling	No injuries, no evacuation required	1
Hazards due to technological processes or failures, materials used, design and personnel errors			
16	Electrical leakage in an OSS	1–5 people died.	3
Onshore section of the PEA, export cables and ONSs Construction phase, installation of export cables and ONSs			
17	Transformers oil spill	No injuries, no evacuation required	1
18	Electrical leakage in a ONSs	1–5 people died.	3
Offshore of the PEA, OWF and export cable corridors Operational phase, operation of OWF and infrastructure			
19	Damage and/or ejection of OWF rotor blades	1–5 people died. 5–10 people injured.	3
20	WTG Collapse	1–5 people died. 5–10 people injured.	3
21	Fire in the WTG nacelle	1–5 people died. 5–10 people injured.	3
22	Rotor oil spillage in WTG	No injuries, no evacuation required	1
23	Current leakage in WTG electrical installations	Injured 1–5 people.	2
24	Fire in WTG electrical equipment	1–5 people died. 5–10 people injured.	3
25	Settlement of the WTG foundations, weakening and loss of WTG tower stability, possible collapse	1–5 people died. 5–10 people injured.	3
26	Fire in OSS electrical equipment	Injured 1–5 people.	2
27	Transformer oil spills into the water area during operation	No injuries, no evacuation required	1
28	Settlement of the substation foundations, loss of stability of the OSS platform, possible collapse	1–5 people died. 5–10 people injured.	3
29	Electrical leakage in a marine transformer substation	Injured 1–5 people.	2

No.	Potential hazard identified	Number of victims (FRD criterion)	Scores
30	Damage to the OWF inter-array cable to OSS, current leakage	Injured 1–5 people.	2
31	Damage to the export cable, current leakage	Injured 1–5 people.	2
Operation phase, activities carried out in the vicinity of OWF and infrastructure			
32	Collision of passing passenger ships with OWF facilities, critical damage	1–5 people died. 5–10 people injured.	3
33	Collision of passing cargo ships with OWF objects, critical damage	1–5 people died. 5–10 people injured.	3
34	Collision of passing tankers with OWF facilities, oil spill	1–5 people died. 5–10 people injured.	3
35	Discharge of bilge water	No injuries, no evacuation required	1
36	Accidental damage to an existing underwater cable	Injured 1–5 people.	2
37	Damage to the marine equipment of the Būtingė terminal	Injured 1–5 people.	2
38	Collision of trawling fishing vessels with OWF objects	Injured 1–5 people.	2
39	Collision of ships bringing soil with OWF	Injured 1–5 people.	2
40	Pleasure boat collision with OWF	Injured 1–5 people.	2
41	Diving boat collision with OWF	Injured 1–5 people.	2
Hazards due to technological processes or failures, materials used, design and personnel errors Offshore section of the PEA, the OWF and the export cable corridors Operational phase, activities carried out in the vicinity of WTGs and infrastructure			
42	OWF damage during military exercises	No injuries, no evacuation required	1
43	A migrating UXO spotted in the OWF water area	Evacuation from the zone	2
44	A migrating UXO device rolled into the OWF detonates near the WTG	1–5 people died. 5–10 people injured.	3
45	Damage to WTG blades by military aircraft during exercises	1–5 people died. 5–10 people injured.	3
46	Damage to WTG blades by border service helicopters during exercises	1–5 people died. 5–10 people injured.	3
47	Damage to the blades of a WTG by aircraft in an uncontrolled or lost-control situation	1–5 people died. 5–10 people injured.	3
48	Unmanned aircraft without engine and unauthorized entry into the OWF fleet	1–5 people died. 5–10 people injured.	3
49	Death of birds due to birds colliding with blade, rotor damage	No injuries, no evacuation required	1
Onshore section of the PEA, export cables and ONSs Operational phase, operation of export cables and ONSs			
50	Damage to export cable during earthworks, electrical leakage	Injured 1–5 people.	2
51	Transformer oil spillage during ONSs operation	No injuries, no evacuation required	1
52	Electrical leakage in an ONSs during operation	1–5 people died. 5–10 people injured.	3

Possible consequences (impact) on property and expected losses have been identified, as well as possible environmental pollution, possible consequences (impact) and expected losses to the environment. Criteria presented in Table 6.9.2.

The FRD recommends assessing the impact of the asset recommendations as a percentage of the asset value. In the early planning stages, there is still no accurate data on the assets of the planned OWF, therefore it is appropriate to accept specific amounts that are determined by the PEA implementer himself. The proposed amounts are those that are commonly used in carrying out HAZID procedures in similar facilities:

A. Impact on assets, means of production, other direct business losses (1–5 points):
    a) Losses up to 100 thousand EUR – equated to an insignificant impact on assets according to the FRD recommendations: 1 point.
    b) Losses from 100 to 200 thousand EUR – equated to limited impact on assets according to the FRD recommendations: 2 points.
    c) Losses from 200 thousand EUR to 1 million EUR – equated to a significant impact on assets according to the FRD recommendations: 3 points.
    d) Losses of 1–5 million EUR – equated to a very significant impact on assets according to the FRD recommendations: 4 points.
    e) Losses in the company and the region exceed 5 million EUR – equated to a catastrophic impact according to the FRD recommendations: 5 points.

The potential impact of a hazardous event on assets, determined in accordance with the FRD recommendations, is presented in Table 6.9.5.

The environmental impact at the EIA stage is assessed according to criteria that are usually used in conducting HAZID procedures in similar facilities and allow for an approximate assessment not only of the damage expressed in losses, which is included in the total losses to property and the environment (P2), but also of the objective impact on individual environmental components, expressed in the exceeding of established limit values, the spread of pollution, the impact on the ecosystem and the need for cleaning and restoration of territories:

- **Minor impact** – spills, evaporation of hazardous substances, concentrations do not exceed limit values.
- **Small but noticeable impact** – the impact is noticeable but short-term, small spills, water pollution, limit values are exceeded briefly.
- **Localized impact** – limited spills of hazardous substances, not spreading widely, but requiring liquidation work, cleaning, containment measures, spreading beyond the boundaries of the OWF. Onshore – spreading of groundwater pollution, but surface water sources are not accessible, exceeding of limit values.
- **Major impact** – large-scale material spills and emissions, causing losses to the companies operating them, requiring costly clean-up work, covering not only the OWF, but also adjacent territories.
- **Regional negative impact on the entire ecosystem** – has an impact on the entire ecosystem, causes significant commercial losses, and violates the recreational and environmental interests of the region.

The impact on the environment and its components is presented in Table 6.9.6. The losses incurred by the company due to environmental damage are added to those determined in Table 6.9.5 and the total loss to property and the environment (P2) is calculated.

Table 6.9.5. Impact on assets (P2) calculated according to the FRD recommendations

No.	Potential hazard identified	Possible impact	Scores
Geographical hazards			
Baltic Sea area			
G1	Natural meteorological phenomenon: wind with a speed of 28–33 m/s	limited	2
G3	Natural meteorological phenomenon: very severe compound frost, frost thickness on wires exceeds 35 mm	insignificant	1

No.	Potential hazard identified	Possible impact	Scores
G4	Natural meteorological phenomenon: very severe frost when frost thickness exceeds 20 mm	insignificant	1
G5	Natural meteorological phenomenon: very dense fog, visibility ≤100 m, duration ≥ 12 hours.	large	3
G6	Natural meteorological phenomenon: very severe storm	limited	2
G8	Natural meteorological phenomenon: hurricane, wind speed >33 m/s	large	3
G9	Natural hydrological phenomenon: very severe icing of ships in the Baltic Sea	insignificant	1
G10	Natural hydrological phenomenon: very strong waves in the Baltic Sea	limited	2
G11	Other extreme event: earthquake in the OWF area	large	3
G12	Other extreme event: liquefaction of thixotropic soils from dynamic loads	large	3
Geographical hazards Onshore			
G2	Natural meteorological phenomenon: very strong wind with a speed of 28–33 m/s	limited	2
G7	Natural meteorological phenomenon: hurricane, wind speed >33 m/s	large	3
G13	Natural meteorological phenomenon: very severe compound frost, thickness on wires > 35 mm	limited	2
G14	Natural meteorological phenomenon: very severe storm	limited	2
Offshore section of the PEA, OWF and export cable corridors Construction and decommissioning stages			
1	Fuel spillage from a vessel or machinery	insignificant	1
2	Collision, damage to service vessels	large	3
3	Personnel injuries during the delivery of workers and cargo to vessels serving the construction of the OWF by transport vessels	limited	2
4	Collision of service vessels with WTGs under construction, critical damage	large	3
5	Falling of lifted objects, damage to the ship, serious injuries	limited	2
6	Collapse of WTGs towers under construction	large	3
7	Installer falls from a great height	insignificant	1
8	Collision of passing vessels with service vessels, critical damage	large	3
9	Collision of passing vessels with WTG under construction, critical damage	large	3
10	Collision of vessels involved in the works near the offshore part of the Būtingė terminal and the port of Šventoji, critical damage	large	3
11	Accidental damage to an existing underwater cable during ground surveys	large	3
12	Damaged UXOs during foundation installation or construction	large	3
13	Damaged UXOs during cable installation	large	3
14	Collision of a passing aircraft with high-rise OWF structures	large	3
15	Transformer oil spill into the water area during OSS filling	insignificant	1
16	Electrical leakage in an OSS	insignificant	1
Onshore section of the PEA, export cables and ONSs Construction phase, installation of export cables and ONSs			
17	Transformer oil spill	insignificant	1

No.	Potential hazard identified	Possible impact	Scores
18	Electrical leakage in a ONSs	insignificant	1
Offshore section of the PEA, OWF and export cable corridors Operational phase, operation of OWFs and infrastructure			
19	Damage and/or ejection of OWF rotor blades	limited	2
20	WTG Collapse	large	3
21	Fire in the WTG nacelle	limited	2
22	Rotor oil spillage in WTG	insignificant	1
23	Current leakage in WTG electrical installations	insignificant	1
24	Fire in WTG electrical equipment	limited	2
25	Settlement of the WTG foundations, weakening and loss of WTG tower stability, possible collapse	large	3
26	Fire in OSS electrical equipment	large	3
27	Transformer oil spills into the water area during operation	insignificant	1
28	Settlement of the substation foundations, loss of stability of the OSS platform, possible collapse	large	3
Hazards due to technological processes or failures, materials used, design and personnel errors Offshore section of the PEA, OWF and export cable corridors Operational phase, operation of OWF and infrastructure			
29	Electrical leakage in an OSS	limited	2
30	Damage to the OWF's inter array cables, current leakage	limited	2
31	Damage to the export cable, current leakage	limited	2
Operation phase, activities carried out in the vicinity of OWF and infrastructure			
32	Collision of passing passenger ships with OWF facilities, critical damage	large	3
33	Collision of passing cargo ships with OWF objects, critical damage	large	3
34	Collision of passing tankers with OWF facilities, oil spill	large	3
35	Discharge of bilge water	insignificant	1
36	Accidental damage to an existing underwater cable	large	3
37	Damage to the marine equipment of the Būtingė terminal	large	3
38	Collision of trawling fishing vessels with OWF objects	limited	2
39	Collision of ships bringing soil with OWF	limited	2
40	Pleasure boat collision with OWF	insignificant	1
41	Diving boats collide with OWF	insignificant	1
42	OWF damage during military exercises	insignificant	1
43	A migrating UXO spotted in the OWF	large	3
44	A migrating UXO rolled into the OWF detonates near the WTG	limited	2
45	Damage to WTG by military aircraft during exercises	large	3
46	Damage to WTG by border service helicopters during exercises	large	3
47	Damage to the blades of a WTG aircraft due to uncontrolled or lost control	large	3
48	Unmanned aircraft without engine and unauthorized entry into the OWF fleet	large	3
49	Deaths of birds flying into rotating blades, rotor damage	large	1
Onshore section of the PEA, export cables and ONSs Operational phase, operation of export cables and ONSs			
50	Damage to export cable during earthworks, electrical leakage	insignificant	2

No.	Potential hazard identified	Possible impact	Scores
51	Transformer oil spillage during ONSs operation	limited	1
52	Electrical leakage in an ONSs during operation	insignificant	2

Table 6.9.6. Environmental impact of potential hazardous events (P2)

No.	Potential hazard identified	Possible air pollution	Possible surface-groundwater pollution	Possible soil contamination	Possible impact on the natural environment	Estimated material losses	Scores
Geographical hazards Baltic Sea area							
G1	Natural meteorological phenomenon: wind with a speed of 28–33 m/s	None	None	None	Insignificant	Insignificant	1
G3	Natural meteorological phenomenon: very severe compound frost, frost thickness on wires exceeds 35 mm	None	None	None	Insignificant	Insignificant	1
G4	Natural meteorological phenomenon: very severe frost when frost thickness exceeds 20 mm	None	None	None	Insignificant	Insignificant	1
G5	Natural meteorological phenomenon: very dense fog, visibility ≤100 m, duration ≥ 12 hours.	None	None	None	Insignificant	Insignificant	1
G6	Natural meteorological phenomenon: very severe storm	None	None	None	Insignificant	Insignificant	1
G8	Natural meteorological phenomenon: hurricane, wind speed >33 m/s	Limited, localized effect	Limited, localized effect	None	Limited	Limit	2
G9	Natural hydrological phenomenon: very severe icing of ships in the Baltic Sea	None	Limited, localized effect	None	Limited	Limit	2
G10	Natural hydrological phenomenon: very strong waves in the Baltic Sea	None	Limited, localized effect	None	Limited	Limit	2
G11	Other extreme event: earthquake in the OWF area	Limited, localized effect	Limited, localized effect	Limited, localized effect	Limited	Limit	2
G12	Other extreme event: liquefaction of thixotropic soils from dynamic loads	None	Limited, localized effect	None	Limited	Limit	2
Geographical hazards Onshore Lithuania							
G2	Natural meteorological phenomenon: very strong wind with a speed of 28–33 m/s	Limited, localized effect	Limited, localized effect	None	Limited	Limit	2
G7	Natural meteorological phenomenon: hurricane, wind speed >33 m/s	Limited, localized effect	Limited, localized effect	None	Limited	Limit	2

No.	Potential hazard identified	Possible air pollution	Possible surface-groundwater pollution	Possible soil contamination	Possible impact on the natural environment	Estimated material losses	Scores
G13	Natural meteorological phenomenon: very severe storm	None	None	None	Insignificant	Insignificant	1
G14	Natural meteorological phenomenon: very strong wind with a speed of 28–33 m/s	Limited, localized effect	Limited, localized effect	None	Limited	Limit	2
Offshore section of the PEA, OWF and export cable corridors							
Construction and decommissioning stages							
1	Fuel spillage from a vessel or machinery	None	Limited, localized effect	None	Limited	Limit	2
2	Collision, damage to service vessels	Insignificant	Limited	Insignificant	Limited	Limit	2
3	Personnel injuries during the delivery of workers and cargo to vessels serving the construction of the OWF by transport vessels	None	None	None	None	Insignificant	1
4	Collision of service vessels with WTGs under construction, critical damage	Insignificant	Limited	Insignificant	Limited	Insignificant	2
5	Falling of lifted objects, damage to the ship, serious injuries	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	1
6	Collapse of WTGs towers under construction	Insignificant	Limited	Insignificant	Limited	Limit	2
7	Installer falls from a great height	None	None	None	None	Insignificant	1
8	Collision of passing vessels with service vessels, critical damage	Insignificant	Limited	Insignificant	Limit	Insignificant	2
9	Collision of passing vessels with WTG under construction, critical damage	Insignificant	Limited	Insignificant	Limit	Insignificant	2
10	Collision of vessels involved in the works near the offshore part of the Būtingė terminal and the port of Šventoji, critical damage	Limited	Large	Limited	Large	Limit	3
11	Accidental damage to an existing underwater cable during ground surveys	None	None	None	Insignificant	Insignificant	1
12	Damaged UXOs during foundation installation or construction	Insignificant	Limited	Limited	Limit	Limit	2

No.	Potential hazard identified	Possible air pollution	Possible surface-groundwater pollution	Possible soil contamination	Possible impact on the natural environment	Estimated material losses	Scores
13	Damaged UXOs during cable installation	Insignificant	Limited	Limited	Limit	Limit	2
14	Collision of a passing aircraft with high-rise OWF structures	Insignificant	Limited	Insignificant	Limit	Limit	2
15	Transformer oil spill into the water area during OSS filling	Insignificant	Limited	Insignificant	Limit	Limit	2
16	Electrical leakage in an OSS	None	None	None	Limited	Insignificant	2
Hazards due to technological processes or failures, materials used, design and personnel errors Construction phase, Installation of export cable and OSS							
17	Transformer oil spill	Insignificant	Limited	Limited	Limited	Insignificant	2
18	Electrical leakage in an ONSs	None	None	None	Insignificant	Insignificant	1
Operation phase, operation of OWF and infrastructure							
19	Damage and/or ejection of WTG rotor blades	None	None	Insignificant	Insignificant	Insignificant	1
20	WTG collapse	Insignificant	Limited	Limited	Limited	Limit	2
21	Fire in the WTG nacelle	Limited	Insignificant	Insignificant	Limited	Insignificant	2
Hazards due to technological processes or failures, materials used, design and personnel errors Operational phase, operation of OWF and infrastructure							
22	Rotor oil spillage in WTG	None	Insignificant	None	Insignificant	Insignificant	1
23	Current leakage in WTG electrical installations	None	None	None	Limited	Insignificant	2
24	Fire in WTG electrical equipment	Limited	Insignificant	Insignificant	Limited	Insignificant	2
25	Settlement of the WTG foundations, weakening and loss of WTG tower stability, possible collapse	Insignificant	Limited	Limited	Limited	Limit	2
26	Fire in OSS electrical equipment	Limited	Insignificant	Insignificant	Limited	Insignificant	2
27	Transformer oil spills into the water area during operation	None	Limited	Insignificant	Limit	Insignificant	2
28	Settlement of the substation foundations, loss of stability of the OSS platform, possible collapse	None	Large	Limited	Limited	Limit	3

No.	Potential hazard identified	Possible air pollution	Possible surface-groundwater pollution	Possible soil contamination	Possible impact on the natural environment	Estimated material losses	Scores
29	Electrical leakage in an OSS	None	None	None	Limited	Insignificant	2
30	Damage to the OWF's inter array cables, current leakage	None	None	None	Insignificant	Insignificant	1
31	Damage to the export cable, current leakage	None	None	None	Limited	Insignificant	2
Operation phase, activities carried out in the vicinity of OWF and infrastructure							
32	Collision of passing passenger ships with OWF facilities, critical damage	Insignificant	Limited	Insignificant	Limit	Insignificant	2
33	Collision of passing cargo ships with OWF objects, critical damage	Insignificant	Limited	Insignificant	Limit	Insignificant	2
Hazards due to technological processes or failures, materials used, design and personnel errors Offshore section of the PEA, OWF and export cable corridors Operational phase, activities carried out in the vicinity of OWF and infrastructure							
34	Collision of passing tankers with OWF facilities, oil spill	Limited	Very large	Very large	Very large	Very large	4
35	Discharge of bilge water	None	Limited	Insignificant	Limited	Insignificant	2
36	Accidental damage to an existing underwater cable	None	None	None	Insignificant	Insignificant	1
37	Damage to the marine equipment of the Būtingė terminal	Limited	Large	Large	Large	Large	3
38	Collision of trawling fishing vessels with OWF objects	None	Insignificant	None	Insignificant	Insignificant	1
39	Collision of ships bringing soil with OWF	None	Insignificant	None	Insignificant	Insignificant	1
40	Pleasure boat collision with OWF	None	Insignificant	None	Insignificant	Insignificant	1
41	Diving boats collide with OWF	None	Insignificant	None	Insignificant	Insignificant	1
42	OWF damage during military exercises	Limited	Limited	Insignificant	Limited	Limit	2
43	A migrating UXO spotted in the OWF	None	Insignificant	None	Insignificant	Insignificant	1
44	A migrating UXO rolled into the OWF detonates near the WTG	Limited	Limited	Limited	Limited	Limit	2
45	Damage to WTG by military aircraft during exercises	Limited	Limited	None	Limited	Limit	2

No.	Potential hazard identified	Possible air pollution	Possible surface-groundwater pollution	Possible soil contamination	Possible impact on the natural environment	Estimated material losses	Scores
46	Damage to WTG by border service helicopters during exercises	Limited	Limited	None	Limited	Limit	2
47	Damage to the blades of a WTG aircraft due to uncontrolled or lost control	Limited	Limited	None	Limited	Limit	2
48	Unmanned aircraft without engine and unauthorized entry into the OWF fleet	Limited	Limited	None	Limited	Limit	2
49	Deaths of birds flying into rotating blades, rotor damage	None	None	None	Limited	Insignificant	2
Onshore section of the PEA, export cables and ONSs Operational phase, operation of export cables and ONSs							
50	Damage to export cable during earthworks, electrical leakage	None	None	None	Insignificant	Insignificant	1
51	Transformer oil spillage during ONSs operation	Insignificant	Limited	Limited	Limited	Insignificant	2
52	Electrical leakage in an ONSs during operation	None	None	None	Limited	Insignificant	1

The potential impact of a hazardous event on business continuity, as determined in accordance with the FRD recommendations, is presented in Table 6.9.7, while the criteria for assessing such impacts are provided in Table 6.9.2.

The assessment of potential impacts on business continuity includes specifying the timeframe, in hours or days, within which the consequences of the incident should be mitigated and operations restored.

Table 6.9.7. Impact on business continuity (in points) determined according to the FRD recommendations (P3)

Serial No.	Potential hazard identified	Impact on business continuity (FRD criterion)	Duration of exposure, hours (day)	Scores
Geographical hazards Baltic Sea area				
G1	Natural meteorological phenomenon: wind with a speed of 28–33 m/s	Limited	6–24	2
G3	Natural meteorological phenomenon: very severe compound frost, frost thickness on wires exceeds 35 mm	Limited	6–24	2
G4	Natural meteorological phenomenon: very severe frost when frost thickness exceeds 20 mm	Insignificant	<6	1
G5	Natural meteorological phenomenon: very dense fog, visibility ≤100 m, duration ≥ 12 hours.	Limited	6–24	2
G6	Natural meteorological phenomenon: very severe storm	Limited	6–24	2
G8	Natural meteorological phenomenon: hurricane, wind speed >33 m/s	Large	1–3 days	3
G9	Natural hydrological phenomenon: very severe icing of ships in the Baltic Sea	Insignificant	<6	1
G10	Natural hydrological phenomenon: very strong waves in the Baltic Sea	Limited	6–24	2
G11	Other extreme event: earthquake in the OWF area	Large	1–3 days	3
G12	Other extreme event: liquefaction of thixotropic soils from dynamic loads	Large	1–3 days	3
Geographical hazards Onshore				
G2	Natural meteorological phenomenon: very strong wind with a speed of 28–33 m/s	Limited	6–24	2
G7	Natural meteorological phenomenon: hurricane, wind speed >33 m/s	Large	1–3 days	3
G13	Natural meteorological phenomenon: very severe storm	Limited	6–24	2
G14	Natural meteorological phenomenon: very strong wind with a speed of 28–33 m/s	Limited	6–24	2
Hazards due to technological processes or failures, materials used, design and personnel errors Offshore section of the PEA, OWF and export cable corridors Construction and decommissioning stages				
1	Fuel spillage from a vessel or machinery	No effect	–	0
2	Collision, damage to service vessels	Limited	6–24	2
3	Personnel injuries during the delivery of workers and cargo to vessels serving the construction of the OWF by transport vessels	Insignificant	<6	1
4	Collision of service vessels with WTGs under construction, critical damage	Limited	6–24	2

Serial No.	Potential hazard identified	Impact on business continuity (FRD criterion)	Duration of exposure, hours (day)	Scores
5	Falling of lifted objects, damage to the ship, serious injuries	Insignificant	<6	1
6	Collapse of WTGs towers under construction	Large	1–3 days	3
7	Installer falls from a great height	Insignificant	<6	1
8	Collision of passing vessels with service vessels, critical damage	Limited	6–24	2
9	Collision of passing vessels with WTG under construction, critical damage	Limited	6–24	2
10	Collision of vessels involved in the works near the offshore part of the Būtingė terminal and the port of Šventoji, critical damage	Limited	6–24	2
11	Accidental damage to an existing underwater cable during ground surveys	Large	1–3 days	3
12	Damaged UXOs during foundation installation or construction	Large	1–3 days	3
13	Damaged UXOs during cable installation	Large	1–3 days	3
14	Collision of a passing aircraft with high-rise OWF structures	Large	1–3 days	3
15	Transformer oil spill into the water area during OSS filling	Insignificant	<6	1
16	Electrical leakage in an OSS	Limited	6–24	2
Onshore section of the PEA, export cables and ONSs Construction phase, installation of export cables and ONSs				
17	Transformer oil spill	Insignificant	<6	1
18	Electrical leakage in an ONSs	Limited	6–24	2
Offshore part of the PEA, the OWF and the export cable corridors Operational phase, operation of OWF and infrastructure				
19	Damage and/or ejection of WTG rotor blades	Insignificant	<6	1
20	WTG tower Collapse	Limited	6–24	2
21	Fire in the WTG nacelle	Insignificant	<6	1
22	Rotor oil spillage in WTG	Insignificant	<6	1
23	Current leakage in WTG electrical installations	Insignificant	<6	1
24	Fire in WTG electrical installations	Insignificant	<6	1
25	Settlement of WTG foundations, weakening and loss of tower stability, collapse	Limited	6–24	2
26	Fire in ONSs electrical equipment	Very large	3–30 days	4
27	Transformer oil spills into the water during operation	Limited	6–24	2
28	Settlement of ONSs foundations, loss of stability of the ONS platform, collapse	Very large	3–30 days	4
29	Electrical leakage in ONSs	Limited	6–24	2
Offshore section of the PEA, OWF and export cable corridors Operational phase, operation of OWF and infrastructure				
30	Damage to the OWF's inter array cables, current leakage	Limited	6–24	2
31	Damage to the export cable, current leakage	Very large	3–30 days	4
Operational phase, activities carried out in the vicinity of OWF and infrastructure				

Serial No.	Potential hazard identified	Impact on business continuity (FRD criterion)	Duration of exposure, hours (day)	Scores
32	Collision of passing passenger ships with OWF facilities, critical damage	Limited	6–24	2
33	Collision of passing cargo ships with OWF objects, critical damage	Limited	6–24	2
34	Collision of passing tankers with OWF facilities, oil spill	Large	1–3 days	3
35	Discharge of bilge water	No effect	–	0
36	Accidental damage to an existing underwater cable	No effect	–	0
37	Damage to the marine equipment of the Būtingė terminal	No effect	–	0
38	Collision of trawling fishing vessels with OWF objects	No effect	–	0
39	Collision of ships bringing soil with OWF	No effect	–	0
40	Pleasure boat collision with OWF	No effect	–	0
41	Diving boats collide with OWF	No effect	–	0
42	OWF damage during military exercises	Insignificant	>6	1
43	A migrating UXO spotted in the OWF	Limited	6–24	2
44	A migrating UXO rolled into the OWF detonates near the WTG	Limited	6–24	2
45	Damage to WTG by military aircraft during exercises	Insignificant	>6	1
46	Damage to WTG by border service helicopters during exercises	Insignificant	>6	1
47	Damage to the blades of a WTG aircraft due to uncontrolled or lost control	Insignificant	>6	1
48	Unmanned aircraft without engine and unauthorized entry into the OWF fleet	Insignificant	>6	1
49	Deaths of birds flying into rotating blades, rotor damage	Insignificant	>6	1
Onshore section of the PEA, mainland export cables and transformer substations Operation phase, operation of onshore power transmission cables and transformer substations				
50	Damage to export cable during earthworks, electrical leakage	Large	1–3 days	3
51	Transformer oil spillage during ONSs operation	Limited	6–24	2
52	Electrical leakage in an ONSs during operation	Limited	6–24	2

6.9.1. Determining the level of risk and its acceptability

The FRD recommendations indicate that the risk level of identified potential hazardous events is calculated according to the formula R=T*P (R – risk, T – probability, P – consequences (impact)).

Using the risk matrix of the FRD recommendations (Fig. 6.9.1), based on the probability (T) and potential consequences (impact) (P) scores of the identified potential hazards, the risk level (R1, R2, R3) of each potential hazard is determined according to the nature of the consequences: very high, high, medium or acceptable.

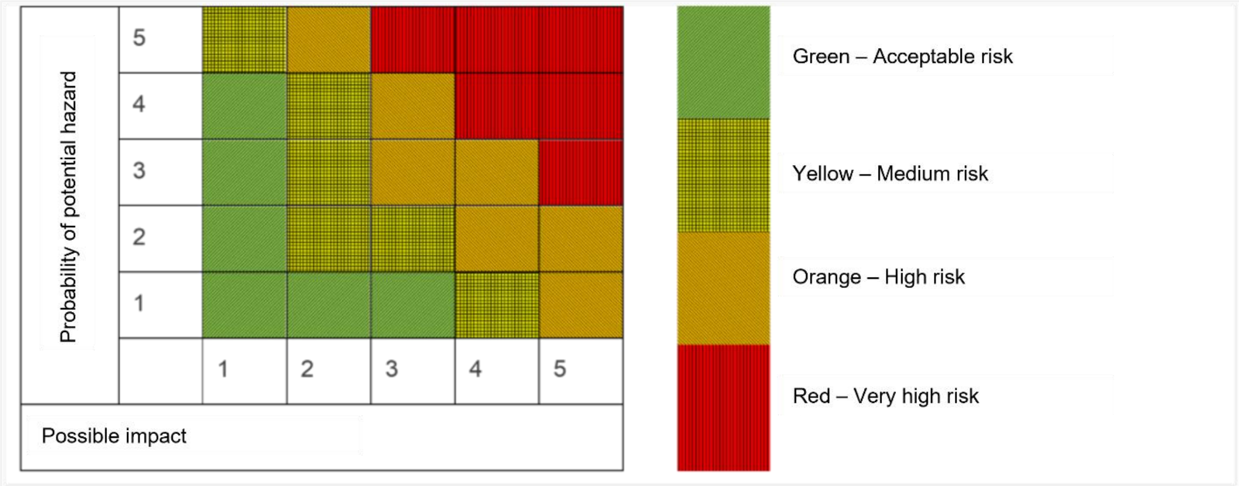


Fig. 6.9.1 Risk matrix of FRD recommendations.

After determining the risk levels for each potential hazard based on the nature of the consequences, the overall risk level (R) of the potential hazards is determined for each analysed potential hazard, i.e.:

- the risk scores (R1, R2 and R3) obtained by the nature of potential hazards are summed up
- the overall risk (R) level (very high, high, medium or acceptable) for each potential hazard is identified, which is determined by adding the values of R1, R2 and R3. This data can be used to compile a list of potential hazards for the municipality in order of priority according to their risk level.

The risk assessment of potential hazards is presented in Table 6.9.8. After the risk assessment of potential hazards is performed, the priorities of potential hazards are determined. Potential hazards are considered, in order of priority:

- hazards that cause major consequences (impact) and are highly probable
- hazards that cause major consequences
- hazards that are of high probability
- all other hazards in order of decreasing overall risk level.

If a very high and high general risk is identified, measures to reduce the risk of possible hazardous events must be provided. The recommendations of the FRD indicate that they must be provided for in the emergency prevention measures plan of the economic entity or other institution. For planned facilities, when RA is performed during the EIA process, measures to reduce the risk of such hazardous events must be provided for when preparing the technical design and implemented during construction. These measures must:

- reduce the likelihood of a potential hazard and/or potential consequences (impact)
- improve preparedness to respond to and eliminate incidents and their consequences
- to increase the safety of employees of an economic entity or other institution in the event of a threat or occurrence of events.

Once the average risk has been identified, it is recommended to include ALARP measures in the technical design, i.e. measures that allow for the reduction of risk using financially reasonable risk reduction measures. The costs of implementing such measures must correspond to the losses caused by possible hazardous events and minimize the possibility of human death.

Once an acceptable risk has been identified, it is not necessary to provide for prevention measures and management of these potential hazards, but it is suggested that they be re-evaluated during the RA review.

Table 6.9.8. Risk assessment of identified hazards

No.	Potential hazard	Scoring of the probability of a potential hazard (T)	Scoring of potential consequences (impacts) (P)				Determining the risk level (Rn)			The summary risk level R=R1+R2+R3
			Possible impact on the life and health of the population (P1)	Potential impact on property and the environment (P2)		Possible impact on business continuity (P3)	Level of potential risk to the life and health of the population (R1) R1=T*P1	Level of potential risk to property and the environment (R2) R2=T*P2	Level of potential threat to business continuity risk (R3) R3=T*P3	
Geographical hazards										
Baltic Sea area										
G1	Natural meteorological phenomenon: wind with a speed of 28–33 m/s	5	2	2	1	2	10	10	10	30
G3	Natural meteorological phenomenon: very severe compound frost, frost thickness on wires exceeds 35 mm	4	1	1	1	2	4	4	8	16
G4	Natural meteorological phenomenon: very severe frost when frost thickness exceeds 20 mm	5	1	1	1	1	5	5	5	15
G5	Natural meteorological phenomenon: very dense fog, visibility ≤100 m, duration ≥ 12 hours.	4	2	3	1	2	8	12	8	28
G6	Natural meteorological phenomenon: very severe storm	5	2	2	1	2	10	10	10	30
G8	Natural meteorological phenomenon: hurricane, wind speed >33 m/s	4	3	3	2	3	12	12	12	36
G9	Natural hydrological phenomenon: very severe icing of ships in the Baltic Sea	4	1	1	2	1	4	8	4	16
G10	Natural hydrological phenomenon: very strong waves in the Baltic Sea	5	2	2	2	2	10	10	10	30
G11	Other extreme event: earthquake in the OWF area	2	2	3	2	3	4	6	6	16
G12	Other extreme event: liquefaction of thixotropic soils from dynamic loads	1	2	3	2	3	2	3	3	8

No.	Potential hazard	Scoring of the probability of a potential hazard (T)	Scoring of potential consequences (impacts) (P)				Determining the risk level (Rn)			The summary risk level R=R1+R2+R3
			Possible impact on the life and health of the population (P1)	Potential impact on property and the environment (P2)		Possible impact on business continuity (P3)	Level of potential risk to the life and health of the population (R1) R1=T*P1	Level of potential risk to property and the environment (R2) R2=T*P2	Level of potential threat to business continuity risk (R3) R3=T*P3	
Geographical hazards										
Onshore										
G2	Natural meteorological phenomenon: very strong wind with a speed of 28–33 m/s	5	2	2	2	2	10	10	10	30
G7	Natural meteorological phenomenon: hurricane, wind speed >33 m/s	4	3	3	2	3	12	12	12	36
G13	Natural meteorological phenomenon: very severe storm	4	1	2	1	2	4	8	8	20
G14	Natural meteorological phenomenon: very strong wind with a speed of 28–33 m/s	4	2	2	2	2	8	8	8	24
Hazards due to technological processes or failures, materials used, design and personnel errors										
Construction and decommissioning stages										
Offshore section of the PEA, the OWF and export cable corridors										
1	Fuel spillage from a vessel or machinery	3	1	1	2	0	3	6	0	9
2	Collision, damage to service vessels	2	2	3	2	2	4	6	4	14
3	Personnel injuries during the delivery of workers and cargo to vessels serving the construction of the OWF by transport vessels	3	2	2	1	1	6	6	3	15
4	Collision of service vessels with WTGs under construction, critical damage	2	2	3	2	2	4	6	4	14
5	Falling of lifted objects, damage to the ship, serious injuries	3	3	2	1	1	9	6	3	18

No.	Potential hazard	Scoring of the probability of a potential hazard (T)	Scoring of potential consequences (impacts) (P)				Determining the risk level (Rn)			The summary risk level R=R1+R2+R3
			Possible impact on the life and health of the population (P1)	Potential impact on property and the environment (P2)		Possible impact on business continuity (P3)	Level of potential risk to the life and health of the population (R1) R1=T*P1	Level of potential risk to property and the environment (R2) R2=T*P2	Level of potential threat to business continuity risk (R3) R3=T*P3	
6	Collapse of WTGs towers under construction	1	3	3	2	3	3	3	3	9
7	Installer falls from a great height	2	3	1	1	1	6	2	2	10
8	Collision of passing vessels with service vessels, critical damage	2	3	3	2	2	6	6	4	16
9	Collision of passing vessels with WTG under construction, critical damage	2	2	3	2	2	4	6	4	14
10	Collision of vessels involved in the works near the offshore part of the Būtingė terminal and the port of Šventoji, critical damage	1	2	3	3	2	2	3	2	7
11	Accidental damage to an existing underwater cable during ground surveys	2	1	3	1	3	2	6	6	14
12	Damaged UXOs during foundation installation or construction	1	3	3	2	3	3	3	3	9
13	Damaged UXOs during cable installation	1	3	3	2	3	3	3	3	9
14	Collision of a passing aircraft with high-rise OWF structures	1	3	3	2	3	3	3	3	9
15	Transformer oil spill into the water area during OSS filling	2	1	1	2	1	2	4	2	8
16	Electrical leakage in an OSS	4	3	1	2	2	12	8	8	30
Onshore section of the PEA, export cables and ONSs										
17	Transformer oil spill	2	1	1	2	1	2	4	2	8
18	Electrical leakage in an ONSs	4	3	1	1	2	12	4	8	24
Operational phase, operation of OWF and infrastructure										

No.	Potential hazard	Scoring of the probability of a potential hazard (T)	Scoring of potential consequences (impacts) (P)				Determining the risk level (Rn)			The summary risk level R=R1+R2+R3
			Possible impact on the life and health of the population (P1)	Potential impact on property and the environment (P2)		Possible impact on business continuity (P3)	Level of potential risk to the life and health of the population (R1) R1=T*P1	Level of potential risk to property and the environment (R2) R2=T*P2	Level of potential threat to business continuity risk (R3) R3=T*P3	
19	Damage and/or ejection of WTG rotor blades	2	3	2	1	1	6	4	2	12
20	WTG Tower Collapse	2	3	3	2	2	6	6	4	16
21	Fire in the WTG nacelle	2	3	2	2	1	6	4	2	12
22	Rotor oil spillage in WTG	2	1	1	1	1	2	2	2	6
23	Current leakage in WTG electrical installations	3	2	1	2	1	6	6	3	15
24	Fire in WTG electrical equipment	2	3	2	2	1	6	4	2	12
25	Settlement of the WTG foundations, weakening and loss of WTG tower stability, possible collapse	1	3	3	2	2	3	3	2	8
26	Fire in OSS electrical equipment	2	2	3	2	4	4	6	8	18
27	Transformer oil spills into the water area during operation	2	1	1	2	2	2	4	4	10
28	Settlement of the substation foundations, loss of stability of the OSS platform, possible collapse	1	3	3	3	4	3	3	4	10
29	Electrical leakage in an OSS	3	2	2	2	2	6	6	6	18
30	Damage to the OWF's inter array cables, current leakage	2	2	2	1	2	4	4	4	12
31	Damage to the export cable, current leakage	2	2	2	2	4	4	4	8	16
Operational phase, activities carried out in the vicinity of OWF and infrastructure										
32	Collision of passing passenger ships with OWF facilities, critical damage	1	3	3	2	2	3	3	2	8

No.	Potential hazard	Scoring of the probability of a potential hazard (T)	Scoring of potential consequences (impacts) (P): Possible impact on the life and health of the population (P1)		Potential impact on property and the environment (P2)	Possible impact on business continuity (P3)	Determining the risk level (Rn): Level of potential risk to the life and health of the population (R1) R1=T*P1	Level of potential risk to property and the environment (R2) R2=T*P2	Level of potential threat to business continuity risk (R3) R3=T*P3	The summary risk level R=R1+R2+R3
33	Collision of passing cargo ships with OWF objects, critical damage	2	3	3	2	2	6	6	4	16
34	Collision of passing tankers with OWF facilities, oil spill	2	3	3	4	3	6	8	6	20
35	Discharge of bilge water	3	1	1	2	0	3	6	0	9
36	Accidental damage to an existing underwater cable	1	2	3	1	0	2	3	0	5
37	Damage to the marine equipment of the Būtingė terminal	1	2	3	3	0	2	3	0	6
38	Collision of trawling fishing vessels with OWF objects	2	2	2	1	0	4	4	0	8
Offshore section of the PEA, OWF and export cable corridors										
Operational phase, activities carried out in the vicinity of OWF and infrastructure										
39	Collision of ships bringing soil with OWF	0	2	2	1	0	0	0	0	0
40	Pleasure boat collision with OWF	1	2	1	1	0	2	2	0	4
41	Diving boats collide with OWF	1	2	1	1	0	2	2	0	4
42	OWF damage during military exercises	1	1	1	2	1	1	2	1	4
43	A migrating UXO spotted in the OWF	2	2	3	1	2	4	6	2	12
44	A migrating UXO rolled into the OWF detonates near the WTG	1	3	2	2	2	3	2	2	7
45	Damage to WTG by military aircraft during exercises	1	3	3	2	1	3	3	1	7
46	Damage to WTG by border service helicopters during exercises	1	3	3	2	1	3	3	1	7
47	Damage to the blades of a WTG aircraft due to uncontrolled or lost control	2	3	3	2	1	6	6	2	14

ptpi

No.	Potential hazard	Scoring of the probability of a potential hazard (T)	Scoring of potential consequences (impacts) (P)				Determining the risk level (Rn)			The summary risk level R=R1+R2+R3
			Possible impact on the life and health of the population (P1)	Potential impact on property and the environment (P2)		Possible impact on business continuity (P3)	Level of potential risk to the life and health of the population (R1) R1=T*P1	Level of potential risk to property and the environment (R2) R2=T*P2	Level of potential threat to business continuity risk (R3) R3=T*P3	
48	Unmanned aircraft without engine and unauthorized entry into the OWF fleet	2	3	3	2	1	6	6	2	14
49	Deaths of birds flying into rotating blades, rotor damage	4	1	1	2	1	4	8	4	16
Onshore part of the PEA, export cables and ONSs										
Operational phase, activities carried out in the vicinity of OWF and infrastructure										
50	Damage to export cable during earthworks, electrical leakage	3	2	2	1	3	6	6	9	21
51	Transformer oil spillage during ONSs operation	2	1	1	2	2	2	4	4	10
52	Electrical leakage in an ONSs during operation	3	3	2	1	2	9	6	6	21

In accordance with the methodological recommendations for the analysis of potential hazards and emergency situations of an economic entity and other institution, approved by Order No. 1-189 of the Director of the Fire and Rescue Department (FRD) under the Ministry of Internal Affairs of 2 June 2011, the risk of PEV is considered acceptable, medium and high. The risk of an outbreak of infectious diseases (epidemic, pandemic) in humans, assessed taking into account current events, is assessed as high.

After assessing the risk of hazards arising from the geographical location of the PEA, it was determined that all meteorological and hydrological phenomena both in the Baltic Sea area (10 potential hazardous events were identified) and in the continental territory of Lithuania (4 potential hazardous events were identified) are classified as high or very high probability event risk groups (4–5 points).

Their impact on life and health is usually limited, rated 2 points (in the Baltic Sea 6 cases out of 10, in the continental territory – 2 out of 4), less often insignificant, rated 1 point (in the Baltic Sea 3 cases out of 10, in the continental territory – 1 out of 4).

A major impact, rated at 3 points, related to potential victims is associated with a catastrophic meteorological phenomenon – a hurricane (in the Baltic Sea 1 case out of 10, in the continental territory – 1 case out of 4). The magnitude of the impact on human health and life is determined by the fact that there is no permanent staff working in the OWF, therefore the number of potential deaths and victims (only personnel performing maintenance, inspections or repairs) cannot exceed the criteria for the major impact level.

Other extreme events, such as earthquakes in the OWF water area and loss of stability of towers due to liquefaction of thixotropic soils due to dynamic loads, are classified as low and very low probability events (1–2 points). Soil investigations prior to pile driving at precise OWF locations will need to ensure that piles are driven up to the Cretaceous bedrock subsidence ridge. In this way, sensitive and weak thixotropic soils would remain above the OWF foundation deepening and would not significantly affect the stability of the foundation foundations. Although earthquakes of magnitude 4–5 have been recorded in the vicinity of Königsberg, the Baltic Sea region is not classified as an active seismic zone, therefore earthquakes are more likely related not to global tectonic movements of the earth's crust, but to local and small displacements of sedimentary rock massifs due to stress redistributions in the stable Baltic geosyncline (deflection) zone.

The impact of hazardous events on property due to the geographical location in the Baltic Sea varies from insignificant (3 cases out of 10) to limited (3 cases out of 10) and major (4 cases out of 10). In the mainland of Lithuania, from limited to major, 3 and 1 case out of 4, respectively.

The impact on the natural environment, according to the recommendations of the EIA, is assessed as insignificant and limited, in the Baltic Sea in 5 cases out of 10, and in the mainland of Lithuania, in order, in cases 1 and 3 out of 4.

The impact on business continuity in the Baltic Sea area ranges from insignificant (2 cases out of 10) to limited (5 cases out of 10) and major (3 cases out of 10), and in the mainland part of Lithuania from limited (3 cases out of 4) to major (1 case out of 4)

The following natural and catastrophic hydrometeorological phenomena are classified as high risk:

- In the Baltic Sea area:
    - very strong wind, with a speed of 28–33 m/s at a height of 24 m
    - very dense fog, visibility ≤100 m, duration ≥12 hours
    - very severe storm
    - hurricane, wind speed at a height of 24 m > 33 m/s
    - very strong waves in the Baltic Sea
- In the continental territory of Lithuania:
    - very strong wind, with a speed of 28–33 m/s at a height of 10 m
    - hurricane, wind speed at 10 m height >33 m/s.

When assessing the risk of hazards arising from technological processes or failures, materials used, design and personnel errors, hazardous events that may occur in the Baltic Sea and the continental territory of Lithuania are assessed separately, as well as the construction, decommissioning and operation stages are distinguished. During decommissioning stage, decommissioning of OWF towers and OSS platforms is carried out, analogous or similar equipment is used, therefore the hazardous events and their risks are similar. These stages are not separated in the RA of the EIA report. If, at the end of operation, when preparing decommissioning plans, it is decided that a RA is required for these works, it can be carried out based on statistical material accumulated during the years of operation and by assessing new technologies.

The 52 identified potential hazardous events due to technological processes or failures, materials used, design and personnel errors are assessed by dividing them into activity stages and territories. The following activity stages and territories were identified in the RA:

- Offshore:
    - construction (dismantling) stage – 16 hazards
    - exploitation – 31 hazards.
- Onshore:
    - construction (dismantling) stage – 2 hazards
    - exploitation – 3 hazards.

The probability (T), impacts (P1, P2, P3), risks of individual impacts (R1, R2, R3) and total risk (R) of the identified events were assessed in scores (Table 6.9.8) taking into account the statistical data provided in the 2023–2024 G+ Global Offshore Wind Health and Safety Organization reports, and the information provided in the section of the Marine Trauma Centre website updated on April 26, 2024 on wind farm incidents (read more in subsection 6.3).

During the construction and decommissioning phase of the PEA, 4 out of 16 potential hazards were identified in the Baltic Sea water area, one of which is classified as a high probability event (4 points, once every 1–10 years) and three medium probability events (3 points, once every 10–50 years). In the continental area, 1 high probability event (4 points) out of 2 was identified. The other 13 hazardous events identified during construction and decommissioning were classified as low (2 points, once every 50–100 years) or very low (1 point) probability events.

During the operation of the PEA, 1 high probability (4 points) event and three medium probability (3 points) events out of 31 were identified in the offshore water area. During the operation of the planned OWF on land, two medium probability (3 points) hazardous events out of 3 were identified.

The most likely hazards (once in 1–10 years) due to technological processes or failures, materials used, design and personnel errors: electrical leakage during the construction of the OSS and ONSs, as well as possible bird strikes on the rotating blades of the WTGs and damage to the equipment. Hazardous events of medium probability (once in 10–50 years) are distinguished: fuel spillage from construction or service vessels; incidents during the transportation of cargo and personnel by ships; cargo lifting during the construction (dismantling) of the OWF; electrical leakage during the operation of the OWF; illegal discharge of stormwater; damage to the onshore power cable.

When assessing the impact of hazardous events on the health and life of residents and workers (P1) on the scale of very high consequences, when 6 to 20 people died or 10 to 50 people were injured (assessment 4 points), no events were identified. The reason for such an assessment result is that during the construction (decommissioning) and especially during the operation of the OWF, large groups of workers or ship crews are not formed, the work is carried out in an open space, automated lifting, digging, laying of electric cables and other equipment is used. Also, individual objects of the OWF are distant from each other and from residential areas; marine and land electric cables are laid underground and do not pose a direct danger to settlements and other economic entities; the land electrical connection and ONSs have their own protection zones with fenced territories, warning signs and signalling systems.

23 out of 52 events with a significant impact on human life and health were identified. A significant impact is assessed with a score of 3, when 1–5 deaths or 5–10 injuries are possible. A significant impact on human health was identified in 7 out of 16 cases of a hazardous event identified during construction in the Baltic Sea. During construction onshore – 1 out of 3. During the operation of the planned OWF offshore – 14 events out of 31. During operation onshore – 1 out of 3.

The dominant events that pose a risk to the life or health of OWF employees, which have a high or medium probability of occurring, are falling of lifted objects, falling of an employee from a height, collisions of OWF construction or service vessels, incidents during operations on vessels (loading, trawling), electrical leakage or fire in OWF and OSS facilities.

When assessing potential damage to property (P2), the preliminary value of the PEA objects and the potential monetary losses to the economic entity in the event of a hazardous event were considered. The results range from insignificant (1 point, loss up to EUR 100,000) to significant (3 points, EUR 0.2–1 million) impact on property.

During construction and dismantling in the Baltic Sea area, 10 out of 16 events with a significant impact on assets were identified. No hazardous events with a medium or high probability, which have a significant impact on assets, were detected. Events with a low probability (once in 50–100 years), but which may have a significant impact on assets, are the following: collision between service vessels, collision with OWF or passing vessels; collision of passing vessels with OWF; damage to an existing underwater cable.

During operation at sea, 14 hazardous non-natural events with a significant impact on assets were identified out of 31. No hazardous events with a medium or high probability, which have a significant impact on assets, were detected. Events with a low probability (once in 50–100 years), but which may have a significant impact on assets, are the following: collapse of the WTG tower, fire in the offshore OSS facilities, collision of passing cargo ships with the OWF, migrating UXOs in the OWF area, collision of aircraft with the OWF.

During the construction and operation of the PEA, the impact of hazardous events on the continental part of the OWF infrastructure was determined to be insignificant or limited. No significant impact on the property was determined.

When assessing the impact on the environment (P2, air, water, soil, natural environment), one hazardous event with a very high environmental impact was identified with a very low probability (once in 100 years) – a collision of a passing tanker with a OWF facilities at sea during operation, an oil spill. Also, 1 hazardous event was identified in the sea area during both construction and operation, which were assessed as having a high environmental impact, namely the collision of ships servicing the OWF with the facilities of the Būtingė terminal at sea. The probability of the latter hazardous events (damage to facilities, spillage of a very large amount of oil) was assessed as very low.

During construction and dismantling in the Baltic Sea area, 11 out of 16 events with limited (small but noticeable) impact on the natural environment were identified, and in the continental part – 1 out of 2.

During operation in the Baltic Sea area, 20 out of 31 events with limited (small but noticeable) impact on the natural environment were identified, and in the continental part – 1 out of 3.

When assessing the impact of the identified hazardous event on the continuity of the planned OWF's operations (P3), the following were taken as the object of assessment: a) suspension of OWF construction works; b) possible cessation of electricity generation (production) for a certain time interval during the operation of the OWF.

During offshore construction and dismantling, 5 out of 16 events with a major (suspension for 1–3 days) impact on business continuity were identified, while onshore – 0 out of 2.

During the operation of the planned OWF in the Baltic Sea, 3 very significant (suspension 3–30 days) events out of 31 with an impact on the continuity of operations were identified, these are: fire on the OSS platform, defect and tilt of the OSS foundation, damage to the export cable from the OSS to the shore. 1 major (suspension 1–3 days) event with an impact was also identified – collision of a passing tanker with the OWF facilities, oil spill. In the mainland part, 1 major impact event out of 3 was identified during the operation, this is damage to an export cable or electrical leakage.

The following technogenic hazardous events are identified in the OWF under consideration, which, according to the methodology recommended by the FRD, have a high level of risk:

- Offshore:
    - electrical leakage at the OSS during construction
    - fire during OSS operation
    - damage to the export cable, current leakage
    - collision of passing tankers with OWF facilities, oil spill.
- Onshore:
    - electrical leakage during the construction and operation of the ONSs
    - damage to the export cable during earthworks, electrical leakage during operation.

6.9.2. Risk and consequence assessment of ship collisions with wind turbines

The identification and assessment of shipping risks is carried out according to various methods, procedures and regulations, which differ in different countries and shipping or risk assessment companies.

SSPA Sweden AB's 2008 work "Methodology for Assessing Risks to Ship Traffic from OWFs" covers the establishment of the legal basis, objectives and methods for risk assessment, hazard identification, RA and its assessment, risk mitigation measures, assessment uncertainties and possible inaccuracies, and emergency preparedness and response.

The probability of collision of vessels sailing with their engines running is directly proportional to the intensity of navigation in the vicinity of the planned wind farms, the direction of navigation in relation to these farms and possible navigational errors. Of the many possible methods and algorithms for determining the probability, this study reviews in more detail the methodologies presented by the Netherlands Institute for Marine Research (hereinafter – MARIN), the German shipping register Germanischer Lloyd (hereinafter – GL) and the Danish company Det Norske Veritas (hereinafter – DNV).

The GL and DNV models multiply the potential collisions by a causality factor calculated by estimating the Gaussian distribution coefficient of the potential deviation from the route in Fig. 6.9.2.

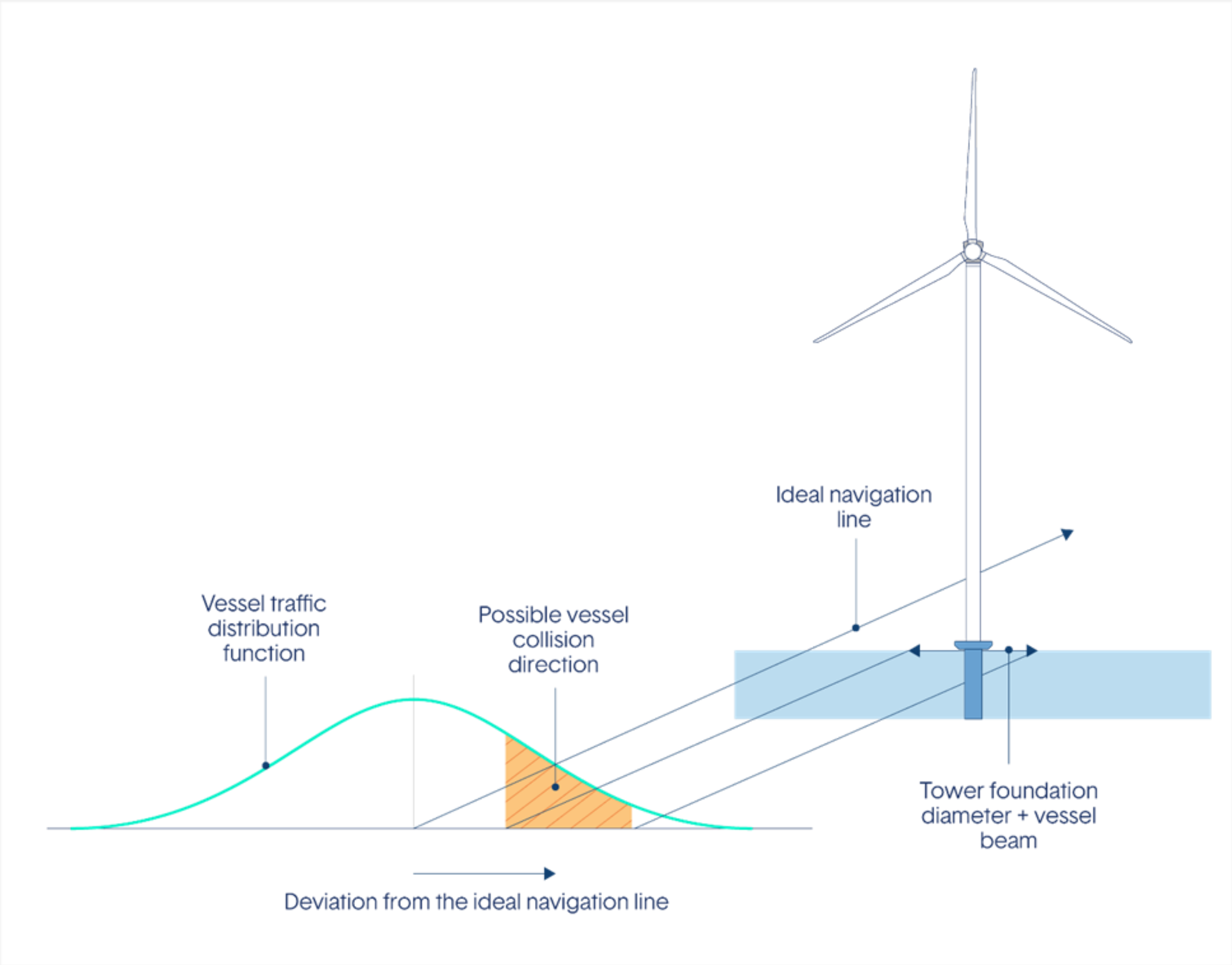


Fig. 6.9.2. Causality factor for collisions between sailing vessels and OWFs.

The density of the standard normal distribution is described by the Gaussian function:

$$\varphi(z) = \frac{1}{\sqrt{2\pi}} e^{-\frac{z^2}{2}}$$

The density plot of the standard normal distribution (Fig. 6.9.3) shows that the Gaussian function reaches a maximum at the zero point. The density at this location is 0.3989, which can be calculated because:

e0=1

square root of 2π = 2.50599281

1/2.5059928 ≈ 0.399.

Values with small deviations from the mean are more common than those with large deviations. The abscissa scale is measured in standard deviations from the mean (σ). Most values are within ±2σ, almost all data are within ±3σ (the three-sigma rule).

The standard normal distribution function allows us to calculate probabilities:

$$P(Z < z) = \Phi(z) = \int_{-\infty}^{z} \varphi(t)\,dt = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{z} e^{-\frac{t^2}{2}} dt$$

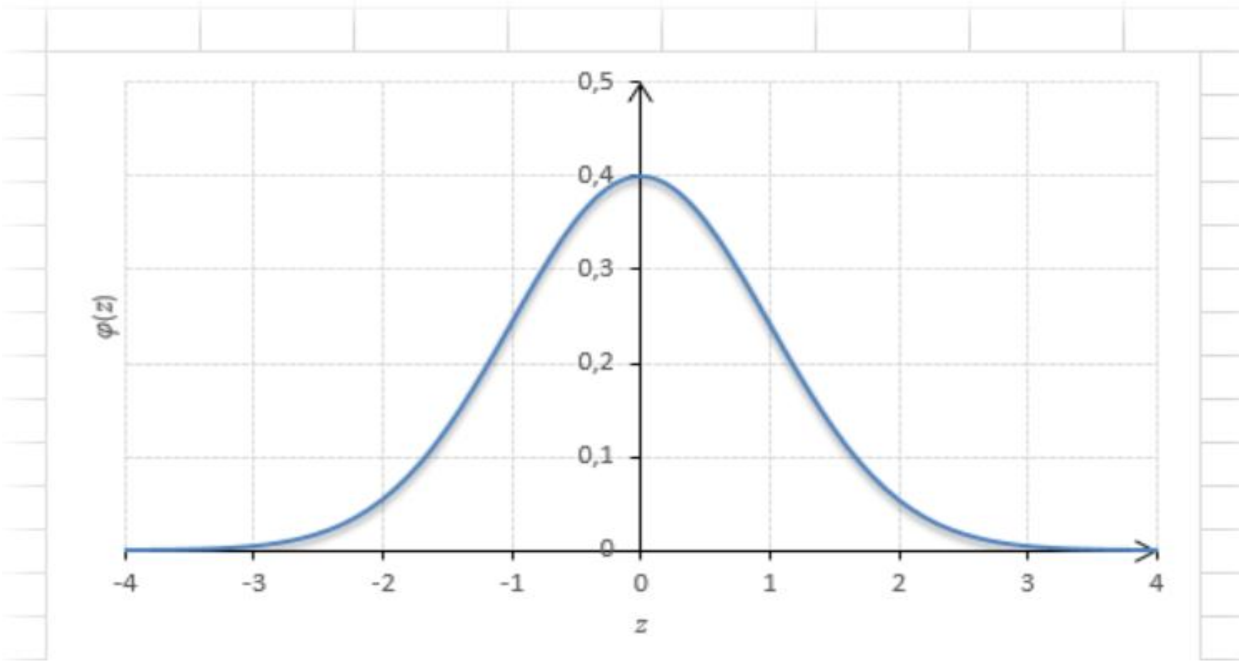


Fig. 6.9.3. Density plot of the standard normal distribution.

The standard normal distribution function allows us to calculate probabilities:

$$P(Z < z) = \Phi(z) = \int_{-\infty}^{z} \varphi(t)dt = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{z} e^{-\frac{t^2}{2}} dt$$

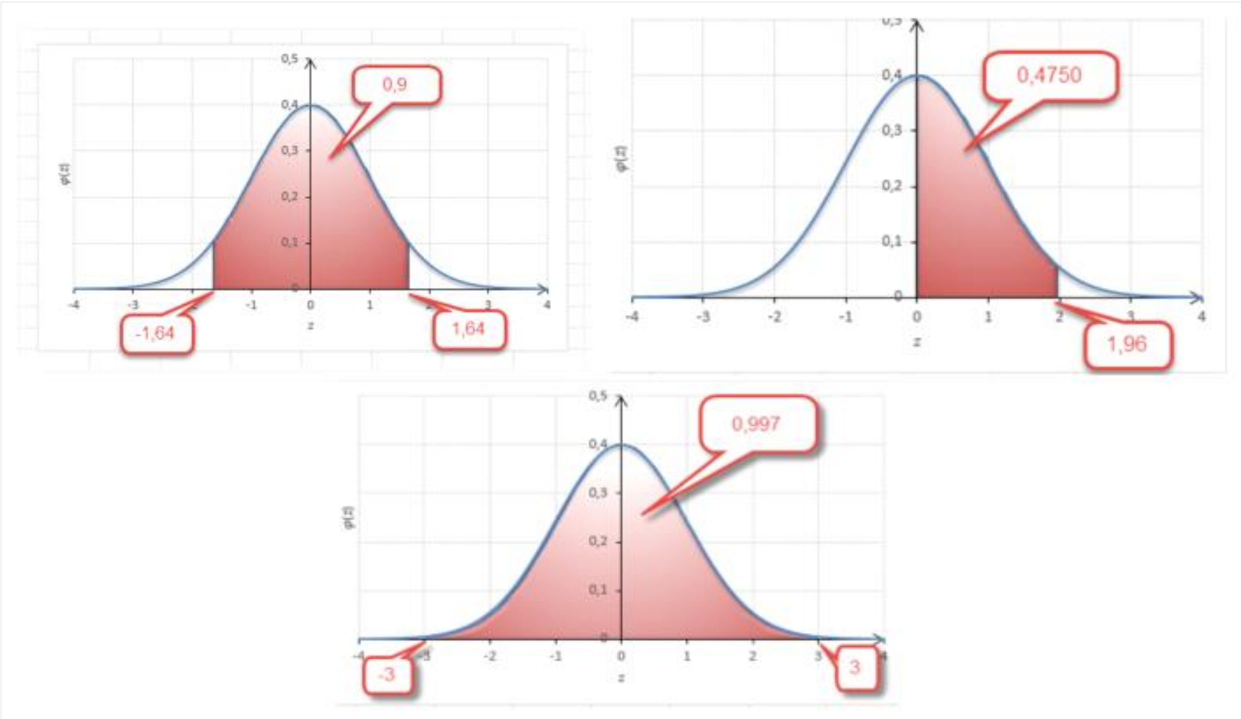


Fig. 6.9.4. Standard normal density distribution with standard probabilities.

90% of normally distributed values fall within the interval ±1.64; 95% fall within the interval ±1.96. 99.7% of normally distributed values fall within the interval ±3 (Fig. 6.9.4).

The MARIN model multiplies the potential collisions by the Navigational Error Rate (NER) Fig. 6.9.5.

In all cases, data on shipping routes, speed limits, meteorological conditions, and OWFs and the location of specific WTGs within them are entered into computerized shipping risk assessment models, which determine collision probabilities.

After evaluating the characteristics of the ships, their age, the training of the crew, and several other factors, the calculated causality factor or navigational error rating, calculated by specialists from the Technical University of Denmark, reaches *5.29-2.95E-04.*

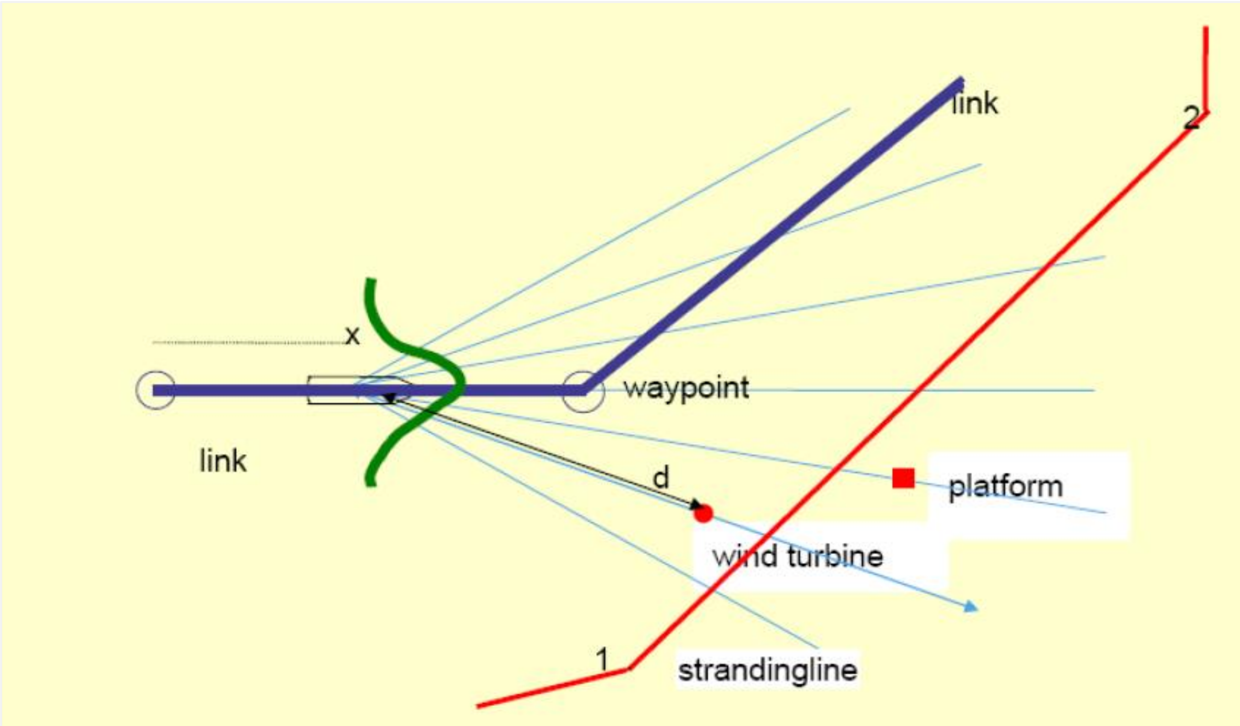


Fig. 6.9.5. Collision navigation error rating.

The probability of collisions between ships and planned OWF directly depends on the intensity of shipping. During the voyage, information about their navigation is transmitted via satellite or a system installed on shore in Klaipėda and Liepaja at intervals of several seconds or minutes, depending on the speed of the ship. ICES and HELCOM use a 0.05-degree grid (about 15 km²) to analyse data collected by the Vessel Monitoring System at intervals of 1–2 hours.

In 2022, 460 ships passed through the nearest shipping corridors to Latvia and Būtingė (Fig. 6.9.6). Each ship passing within 1 km of the OWF can be considered as a likely collision opportunity. The border of the shipping corridor is 340 m from the border of the planned OWF. The distance of the most intensive navigation flow to the OWF territory is 3.8 km.

Collisions with fishing, service and recreational vessels do not pose a significant risk to the OWF. Collisions with large vessels are dangerous, the intensity of which in the northeast-west shipping corridors is presented in the footnotes to Fig. 6.9.6.

Assuming the maximum value of the navigation error rating and evaluating the navigation intensity along the expected tanker route to Būtingė (460 large ships passing through in 2020, introducing a coefficient of 1.3 for the possible increase in shipping intensity), the probability of collision per year is:

$$460*1.3*5.29E\text{-}4=0.3$$

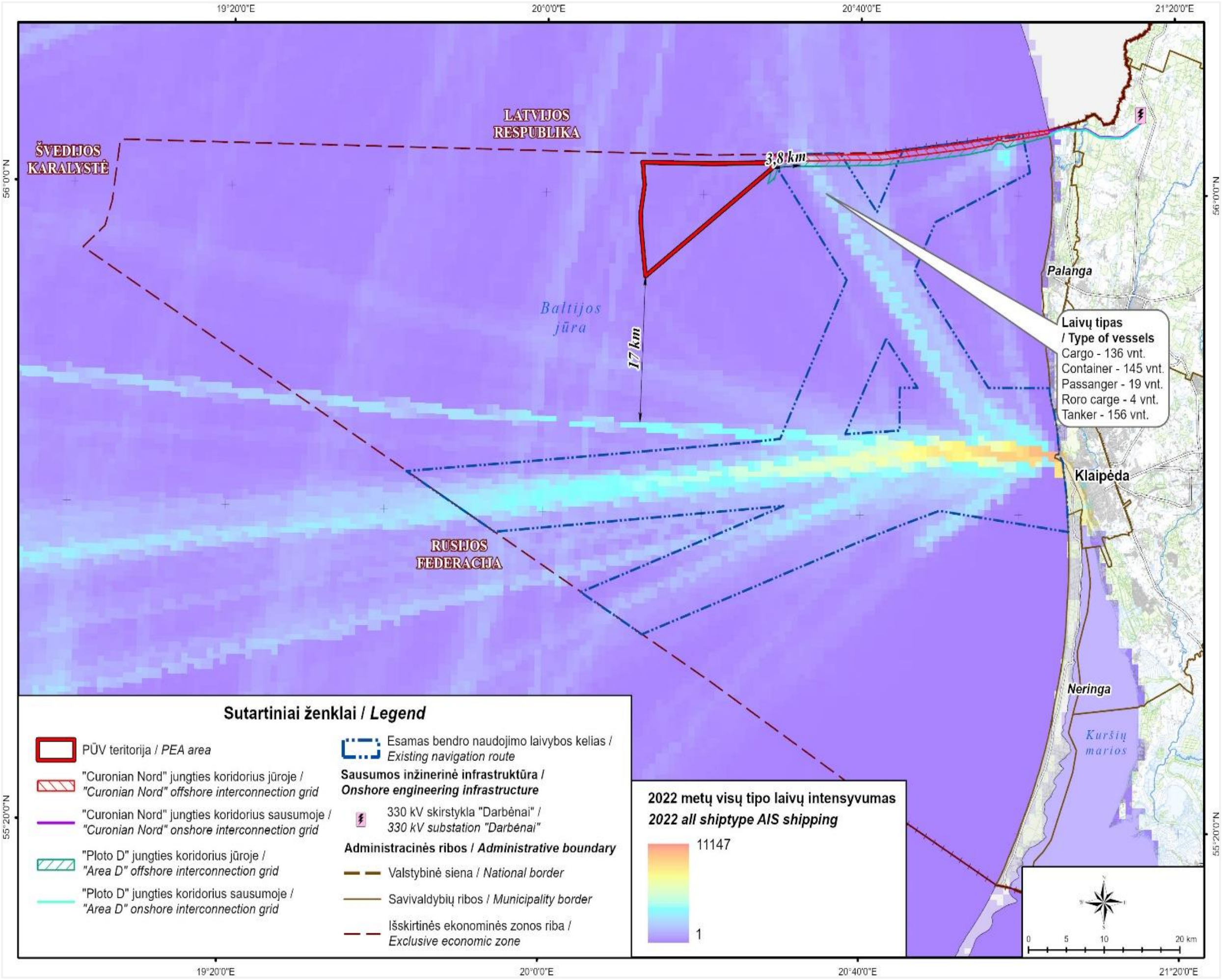


Fig. 6.9.6. Shipping intensity in the vicinity of the OWF in 2022.

Approximately 6 km wide, according to the Gaussian deviation distribution law, could conservatively reach 0.03%, and in a strip of about 50 m near the OWF territory about 0.14 ships. Then the probability of collision with the OWF of large ships passing by that may cause damage to the OWF per year:

0.14*5.29E-4=7.4E-05

The probability of a drifting vessel colliding can be calculated either by estimating the probability of a vessel's engine failure, which, depending on the vessel's size and number of engines, can vary from 2.30E-4 to 5.0E-5 per engine operating hour and by estimating the number of vessels anchored near the OWF site. The nearest vessel anchoring sites are 30 km away. Considering changing meteorological conditions and increasing storm winds, an uncontrolled vessel can drift 10–12 km. The probability of reaching the OWF is reduced by the prevailing westerly storm wind directions, which carry the vessel towards the shore.

The probability of collision between passing ships, even conservatively calculating the number of ships that could be located at the edge of the 6 km wide strip (near the PEA territory), is 7.4E-5, with a frequency of approximately once every 13,500 years. The risk of collision between passing large ships that could damage the WTG towers and the OWF is acceptable.

When preparing the technical design, once the exact location of the OWF is known, it is recommended that the contractor conduct a more detailed navigation study and refine the RA. Also, when designing and constructing the planned OWF, it is recommended to implement the ALARP principle, and it is appropriate to provide for possible financially reasonable measures to reduce the risk of collisions, following the world-renowned good practice in constructing OWFs at sea.

In a RA prepared by Ramboll in 2009[114] The calculated individual risk of death was 6.26–5.27E-08 for crew members of cargo ships and tankers and 5.32–5.60 E-07 for passengers.

[114] Anholt Offshore Wind OWF. Analysis to Risk to Ship Traffic .

The Location-Specific Individual Risk (LSIR) and Individual Risk per Annum (IRPA) indicators are used to determine individual risk. LSIR – the probability that a person hypothetically placed in a certain location, in an open space (unprotected by building structures) 24 hours a day and 365 days a year, will be fatally injured. According to the LSIR indicator, the threshold of unacceptable risk for the public is 1.00E-04, the degree of generally acceptable risk in industrial areas <1.00E-05, in residential areas <1.00E-06, in socially sensitive areas <1.00E-07.

On shipping routes, people only pass through a dangerous risk zone, their time of stay in it is limited, therefore the IPRA indicator should be used – the probability that one person will be fatally injured within a one-year period, taking into account the actual time of their stay in the analysed location (dependence on the duration of their stay in the risk zone). According to the IPRA indicator, the degree of acceptable risk in industrial areas is <1.00E-05, in residential areas <1.00E-06, in sensitive areas <1.00E-07.

Passage time near the OWF is 1 hour. Annual number of hours is 8,760. The IPRA value for passengers would be:

7.4E-05/8760*1=8.45E-09

The significance of IPRA for the crew of a passing ship, assuming that it may pass 12 times per year, would be:

7.4E-05/8760*12=1.01E-07

The IPRA risk level for crews of tankers, dry bulk carriers and other cargo vessels is 1.00E-05, and for ferry passengers – 1.00E-06. It is predicted that if the available data on the number of passing ships is multiplied by a factor of 1.3 (to assess the increase in the number of ships in the near future), the annual individual risk thresholds for passengers and ship crew members will not be achieved.

In addition to the risk of collisions (likely frequency), the second aspect to be assessed is the consequences of collisions.

Environmental impacts may arise from a collision between a ship and a OWF or OSS. The impact of accidents may result in environmental pollution by materials from the power plant or the colliding ship. The impacts of collisions depend on a number of factors, such as the type of ship, the angle of collision, the speed, the structural design of the WTG, the type of foundation, etc. If larger ships, such as tankers, were to collide with a power plant, in most cases it is likely that only the power plant and the foundations will be seriously damaged.

Ramboll's RA, which assessed the collision of different ship types with OWF, found that in the case of collisions between dry cargo and passenger ships, the environmental consequences are limited to large, while in the case of collisions between tankers, they can range from limited to very large.

The most likely pollutant in these cases is petroleum products.

- Spillage of oil products (rotor oil) from the OWF is not of great concern, as the OWF nacelle contains a very small amount of oil, most often degrading oil is used.
- The oil used in the substations also does not pose a significant risk of pollution, as its quantity is limited. To reduce this risk, OSS should be double walled.
- The most dangerous impact of oil pollution on the environment can be caused by its spillage from ships.
- The most critical case would be pollution caused by a collision with an oil tanker. This could result in a significant spill of oil products, which are more harmful to the environment due to their low evaporation. According to the EU-funded "Final Report on Offshore Wind Energy in Europe" [115], prepared by Delft University, the consequences of such collisions require the development of special emergency response procedures.

In addition to ships sailing to the Klaipėda Seaport, small fishing and recreational vessels operate in the water area.

Since commercial trawl fishing is currently practically non-existent in the PEA area, this aspect can be ignored. However, if fish stocks recover during the operation of the OWF, it is possible that fish will appear there and vessel traffic using other fishing techniques will be intense, unless the safety zone regulation provides for a ban on activities. In that case, the possibility and consequences of colliding with a power plant or transformer tower remain.

Fishing vessels may navigate within the PEA area or approach this area. Old vessels are used, with a 2.0E-4 probability of engine failure and practically exhausted resources. During strong winds, they may lose control and be carried towards the OWF. Based on a rough estimate of the number of fishing vessels operating in the PEA area, the probability of such vessels colliding with power plants may be:

[115] "Concerted Action on Offshore Wind Energy in Europe Final Report. 2001", Delft University Wind Energy Research Institute (Netherlands).

100*2.0E-4=2.0E-2

If a 100 m protection zone is established, about 10% of vessels manoeuvring in the water area could accidentally enter it. Then the probability could be as follows:

10*2.0E-4=2.0E-3

With a 500 m protection zone, the possibility of accidental entry would be low, about 1%, and the probability of collision would be:

1*2.0E-4=2.0E-4

For small fishing vessels, if they were allowed to sail in and near the OWF, a collision with power plants is possible once every 50 years, in a 100 m protection zone – once every 100 years, and in a 500 m zone – once every 5,000 years.

Collisions of light fishing vessels with WTG towers and OSS are not considered to be an event that could cause significant damage to the WTG towers or OSS. Small spills of their diesel fuel would also evaporate quickly, and the consequences would be limited.

The traffic of service vessels in the territory of the OWF may be of similar or lower intensity. Service vessels will navigate the water area at low speeds, mooring at the designated mooring places. The traffic of service vessels is considered safe; the risk of their collision is not assessed.

6.9.3. As low as reasonably practicable (ALARP) principle and risk reduction measures

Efforts to reduce risk from the upper to the lower limit must be balanced, taking into account the factors influencing risk reduction: time, complexity, severity, and cost. The principle of the lowest practically achievable level refers to the threshold at which further risk reduction measures become unjustifiable due to a disproportionate cost–benefit ratio. This principle is illustrated graphically in Fig. 6.9.7.

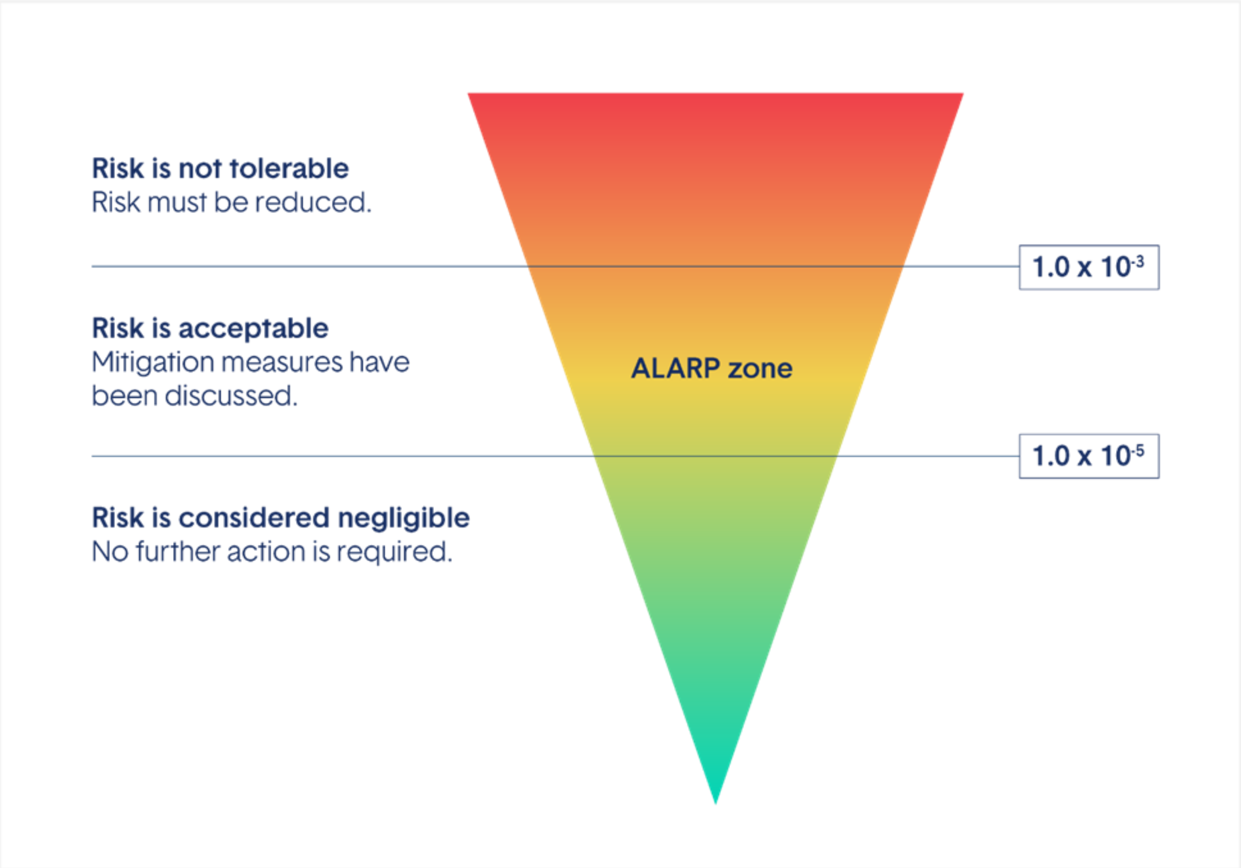


Fig. 6.9.7. Risk reduction principle (ALARP principle).

Most of the risk factors of the OWF fall into the ALARP zone, i.e., medium risk factors for which it is strictly recommended to apply the ALARP principle.

Risk mitigation measures for the selected risk area (technological node, regulatory documents, scenario group, specific HAZID scenario) include:

- measures to eliminate hazards
- measures to eliminate the causes of the danger and the spread of the accident
- measures to reduce the impact and consequences.

When preparing a technical project, constructing and operating a hydroelectric power plant, accident prevention measures must be provided for and ALARP measures must be applied, considering the existing risk objects and their hazardous factors. ALARP measures are those accident prevention and risk reduction measures that are not regulated as mandatory by national regulatory documents or EU directives, but are inexpensive and effective, and their implementation allows for the effective reduction of risk to a reasonably feasible, practical level (ALARP) at minimal cost.

ALARP measures are always advisory in nature and usually include:

- recommendations are provided in good practice guides prepared by safety authorities
- experience of leading companies in the field in implementing risk mitigation measures
- the application of best available production methods and the latest technologies wherever possible
- prompt response to changing operating environment conditions (social, economic, natural)
- additional staff training, emergency preparedness and response.

ALARP measures always pay off, being most effective in reducing the risk of hazardous factors with lower probability but greater consequences.

During the construction and operation of the OWF in the Lithuanian EEZ, rare but potentially critical incidents of OWF facilities include collisions with large passing ships, including tankers (approximately 200 tankers in 2020). Although their estimated probability is low, equal to 9.0E-5, and the frequency is approximately once every 11,000 m, the transported spilled oil volume would damage approximately 10% of the Lithuanian coastline in the Šventoji–Palanga section, therefore the recommended ALARP measure is to establish a maximum protection zone of 1000 m and mark it with periodically signalling buoys from the side of the nearest shipping corridor. Activities should be identified in the safety zone, the impact of which would be limited or insignificant and which would be permitted with the consent of the facility operator.

A distinctive feature of this OWF is that part of the water area falls into a submerged minefield. According to the data of the mine clearance units of the Lithuanian Navy, which carry out the demining, newly emerging submerged explosives occur in already cleared areas, which are transported by temporary or constant currents. The recommended ALARP measure is periodic monitoring of the bottom of the OWF territory to be able to timely detect and destroy migrating UXOs.

Extreme hydrometeorological phenomena are common during the operation of OWF, when preparing a technical project, their potential impact is assessed by calculating the structures of foundations, towers, and assessing the conditions of OWF operation and necessary shutdown. An additional ALARP measure is recommended – to prepare an emergency management plan that includes both preparation for extreme hydrometeorological phenomena and other possible extreme hazardous events. The developer and beneficiary are recommended to consider the issue of OWF security, assessing the attacks on energy infrastructure objects in the Baltic Sea.

6.10. Preventive measures during construction, operation and dismantling

6.10.1. Shipping

To reduce possible ship collisions with the OWF or to avoid cable damage, the developer sets conditions on the entry of ships into the OWF's water area and navigation in or near the OWF's water area.

During the preparation of the technical project, interested shipping authorities will also be consulted, and decisions will be made regarding:

- establishment of a safety zone, its configuration and application to designated ships during the construction, operation or dismantling of the fleet
- the timing of the publication of information and warnings through notices to mariners or other appropriate information sources
- determination of shipping routes within or near the OWF

- designating places as areas to be avoided
- of surveillance radars, AIS [116](automatic information and identification system) and/or video surveillance systems
- constant vigilance
- any other appropriate measures and procedures.

In addition, the developer, in coordination with the Water Transport Department of the Lithuanian Transport Safety Administration (hereinafter – the Water Transport Department), shall establish navigation markings for individual structures of the OWF located on the edges and inside the OWF perimeter, as well as their parts above and below water (AIS transceivers, radio beacons, sounders, lighting), during the day and night, based on the established procedure for the operation of navigation devices.

In the areas of protection of state and military objects of national importance and important for national security, where military aircraft flights may be carried out, all design solutions are coordinated with the command of the Lithuanian Armed Forces. No special restrictions prohibiting the construction and operation of the OWF in the selected PEA territory are foreseen.

6.10.2. Measures during construction

During the design stage, the developer must establish and coordinate with the Water Transport Department the navigation rules for vessels servicing the construction and define their routes.

To avoid accidents/collision with normally operating vessels, the location and coordinates of the construction area are announced through navigational messages, which are administered and uploaded to electronic shipping control systems by the Water Transport Department. The construction site onshore must be illuminated at night. Continuous monitoring of shipping near the construction site is planned (both visually from vessels participating in the construction work and/or using a traffic safety vessel on duty, and with the help of radar) to help reduce and avoid the risk of collisions. To avoid additional accidents or collisions, the Water Transport Department will have to be notified of construction dates near shipping lines (especially relevant during cable laying).

Similar measures will be applied during the decommissioning phase.

6.10.3. Marine pollution incident and rescue planning

During operation, the central headquarters of the OWF is on duty 24 hours a day. The operator will have a sea chart with a global positioning system (GPS), which allows determining the coordinates of the object anywhere in the world, and the coordinates and identification numbers of each WTG in the OWF. The Lithuanian Navy Maritime Rescue Coordination Centre (hereinafter – LNMRCC), the institution responsible for organizing search and rescue of people, as well as pollution incident liquidation work at sea, must also have the same information. To ensure quick and adequate response actions in the event of an accident, mishap or otherwise, during construction and operation, operational procedures (notifications, communication means, response forces and equipment, turbine shutdown/start-up procedures, etc.) will be established in the OWF search and rescue and pollution incident liquidation plan. The plan will be coordinated with the interested institutions. Communication and shutdown procedures are regularly tested, and exercises are conducted.

Law on Marine Environment Protection of the Republic of Lithuania[117] Article 23 states: "Installations, oil and chemical terminals, other potential sources of pollution, seaport administrations and municipal administrations must have local plans for the liquidation of pollution incidents coordinated with institutions authorised by the Government. The list of institutions and objects that must have local plans for the liquidation of pollution incidents shall be approved by the Minister of the Environment."

By the order of the Minister of Environment of the Republic of Lithuania No. D1-285[118] The approved list currently includes six coastal city and district municipalities and 22 companies that must have local plans for the liquidation of pollution incidents. The decision on including the planned OWF in the list will have to be made before its operation begins – during the preparation of the technical project.

116AIS technology was developed to increase shipping safety and reduce ship collisions. These automatic ship identification systems must be installed on all passenger ships and cargo ships of 300 GT (gross tonnage) and larger. The International Maritime Organization is currently considering the possibility of installing this system on smaller ships. According to the statistical and navigation-related information received from these ships through the AIS system by shipping regulatory authorities, it is possible to “see” the location, name, size, draft, cargo carried, speed, course and, if necessary, control the ship’s navigation or planned maneuvers.
117Law of the Republic of Lithuania on Marine Environment Protection, 13 November 1997. No. VIII-512.
118Order of the Minister of Environment of the Republic of Lithuania "On institutions and objects that must have local pollution incident liquidation systems"
plans, list approval", 2011. April 5. No. D1-285.

By the order of the Minister of National Defence, the Minister of the Environment and the Minister of the Interior No. V-1044/D1-673/1V-596[119] The approved work plan for the liquidation of pollution incidents in the sea area establishes the strategy for the liquidation of pollution incidents in the sea area, the procedures for receiving reports on pollution incidents and mobilizing forces performing liquidation work, the duties of institutions and responsible persons participating in the liquidation process of pollution incidents, the principles and schemes for management and the execution of these works, the requirements for communication means used during the liquidation operation of a pollution incident, and recommendations for the preparation of local plans for the liquidation of pollution incidents. Three levels of pollution incidents are distinguished according to the scale of pollution and the forces required for liquidation.

The annexes to this plan identify the institutions involved in the pollution incident liquidation process, the procedures for reporting a pollution incident and mobilizing forces, the general principles of third-level management for the liquidation of pollution incidents, the communication plans for the liquidation of pollution incidents, and the general list of forces and means for liquidating pollution incidents.

The companies included in the list prepare local plans for the liquidation of pollution incidents in the sea area within the limits of their responsibility. After conducting a RA of pollution incidents, hazardous substances that may spill into the sea area, their quantities, the means necessary to stop the spread and liquidate the consequences, their quantities and storage locations are determined. The extent of pollution, when the available forces are not enough and the LNMRCC is contacted regarding the mobilization and use of national pollution incident liquidation forces.

In construction, service and repair, maintenance and other cases where people work in the OWF, preparation for rescue operations in the event of accidents and emergencies is required. It is necessary to provide for means and routes for the evacuation of employees, means of providing first aid and methods of delivery to stationary medical institutions, methods and means for the rescue and evacuation of victims.

Before the start of operation of the OWF, during the preparation of the technical project and planning of the construction phase, rescue and emergency and accident liquidation plans must be prepared. It is recommended that during the preparation of the technical project, in accordance with the recommendations prepared by the Fire and Rescue Department, [120]a RA be conducted and an Emergency Management Plan be prepared, covering the construction, operation and liquidation phases of the work.

6.10.4. Fire prevention and fire extinguishing equipment

OWF must be built in accordance with the Construction Technical Requirements Regulation STR 2.01.01(2):1999 "Essential Requirements for Buildings. Fire Safety" [121]and the Basic Requirements for Fire Safety [122].

The following risk management measures are applied to prevent the possibility of fire and other emergencies:

- an automatic control system installed in each WTG. OWF control is carried out remotely. A comprehensive monitoring system will be able to set all the necessary commands for OWF control elements. Considering the information received from sensors, such as wind speed, wind direction, etc., maximum safety of OWF operations will be ensured
- each WTG must be equipped with an automatic braking system. The WTGs planned to be built must be equipped with a blade rotation braking system consisting of 2 independent braking systems. The designed sensor system will ensure automatic shutdown of the WTG (in case of detection of significant deviations from the normal course of activity). The possibility of stopping the WTG manually must also be provided. The braking system must be equipped with an emergency battery that will supply electricity in the event of a disruption in its supply from the electricity transmission networks
- The WTGs must be equipped with storm control mechanisms that will reduce the rotation speed of the blades in strong winds (when the wind speed is greater than 28 m/s)
- Each WTG must be equipped with a lightning protection system that transfers the electrical charge to the foundation of the structure (grounding is installed)

119Order of the Minister of National Defence, the Minister of the Environment and the Minister of the Interior of the Republic of Lithuania “On the liquidation of pollution incidents”
"On the approval of the work plan in the sea region" by order No. V-1044/D1 673/1V-596 of 9 November 2009.
[120]By order of the Director of the Fire and Rescue Department under the Ministry of Internal Affairs of 2011-06-02.
No. 1-189 approved methodological guidelines for the analysis of potential hazards and emergency situations of an economic entity and other institutions recommendations.
[121]Construction Technical Requirements Regulation STR 2.01.01(2):1999 "Essential Requirements for Construction. Fire Safety".
[122]Order of the Director of the Fire and Rescue Department under the Ministry of Internal Affairs "On Approval of the Basic Requirements for Fire Safety", 7 December 2010. No. 1-338.

- Each WTG must be equipped with a signalling lighting system. In order to avoid collisions at night, special coloured lighting lights will be installed on the WTG, which will signal birds and other objects about an obstacle in their path
- Periodic technical inspection of the WTGs must be performed, and scheduled maintenance must be carried out.

The probability of fires in WTGs is insignificant. A fire may occur in the OSS, where transformer oil is stored. Transformer oil is not classified as a flammable liquid, but fires in the OSS are possible, therefore the amount of primary fire extinguishing agents will be provided during the technical design.

In the OWF, according to STR1.01.03:2017 "Classification of Structures" and the clarification of the State Territorial Planning and Construction Inspectorate, [123]a structure is a WTG tower, as well as OSS and electrical cables with a voltage higher than 110 kV.

Technological equipment is installed in a nacelle, which is manufactured in a factory and delivered to the installation site as a single module, therefore it is a product according to the regulatory acts of the Republic of Lithuania.

The WTG tower uses power cables with non-combustible insulation, with a flammability class of at least Dca s2,d2,a2.

Initial fire suppression is planned using gas and powder extinguishers of class ABC. The quantities of fire extinguishers, as specified in Annex No. 5 of the General Fire Safety Regulations, are provided in Table 6.10.1.

Table 6.10.1. Quantities of fire extinguishers as specified in Annex No. 5 of the General Fire Safety Regulations[124]

No.	Fire extinguisher storage area	Calculated unit of measurement	Minimum amount of extinguishing agent in fire extinguishers (powder or carbon dioxide – in kilograms, water or foam-water mixture – in litres)		
			2 kg (l)	4 kg (litres)	6 kg (litres)
13.	Special purpose buildings	300 m^2	4	3	2

Usual arrangement of fire extinguishers used in OWF is:

- 1 unit of 4 kg – the 1st fire extinguisher is placed in the WTG tower near the 66 kV switchgear
- 1 unit of 4 kg – the 2nd fire extinguisher is placed in the WTG nacelle near the elevator
- 1 unit of 4 kg – the 2nd fire extinguisher is placed in the control room of the WTG nacelle.

Fires in OWF are rare, their consequences do not have the possibility of spreading to surrounding objects and adjacent OWFs. Therefore, in case of fires, extinguishing of burning generator units is not planned. WTG nacelle with generator unit is treated as a product, it should not be subject to the requirements of the General Fire Safety Rules. The device is insured and in case of fire, the oil in it is allowed to burn out.

The PEA executor and the technical project developer have the right and may provide measures for extinguishing fires in the generator units of the WTGs. In such a case, when preparing the technical project, an automatic gas extinguishing system or similar measures ensuring effective fire extinguishing would be provided for.

6.10.5. Preventive measures in the continental part of the PEA

The strategic plan envisages the application of the following risk management measures to prevent the possibility of electrical leakage and other emergencies or to mitigate their consequences:

- Electricity export from the OWF to the continental grid in both corridors is planned via a minimum of two main transmission cables and two backup cables.

[123]Order of the Minister of Environment of the Republic of Lithuania "On approval of the construction technical regulation STR 1.01.03:2017 "Classification of structures and premises", 2016. October 27. No. D1-713.
[124]Order of the Director of the Fire and Rescue Department under the Ministry of Internal Affairs "On the Approval of General Fire Safety Rules", 18 February 2005 No. 64.

- The depth of electrical cable burial in the ground, the safety zones, and the distances between the main and backup electrical cables shall be determined in the technical design in accordance with the Rules for the Installation of Electrical Lines and Installations.[125];
- Oil collection pits with sides and oil drain channels to the collection pit are concreted under oil-containing OSS devices.
- Connections of 220 kV and 330 kV power lines with ONSs within the boundaries of the designed substation plot.
- Lightning protection is installed.
- Access roads of at least 3.5 m width to the facilities within the boundaries of the ONSs plot and other technical design solutions that meet the requirements of the Fire and Rescue Service are installed.
- Periodic technical inspection of the ONSs and the connections, i.e. the connections of offshore section of export cables with onshore section is carried out, and scheduled maintenance is carried out.
- The ONSs territories are enclosed by a protective fence with warning signs and automatic safety equipment. These solutions are detailed in the technical project.

The spread of impacts beyond the boundaries of the substation and connection plots during potential accidents is limited. Final risk reduction, accident and hazard prevention, and safety measures will be defined in the technical design during project preparation in accordance with the Rules for the Installation of Switchgear and Substation Electrical Equipment[126]. The technical design solutions will be implemented during the construction phase.

[125]Order of the Minister of Energy of the Republic of Lithuania "On the Approval of the Rules for the Installation of Power Lines and Installations", 20 December 2011. No. 1-309.
[126]Order of the Minister of Energy of the Republic of Lithuania "On the Approval of the Rules for the Installation of Electrical Equipment in Switchgear and Substations", December 15, 2011 No. 1-303.

7. ANALYSIS AND EVALUATION OF ALTERNATIVES

7.1 Assessment method

The comparison of OWF development alternatives is based on the principles of the sustainable development concept. That is, alternatives are compared using the three fundamental components of sustainable development: economic growth, societal well-being, and environmental quality, ensuring a balanced development of all dimensions without prioritizing one at the expense of the others.[127]:

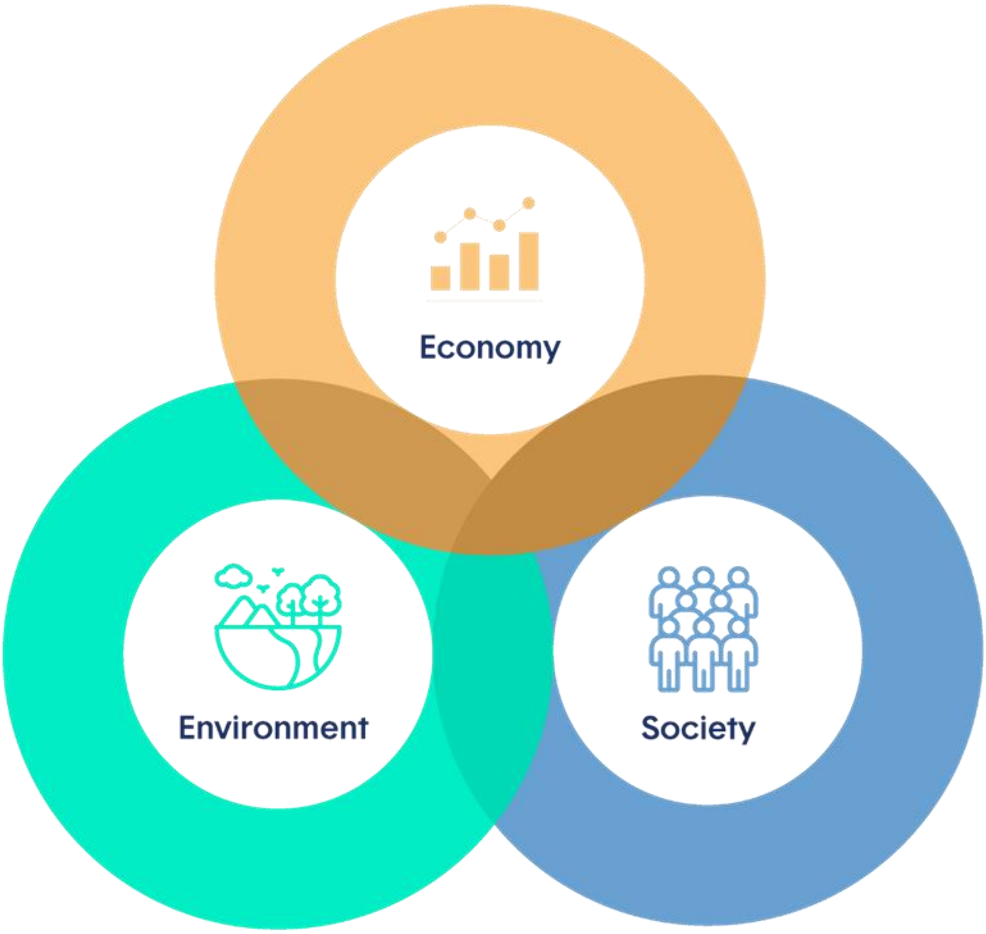


Fig. 7.1. Sustainable development concept (illustration from the set of recommendations for Sustainable Development Goals).

The impact of alternatives on the components of each dimension is evaluated according to its significance and the weight (importance) of the evaluated criterion in percent. The significance of the impact is determined by considering quantitative indicators and qualitative aspects.

Table 7.1.1. Impact assessment values

Impact significance	Positive impact	Negative effects
Significant	3	-3
Moderately significant	2	-2
Slightly significant	1	-1

127A set of recommendations for the Sustainable Development Goals. "Create for Lithuania" project "Towards a Sustainable Lithuania: Integrating Sustainable Development Goals into State Strategic Documents" http://lrv.lt/uploads/main/documents/files/Darnaus%20vystymosi%20tiksl%C5%B3%20rekomendacij%C5%B3%20rinkinys(1).pdf

Impact significance	Positive impact	Negative effects
No impact or neutral impact, i.e., the impact is equally positive and negative	0	0

From a sustainable development perspective, the aggregated indicator is calculated by summing the environmental, social, and economic indicators, each assigned a weight of one-third, thereby giving them equal importance.

7.2 Assessed alternatives

The EIA report examines two main alternatives for the CN OWF: **the "zero" alternative**, i.e., no activity is carried out, and **the OWF development alternative** – the installation of an OWF in the Lithuanian marine territory.

The "zero" alternative, meaning no activity is carried out, reflects the current situation and environmental condition when the project is not implemented. In this case, any changes in the environmental condition of Lithuania's Baltic Sea waters would not be attributed to the development of the proposed economic activity. It should be noted that if the zero alternative is chosen and the OWF is not developed, the implementation of EU energy and climate change policy goals, as well as NECP (National Energy and Climate Plan) objectives to reduce GHG emissions, would be hindered.

OWF development alternative: an OWF with a capacity of up to 700 MW is installed and operated in the area approved by Government Resolution No. 171. The developer may install an OWF with a capacity exceeding 700 MW if the environmental restrictions set out in the EIA (e.g., OWF size, number of turbines) are respected and if such development complies with the legislation in force at that time.

7.2.1. The area of CN OWF and export cable corridor

The designated area/site alternative for the installation of the CN OWF has been approved by Government Resolution No. 697; therefore, other potential locations for the OWF are not considered in this EIA.

The EIA report analyses the engineering infrastructure route for connecting the CN OWF to the onshore grid, as proposed in the Engineering Infrastructure Development Plan. This corridor runs from the boundary of the OWF to the existing 330 kV "Darbėnai" Switchyard located in Žyneliai village, Darbėnai eldership, Kretinga district municipality. Other route alternatives for the connection are not considered further in this EIA report.

7.2.2. Export cable corridor for "Area D" OWF

The EIA report analyses the export cable route of the "Area D" OWF, as proposed in the Engineering Infrastructure Development Plan. This route extends from the OWF boundary to the existing 330 kV "Darbėnai" Switchyard, located at Žyneliai village, Darbėnai eldership, Kretinga district municipality. Other alternative routes for this connection are not further considered in this EIA report.

7.2.3. Technical and physical characteristics of the WTG models

For the project implementation alternative, the technical and physical characteristics of the WTG models were analysed. Considering the trends in the development of advanced offshore WTG technologies, the technical solutions used in existing OWFs in the Baltic and North Seas, and the economic efficiency associated with advanced technologies, the EIA analysed offshore WTG models with a capacity of up to 20 MW or more. The EIA report assessed the environmental impact of installing WTG models with the following maximum technical-physical parameters: tower height: 170 m; rotor diameter: 300 m; total height to the upper blade tip: 350 meters.

7.2.4. Layout alternatives for the OWF in the PEA area

Considering the sea depth, the shape of the designated area, seabed conditions, and current land-use designations, two OWF development layout alternatives were analysed and compared in the EIA report:

- **1st alternative – maximum OWF development.** WTGs are distributed throughout the entire designated OWF area, using a geometric layout principle. Under this alternative, up to 68 turbines could be installed (see Fig. 4.1.1).
- **2nd alternative – optimal OWF development**. WTGs are laid out within the designated area but set back 2 km from the boundaries of the Natura 2000 site and in consideration of seabed habitats. Under this alternative, up to 55 turbines could be installed (see Fig. 4.1.2).

Conditions implemented in the 2^{nd} – optimal alternative identified during the EIA:

- To reduce potential impacts on the Klaipėda-Ventspils Plateau Biosphere Polygon and the Natura 2000 Klaipėda-Ventspils Plateau area for wintering and aggregating birds, WTGs must not be designed or constructed within at least 2 km of the site boundary.
- Although the impact values remain well below the established threshold limits, it is recommended where technically feasible and reasonably practicable, to avoid the installation of wind turbines within sensitive seabed zones and/or to minimize seabed disturbance by limiting the extent of cable trenching. Compared to the 1st alternative, the 2nd (optimal) alternative reduces the number of WTGs in the circalittoral reef (1170) habitat by 13 units (a 31.7% reduction), requires 38.4 km less cable, which in turn reduces the impact on reef habitats.

7.3 Comparison of alternatives according to their potential impact on individual environmental components

A comparison of the alternatives for the development of the OWF, applying the principles of the sustainable development concept and integrating expert explanations regarding the potential environmental impact of the alternatives, is presented in Table 7.3.1.

Table 7.3.1. Assessment of alternatives for the development of an OWF based on their impact on various environmental components

	Environmental component	Alternatives under consideration				Weighted impact assessment of alternatives			Possible impacts and their comparison
		0: OWF is not being developed	1st: Maximum (68 WTGs)	2nd: Optimal (55 WTGs)	Weight percent	0: OWF is not being developed	1st Maximum (68 WTGS)	2nd Optimal (55 WTGs)	
						Natural environment			
1	Water	0	0	0	10	0.00	0.00	0.00	Under normal operating conditions, the OWF will not have an impact on seawater quality. Temporary changes in water quality are possible during the construction phase when installing foundations and laying cables due to an increase in the number of suspended particles (turbidity) in the bottom water column. It is expected that during the construction phase, secondary water pollution with chemicals (heavy metals, organic compounds) is possible due to the movement of bottom sediments. The territory of the OWF is located at depths greater than 30 m, in a stable geological environment, therefore the impact of the foundation structures on the hydrodynamic environment is insignificant. The increase in turbidity will occur only in the areas of foundation installation and cable laying, therefore its impact should be assessed as local (bottom layer) and temporary (only during installation), not having a significant long-term impact on the hydrochemical water parameters and water quality of the Baltic Sea. In terms of impact on water, both alternatives are equivalent.
2	Ambient air and climate	0	3	3	15	0.00	0.45	0.45	During the construction and operation of the OWF, emissions of ambient air pollutants are possible from the internal combustion engines of the serving vessels. In the open sea, far from the coast and the residential or public environment, there are favourable conditions for the dispersion of pollutants, therefore the emitted pollutants

	Environmental component	Alternatives under consideration			Weight percent	Weighted impact assessment of alternatives			Possible impacts and their comparison
		0: OWF is not being developed	1st: Maximum (68 WTGs)	2nd: Optimal (55 WTGs)		0: OWF is not being developed	1st Maximum (68 WTGS)	2nd Optimal (55 WTGs)	
									will be easily dispersed and will not have a significant negative impact on the environment. The use of RES is highly favoured in the context of climate impact, as a means of reducing climate change. The use of wind energy significantly reduces dependence on fossil fuels, its use, and at the same time CO_2 and other GHG emissions into the ambient air. After evaluating the technical parameters of the CN OWF (700 MW capacity), the total amount of avoided carbon dioxide was calculated to be approximately 1,663,049 tCO_2e.
3	Seabed	0	-1	-1	10	0.00	-0.10	-0.10	Considering the seabed structure, the type and distribution of surface sediments, and the formation of valuable benthic communities associated with these, it can be stated that the impact on the seabed will essentially be only local and relatively minor. The main negative impact is associated with localized partial seabed disturbance and secondary sedimentation at the sites of foundation and export cable route installation. Since the project area (located more than 36.8 km from the shore) is far offshore, the installed WTGs will not have a significant effect on coastal dynamics or sediment transport dynamics, as the primary sediment flow along the Lithuanian nearshore extends only 1–1.5 km offshore. Scour formation in loose soils (sandy sediments) is typical for pile foundation structures. To prevent such scouring, the seabed around the foundation may be reinforced with stones. For laying high-voltage cables on the seabed, two main technological methods are used: trenching or covering the cable laid

	Environmental component	Alternatives under consideration			Weight percent	Weighted impact assessment of alternatives			Possible impacts and their comparison
		0: OWF is not being developed	1st: Maximum (68 WTGs)	2nd: Optimal (55 WTGs)		0: OWF is not being developed	1st Maximum (68 WTGS)	2nd Optimal (55 WTGs)	
									directly on the seabed with heavy concrete mats or a layer of sand or gravel. In all cases, this impact on the seabed is local and minimal, and equivalent for both alternatives.
4	Landscape	0	-2	-2	15	0.00	-0.30	-0.30	In terms of landscape, the impact of OWF is assessed on a regional scale, i.e., it includes the project implementation area itself and the surrounding areas that may be affected from a landscape perspective or whose character determines the visual perception of OWF. When assessing the potential impact of the planned OWF on the landscape, it was determined that, according to the provisions of the current legal acts of the Republic of Lithuania, installing wind farms at a significant distance from the coastline (approximately 36.8 km from the nearest boundary of the OWF territory) would not exceed the threshold for significant landscape impact, therefore, the impact on the landscape is considered insignificant. Considering the fact that the OWF may be visually detectable from the coast under very clear visibility conditions, the total visual impact significance score suggests that the impact of both alternatives is equivalent.
5	Biodiversity: seabed habitats	0	-2	-1	5	0.00	-0.10	-0.05	The installation phase of the OWF will have a temporary impact on benthic habitats due to local seabed disturbance when installing foundations and export cable trenches, as well as due to temporary water turbidity. The most significant theoretical habitat loss is expected in circalittoral reef (1170) habitats. For Alternative 2 (optimal), the impact is lower: 13 less WTGs (31.7%

	Environmental component	Alternatives under consideration				Weighted impact assessment of alternatives			Possible impacts and their comparison
		0: OWF is not being developed	1st: Maximum (68 WTGs)	2nd: Optimal (55 WTGs)	Weight percent	0: OWF is not being developed	1st Maximum (68 WTGS)	2nd Optimal (55 WTGs)	
									reduction), 38.4 km less cable length required, leading to a reduced impact on reef habitats. During the operation phase, the negative impact on benthic habitats is negligible. A likely and positive effect may occur, as underwater wind farm structures can serve as secondary (artificial) substrates for various sedentary aquatic organisms. This may increase habitat diversity, benthic community biomass, and species richness.
6	Biodiversity: ichthyofauna	0	0	0	5	0.00	0.00	0.00	The most significant impact on certain fish species may occur during installation and decommissioning. This effect will be short-term and, if noise mitigation measures are applied during pile driving, the impact is considered insignificant. Some species with large swim bladders (e.g., Baltic cod) may temporarily leave the area due to noise sensitivity but are expected to return after construction. Avoidance behaviour is limited to a few meters from turbines and only during strong wind conditions, so during operation, a positive effect may arise from artificial reef creation. Overall, the impact on fish is assessed as neutral for both alternatives.
7	Biodiversity: Marine Mammals	0	0	0	5	0.00	0.00	0.00	Marine mammals may be impacted during construction, particularly during impact pile driving. However, based on data, only few marine mammals are present in the OWF area, and with mitigation, both construction and operation are not expected to have significant negative effects. Hence, the impact on marine mammals is assessed as neutral for both alternatives.

	Environmental component	Alternatives under consideration			Weighted impact assessment of alternatives				Possible impacts and their comparison
		0: OWF is not being developed	1st: Maximum (68 WTGs)	2nd: Optimal (55 WTGs)	Weight percent	0: OWF is not being developed	1st Maximum (68 WTGS)	2nd Optimal (55 WTGs)	
8	Biodiversity: birds and bats	0	-3	-1	15	0.00	-0.45	-0.10	No impact on bats is expected, as bat migration intensity drops significantly beyond the coastline. The implementation of the PEA may lead to disturbance, obstruction, and collisions for wintering and migratory birds. Displacement and scaring may especially affect sea ducks, such as scoters and long-tailed ducks, that feed on benthic organisms. No significant impact is expected on other bird species (wintering, breeding, or migratory). Bird scaring effects may occur due to increased vessel traffic during construction, regular helicopter or ship-based maintenance during operation. Relocating wind farm locations 2 km away from protected area borders (Alternative 2) is considered effective in reducing bird disturbance and foraging habitat loss in valuable benthic zones.
9	Protected and “Natura 2000” areas in the Republic of Lithuania	0	-3	-1	20	0.00	-0.60	-0.20	The OWF borders the Klaipėda-Ventspils Plateau Biosphere Reserve and “Natura 2000” SPA and SAC over a length of about 700 meters. There is potential impact on protected bird species due to disturbance and displacement from suitable foraging areas. This may lead to a reduction in bird density in “Natura 2000” areas, as birds using these protected zones may be forced to leave and seek alternative feeding grounds. However, maintaining a 2 km buffer from protected areas to the nearest turbines (Alternative 2) would prevent significant negative effects on benthic habitats (reefs) and protected bird species by reducing disturbance.

	Environmental component	Alternatives under consideration			Weighted impact assessment of alternatives				Possible impacts and their comparison
		0: OWF is not being developed	1st: Maximum (68 WTGs)	2nd: Optimal (55 WTGs)	Weight percent	0: OWF is not being developed	1st Maximum (68 WTGS)	2nd Optimal (55 WTGs)	
					Total	**0.00**	**-1.10**	**-0.35**	
					Social environment and society				
10	Restrictions on other marine activities in the territory of the OWF	0	-1	-1	30	0.00	-0.30	-0.30	The territory of the OWF falls within areas where WTG locations must be coordinated under the condition that the renewable energy producer signs an agreement with the Lithuanian Armed Forces regarding a share of the investments and other related costs. The OWF territory is located outside existing navigation corridor limits, port roadstead, and anchor zones, therefore, the implementation of the planned solutions will not have a significant impact on navigation. A cer]tain economic impact on the fishing industry is expected due to the fishing restrictions that will arise in the OWF territory – once the wind farm is installed, trawling will no longer be allowed in the area due to the risk of damaging the seabed-laid power transmission cables.
11	Cultural heritage	0	0	0	15	0.00	0.00	0.00	A potential negative impact on cultural heritage objects may occur in areas where remains of possible anthropogenic origin are identified. In such cases, additional archaeological investigations must be carried out before any removal or seabed disturbance near those remains. No objects with cultural value and/or monument status were identified in the study area. A wreck – ID 231123 – was found, but it is not considered an archaeological artifact. However, it poses an obstacle to the planned project, so a protective buffer zone of at least 50 m around the wreck is recommended. This would

Environmental component		Alternatives under consideration			Weighted impact assessment of alternatives				Possible impacts and their comparison
		0: OWF is not being developed	1st: Maximum (68 WTGs)	2nd: Optimal (55 WTGs)	Weight percent	0: OWF is not being developed	1st Maximum (68 WTGS)	2nd Optimal (55 WTGs)	
									ensure the safe planning of WTG placement and cable infrastructure installation, as well as protect the wreck from accidental destruction.
12	Resource deposits	0	0	0	15	0.00	0.00	0.00	The project area does not overlap with zones of oil, sand, or other valuable mineral deposits, so no negative impact on natural resources is expected.
13	Social impact on national and Baltic region scales due to energy security	0	3	3	40	0.00	1.20	1.20	The installation and operation of the OWF will create conditions for increasing energy production from RES, which directly supports the National Energy and Climate Plan (NECP) goals. From this perspective, the impact is assessed as significantly positive in all three alternatives.
					Total	**0.00**	**0.90**	**0.90**	
					Economic environment				
14	Support for local communities, investments, job creation for the Lithuanian labour market, service sector	0	3	3	20	0.00	0.60	0.60	According to the provisions of the Renewable Energy Sources Act, local communities located in municipalities bordering the maritime territory where renewable energy facilities are installed are eligible to receive support. During the construction phase of the OWF, it is anticipated that a portion of specialists will be hired locally: mechanical, civil, and electrical engineers will be needed, as well as cargo handlers, crane operators, and equipment operators responsible for assembling steel structures. Once the OWF enters operation, the demand for local labour will increase significantly. There will be a need for maintenance engineers, electrical equipment operators, logistics, transport, and administrative specialists. Most

Environmental component		Alternatives under consideration			Weighted impact assessment of alternatives				Possible impacts and their comparison
		0: OWF is not being developed	1st: Maximum (68 WTGs)	2nd: Optimal (55 WTGs)	Weight percent	0: OWF is not being developed	1st Maximum (68 WTGS)	2nd Optimal (55 WTGs)	
									jobs will go to local residents, thus promoting sustainable employment and long-term economic growth. Additionally, during the operational phase, demand will increase in local logistics, service, and other sectors, and this trend is expected to continue throughout the project's lifecycle. The implementation of the project will have direct, indirect, and induced effects on the Gross Domestic Product (GDP) due to the growth of the wind energy industry and other manufacturing sectors, the expansion of engineering services, and in the long term – the potential for investments in research and innovation in the wind energy field.
15	Economic viability (construction costs/ payback)	0	3	2	30	0.00	0.90	0.60	The installation of the OWF and its integration into Lithuania's transmission grid will require both internal grid expansion and the development of infrastructure at sea. Therefore, costs for achieving the National Energy and Climate Plan (NECP) goals are inevitable and will partly determine the expected payback period and the overall economic viability of the project. At the EIA stage, the installation and operational costs of the OWF and its payback period are not detailed, but it is assumed that the first (maximum) alternative would provide greater economic benefits.
16	Contributing to the implementatio n of energy	0	3	3	50	0.00	1.50	1.50	The NECP aims to ensure that by 2050, 100% of the country's total electricity consumption comes from domestically produced electricity. The installation of the OWF would make a significant contribution to the

Environmental component	Alternatives under consideration				Weighted impact assessment of alternatives			Possible impacts and their comparison
	0: OWF is not being developed	1st: Maximum (68 WTGs)	2nd: Optimal (55 WTGs)	Weight percent	0: OWF is not being developed	1st Maximum (68 WTGS)	2nd Optimal (55 WTGs)	
independence goals								successful implementation of NECP targets. Therefore, the impact is assessed as significantly positive in the case of both development alternatives
				Total	**0.00**	**3.00**	**3.00**	
Total (summary indicator in terms of sustainable development)					**0.00**	**0.93**	**1.18**	

7.4 Conclusions of the analysis of alternatives

According to the alternatives analysis, it is planned to choose the 2nd optimal alternative for the implementation of the CN OWF, i.e.:

- No more than 55 WTGs will be installed.
- It is recommended where technically feasible and reasonably practicable, to avoid the installation of wind turbines within sensitive seabed zones and/or to minimize seabed disturbance by limiting the extent of cable trenching.
- A setback of approximately 2 km from the western boundary of the “Natura 2000” area will be maintained.

By placing the WTGs considering the most abundant benthic habitats and applying impact mitigation measures for bird protection areas (see Table 7.4.1), the selected alternative will have the least impact on natural values while ensuring the feasibility of the renewable energy generation goal.

The CN OWF will be connected to the existing onshore electricity transmission network at the 330 kV “Darbėnai” Switchyard, located in Darbėnai Eldership, Kretinga District Municipality, using the corridor analysed in the EIA report (Fig. 7.4.1).

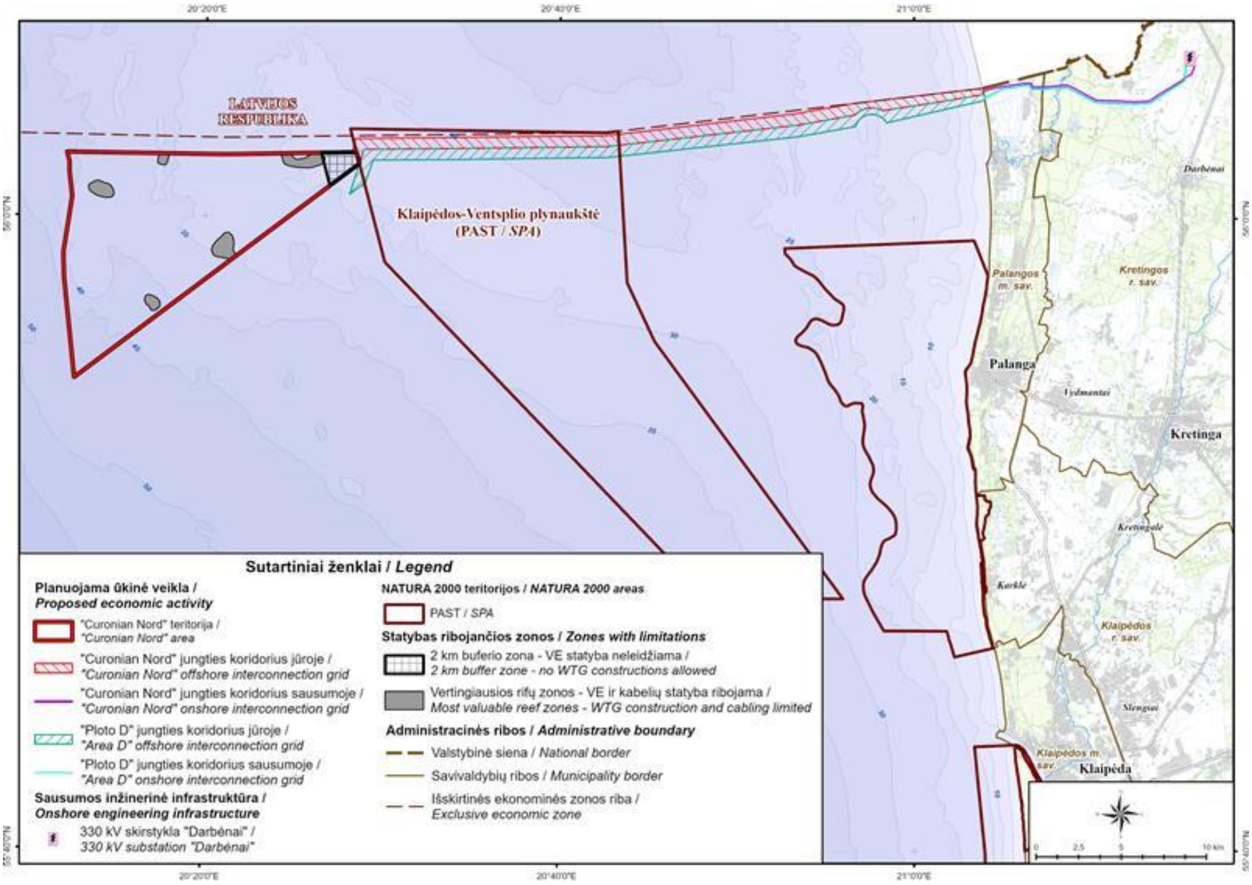


Fig. 7.4.1. Planned offshore and onshore export cable corridors for the CN OWF and “Area D” OWF.

The connection of the “Area D” OWF to the existing 330 kV “Darbėnai” Switchyard, located in Darbėnai Eldership, Kretinga District Municipality, is possible by using the route analysed in the EIA report (Fig. 7.4.1) and by applying the prescribed environmental impact mitigation measures (Table 7.4.2).

Table 7.4.1. Measures to avoid, reduce and compensate for the environmental impact of the CN OWF and the installation of the export cable corridors

<table>
<tr><th rowspan="2">Environmental component</th><th colspan="2">Measures to avoid, reduce and compensate for environmental impacts</th></tr>
<tr><th>Offshore</th><th>Onshore</th></tr>
<tr><td rowspan="3">Waste</td><td colspan="2"><u>Planning stage</u>
During the technical design phase, the expected amount of waste generated during the construction and operation of the OWF and export cables will be estimated, and a waste management plan prepared.</td></tr>
<tr><td><u>Construction and operation stage</u>
All waste generated during construction and operation will be delivered by ships to service ports and handed over to waste handlers.</td><td><u>Construction stage</u>
All construction waste generated will be sorted and stored in containers until removed and handed over to waste handlers.</td></tr>
<tr><td colspan="2"><u>Decommissioning stage:</u>
After decommissioning the OWF, most of the components will be reused, and if not possible, recycled or disposed of in designated disposal sites in accordance with Lithuanian legislation. A waste management plan must be included in the decommissioning project.</td></tr>
<tr><td>Water</td><td><u>Construction and operation stage</u>
Flow regime monitoring will be carried out at the wind farm access points during the installation and after the completion of construction works. Pollutant substance testing will be conducted before construction works (baseline concentrations), during construction (foundation installation, cable laying), and after the completion of construction works (3–6 months after completion).
During the construction and operation phases of the OWF, environmentally friendlier corrosion control methods shall be used to reduce or avoid the release of heavy metals into the water.
<u>Operation stage</u>
Surface runoff generated on the OSS platform will be directed to an automatic water and oil separator before being discharged into the environment, where the instantaneous concentration of oil products will be recorded. If the instantaneous concentration of oil products in the surface runoff exceeds thresholds, set in Regulations, discharge into the environment will be stopped, and the polluted runoff will be directed to a closed wastewater system installed at the substation.
To reduce the risk of spills, additional technical measures for the capture and collection of oil products (e.g., drip trays, wastewater tanks) will also be installed at the substation. When designing/planning the surface runoff treatment facility, the requirements of the Regulation on the Application of Wastewater Treatment Facilities, approved by Order</td><td><u>Construction stage</u>
During the export cable installation onshore, to avoid potential impacts of construction works on surface water bodies, construction equipment sites and temporary access roads must not be established within the coastal protection zones of water bodies or closer than 25 meters to the shoreline.
While installing export cable and conducting construction work within water body protection zones, it is necessary to comply with the requirements outlined in Articles 99 and 100 of the Law on SLUC.
At the crossing point with the Šventoji River, it is planned to use trenchless cable laying technology (HDD or similar) to avoid the direct impact of excavation works on the river.</td></tr>
</table>

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	**Onshore**
	No. D1-412 of the Minister of Environment of the Republic of Lithuania of 11 September 2006, must be followed**.**	
Air	*Construction and operation stage* All vessels shall comply with international MARPOL regulations.	*Construction stage* During construction, cable laying, or other earthworks, as well as during operation, low-emission equipment should be used. When transporting dusty construction materials or bulk cargo, the requirements set out in the Order No. D1-682 of the Minister of Environment of the Republic of Lithuania of 11 November 2020 "On the Approval of Minimum Requirements for Dust Reduction When Storing, Loading, and Transporting Loose Solid Materials" shall be followed.
Seabed, subsurface and soil	*Construction stage* To avoid excessive fragmentation of seabed sediments and the emergence of new lithological types due to secondary sedimentation in areas with disturbed soil, environmentally friendly technologies should be used during the excavation of cable trenches to minimize the impact on the seabed. During the design phase, it is necessary to avoid identified objects of possible anthropogenic origin or to plan seabed clearing operations in construction areas in accordance with all occupational safety principles. Applicable measures to reduce potential impacts on power infrastructure: • To reduce potential risks to foundations and cables from seabed erosion, it is recommended to carefully assess the lithological conditions of surface sediments and, if necessary, apply additional reinforcement around foundation piles during construction. • Before commencing detailed OWF and cable design work, the developer will organise a survey for unexploded ordnance (hereinafter – UXO). This will also help identify any unknown historical cables and associated risks. • It is recommended not to plan export cable routes through areas of large-scale seabed topography changes (steep slopes and deep depressions). Alternatively, to avoid potential	*Construction stage* At construction sites, in cable-laying zones, and in the ONSs area, before any earthworks are carried out, the top fertile soil layer must be removed and stored separately. After the completion of excavation works, this soil must be reused for land restoration. After construction is completed, compacted (mechanically damaged) soil is to be restored by shallow ploughing. All construction waste generated during the works must be promptly removed to minimize any potential chemical impact on the topsoil. During construction, only technically sound machinery should be used to ensure that fuel or lubricants do not leak into the environment – this is essential to avoid chemical pollution and to protect the soil and subsurface layers.

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	**Onshore**
	damage to the electrical transmission system, partial seabed levelling procedures should be foreseen in cable route areas.	
State protected areas and "Natura 2000" sites	*Planning stage* To protect seabed habitats important for bird foraging and reduce disturbance to overwintering birds, it is proposed to locate the nearest WTGs at least 2 km away from the boundary of the "Natura 2000" site Klaipėda-Ventspils Plateau. *Construction stage* To minimize potential impacts on the Klaipėda-Ventspils Plateau Biosphere Polygon and the seabed habitats of the Natura 2000 SAC site, any boulders displaced during export cable laying should be left in the same environment, i.e., not removed from their natural area. Other coarse material (gravel and pebbles), which also forms reef habitat, should be used to backfill trenches after cable installation, where possible. For cable covering, plates simulating artificial reef functions shall be used: plates must be at least 1x1 m in size, with 30–50% porosity, pore size of 2–5 mm, and made of limestone, or alternative characteristics with scientifically proved ecological performance. *Construction and decommissioning stage* To reduce impacts on wintering birds during the main period of migratory and wintering bird aggregations (15 November–15 April), the noisiest activities, such as pile driving and decommissioning works, should start at WTGs locations furthest from the SPA, while also applying appropriate noise mitigation measures (e.g., DBBC or similar, around the pile-driving sites to mitigate the emitted underwater noise). *Construction, operation, and decommissioning stage* During the construction, operation and decommissioning stages of the OWF to minimise disturbance to wintering birds, shipping routes must be planned to bypass protected areas if the works are carried out during the main period of migratory and wintering bird aggregations (15 November–15 April). Routes must be planned in the same way during the export cable laying and decommissioning phases. Restrictions do not apply for repair and maintenance works of cables. *Construction and decommissioning stage*	*Planning stage* A trenchless connection cable laying technology is planned for the landfall and the crossing of the SAC Šventoji River. This approach eliminates the impact on the Būtingė Geomorphological Reserve and the Šventoji River, as well as the integrity of the designated habitat, and minimizes the impact on targeted protected values and species. *Construction stage* To reduce the potential impact on fish in the SAC Šventoji River when applying the trenchless cable installation method, alternative or natural additives should be used in the drilling mixture – ones that would have minimal impact on protected values even in the event of a leak. To avoid a potential "migration barrier" effect, cable laying should not be conducted during the active migration or spawning periods of salmonid species and river lampreys. Additionally, the cables must be buried at least 3 m into the riverbed. The cables crossing the Kulšė River will be installed using an open trench (or trenchless) method. To minimize the runoff of sediments into the Šventoji River because of these works, sediment control measures must be applied – such as sediment retention screens or other technologies that reduce sediment dispersal and water turbidity. The most sensitive periods for migratory fish in the Šventoji River and its tributaries – during which no cable construction work should be carried out – are as follows: • For salmonid fish: from October 1 to January 15. • For river lampreys: from April 1 to May 15.

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	Onshore
	During the construction and decommissioning phases, cable laying or decommissioning activities within the offshore protected areas and a 2 km buffer zone around them must be avoided during the main period of migratory and wintering bird aggregations (15 November–15 April). *Operational stage* If a significant negative impact is identified during the operation phase, which was not foreseen during the EIA, additional mitigation measures shall be taken, selecting them depending on the impact. After the implementation of additional measures, their effectiveness shall be monitored until it is ensured that the additional measures applied to avoid significant impacts are effective. If the impact remains significant even with all tested mitigation measures, individual wind turbines or group of WTGs may not be operated during the period when they may have a significant impact on biodiversity. The impact (displacement from the protected area) is considered significant when the abundance of protected birds in the “Natura 2000” SPA – the number and/or density of individuals of protected bird species in the monitored area – decreases by more than 20% from the natural long-term (10-year) population fluctuation (according to long-term research data collected under the state environmental monitoring program).	
Benthic habitats offshore/ Vegetation and habitats onshore	*Construction stage* During the installation of the export cable corridors, cables will be laid in trenches and buried using the same excavated sediments, if technologically feasible. During cable laying, boulders will be locally relocated, while gravel and pebbles will be returned to the trench to cover the cables, if technologically feasible. In the coastal zone, closed HDD technology will be used to bring the cables from the sea to the shore. Therefore, no impact on seabed habitats is expected from the closed HDD site to the shoreline.	*Construction stage* Measures to reduce the impact on vegetation in meadow habitats: • Imported soil cannot be used for land reclamation. Reclamation shall use the preserved local soil. • When restoring damaged vegetation cover, seed mixtures not characteristic of the previous (original) vegetation cannot be used. The area shall be left for natural regeneration. • Before starting the work, it shall be ensured that there are no invasive plant species in the work zone. If found, an invasive species management plan must be prepared, and measures taken to prevent their spread from the work area to adjacent territories. Measures to reduce the impact on forests:

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	Onshore
		• In order to reduce the impact on the Group III protective forest growing on the banks of the Šventoji River, at the intersection with the Šventoji River, using trenchless method (HDD or similar), it is planned to move the technological sites of the beginning and end of drilling works beyond the riverbank protection strip, and to plan the works in such a way that these sites are designed as far as possible from the riverbank, if possible, outside the river protection zone. • Imported soil cannot be used for land reclamation. Reclamation shall use the preserved local soil. • Upon completion of the construction works, the disturbed areas in former forest plots shall be left to regenerate naturally purchased grass seed mixtures shouldn't be sown. • A monetary compensation shall be paid for converting forest land to other uses (for the felled forest), which will be included in the state budget of the Republic of Lithuania. It will also be used in the General Forestry Needs Financing Program for the acquisition of land for afforestation, forest planting, and other forestry-related measures defined in Article 7(2) of the Forest Law of the Republic of Lithuania. Measures to reduce the impact on protected vegetation: • The design of the export cable corridors should preserve large trees within the protected greenery as much as possible. • The design of the export cable corridor should preserve mature linden trees in protected greenery areas as much as possible. • Imported soil cannot be used for land reclamation. Reclamation shall use the preserved local soil. • Upon completion of construction, disturbed areas shall be left to regenerate naturally purchased grass seed mixtures shouldn't be sown. • Compensation for the removal of protected greenery shall be paid based on the compensatory restoration value as determined and calculated by the representative institution of the municipality. This obligation is defined in the Law on Greenery of the Republic of

<table>
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<tr><th>Offshore</th><th>Onshore</th></tr>
<tr><td></td><td></td><td>Lithuania (approved by the Seimas resolution No. X-1241 of June 28, 2007, consolidated version effective from 2025-01-01).</td></tr>
<tr><td>Birds</td><td><u>Planning stage</u>
WTGs must not be designed or constructed within at least 2 km of the protected area.
<u>Construction and decommissioning stage</u>
During the construction and decommissioning phase to minimise the disturbance of wintering seabirds during the main period of migratory and wintering bird aggregations (15 November–15 April), the installation of foundations (or decommissioning works) should start at WTGs locations furthest from the SPA, while also applying appropriate noise mitigation measures (see section 5.4.5.4.1). Throughout this sensitive period, for pile driving activities “soft-start” method should be applied, when work begins at minimum power and gradually increasing it creates a gradual rise in sound level avoiding sudden noise shockwaves.
During the construction and decommissioning phases, cable laying or decommissioning activities within the offshore protected areas and a 2 km buffer zone around them must be avoided during the main period of migratory and wintering bird aggregations (15 November–15 April).
<u>Operation stage</u>
Operation phase: radar and/or video surveillance systems must be installed in the northern and south-western parts of the OWF, capable of accurately capturing and archiving data during bird migration periods.
Construction and operation phase: reducing unnecessary artificial lighting can help prevent collisions by minimising the attraction of certain bird species, which may be disoriented by artificial light. Effective measures include lowering illumination levels and intensity, adjusting the light spectrum, using deflectors, and modifying lighting patterns and lightning control systems to reduce interference with bird natural orientation mechanisms.
<u>Construction, operation, and dismantling stage</u>
During the construction, operation and decommissioning stages of the OWF to minimise disturbance to wintering birds, shipping routes must be planned to bypass protected areas if the works are carried out during the</td><td><u>Construction and decommissioning stage</u>
It is particularly important that the hydrological regime of the territory is not disturbed. Activities that may affect the hydrological regime should not be carried out from November to February. If it is impossible to carry out the work without changing the hydrological regime, the hydrological regime and water level must be restored immediately after the cable installation.
Before carrying out any work, it is necessary to check whether there are any Western Marsh Harrier or Montagu's Harrier nests in the area where the work is planned or in its immediate vicinity. These surveys must be carried out by an ornithologist with the appropriate expertise. If Western Marsh Harrier nest is found, work shall not be carried out between April 1 and August 31, and between April 15 and August 31 for Montagu's Harrier. The restrictions apply within a 500 m radius of the nest.
To avoid disturbance and displacement of birds and potential impact on bird breeding, feeding and resting habitats, preparatory infrastructure works (e.g. access roads) for cable laying activities in the section from the sea to the forest should be carried out from November to February.
To avoid bird disturbance and potential impact on nesting sites, all tree and shrub cutting must not be performed during the bird breeding season, which is from March to July inclusive.
If excavation works are planned during the March to July period, a thorough inspection shall be carried out before starting to ensure no nesting birds are present in the excavation or storage areas. These surveys must be carried out by an ornithologist with the appropriate expertise.</td></tr>
</table>

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	**Onshore**
	main period of migratory and wintering bird aggregations (15 November–15 April). Routes must be planned in the same way during the export cable laying and decommissioning phases. Restrictions do not apply for repair and maintenance works of cables. *Compensatory measures before, during, and after construction and operation of the OWF* To better understand and analyse seabird movement in the planned OWF and the protected area, it is recommended to place GPS/GSM transmitters on seabirds: • 40 seabirds before construction • 40 seabirds during construction • 40 seabirds after construction, during operation. Transmitters should be placed on the birds at the beginning of the wintering season to collect the maximum amount of data. This would allow a comparative analysis of bird behaviour before, during, and after OWF construction and operation. To reduce the cumulative impact of various activities on seabirds, compensatory actions are encouraged to offset other negative activities, for example, minimizing seabird bycatch in fisheries. This can be achieved through measures such as: selecting safer fishing gear to minimise bird entanglement, providing financial support for the adoption of seabird-friendly fishing practices, funding safer fishing initiatives to promote sustainable methods, implementing temporary fishing bans in critical seabird habitats. Nature conservation measures should be implemented in protected areas, and applied scientific research in seabird wintering and breeding grounds should be funded. *Monitoring Implementation* Bird monitoring shall be conducted during construction and for 3 years after construction is completed. Subsequently, 2-year monitoring cycles should be repeated every 5 years. If a significant negative impact is identified during the operation phase, which was not foreseen during the EIA, additional mitigation measures shall be taken, selecting them depending on the impact. After the	

<table>
<tr><th rowspan="2">Environmental component</th><th colspan="2">Measures to avoid, reduce and compensate for environmental impacts</th></tr>
<tr><th>Offshore</th><th>Onshore</th></tr>
<tr><td></td><td>implementation of additional measures, their effectiveness shall be monitored until it is ensured that the additional measures applied to avoid significant impacts are effective. If the impact remains significant even with all tested mitigation measures, individual wind turbines or group of WTGs may not be operated during the period when they may have a significant impact on biodiversity. The impact (displacement from the protected area) is considered significant when the abundance of protected birds in the “Natura 2000” SPA – the number and/or density of individuals of protected bird species in the monitored area – decreases by more than 20% from the natural long-term (10-year) population fluctuation (according to long-term research data collected under the state environmental monitoring program).</td><td></td></tr>
<tr><td>Bats</td><td colspan="2">Construction stage

It has to be ensured that bat migration can be monitored during the construction and operation of the OWF. Monitoring shall be carried out using ultrasonic detectors installed on vessels during construction and on WTGs and the OSS during OWF operation. During construction, detectors have to be installed on at least two vessels involved in building the OWF from April to October. The data collected during construction has to be assessed when preparing the monitoring programme for the operational phase of the OWF. The species composition and environmental conditions (wind speed, direction, temperature, precipitation) during which bat activity was recorded in the open sea must be determined.

On land, in the forested area where deforestation is planned for cable installation, prior to felling, the identification of day roosts of breeding bats has to be repeated (as bats could have settled in new sites since the initial assessment was carried out). If breeding sites are identified, they have to be preserved, or tree stumps with hollows and cavities have to be relocated to adjacent forest areas so as not to deteriorate the living conditions of species listed in the Habitats Directive. Relocation shall be carried out outside the breeding and migration periods – from the end of November until the beginning of April. All works shall be undertaken to ensure that the conservation status of bat species listed in Annex II and Annex IV of the Habitats Directive is not deteriorated.

Operation stage

Due to the likelihood that the OWF may attract bats, bat activity monitoring shall be carried out. Bat activity has to be recorded using ultrasonic and, if possible, visual monitoring equipment. Detectors should be placed around the perimeter of the OWF, with at least two detectors in the first rows of WTGs facing north, west, and south, as well as one detector in the centre of the OWF and one at the substation. Ultrasonic microphones should record activity in the rotor-swept zone from early April to the end of October.

Simultaneously, on the coast near Būtingė and Palanga, one ultrasonic detector each have be installed to collect data on activity in the coastal zone, enabling comparison of bat activity at sea and on land. During measurements, data on wind speed, direction, and temperature have to be collected both at sea and on land.</td></tr>
</table>

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	Onshore
	After the first year of operation, the collected data has to be evaluated, and the OWF's operation adjusted accordingly: if the impact is found to be significant (as per existing Regulation), the most appropriate mitigation measures (technological or phenological) must be selected. *Compensatory measures* To reduce the likelihood of potential harm to bats both on land and at sea, and to compensate for any possible bat mortality or loss of daytime roosting habitats, the developer should install temporary special roosting **sites** along the coast, designed specifically for bats, where migrating individuals can safely rest. Such roosting sites should be established in at least 10 locations important for bat foraging, from the Latvian coastline to Klaipėda. In the forested area where tree felling is planned for cable installation, 10 bat boxes or artificial roosts suitable for breeding and daytime shelter for different bat species will be installed in adjacent plots. *Monitoring implementation* The plan for monitoring bats involves continuous observation during the construction phase and for three years post-construction. After this initial period, monitoring will be repeated for two years every five years. If monitoring reveals a more significant negative impact than anticipated in the EIA, mitigation measures (technological or phenological) must be selected.	
Marine and terrestrial mammals	<u>*Construction stage*</u> Acoustic deterrence of animals before pile driving: 1. Use of ADDs to scare marine mammals away from the pile driving zone. 2. Soft-start of pile driving, i.e., gradually increasing the impact energy, allowing animals to move away while avoiding sudden, highly harmful noise pulses. Use of technical noise reduction measures (one or more, depending on the conditions) during pile driving, e.g.: • DBBCs installed around the pile driving location • HSD systems • Or alternative, market-available technologies capable of achieving equivalent noise reduction. It is recommended, where possible throughout the year and mandatory from November to April, that construction, OWF servicing, and decommissioning use only common shipping lanes and designated corridors to and from the project site. This helps concentrate noise in one area, reducing disturbance to marine mammal foraging. Restrictions do not apply to cable repair and maintenance activities. <u>*Decommissioning stage*</u>	<u>*Construction stage*</u> If excavation work is to be carried out from March to July, the excavated soil storage area shall be inspected before dumping the soil to ensure there are no mammal young, reptiles or amphibians present. The excavated soil must be pushed slowly so that animals in the meadow have time to escape.

<table>
<tr><th rowspan="2">Environmental component</th><th colspan="2">Measures to avoid, reduce and compensate for environmental impacts</th></tr>
<tr><th>Offshore</th><th>Onshore</th></tr>
<tr><td></td><td>Gradual noise increase (soft-start): applying this measure during decommissioning allows for a gradual increase in noise levels, providing marine mammals with the opportunity to move away from the noisy work area. This approach, often combined with marine mammal deterrent devices (such as ADDs), helps avoid sudden acoustic disturbances that could cause stress and disrupt animal behaviour.
If harbour porpoise presence is detected in the area during the November–April period, decommissioning works are suspended for one week from the last detection or underwater noise mitigation measures must be applied to avoid the possible effect on marine mammals.
Application of monopile cutting technologies, such as diamond wire cutting, allows for structural removal without generating significant noise, thereby minimizing the impact on marine mammal habitats.</td><td></td></tr>
<tr><td>Marine and inland fish</td><td><u>Construction stage</u>
Multiple noise reduction measures, including ADDs, must be applied simultaneously.
<u>Decommissioning stage</u>
Gradual noise increase (soft-start) – this measure, applied during dismantling, allows for a gradual increase in noise, giving fish a chance to move away from the noisy work zones. Recently, this method has often been combined with marine ADDs to avoid sudden acoustic stimuli that could injure fish.
Application of monopile cutting technologies.
If monitoring of fish and benthic communities during operation identifies that secondary habitats have formed and have a significant positive effect, it is recommended to partially leave the monopiles in place by cutting them at 1–2 m above the seabed, or to apply compensatory measures during the decommissioning phase of the OWF. Such measures would include the installation of artificial habitats of equivalent area, using 0.1–1 m boulder placed near the decommissioned foundations. These habitats should be installed within a maximum</td><td><u>Construction stage</u>
A trenchless cable laying technology (e.g., HDD or other) is planned for the crossing of the Šventoji River.
For trenchless cable laying technology, it is recommended to choose alternative or natural additives, whose impact on protected areas would be minimal, even in the event of a leak.
To avoid the potential "migration barrier" effect, cable laying works should not be carried out during the active migration or spawning periods of salmonid fish and river lampreys (Lampetra fluviatilis).
Cables across the Kulšė River will be laid using an open trench method. To reduce the impact on fish communities, the work must be carried out during a period when fish migration is at its lowest intensity.
Additionally, sediment dispersion mitigation measures must be applied, such as sediment retention screens or other technologies that reduce sediment leaching and water turbidity.</td></tr>
</table>

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	Onshore
	distance of 50 m from the dismantled WTGs and should be established no later than two years after the decommissioning date. Specific measures will be identified and selected during the planning phase of the OWF decommissioning.	
Landscape	*Planning stage* To minimise the potential impact on the landscape, it is recommended to: • Paint the WTGs in light colours that create minimal colour contrast, avoiding pure white, which would create a stronger visual contrast. • Use special paint compositions that prevent glare and reflections from the structures.	*Construction stage* • Avoid establishing temporary storage sites for construction materials, excavated soil, construction cabins, construction machinery, or parking areas in or near pollution-sensitive areas (such as protected areas, waterlogged areas, coastal protection strips and zones of surface water bodies, etc.). • If tree or vegetation removal is necessary, during the technical design phase it is recommended to carefully assess the necessity and, as far as possible, minimize the number of trees to be cut. Existing trees should be protected from damage during construction. After construction is completed, the damaged areas must be rehabilitated. • During open trench cable laying, the areas used for storing excavated soil, construction materials, equipment, and machinery must be properly managed. Soil from excavated areas must be re-cultivated using plant species and tree forms characteristic of the local environment, and the original landform must be restored.
Cultural heritage	*Planning stage* Although the wreck discovered on the seabed during the investigation – ID 231123 – is not an archaeological artifact, it is recommended to establish at least a 50-meter protective zone (buffer) around the wreck, measured from the outermost points of the shipwreck as determined by sonar surveys. This will ensure safe planning of the OWF layout and cable infrastructure installation and will also protect the wreck itself from accidental destruction.	*Planning stage* To avoid negative impacts on cultural heritage values, the export cable corridors has been selected by moving away from valuable cultural heritage areas or objects. No activities are planned within the territories and protection zones of cultural heritage objects that could physically damage the valuable features of the cultural heritage objects or hinder their visibility. During the technical design, it is necessary to conduct archaeological research at the Laukžemė Cemetery II (ID 37960) and the Būtingė site-7 territories. *Construction stage* When performing export cables installation works involving ground excavation, if archaeological finds are discovered, this must be reported to the municipality's heritage protection department, which will inform the Department of Cultural

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	**Onshore**
		Heritage, as specified in Article 9, Part 3 of the Law on the Protection of Immovable Cultural Heritage of the Republic of Lithuania.
Public health	The PEA is located at a significant distance from the coastal zone as well as from residential, public, and recreational areas. Therefore, physical pollution in these areas due to the operation of the OWF is not anticipated; no environmental avoidance, mitigation, or compensation measures are necessary.	Construction works will be carried out in accordance with the Construction Technical Regulation STR 1.06.01:2016 "Construction Works. Supervision of Building Construction" and the provisions of the Law on Noise Management and STR 2.01.08:2003 "Control of environmental noise emitted by equipment used outdoors". If, during construction works, noise impact exceeding the limit values established by legislation (according to HN 33:2011) is identified, appropriate mitigation measures will be applied, such as noise barriers, restrictions on working hours, optimization of equipment use, or informing local residents about planned noisy activities, among others. To mitigate the potential noise impact from the planned installation of two ONS on the surrounding residential environment, it is proposed to implement noise reduction measures by installing noise-absorbing walls or other technologies capable of reducing noise. A total of 9 barriers were assessed, positioned adjacent to preliminary equipment 4 shunt reactors, 2 power transformers, and 3 synchronous condensers. Each barrier is 35–40 m long and 6 m high. This solution was assessed as one of the possible noise mitigation methods, demonstrating that by applying appropriate noise reduction measures, it is possible to ensure that noise levels in the residential environment do not exceed the legal limit values.
Material assets	*Operation stage* • Support to local communities must be provided in accordance with the procedures established by the laws of the Republic of Lithuania. The collected funds are disbursed by the payment administrator to the designated coastal municipalities under the terms and procedures set by the Government. Municipal councils decide, according to their own procedures, on the use of funds to meet the social, economic, and environmental protection needs of local communities and residents. • Compensation for lost fishing opportunities in the open Baltic Sea is provided according to the procedures established by the legislation of the Republic of Lithuania.	*Planning and construction stage* For land plots falling within the planned export cable corridors, compensation for servitudes must be paid in accordance with the procedures established by the Government.

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	Onshore
	• Compensation for fishing restrictions set in 29th fishing sector. Losses due to the loss of fishing opportunities must be calculated and compensated according to the procedure and rates specified in the rules approved by Order No. 3D-695 of the Minister of Agriculture of the Republic of Lithuania of December 3, 2008, "On the Approval of the Rules for the Calculation of Losses Incurred Due to the Loss of Fishing Opportunities Due to the Activities of Other Persons and the Determination of Rates" for the IV coastal area of the Baltic Sea.	

Table 7.4 2. Measures to avoid, reduce and compensate for the environmental impact of the installation of the “Area D” OWF export cable

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	Onshore
Waste	*Planning stage* During the technical design phase, the expected amount of waste generated during the construction and operation of the OWF’s cables will be estimated, and a waste management plan prepared.	
	Construction and operation stage All waste generated during construction and operation will be delivered by ships to service ports and handed over to waste handlers.	*Construction stage* All construction waste generated will be sorted and stored in containers until removed and handed over to waste handlers.
	Decommissioning stage: After decommissioning the OWF, most of the components will be reused, and if not possible, recycled or disposed of in designated disposal sites in accordance with Lithuanian legislation. A waste management plan must be included in the decommissioning project.	
Water	*Construction and operation stage* Flow regime monitoring will be carried out at the OWF access points during the installation and after the completion of construction works. Pollutant substance testing will be conducted before construction works (baseline concentrations), during construction (cable laying), and after the completion of construction works (3–6 months after completion).	*Construction stage* During the installation of export cables, to avoid potential impacts of construction works on surface water bodies, construction equipment sites and temporary access roads cannot be installed within the coastal protection zones of water bodies or closer than 25 meters to the shoreline. While laying the export cables and conducting construction work within water body protection zones, it is necessary to comply with the requirements outlined in Articles 99 and 100 of the Law on SLUC. At the crossing point with the Šventoji River, it is planned to use trenchless cable laying technology (HDD or similar) to avoid the direct impact of excavation works on the river.

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	**Onshore**
Air	*Construction and operation stage* All vessels must comply with international MARPOL regulations.	*Construction stage* During cable laying, or other earthworks, as well as during operation, low-emission equipment should be used. When transporting dusty construction materials or bulk cargo, the requirements set out in the Order No. D1-682 of the Minister of Environment of the Republic of Lithuania of 11 November 2020 "On the Approval of Minimum Requirements for Dust Reduction When Storing, Loading, and Transporting Loose Solid Materials" shall be followed.
Seabed, subsurface and soil	*Construction stage* To avoid excessive fragmentation of seabed sediments and the emergence of new lithological types due to secondary sedimentation in areas with disturbed soil, environmentally friendly technologies should be used during the excavation of cable trenches to minimize the impact on the seabed. During the design phase, it is necessary to avoid identified objects of possible anthropogenic origin or to plan seabed clearing operations in construction areas in accordance with all occupational safety principles. Applicable measures to reduce potential impacts on power infrastructure: • To reduce potential risks to foundations and cables from seabed erosion, it is recommended to carefully assess the lithological conditions of surface sediments and, if necessary, apply additional reinforcement around foundation piles during construction. • Before commencing detailed OWF and cable design work, the developer will organise a survey for unexploded ordnance (hereinafter – UXO). This will also help identify any unknown historical cables and associated risks. • It is recommended not to plan export cable routes through areas of large-scale seabed topography changes (steep slopes and deep depressions). Alternatively, to avoid potential damage to the electrical transmission system, partial seabed levelling procedures should be foreseen in cable route areas.	*Construction stage* At construction sites, in cable-laying zones, and in the ONSs area, before any earthworks are carried out, the top fertile soil layer must be removed and stored separately. After the completion of excavation works, this soil must be reused for land restoration. After construction is completed, compacted (mechanically damaged) soil is to be restored by shallow ploughing. All construction waste generated during the works must be promptly removed to minimize any potential chemical impact on the topsoil. During construction, only technically sound machinery should be used to ensure that fuel or lubricants do not leak into the environment – this is essential to avoid chemical pollution and to protect the soil and subsurface layers.

<table>
<tr><th rowspan="2">Environmental component</th><th colspan="2">Measures to avoid, reduce and compensate for environmental impacts</th></tr>
<tr><th>Offshore</th><th>Onshore</th></tr>
<tr><td>State protected areas and "Natura 2000" sites</td><td><u>Construction stage</u>
To minimize potential impacts on the Klaipėda-Ventspils Plateau Biosphere Polygon and the seabed habitats of the Natura 2000 SAC site, any boulders displaced during export cable laying should be left in the same environment, i.e., not removed from their natural area. Other coarse material (gravel and pebbles), which also forms reef habitat, should be used to backfill trenches after cable installation, where possible. For cable covering, plates simulating artificial reef functions shall be used: plates must be at least 1x1 m in size, with 30–50% porosity, pore size of 2–5 mm, and made of limestone, or alternative characteristics with scientifically proved ecological performance.
<u>Construction, operation, and decommissioning stage</u>
During the construction, operation and decommissioning stages to minimise disturbance to wintering birds, shipping routes must be planned to bypass protected areas if the works are carried out during the main period of migratory and wintering bird aggregations (15 November–15 April). Routes must be planned in the same way during the export cable laying and decommissioning phases. Restrictions do not apply for repair and maintenance works of cables.
<u>Construction and decommissioning stage</u>
During the construction and decommissioning phases, cable laying or decommissioning activities within the offshore protected areas and a 2 km buffer zone around them must be avoided during the main period of migratory and wintering bird aggregations (15 November–15 April).</td><td><u>Planning stage</u>
A trenchless export cable laying technology is planned for the cable's sea-to-shore route and the crossing of the SAC Šventoji River. This approach eliminates the impact on the Būtingė Geomorphological Reserve and the Šventoji River, as well as the integrity of the designated habitat, and minimizes the impact on targeted protected values and species.
<u>Construction stage</u>
To reduce the potential impact on fish in the SAC Šventoji River when applying the trenchless export cable installation method, alternative or natural additives should be used in the drilling mixture – ones that would have minimal impact on protected values even in the event of a leak.
To avoid a potential "migration barrier" effect, cable laying should not be conducted during the active migration or spawning periods of salmonid species and river lampreys. Additionally, the cables must be buried at least 3 meters into the riverbed.
The cables crossing the Kulšė River will be installed using an open trench method. To minimize the runoff of sediments into the Šventoji River because of these works, sediment control measures must be applied – such as sediment retention screens or other technologies that reduce sediment dispersal and water turbidity.
The most sensitive periods for migratory fish in the Šventoji River and its tributaries – during which no cable construction work should be carried out – are as follows:
For salmonid fish: from October 1 to January 15.
For river lampreys: from April 1 to May 15.</td></tr>
<tr><td>Benthic habitats offshore/ Vegetation and habitats onshore</td><td><u>Construction stage</u>
During the installation of the export cables, cables will be laid in trenches and buried using the same excavated sediments, if technologically feasible.
During cable laying, boulders will be locally relocated by a few meters, while gravel and pebbles will be returned to the trench to cover the cables, if technologically feasible.</td><td><u>Construction stage</u>
Measures to reduce the impact on vegetation in meadow habitats:
Imported soil cannot be used for land reclamation. Reclamation must use the preserved local soil.
When restoring damaged vegetation cover, seed mixtures not characteristic of the previous vegetation shouldn’t be used. The area have to be left for natural regeneration.</td></tr>
</table>

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	Onshore
	In the coastal zone, closed HDD technology will be used to bring the cables from the sea to the shore. Therefore, no impact on seabed habitats is expected from the closed HDD site to the shoreline.	• Before starting the work, it has to be ensured that there are no invasive plant species in the work zone. If found, a plan for the eradication of invasive plants has to be prepared, and measures taken to prevent their spread from the work area to adjacent territories. Measures to reduce the impact on forests: • in order to reduce the impact on the Group III protective forest growing on the banks of the Šventoji River, at the intersection with the Šventoji River, using trenchless method (HDD or similar), it is planned to move the technological sites of the beginning and end of drilling works beyond the riverbank protection strip, and to plan the works in such a way that these sites are designed as far as possible from the riverbank, if possible, outside the river protection zone. • Imported soil shall not be used for land reclamation. Reclamation shall use the preserved local soil. • Upon completion of the construction works, the disturbed areas in former forest plots have to be left to regenerate naturally purchased grass seed mixtures must not be sown. • A monetary compensation will be paid for converting forest land to other uses (for the felled forest), which will be included in the state budget of the Republic of Lithuania. It will also be used in the General Forestry Needs Financing Program for the acquisition of land for afforestation, forest planting, and other forestry-related measures defined in Article 7(2) of the Forest Law of the Republic of Lithuania. Measures to reduce the impact on protected greenery: • The design of the export cable corridor should preserve large trees within the protected greenery as much as possible. • The design of the export cable corridor should preserve mature linden trees in protected greenery areas as much as possible. • Imported soil must not be used for land reclamation. Reclamation must use the preserved local soil. • Upon completion of construction, disturbed areas must be left to regenerate naturally purchased grass seed mixtures must not be sown.

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	Onshore
		• Compensation for the removal of protected greenery will be paid based on the compensatory restoration value as determined and calculated by the representative institution of the municipality. This obligation is defined in the Law on Greenery of the Republic of Lithuania (approved by the Seimas resolution No. X-1241 of June 28, 2007, consolidated version effective from 2025-01-01).
Birds	<u>*Construction and dismantling stage*</u> During the construction and decommissioning phases, cable laying or decommissioning activities within the offshore protected areas and a 2 km buffer zone around them must be avoided during the main period of migratory and wintering bird aggregations (15 November–15 April). <u>*Construction, operation, and decommissioning stage*</u> During the construction, operation and decommissioning stages to minimise disturbance to wintering birds, shipping routes must be planned to bypass protected areas if the works are carried out during the main period of migratory and wintering bird aggregations (15 November–15 April). Routes must be planned in the same way during the export cable laying and decommissioning phases. Restrictions do not apply for repair and maintenance works of cables.	<u>*Construction and decommissioning stage*</u> It is particularly important that the hydrological regime of the territory is not disturbed. Activities that may affect the hydrological regime should not be carried out from November to February. If it is impossible to carry out the work without changing the hydrological regime, the hydrological regime and water level must be restored immediately after the cable installation. Before carrying out any work, it is necessary to check whether there are any Western Marsh Harrier or Montagu's Harrier nests in the area where the work is planned or in its immediate vicinity. These surveys must be carried out by an ornithologist with the appropriate expertise. If Western Marsh Harrier nest is found, work shall not be carried out between April 1 and August 31, and between April 15 and August 31 for Montagu's Harrier. The restrictions apply within a 500 m radius of the nest. To avoid disturbance and displacement of birds and potential impact on bird breeding, feeding and resting habitats, preparatory infrastructure works (e.g. access roads) for cable laying activities in the section from the sea to the forest should be carried out from November to February. To avoid bird disturbance and potential impact on nesting sites, all tree and shrub cutting must not be performed during the bird breeding season, which is from March to July inclusive. If excavation works are planned during the March to July period, a thorough inspection shall be carried out before starting to ensure no nesting birds are present in the excavation or storage areas. These surveys must be carried out by an ornithologist with the appropriate expertise.
Marine and terrestrial mammals	Soft-start procedures are required to allow marine mammals to leave the area before noise-intensive work begins. This should be combined with ADDs to prevent abrupt acoustic stimuli that might cause stress or behavioural disturbances.	<u>*Construction stage*</u> If excavation work is to be carried out from March to July, the excavated soil storage area must be inspected before dumping the soil to ensure there are no mammal young, reptiles and amphibians present.

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	Onshore
		The excavated soil must be pushed slowly so that animals in the meadow have time to escape.
Marine and inland fish		*Construction stage* • A trenchless cable laying technology (e.g., HDD or other) is planned for the crossing of the Šventoji River. • For trenchless cable laying technology, it is recommended to choose alternative or natural additives, whose impact on protected areas would be minimal, even in the event of a leak. • To avoid the potential "migration barrier" effect, cable laying works should not be carried out during the active migration or spawning periods of salmonid fish and river lampreys (*Lampetra fluviatilis*). • Cables across the Kulšė River will be laid using an open trench method. To reduce the impact on fish communities, the work must be carried out during a period when fish migration is at its lowest intensity. • Additionally, sediment dispersion mitigation measures must be applied, such as sediment retention screens or other technologies that reduce sediment leaching and water turbidity.
Landscape		*Construction stage* • Avoid establishing temporary storage sites for construction materials, excavated soil, construction cabins, construction machinery, or parking areas in or near pollution-sensitive areas (such as protected areas, waterlogged areas, coastal protection strips and zones of surface water bodies, etc.). • If tree or vegetation removal is necessary, during the technical design phase it is recommended to carefully assess the necessity and, as far as possible, minimize the number of trees to be cut. Existing trees should be protected from damage during construction. After construction is completed, the damaged areas must be rehabilitated. • During open trench cable laying, the areas used for storing excavated soil, construction materials, equipment, and machinery must be properly managed. Soil from excavated areas must be re-cultivated using plant species and tree forms characteristic of the local environment, and the original landform must be restored.

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	Onshore
Cultural heritage		*Planning stage* To avoid negative impacts on cultural heritage values, the export cable corridor has been selected by moving away from valuable cultural heritage areas or objects. No activities are planned within the territories and protection zones of cultural heritage objects that could physically damage the valuable features of the cultural heritage objects or hinder their visibility. During the technical design, it is necessary to conduct archaeological research at the Laukžemė Cemetery II (ID 37960) and the Būtingė site-7 territories. *Construction stage* When performing export cable installation works involving ground excavation, if archaeological finds are discovered, this must be reported to the municipality's heritage protection department, which will inform the Department of Cultural Heritage, as specified in Article 9, Part 3 of the Law on the Protection of Immovable Cultural Heritage of the Republic of Lithuania.
Public Health		*Operation stage* Construction works will be carried out in accordance with the Construction Technical Regulation STR 1.06.01:2016 “Construction Works. Supervision of Building Construction” and the provisions of the Law on Noise Management and STR 2.01.08:2003 "Control of environmental noise emitted by equipment used outdoors”. If, during construction works, noise impact exceeding the limit values established by legislation (according to HN 33:2011) is identified, appropriate mitigation measures will be applied, such as noise barriers, restrictions on working hours, optimization of equipment use, or informing local residents about planned noisy activities, among others. To mitigate the potential noise impact from the planned installation of two ONS on the surrounding residential environment, it is proposed to implement noise reduction measures by installing noise-absorbing walls or other technologies capable of reducing noise. A total of 9 barriers were assessed, positioned adjacent to preliminary equipment 4 shunt reactors, 2 power transformers, and 3 synchronous condensers. Each barrier is 35–40 m long and 6 m high. This solution was assessed as one of the possible noise mitigation methods, demonstrating that by applying appropriate noise reduction measures, it is

Environmental component	Measures to avoid, reduce and compensate for environmental impacts	
	Offshore	**Onshore**
		possible to ensure that noise levels in the residential environment do not exceed the legal limit values.
Material assets	*Operation stage* • Compensation for lost fishing opportunities in the open Baltic Sea is provided according to the procedures established by the legislation of the Republic of Lithuania. • Compensation for fishing restrictions set in 29th fishing sectors. Losses due to the loss of fishing opportunities must be calculated and compensated according to the procedure and rates specified in the rules approved by Order No. 3D-695 of the Minister of Agriculture of the Republic of Lithuania of December 3, 2008, "On the Approval of the Rules for the Calculation of Losses Incurred Due to the Loss of Fishing Opportunities Due to the Activities of Other Persons and the Determination of Rates" for the IV coastal area of the Baltic Sea. .	*Planning and construction stage* For land plots falling within the planned export cable corridors, compensation for servitudes must be paid in accordance with the procedures established by the Government.

8. MONITORING

The CN OWF planned in the EEZ of the Republic of Lithuania in the Baltic Sea, along with its connection to the onshore transmission grid and related infrastructure, as well as the planned connection of the “Area D” OWF to the onshore transmission grid, will inevitably impact various environmental components. Therefore, it is essential to provide for appropriate environmental monitoring.

The purpose of environmental impact monitoring is to observe, assess, and predict the effects of economic activity on the natural environment and to ensure the reduction of pollution or other negative impacts caused by such activities.

The EIA report outlines the monitoring framework for the CN OWF. The monitoring programme must be prepared and agreed with EPA before the start of OWF construction and should cover the monitoring of impacts from the OWF and OSS construction, as well as cable laying on the seabed, water quality, and wildlife. When developing the monitoring programme and selecting monitoring methods, it is necessary to consider the guidelines of HELCOM.

The monitoring for the connection of the planned “Area D” OWF to the onshore transmission grid will be integrated into the monitoring programme of the “Area D” OWF.

8.1. Outline of monitoring of the CN OWF and its onshore transmission grid connection

8.1.1. Recommendations for underwater noise monitoring

Underwater noise monitoring is mandatory during the construction phase when the OWF foundations are being installed. The aim is to monitor the noise generated to control its negative impact on marine organisms (marine mammals, fish), and to evaluate/control the effectiveness of noise reduction measures.

Currently, two main standards are used in practice – ISO 18406 and DIN SPEC 45653 (Remmers and Belmann, 2016; Belmann et al., 2020).

ISO 18406 – "Underwater acoustics – Measurement of underwater sound emitted by pile driving" describes the methodologies, procedures, and measurement systems used for measuring underwater acoustic noise generated by impact hammer pile driving.

DIN SPEC 45653 – "Offshore wind power plants – Determination of losses of underwater control devices during pile driving" details methods for evaluating the effectiveness of noise reduction systems in situ, including measurement distances. This standard recommends measuring underwater noise at distances of 750 m and 1500 m from the pile driving location, and it defines the number of hydrophones and the measurement system setup.

The underwater noise monitoring system strongly depends on the chosen foundation type and pile driving procedures, so a precise underwater noise monitoring scheme must be developed along with the technical design for pile installation.

8.1.2. Water monitoring

To properly select technological solutions for the development of the OWF and to assess the impact of planned OWF structures on the hydrodynamic environment, it is advisable to conduct current measurements near the planned OWF area before construction begins (to evaluate baseline conditions) and after the completion of construction works.

During the installation of the OWF, increased shipping may cause local and temporary impacts on water quality due to additional pollution by chemicals (e.g., heavy metals, petroleum hydrocarbons, polycyclic aromatic hydrocarbons). To assess whether pollutant concentrations meet GES standards, pollutant testing should be included in the environmental monitoring program, scheduled: before construction (to determine baseline concentrations), during construction (foundation installation, cable laying), and after construction (3–6 months post-completion).

8.1.3. Seabed monitoring

Detailed seabed investigations will be carried out before OWF construction – specifically at cable routes and foundation installation sites. During the operational phase, the developer will conduct scheduled inspections of foundation structures and cable routes to ensure there is no physical damage, exposure, or other disruptions (e.g., due to anchors or trawling). Therefore, additional seabed monitoring during operation is not necessary.

However, seabed investigations (among other environmental components) must be conducted before and after decommissioning of the OWF. It is recommended to perform full seabed morphology and side-scan sonar surveys along the installed/dismantled cable routes and separately at each foundation site.

During OWF construction, increased shipping may lead to localized and temporary impacts on seabed sediment quality due to accidental chemical pollution (e.g., heavy metals, petroleum hydrocarbons, polycyclic aromatic hydrocarbons).

To assess the impact of OWF construction and operation on geochemical changes and ensure sediment quality meets environmental standards, pollutant testing in seabed sediments should be conducted: after construction, and regularly during operation (every 6–12 months, or less frequently if no significant pollution is found), immediately after decommissioning. Sampling locations should be designated near installed/dismantled cable routes and at each foundation site.

8.1.4. Monitoring of seabed habitats in state Protected and “Natura 2000” areas

Monitoring is planned to be carried out at least 3 years once a year along the OWF export cable corridor (using bottom filming). The aim is to observe the recovery of colonies, using the results of the 2023 (EPA) and 2024 (PTPI) surveys for comparison.

The condition of habitat recovery should be assessed based on the following indicative features:

- **Physical environment** – lithological structure of the substrate, the percentage ratio between stable reef-specific substrate (boulders, gravel) and mobile substrate (sand, small gravel).
- **Biological environment** – *Mytilus edulis trossulus* colonies: shell size (age); organism abundance; presence/absence of other species; number of other species.

8.1.5. Zoobenthos monitoring

Monitoring of zoobenthos habitats during OWF construction should be performed immediately after installation to assess the impact on different habitats (infauna, epibenthos). Sampling should be carried out at 5–7 sites within the project area using quantitative and qualitative methods (Van Veen grab, dredge, video) and at 3 reference sites using a quantitative method (Van Veen grab).

During the operational phase, zoobenthos monitoring should be carried out at 6–7 locations (Van Veen grab, dredge). Vertical gradient monitoring (on piles) is conducted using video and colonization plates from different depths, as technically feasible.

8.1.6. Monitoring of seabirds and bats

Bird monitoring must be carried out during construction and for 3 years after its completion. Afterwards, two-year monitoring cycles are repeated every 5 years. If a more significant negative impact is identified than was assessed in the EIA, additional mitigation measures must be taken, selected according to the type and magnitude of the impact. If a significant negative impact is identified during the operation phase, which was not foreseen during the EIA, additional mitigation measures shall be taken, selecting them depending on the impact. After the implementation of additional measures, their effectiveness shall be monitored until it is ensured that the additional measures applied to avoid significant impacts are effective. If the impact remains significant even with all tested mitigation measures, individual wind turbines or group of WTGs may not be operated during the period when they may have a significant impact on biodiversity. The impact (displacement from the protected area) is considered significant when the abundance of protected birds in the “Natura 2000” SPA – the number and/or density of individuals of protected bird species in the monitored area – decreases by more than 20% from the natural long-term (10-year) population fluctuation (according to long-term research data collected under the state environmental monitoring program).

Migratory and transient bird counts must be conducted during autumn and spring migrations using radar and visual daytime observations, as well as acoustic recordings (microphones or sound recorders) at night. At least 20 full observation days (including nights) must be conducted per year.

Resting and feeding seabird counts must be conducted monthly throughout the year via transects from ships or aircraft. At least 7% of the OWF area and an additional 2 km beyond its borders must be surveyed. Transects should preferably be aligned with the greatest depth gradient or in a north-south direction. The spacing between transects should be 2 km within the OWF area, and 4 km outside.

Seasonal bird migration (autumn/spring) at sea should be monitored from one point in the OWF area, preferably its centre. Observations should be carried out in calm weather (wind ≤8–9 m/s) with the vessel maintaining position using dynamic positioning or anchoring. The radar should be oriented vertically and perpendicular to the migration direction. Observations must begin at dawn or dusk and cover the full dark or light period, with a minimum observation duration of 24 hours. Once the OWF is operational, observations can continue from a platform within the OWF.

Bat monitoring is planned during construction and for 3 years post-construction. Later, two-year monitoring will repeat every 5 years. It has to be ensured that bat migration can be monitored during the construction and operation of the OWF. Monitoring shall be carried out using ultrasonic detectors installed on vessels during construction and on WTGs and the OSS during OWF operation. During construction, detectors have to be installed on at least two vessels involved in building the OWF from April to October. The data collected during construction has to be assessed when preparing the monitoring programme for the operational phase of the OWF. The species composition and environmental conditions (wind speed, direction, temperature, precipitation) during which bat activity was recorded in the open sea must be determined.

Bat detectors must be installed on structures or buoys within the planned OWF area to record migration activity. Coastal monitoring should also be conducted to compare migration patterns.

Bird and bat monitoring scope must comply with the "Detailed description of criteria for significant negative impacts of wind farms on birds and bats, application of prevention and mitigation measures, and research requirements", which the developer must follow, and revise as needed if the description changes.

8.1.7. Marine mammal monitoring

Parameters to be monitored during different stages of OWF development (1. Planning; 2. Installation; 3. Operation; 4. Decommissioning):

- Seal and harbour porpoise monitoring to determine species presence, distribution, and possible diversity in the project area and adjacent zones (1–4).
- Total and relative abundance assessment of seals and porpoises (1–4).
- Habitat usage assessment by seals and porpoises (1–4).
- Anthropogenic noise level assessment in the project area (2–4).

8.1.8. Baltic Sea fish monitoring

Parameters to be monitored during different OWF lifecycle stages (1. Planning; 2. Installation; 3. Operation; 4. Decommissioning):

- Assessment of total and relative abundance, and community structure of different species in the project and nearby areas (1–4).
- Evaluation of fish species presence, distribution, and diversity (1–4).
- Mapping and condition assessment of seabed habitats in the project area, including monitoring of secondary habitats potentially important for fish feeding on turbine foundations (1, 2, 4).
- Noise levels in the project area (2–4).
- Pollutant concentrations in fish within the project area (2–4).
- Monitoring of invasive species in expected impact zones of the project area (2–4).

Some parameters may be adjusted using modern techniques such as fish telemetry, acoustic monitoring, or environmental DNA (eDNA) analysis.

8.1.9. Monitoring of plankton

Monitoring of plankton (phytoplankton and zooplankton) should be carried out at all stages of the OWF life cycle – planning, construction, operation, and decommissioning. Samples are taken both within the OWF area (at approximately 8 stations) and in “control” zones outside the OWF boundaries (at approximately 6 stations).

During the *planning and operational phases* of the wind farm, monitoring is conducted four times a year – in late autumn to early spring (November to March), in spring (April to May), in summer (August), and in autumn (September to October).

During the *construction and decommissioning* phases, if possible, surveys are carried out monthly.

Parameters monitored:

- Total and relative abundance and biomass of different phytoplankton species – in the surface layer (integrated sample from 0–1 m, 2.5 m, 5 m, 7.5 m, and 10 m) and in the near-bottom layer (approximately 0.3–5 m above the seabed).
- Water transparency (turbidity).
- Zooplankton species composition, abundance, and size structure – in the surface layer (0–25 m) and in the deeper layer (from the surface to near the seabed).

Sample analysis will be carried out using automated image recognition devices – ZooScan (HYDROPTIC Inc., France) for *zooplankon* and FlowCam® Cyano (Yokogawa Fluid Imaging Technologies, US) – for phytoplankton analyses.

8.2. Monitoring of the “Area D” OWF’s connection to the onshore transmission grid

Monitoring is planned for at least 3 years once per year along the “Area D” OWF export cable corridor (using bottom filming). The aim is to monitor colony recovery, using the monitoring results from EPA (2023) and PTPI (2024) for comparison.

The condition of habitat recovery should be assessed using the following indicators:

- **Physical environment** – lithological composition of the substrate, percentage ratio between stable reef-specific substrate (boulders, gravel) and mobile substrate (sand, small gravel).
- **Biological environment** – *Mytilus edulis trossulus* colonies: shell size (age); organism abundance; presence/absence of other species; number of other species.

9. INFORMATION ON POTENTIAL SIGNIFICANT TRANSBOUNDARY IMPACTS

The United Nations Economic Commission for Europe Convention on Environmental Impact Assessment in a Transboundary Context[128] (hereinafter – Espoo Convention) establishes that a transboundary EIA is carried out when the PEA is listed in Annex I to the Espoo Convention. According to the second amendment to the Espoo Convention (Decision III/7 of 4 June 2004), large installations using wind energy for energy production are included in Annex I to the Espoo Convention.

In accordance with the paragraph 1 of Resolution No. 900 of the Government of the Republic of Lithuania of 28 July 2000 "On the Granting of Powers to the Ministry of the Environment and its Subordinate Institutions[129]", the transboundary EIA process is coordinated by the Ministry of the Environment of the Republic of Lithuania (hereinafter – MoE).

The MoE, in accordance with Article 3.3 of the Espoo Convention, during the preparation stage of the EIA program, notified Latvia, Estonia, Finland, Sweden, Denmark, Germany and Poland by official letter No. D8(E)-4122 of 2024-09-04 about the PEA – the development of an OWF in Lithuania.

The MoE in its official letter No. D8(E)-4888 of 25 October 2024 informed that Latvia, Denmark, Finland, Sweden and Germany expressed their willingness to participate in the transboundary EIA procedures and submitted comments and proposals. In addition, Latvia recommends organizing a public presentation of its society with the EIA report of the PEA. Estonia informed that it will not participate in the transboundary EIA procedures but submitted proposals and expressed a desire to receive EIA documents.

The documents of the transboundary consultations of the EIA program stage and a summary of the proposals received are presented in Annex 9 of the EIA report. The EIA report is prepared considering the MoE's official letter No. D8(E)-4888 of 25 October 2024.

The distance from the CN OWF area to the Latvian EEZ is approximately 0.9 km, to the Swedish EEZ approximately 69 km, and to the Russian Federation EEZ approximately 35.8 km.

According to the results of the EIA, the impact on such environmental components as water, ambient air, seabed, cultural values and public health is only possible on a local scale. Due to its specifics, the transboundary impact of the PEA is most relevant in the following aspects:

- biodiversity (especially bird migration)
- landscape: visual impact
- impact on international maritime shipping
- possible restrictions on the exploration and extraction of offshore oil fields located on the seabed
- impact on fishing.

9.1. Potential impacts on biodiversity

9.1.1. Impact on "Natura 2000" sites

In the Baltic Sea waters and coastal zone of Latvia, approximately 23.5 km from the boundary of the area analysed for OWF installation, lies the "Natura 2000" SAC and SPA Nida-Perkonė, and approximately 36.9 km away is the "Natura 2000" SAC and SPA Papė. The distance from the northernmost planned onshore section of export cable corridor to the boundary of the Papė "Natura 2000" SAC and SPA is approximately 120 meters.

[128] The United Nations Economic Commission for Europe Convention on Environmental Impact Assessment in a Transboundary Context

[129] On the Granting of Powers to the Ministry of the Environment and its Subordinate Institutions

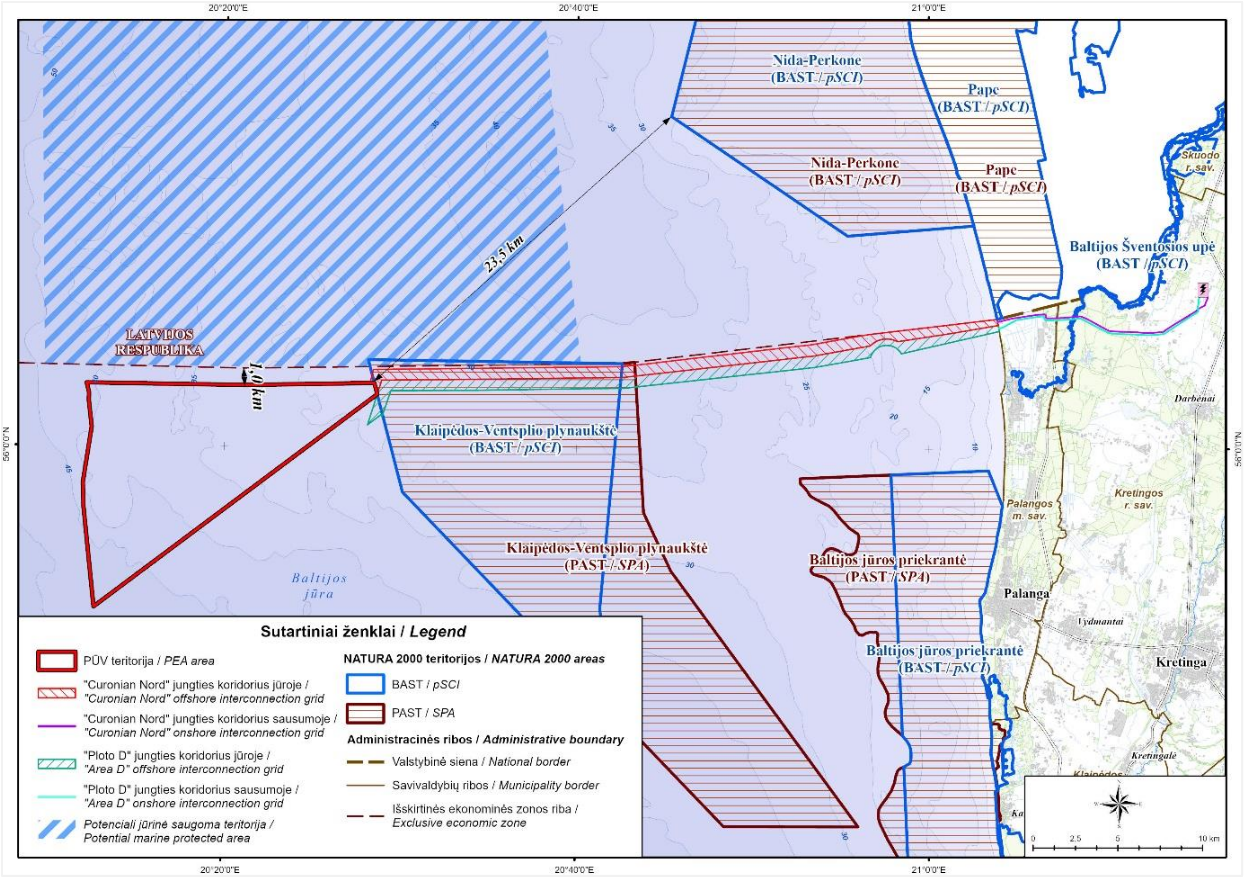

Fig. 9.1.1. Distances from the PEA territory to the boundaries of Natura 2000 areas designated in Latvia.

The Pape protected area consists of Lake Pape and the Nida Marsh. The territory of Lake Pape protects important plant habitats. The lake is surrounded by meadows and swamps, serving as a significant stopover site for many migratory bird species and supporting abundant breeding populations of waterfowl. Notable species include the great bittern (*Botaurus stellaris*) and the Eurasian curlew (*Numenius phaeopus*). The lake also provides important feeding grounds for several bat species, including the pond bat (*Myotis dasycneme*).

Nida Marsh, together with Lake Pape, is designated as a Latvian Ramsar site.

The Natura 2000 Nida-Perkonė area is significant for the protection of reef habitats (code 1170), the twaite shad (*Alosa fallax*), and 20 protected bird species, including: the brown-headed duck (*Aythya ferina*), ruddy duck (*Aythya fuligula*), bellflower (*Bucephala clangula*), ice duck (*Clangula hyemalis*), mute swan (*Cygnus olor*), common willow (*Fulica atra*), black-necked diver (*Gavia arctica*), brown-necked diver (*Gavia stellata*), white-tailed eagle (*Haliaeetus albicilla*), brown-headed gull (*Larus ridibundus*), scaly-winged sedge (*Melanitta fusca*), black duck (*Melanitta nigra*), lesser spotted woodpecker (*Mergus albellus*), greater toothed warbler (*Mergus merganser*), common merganser (*Mergus serrator*), great cormorant (*Phalacrocorax carbo*), horned grebe (*Podiceps auritus*), eared grebe (*Podiceps cristatus*), little grebe (*Tachybaptus ruficollis*).

9.1.2. Impact on birds

The wintering grounds of common scoter (*Melanitta nigra*) and long-tailed duck (*Clangula hyemalis*) in the Baltic Sea extend from Słupsk (Poland) to Kolka Cape (Latvia), indicating that suitable feeding habitats for these species are available across the southeastern Baltic. Although the planned OWF area does not contain the most important benthic habitats for these species, displacement due to avoidance behaviour is possible.

On the Latvian side, an OWF is also planned; therefore, the cumulative impact could be comparable to that assessed for the Lithuanian project. However, due to insufficient data on seabird wintering grounds in Latvian waters, the overall impact on wintering birds remains uncertain.

From a migration perspective, the OWF planned in Lithuanian waters – together with other already planned Lithuanian OWF projects and the planned Latvian OWF – should not cause significant cumulative impacts on migratory birds, as migration intensity was found to be low during field studies.

From a transboundary perspective, the highest risk is expected for benthic-dependent species. Therefore, common scoter and long-tailed duck populations could be affected if wintering numbers on the Latvian side are similar to those recorded in Lithuania.

Mitigation and compensation measures for bird protection during the operational phase of the OWF are presented in Section 5.4.3 of this report.

9.1.3. Impact on bats

According to scientific research, bats may migrate to their wintering grounds over the Lithuanian part of the Baltic Sea near the coast under favourable environmental conditions. However, at a distance of approximately 36.8 km from the shoreline, bat migration intensity is significantly lower than in onshore or nearshore areas.

Bat migration monitoring carried out within the scope of this EIA indicates that the OWF is not expected to have a negative impact on bats, as migration intensity decreases sharply with increasing distance from the coast. Studies show that intense bat migration occurs up to 300 m from the shore near Palanga, above the Palanga Bridge; however, 5–7 km offshore at Būtingė, migration intensity is less than 10% of that recorded at the end of the Palanga Bridge. At Būtingė, the observed migration intensity was very low and did not reach levels recorded in eastern Lithuania.

Based on these findings, it is likely that regular bat migration does not occur at the PEA site located 20–30 km offshore, and only a few disoriented individuals may reach this distance.

Mitigation and compensatory measures for bat protection during the operational phase of the OWF are described in Section 5.4.4 of this report.

9.1.4. Impact on fish

The greatest impact on individual fish species is expected only during the installation and removal of OWF structures. This impact will be short-term, minor, and local in nature. Upon completion of installation (or removal), fish are expected to return to the feeding grounds. Avoidance reactions have been recorded only a few meters from wind farm structures and only at high wind speeds. During the operational phase, positive effects on fish populations may occur due to the creation of artificial reef habitats. Transboundary impacts on fish are unlikely.

The assessment considered the spatial and geographical location of the planned activity in the broader Baltic Sea context, as well as its proximity to other planned or existing OWF projects in Lithuania and neighbouring countries. The evaluation focused on the dominant fish species identified during surveys and in regional monitoring data: Baltic flounder, Baltic cod, and Baltic herring. All three are commercially fished species whose resources are assessed and managed at a regional scale and could be evaluated cumulatively across the Baltic Sea or wider.

Key species-specific findings:

- Baltic flounder is relatively sedentary; thus, cumulative effects with distant wind farms are scientifically unfounded.
- Baltic cod can detect operational wind farm noise up to 13 km away; the nearest Polish OWFs are located over 180 km from the PEA.
- Baltic herring spawns successfully in industrial environments (e.g., Klaipėda Port), where both continuous and impulsive noise occur. Therefore, no additional negative impacts from remote wind farms are anticipated.

Additional considerations:

- No reliable scientific data confirm significant behavioural effects or area avoidance due to continuous noise from operating turbines. Studies indicate avoidance only at wind speeds above 13 m/s, with a reaction range of approximately 4 m from the WTG foundation, i.e., a highly localised effect.
- Klaipėda State Seaport is a continuous and impulsive noise source (e.g., from shipping, dredging, quay piling). Nevertheless, Baltic herring spawn on the southern pier, with egg densities ranging from 53 thousand/m² to 14.5 million/m². A deterrent effect is expected mainly during construction, and locally. Once installed, turbine foundations may provide additional artificial spawning substrates.

Of the anadromous species, only Atlantic sturgeon and European sturgeon have been recorded in the PEA area. Available research does not indicate that the PEA lies on their primary migration routes. Sturgeon migration to the Curonian Lagoon occurs in November–March, primarily from the north, at depths of 6–40 meters. During construction, some alteration of migration routes or temporary aggregations may occur due to increased turbidity or noise. However, European sturgeon is classified as an accidental species in the PEA fish community, and no large spawning migrations were recorded.

9.1.5. Impact on marine mammals

The primary potential impact of the OWF on marine mammals is associated with underwater noise generated during construction, particularly impact noise from pile driving. EIA survey results indicate that marine mammals are not permanently present in the planned OWF area but may return periodically. Mitigation measures – especially those aimed at reducing pile-driving noise – will be essential during both construction and decommissioning to minimise disturbance.

Noise from operating WTG is assessed as negligible for grey seals and harbour porpoises. If behavioural effects occur, they are expected to be limited to within a few hundred metres of the WTG.

Cumulative impacts with other OWFs – including the planned development in Latvian waters – are possible only if installation or decommissioning of multiple parks occurs simultaneously in adjacent areas. In such cases, some feeding grounds may become temporarily inaccessible, and migration or aggregation patterns could shift. Coordinating construction schedules at both national and international levels is recommended to reduce such cumulative effects.

9.1.6. Impact on plankton

The planned offshore wind farm (OWF) activities are expected to have a localised, temporary, and insignificant impact on plankton communities. During the construction and operational phases, temporary changes in plankton community structure may occur; however, these changes will be confined to the OWF area and will not have a significant effect on the broader ecological status of the Baltic Sea region.

According to the assessment data from the Marine Strategy Framework Directive (MSFD) – Phase III, during the 2012–2017 period, the average size and total abundance indicators of zooplankton in the Lithuanian territorial waters and Exclusive Economic Zone (BAL-LT-AA-03) did not meet Good Environmental Status (GES) thresholds only in 2014, resulting in the area being classified as having a poor ecological status (AAA, 2020). Nevertheless, the planned OWF development is not expected to have a significant impact on this status.

It should be noted that insufficient data are currently available to comprehensively assess the potential impact of the OWF on plankton communities in the central Baltic Sea, where salinity levels are approximately 7 PSU. These communities differ from those in more saline marine areas (e.g., where salinity reaches ~30 PSU), and therefore additional studies are needed to assess the possible effects in those regions.

In conclusion, the construction and operation of the OWF do not pose a significant threat to the condition of plankton communities and do not conflict with the environmental protection objectives set by the Marine Strategy Framework Directive.

The EIA report provides for the mitigation measures to be applied to the protection of plankton during the operational phase of the OWF park (see Section 5.4.10).

9.2. Impact on the landscape: visual impact

The PEA territory is located approximately 37 km from the Latvian coastline. At this distance, OWF will be difficult to observe from shore-based viewpoints. Landscape impact assessment indicates that visibility from Pape Beach in Latvia is insignificant, and no perceptible visual impact is expected.

It should be noted that similar OWF developments are planned on the Latvian side, along the northern border with the Republic of Lithuania, in accordance with the Marine Territories Plan of the Republic of Latvia (approved May 14, 2019). The concurrent implementation of both projects may increase the cumulative horizontal visibility OWF. However, this cumulative effect is expected to be more relevant for the Palanga city resort area rather than for Latvian coastal settlements.

9.3. Impact on international shipping

The Lithuanian waters of the Baltic Sea are crossed by two main 4-nautical-mile navigation routes, established in accordance with the 2001 HELCOM Copenhagen Declaration and officially mapped. No other internationally established shipping lanes, port roads, or anchorage areas intersect the PEA territory; therefore, no significant impact on shipping and international navigation routes is anticipated.

Based on the RA conducted in the EIA report, the likelihood of a ship colliding with wind turbine structures is low. Collision probability was calculated using a Gaussian function based on the standard normal distribution and collision navigation error ratings. Considering the distance of the central shipping channel from the PEA site and the small number of vessels potentially able to damage OWF structures, the collision probability is estimated at 9.0×10^{-5}. The individual annual risk is 2.05×10^{-8} for passengers and 2.5×10^{-7} for crew members, which are below the marginal acceptable values.

In terms of potential consequences, collisions involving dry cargo ships or passenger vessels are expected to have limited to moderate environmental impacts. Collisions involving tankers could range from limited to catastrophic, with catastrophic events primarily involving oil spills. Such incidents could result in substantial environmental harm due to the low evaporation rate of oil products, necessitating the development of dedicated emergency response procedures.

9.4. Transboundary impacts due to potential restrictions on oil field exploration

The PEA territory does not overlap with any structures with potential for oil production. However, such structures are known to exist within the maritime territory of the Republic of Latvia. The distance from the PEA boundary to the maritime border with Latvia is approximately 0.9 km. Given this separation, significant impacts on Latvian oil resources or their potential production are considered unlikely.

9.5. Impact on fisheries

According to ICES classifications, the Lithuanian marine territory falls within statistical squares 41H10, 40H10, 40G9, and 39H10 of the 26th ICES fishing area. The PEA territory is located within squares 41H10 and 40H10, which are used for trawl and set net fishing. These areas lie in the high seas and are not assigned to individual enterprises. While foreign vessels are allowed to fish in this area, recent data indicate limited activity by foreign fleets.

Between 2015 and 2018, a total of 9 Lithuanian-registered vessels and 14 foreign trawlers (from Latvia and Russia) operated in the PEA territory. From 2015–2017, foreign vessels dominated fishing effort (52–87%), while since 2018, Lithuanian-registered vessels accounted for 63–100% of total trawling effort.

Restrictions caused by OWF construction and operation are not expected to result in significant losses to fishermen, as adjacent fishing areas remain accessible. Potential impacts on fishing could occur due to:

- Temporary fishing restrictions within the wind farm area.
- Noise and disturbance from construction activities, particularly pile driving, which may affect fish behaviour, especially herring (*Clupeidae*) and sprats, up to 33 km from the source. To mitigate impacts, it is recommended that pile installation be conducted from May to August, when pelagic species are less abundant in the area.

The OWF may also provide long-term benefits for fish populations. Foundations can act as artificial reefs, attracting fish from surrounding areas. Over time, this may increase fish productivity within the OWF area, support food base development, create spawning habitats, and enhance local biodiversity.

10. DESCRIPTION OF FORECASTING METHODS, EVIDENCE USED IN DETERMINING AND ASSESSING ENVIRONMENTAL IMPACT AND PROBLEMS

10.1. Environmental impact assessment methods

The following methods were utilised to assess the potential environmental impact of the PEA:

- Quantitative methods, based on measurements, calculations, and modelling (e. g., bird and bat observations, seabed habitat analysis; modelling of underwater and acoustic noise dispersion, assessment of electromagnetic fields, and visual impact zoning).
- Qualitative methods were applied where sufficient quantitative data were lacking. These methods included expert assessments and comparative analyses (e.g., habitat sensitivity evaluations and social impact analyses).
- Mixed methods were used when combining elements of both quantitative and qualitative methods, particularly in the assessment of biodiversity, ecosystems, and socio-economic impacts.

Various models were applied for impact forecasting, including:

- Noise dispersion models, used to assess underwater noise (during construction) and airborne noise (during operation of onshore substations).
- GIS analysis was used for zoning visual impacts, protected areas, habitats, and other sensitive elements.
- Risk analysis of emergency situations, based on probabilistic scenarios and consequence evaluation.

Within the scope of the EIA, field studies and observations were conducted. The following types of studies were carried out to substantiate the assessment:

- Geophysical and geotechnical studies were conducted to identify seabed structure and sediment types.
- Biological surveys of birds, fish, marine mammals, bats, plankton, benthos, seabed, and coastal habitats.
- Acoustic studies, including PAM data.
- Cultural heritage surveys, both on land and on the seabed.

The EIA methods used are described in Chapter 5 subsections, detailing the individual methods, studies, and their scope applied to each environmental component.

10.2. Methods for assessing the significance of impacts

The significance of the proposed activity's impact on environmental components was evaluated according to the following main criteria:

- Duration of impact (short-term, long-term)
- Intensity and geographic extent (local or regional)
- Reversibility (whether the impact is temporary and restorable)
- Cumulative impact, related to similar planned activities (e.g., nearby planned OWFs) or other activities in the area
- Sensitivity of environmental components, evaluated according to legal acts and/or expert information.

Impact significance classification was determined based on the following aspects:

- Nature of the impact (positive or negative)
- Strength/intensity of the impact (from minor to major)
- Duration of the impact (short-term, long-term, permanent)
- Scale/geographic extent (local, regional, national)
- Component sensitivity (protected status under legislation, rarity, ecological value of habitats or species)
- Cumulative effects (interaction with other existing or planned projects)
- Ability to restore original condition (reversibility).

The categories used to classify the significance of impacts, based on these criteria, are presented in Table 10.2.1.

Table 10.2.1. Categories of impacts significance

Level of significance	Definition
Significant negative impact	Large-scale, long-term, widespread impact on sensitive or protected components; significant mitigation or compensation measures must be applied.

Moderate negative impact	Tangible, but limited in scale or duration; can be managed using standard measures.
Minor/insignificant negative impact	Negligible, short-term, reversible, or affecting components with low sensitivity; additional measures usually unnecessary.
No negative impact identified	No evidence that the planned activity would affect the component.
Positive impact	Activity may have a favourable effect on the environment (e.g., habitat restoration, infrastructure modernization).

Significance was determined separately for each environmental component, taking into account the specifics of the construction, operation, and decommissioning stages.

10.3. EIA methods and data sources

The EIA of the planned OWF was carried out using methodologies recognized and valid in the Republic of Lithuania, including approved assessment frameworks and mathematical modelling programs. The assessment relied on a combination of primary data collection, scientific research, and established international guidance. Information on the current state of the environment was collected using officially accessible databases, the experience of EIA developers in conducting observations of similar activities.

Table 10.3.1 Official databases and other data sources used during the EIA of the PEA

No.	Data source	Data used	Data source
1	Supplement to the General Plan of the Territory of the Republic of Lithuania (2015) with a section on maritime territories	Maritime infrastructure corridors, areas for wind energy development, important military surveillance zone	MoE
2.	Specific solutions of the General Plan of the Territory of the Republic of Lithuania.	“Responsible use of the sea and coast” drawing	MoE
3.	Chart of the territorial and economic waters of the Republic of Lithuania (No. LT282001)	Sunken ships, obstacles, anchorages, harbours, shipping lanes, restricted areas, military areas, sunken chemical weapons area, soil dumps	Lithuanian Transport Safety Administration
4.	State cadastre of protected areas	Protected areas, Natura 2000 SACs and SPAs	SSPA
~~4.~~	Protected Species Information System (SRIS)	Locations of protected species (plants, fungi, animals)	
5.	Register of cultural assets	Cultural heritage sites and their protection zones	Department of Cultural Heritage under the Ministry of Culture
6.	Georeferenced cadastral spatial data set (GPRK)	Municipal boundaries, built-up areas	Ministry of Agriculture of the Republic of Lithuania
7.	Lithuanian water area map for fishing	Trawling lanes, bottom sediments	Žaromskis R., Repečka R., Gulbinskas S., 2005.
8.	Proofreading of the Special Plan for the Management of the Continental Part of the Coastal Zone. Solutions	Recreational land	MoE
9.	Territories of the Republic of Lithuania where design and construction work of WTGs (tall buildings) may be restricted	An area where the design and construction of WTG is prohibited. An area where the location of WTG is subject to conditions.	Latvian Military Cartography Centre

No.	Data source	Data used	Data source
10.	State Geological Information System (GEOLIS), Earth's Depth Register	Potential oil structures	Lithuanian Geological Survey under the Ministry of Environment
11.	National Landscape Management Plan (approved by Order No. D1-703 of the Minister of the Environment of 2015-10-02)	Landscape management zones The visual aesthetic potential of the landscape.	MoE
12.	Database of special land use conditions	Airport security zones	National Land Service under the Ministry of Agriculture
13.	TPD register	Approved territorial planning documents, as well as those currently under preparation	VTPSI under the Ministry of Agriculture of the Republic of Lithuania
14.	HELCOM GIS portal	Shipping intensity	HELCOM
15.	Bathymetric map of the Central Baltic Sea, scale 1:500,000. LGT series of Marine Geological Maps. Edited by Leonora-Živilė Gelumbauskaitė	Bathymetric data	Lithuanian Institute of Geology, the Geological Survey of Lithuania, the Geological Survey of Sweden, the Swedish Maritime Administration
16.	INVA – Invasive Species Information System	Locations of invasive plants and animals	MoE

10.4. EIA problems and possible inaccuracies

During the preparation of the EIA, no problems arose that would have prevented the identification and evaluation of potential environmental impacts. Considering possible inaccuracies or data gaps, a conservative worst-case scenario approach was applied when necessary. For risk assessment uncertainty management, the ALARP principle (as low as reasonably practicable) was applied.

11. STAKEHOLDER ENGAGEMENT

11.1. Public information and consultation

Public information is conducted in accordance with the Order of the Minister of Environment of the Republic of Lithuania of 31 October 2017 No. D1-885 "On the Approval of the Descriptions of the Procedures for Environmental Impact Assessment of Proposed Economic Activities," which approved the Procedure for Public Information and Participation in the Environmental Impact Assessment (EIA) Process.

11.1.1. Public information at the EIA Programme Stage

The EIA process was initiated on 21 February 2024 by letter No. S24-041–S24-043, notifying the public, relevant EIA authorities, and the EPA of the prepared EIA programme for the planned construction and operation of the "Curonian Nord" OWF by UAB Ignitis Renewables in the Lithuanian marine area.

Public information on the opportunity to review the EIA programme and submit proposals was published as follows:

- By e-mail to the administrations of Palanga City, Neringa, Klaipėda City, Klaipėda District, and Kretinga District municipalities, with a request to publish it on their websites and notice boards.
- On the website of the project developer, UAB Ignitis renewables: https://ignitisrenewables.com/lt/.
- On the website of the EIA documentation developer, Public Institution Coastal Research and Planning Institute: http://corpi.lt/ (2024-02-21); direct link: https://corpi.lt/index.php/juros-parkas/.
- In newspapers:
  - Palangos tiltas (Palanga city newspaper), published 2024-02-23.
  - Vakarų ekspresas (Klaipėda regional daily newspaper), published 2024-02-22.
  - Banga (Klaipėda District newspaper), published 2024-02-23.
  - Pajūrio naujienos (Kretinga District newspaper), published 2024-02-23.

During the public consultations of the EIA programme, proposals were received from EIA authorities and were taken into account in the EIA report.

11.1.2. Public information at the EIA Initiation Stage

An announcement on the initiation of the EIA was made in order to incorporate an additional element of the proposed activity – the transmission connection between the OSS planned in "Area D" OWF and the onshore electricity grid infrastructure, namely the 330 kV Darbėnai substation.

It should be noted that the Ministry of Energy of the Republic of Lithuania conducted an EIA for the "Area D" in 2023. The report was approved by the EPA on 23 October 2023 (letter No. (30-2)-A4E-10794, decision No. S23-216); however, the export cable route was not included within the scope of that report.

Public information on the initiation of the EIA was provided through the following channels:

- The EPA and EIA authorities were informed by e-mail on 16 July 2025. The information was published on the EPA's website (https://aaa.lrv.lt/) on 22 July 2025 under: Activities > Environmental Impact Assessment > 2025 > Announcements on the Initiation of EIAs in 2025 > Territory of the Republic of Lithuania (linear and other objects spanning multiple counties).
- Published on the official websites and notice boards of the municipalities (Palanga, Neringa, Klaipėda City, Klaipėda District, Kretinga District) between 18 and 28 July 2025 (direct links provided in the original document).
- Published on the website of the Coastal Research and Planning Institute: https://corpi.lt/index.php/curoniannordparkas/ (17 July 2025).
- Published in newspapers:
  - Palangos tiltas – 2025-07-18.
  - Vakarų ekspresas – 2025-07-18.
  - Banga – 2025-07-18.
  - Pajūrio naujienos – 2025-07-18.

On 25 July 2025, the EPA issued letter No. (30-2)-A4E-7701, stating that, as the competent authority in the EIA process and in accordance with Article 5(2) of the Law on Environmental Impact Assessment of Proposed Economic Activities and Paragraph 31 of the Procedure for Conducting Environmental Impact Assessments, it had taken into account the nature, scale, and location of the proposed activity (including the crossing of forest land and mineral deposit areas, as well as potential impacts on forests, mineral resources, fish stocks, and maritime navigation). On this basis, the EPA invited the following institutions to participate in the EIA process of UAB Ignitis Renewables as EIA authorities:

- Klaipėda State Seaport Authority.
- Lithuanian Geological Survey under the Ministry of Environment.
- State Forest Service.
- Fisheries Service under the Ministry of Agriculture of the Republic of Lithuania.

11.1.3. Public information at the EIA Report Stage

Information to the public regarding the opportunity to review the prepared EIA report and submit proposals was published:

- By e-mail to the EPA, with a request to publish on its website.
- By e-mail to the administrations of Palanga City, Neringa, Klaipėda City, Klaipėda District, and Kretinga District municipalities, with a request to publish on their websites and notice boards.
- On the website of the project developer, UAB Ignitis Renewables.
- On the website of Public Institution Coastal Research and Planning Institute.
- In newspapers: Klaipėda, Banga, Palangos tiltas, Pajūrio naujienos.

The public presentation of the EIA report is planned to take place in a hybrid format (in-person and live-streamed online):

- At the Palanga Resort Museum Hall (Villa Anapilis), Birutės al. 34A, Palanga, on 11 November 2025 at 14:00;
- Via live broadcast at this link: https://bit.ly/3Irrk9B.

Remote participation will be available at the following locations to watch the live broadcast, ask questions, and receive answers:

- Neringa Municipality Council meeting hall, Taikos g. 2, Neringa;
- Klaipėda City Municipality meeting hall, room 137, Liepų g. 11, Klaipėda;
- Klaipėda District Municipality J. Lankutis Public Library hall, Klaipėdos g. 15, Gargždai;
- Kretinga District Municipality, Darbėnai Eldership Hall, Skuodo g. 4, Darbėnai, Kretinga District.

Public information documents are provided in Annex 10.

11.2. Transboundary consultations

Considering the nature, scale, and location of the planned activity, and paying particular attention to the fact that the activity is listed in Annex I of the United Nations Economic Commission for Europe Convention on Environmental Impact Assessment in a Transboundary Context (*Espoo Convention*) as potentially causing significant adverse transboundary effects, the Ministry of Environment of the Republic of Lithuania, in accordance with Article 10(2) of the Law on Environmental Impact Assessment of Proposed Economic Activities, concluded by letter No. D8(E)-4044 of 28 August 2024 that the planned activity may have a significant impact on the environment of another European Union Member State, and therefore transboundary EIA procedures must be applied.

In accordance with Article 3 of the Espoo Convention, the Ministry of Environment, by letter No. D8(E)-4122 of 4 September 2024, notified Latvia, Estonia, Finland, Sweden, Denmark, and Germany and informed Poland about the planned activity in Lithuania – the development of the OWF in Lithuanian marine waters.

Latvia, Denmark, Finland, Sweden, and Germany expressed their intention to participate in the transboundary EIA procedures and submitted comments and proposals. In addition, Latvia recommended organizing a public consultation for its population regarding the EIA report of the planned activity.

Estonia informed that it would not participate in the transboundary EIA procedures but submitted proposals and expressed its wish to receive the EIA documentation.

The prepared EIA report takes into account the comments submitted by neighbouring countries during the EIA programme stage. Information on received comments and how they were addressed in the report is provided in Annex 10.

Following the inclusion of the export cable route assessment of the “Area D” in the EIA process, the Ministry of Environment, by letter No. D8(E)-3140 of 29 July 2025, concluded that:

1) The EIA procedures for the CN OWF were initiated on 21 February 2024, and the Notice on the Initiation of the EIA was issued solely because a new element – the export cable route of the “Area D” OWF – was included.
2) Foreign countries potentially affected by the project were notified of the initiated EIA procedures on 4 September 2024 by the Ministry of Environment (letter No. D8(E)-41221), and several of them (Denmark, Latvia, Sweden, and Germany) indicated their intention to participate in the transboundary EIA.
3) The new CN OWF EIA element – the export cable route of the “Area D” OWF – by its nature, location, and scale, is not expected to have an adverse impact on the environment of other foreign states; therefore, it is not necessary to notify other foreign states in 2024 that did not express an intention to participate in the transboundary EIA.

Consequently, the transboundary EIA procedures for the CN OWF EIA have already been initiated and will continue.

11.3. Social engagement and stakeholder involvement

Stakeholder engagement and transparent communication constitute essential components of the EIA process. In accordance with the Law on Environmental Impact Assessment of the Republic of Lithuania, formal requirements for stakeholder involvement are observed throughout the assessment process. Beyond these statutory obligations, efforts are made to ensure meaningful participation by engaging a broad range of stakeholders.

Engagement activities are designed to address stakeholder concerns, provide relevant information, and facilitate constructive dialogue. These activities include meetings and consultations with the public, business representatives, non-governmental organizations, the scientific community, and relevant governmental institutions. By providing structured opportunities for participation, the process seeks to enhance trust, support informed decision-making, and ensure that diverse perspectives are incorporated into project planning and assessment.

11.3.1. Stakeholder management strategy

The stakeholder management strategy for the project is designed to facilitate structured interaction between the OWF development and relevant stakeholders, including local businesses, communities, and key maritime sectors such as commercial fisheries, shipping, tourism, and nature conservation.

The strategy provides a comprehensive framework for stakeholder engagement, employing communication approaches tailored to the specific needs and interests of each stakeholder group. Engagement activities are structured to ensure that stakeholder input is collected, documented, and considered in project planning and decision-making.

The strategy is implemented throughout the different phases of the project development process, as outlined in Table 11.2.1, to support consistent and effective engagement across the project lifecycle.

Table 11.2.1. Integrated engagement efforts aligned with the project development phases

Development phase	Engagement Efforts
Pre-development phase (Q3 2023–Q2 2024)	• Stakeholder briefings: conducting structured meetings and discussions with stakeholders to provide information, clarify project objectives, and obtain relevant input. • Stakeholder mapping and development planning: performing detailed analysis to identify key stakeholders and design engagement strategies that correspond to project objectives and phases. • Pre-consultation activities: organising meetings and information sessions to present initial project information, address stakeholder concerns, and facilitate early participation. • Communication toolkit: developing and maintaining engagement resources, including a project website and informational materials, to ensure transparent, accessible, and consistent dissemination of project-related information.
Development phase (Q3 2024–Q2 2026)	• Community poster session (two rounds): conducting interactive poster sessions to provide information to local communities and gather feedback at key project stages. • Engagement with municipalities and educational institutions: coordinating with local authorities and schools to share project-related information and facilitate knowledge exchange. • Grievance Mechanism: establishing a multi-channel system to allow stakeholders to submit concerns or inquiries in a structural manner. • Communication toolkit: disseminating project information through newsletters, factsheets, and digital channels while supporting community events to maintain transparent and continuous information flow.
Pre-construction (Q3 2026–Q2 2028)	• Fisheries Code of Conduct: developing guidelines to support the coexistence of offshore wind farm activities with the fishing industry. • Community poster sessions (two rounds): conducting sessions to provide information to local communities and receive feedback on project developments. • Stakeholder engagement meetings: organizing structured meetings with key stakeholders to address questions, gather input, and facilitate collaboration. • Communication toolkit: providing project information through newsletters, factsheets, and digital channels while supporting community events to ensure transparent and continuous communication.
Construction phase (Q3 2028–Q3 2030)	• Local information-sharing meetings (two rounds): organizing meetings to provide updates to local communities, maintain transparency, and address concerns during the construction phase. • Internal, and external communication efforts: ensuring consistent communication across project teams, local communities, and relevant industry stakeholders. • Communication toolkit: distributing newsletters, factsheets, and digital updates while coordinating community events to maintain transparent and continuous information flow.
O&M (after 2030)	• Local assessment surveys: conducting regular surveys to monitor community perspectives, collect feedback, and evaluate the ongoing impact of the project. • Communication toolkit: distributing newsletters and factsheets to provide continuous updates and maintain transparency during the operational phase.

The stakeholder management strategy has been informed by international best practices and is aligned with relevant global standards, including Equator Principles IV (Principle 5 – Stakeholder Engagement), IFC Performance Standard 1 (Assessment and Management of Environmental and Social Risks and Impacts), EIB Environmental and Social Standard 2 (Stakeholder Engagement), and EBRD Performance Requirement 9 (Information Disclosure and Stakeholder Engagement).

A grievance mechanism is being developed as part of the engagement plan, with implementation scheduled to commence in Q2 2026. All engagement activities are systematically recorded and monitored through an internal Stakeholder Relationship Management Tool, ensuring compliance with international standards and adherence to EBRD Principle 4.

11.3.1.1. Engagement toolkit

As part of the CN OWF stakeholder engagement process, a structured engagement toolkit is employed to facilitate communication and ensure that relevant stakeholder groups have access to information on the project's progress. The toolkit includes the following components:

1. CN OWF website[130]: a centralised platform providing resources, project updates, and information related to the OWF development, including dedicated sections for local communities.
2. Social media channels: updates and key project information shared through professional networks such as LinkedIn to maintain transparency and stakeholder awareness.
3. Factsheets: stage-specific factsheets outlining project developments, providing stakeholders with concise and accessible information.
4. Local media coverage: reporting of community events and engagement activities in local newspapers and media outlets to enhance public awareness and provide accessible information.

Additional tools are utilized during stakeholder events and workshops to support effective engagement:

1. Visual facilitation: visual summaries and illustrations of key discussion points to support stakeholder understanding and document meeting outcomes.
2. Workshop essentials: standard materials, including participant sign-in sheets, name tags, and relevant project-branded materials, to support the organization of events.
3. Community surveys: surveys conducted online and in paper format to collect stakeholder feedback during engagement activities.
4. Educational and outreach activities: initiatives, such as the collaboration with educational programs for children, provide hands-on learning opportunities to increase awareness of offshore wind energy and promote community participation.

11.3.1.2. Stakeholder identification and log

Stakeholder identification is a critical component of the engagement process, enabling the project to recognize individuals, groups, and institutions connected to its development. A structured stakeholder identification exercise was initiated in Q3 2023, beginning with internal desk research. This phase was complemented by informal discussions and meetings with initially identified stakeholders, providing additional insights and supporting refinement of the stakeholder list.

As a result of this process, 65 stakeholders were identified. All stakeholder information and interactions are systematically recorded in the Stakeholder Log, maintained as an internal Customer Relationship Management (CRM) tool. The log is continuously updated as new stakeholders are identified and as consultations occur.

The Stakeholder Log functions as a dynamic record of engagement activities, documenting stakeholder interactions, concerns, and the corresponding responses until they are formally addressed. The CN OWF's Stakeholder Manager is responsible for maintaining the log to ensure completeness, accuracy, and consistency throughout the engagement process.

11.3.1.2.1. Stakeholder categories

Stakeholders associated with the CN OWF are organised into five primary categories. The complete stakeholder list is maintained in the Project's CRM system, with a summary of categories provided below.

1. Community: individuals and groups residing, working, or operating in proximity to the project, who may be directly or indirectly affected, or perceive themselves to be affected by the project. This category includes:
   - Non-governmental organisations (NGOs, ENGOs).
   - Civil society organisations (CSOs, e.g. neighbourhood associations).
   - Commercial fishermen organisations and registered commercial fishermen.
2. Institutional stakeholders: entities with regulatory, policy-making, or decision-making authority over the project, including:
   - Regulatory authorities (e.g., landscape and heritage departments, municipal policymakers).
   - Parish authorities.

[130] CN OWF website

3. Local businesses: organisations and enterprises that may be impacted by, or have an interest in, the project's development, including:
    - Local Enterprise Partnerships (LEPs).
    - Chambers of Commerce.
    - Tourism agencies and businesses.
4. Educational institutions: academic and research entities involved in technology innovation, and related fields, including:
    - Universities.
    - Research and technology centres.
5. Media: key opinion leaders and media professionals who shape public awareness and perception of the project, including:
    - Journalists and media outlets.
    - Local and regional news agencies.

11.3.2. Stakeholder engagement to date

Stakeholder engagement activities for the project have been conducted throughout Q4 2023, 2024, and the second quarter of 2025. and will continue throughout the project duration. The detailed engagement can be found on the CN OWF project website131. These activities have involved consultations with regulatory authorities, local government representatives, and community stakeholders through both structured and informal engagement methods.

Engagement activities have included:

- Informal meetings with local authorities and parish representatives.
- Interviews and consultations with key stakeholders and their representatives.
- Group discussions with community members and interest groups.
- Surveys to collect broader stakeholder input.

The primary objectives of these engagement activities were to:

- Introduce the project and provide updates on its progress.
- Gather feedback on the project's development, including recommendations for potential improvements.
- Identify socio-economic concerns and opportunities affecting local communities and stakeholders in the Lithuanian coastal region.

Table 11.2.2 provides a summary of stakeholder engagement activities conducted to date. These engagements have involved regulatory authorities, local municipalities, businesses, community representatives, and educational institutions, supporting a transparent and inclusive dialogue throughout the Project's development.

Table 11.2.2. Summary of stakeholder engagement for the CN OWF project to date

Timeframe	Type of engagement	Organisations involved	Contents covered in the meetings
September 2023	Stakeholder briefing session	Klaipėda Port Authority Western Shipyard Engineering	• Project overview and key concepts • Discussion of local supply chain considerations and potential for regional manufacturing
October 2023–ongoing	Informal consultation with TSO	Litgrid AB, EPSO-G	• Project overview and objectives • Technical discussions regarding grid connection requirements and related infrastructure
September, November, December 2023	Stakeholder briefing session with the local regulatory bodies	EPA SSPA National Public Health Centre under the Ministry of Health	• Project overview and objectives • Review and discussion of EIA considerations • Discussion of survey methodologies

[131] CN OWF website

Timeframe	Type of engagement	Organisations involved	Contents covered in the meetings
		Emergency Service providers (The Fire and Rescue Department)	• Collection of stakeholder recommendations and input
September 2023–ongoing	Targeted community information-gathering consultations	Coastal community organisations and parishes in Šventoji, Nida, and Palanga	• Overview of community support initiatives • Collection of local concerns and feedback from community members
February–March 2024	Informal consultations with municipalities	Municipality administrations and Mayors of Klaipėda, Neringa, Palanga, Šventoji, Klaipėda, and Kretinga	• Project overview and EIA progress • Identification of preferred communication channels • Discussion of community concerns and feedback • Review of administrative procedures and regulatory considerations
February 2024	Stakeholder briefing with local commercial fishing organisations	Leading commercial fishermen organisations: Lietuvos Žvejas, Lampetra, Baltijos Žvejas, Lithuanian Fish Products Association	• Presentation of the project • Open discussion on stakeholder concerns • Exploration of potential collaboration opportunities • Consideration of possible solutions and mitigation measures
March, April, June, August 2024	Informal consultations with the Kretinga Municipality	Kretinga Municipality Mayor and administration	• Four informal consultations on regulatory considerations specific to Kretinga • Discussion of community funding mechanisms • Examination of potential implications for EIA approval
May, June, September 2024	Presentation in scientific conferences	Klaipėda University Sea and Seashore Conference Blue Banos Conference Nautical Marine Conference, held by the Lithuanian Maritime Academy, part of Vilnius Tech	• Presentation of the project and EIA process • Discussion of research and collaboration opportunities in OWF development • Dissemination of project information to scientific and professional audiences
May–September 2024	Stakeholder briefing sessions	Lithuanian Maritime Academy Maritime Vocational School in Klaipėda	• Presentation of the project and its development stages • Discussion of opportunities for academic collaboration • Support for educational programs and capacity-building in OWF technology
June–September 2024	Consultations with independent commercial fishermen	Independent fishermen operating outside formal associations	• Overview of the local fishing sector and operational patterns • Identification of potential impacts and opportunities related to OWF development

Timeframe	Type of engagement	Organisations involved	Contents covered in the meetings
			• Discussion of challenges and mitigation measures for coexistence
June 2024	Briefing session with local municipal leaders	Mayors and Vice-Mayors of Klaipėda, Palanga, Šventoji, Neringa, Kretinga, Klaipėda Region	• Discussion of local community support initiatives • Exploration of opportunities for regional cooperation and collaboration • Exchange of feedback on project-related impacts and benefits
August–September 2024	Consultations with local supply chain representatives	Western Engineering Lithuanian Maritime Cluster Klasco Klaipėda Port Authority Novikontas	• Exploration of potential partnerships with local suppliers • Discussion of supply chain integration opportunities • Exchange of information on project requirements and collaboration options
September 2024	Consultation with small vessel owners	Local Shipowners Association, in cooperation with crewing companies	• Presentation of project requirements relevant to local maritime suppliers • Introduction to green shipping standards and sustainability practices • Discussion of opportunities for local supplier involvement in the project
November 2024	Consultation with environmental non-governmental organizations (ENGOs)	Environmental NGOs: Klaipėdos Žalieji and Klaipėda už demokratiją ir ekologiją	• Presentation of the project and current EIA progress • Discussion of applied research methodologies and data collection approaches • Open Q&A session to address stakeholder questions and gather feedback
November 2024	Community meeting	Neringa-Nida, Juodkrantė, Preila, and Pervalka community members	• Presentation of the project and its objectives • Discussion of community funding opportunities and initiatives • Open dialogue to capture stakeholder expectations and feedback mechanisms
November 2024	Community meeting	Šventoji and Monciškė community members	• Presentation of the project and its objectives • Discussion on local engagement initiatives and community funding opportunities • Facilitation of stakeholder feedback and dialogue mechanisms

Timeframe	Type of engagement	Organisations involved	Contents covered in the meetings
November 2024-2025, March-June ongoing	Consultations with governmental and regulatory authorities	Lithuanian Transport Safety Administration State Border Guard Service Lithuanian Navy and others	• Overview of the CN OWF project, including objectives and scope • Presentation of the project timeline and planned activities • Discussion of potential collaboration opportunities with governmental and regulatory stakeholders
November 2024	Local Supply Chain Briefing Event	Members of the Kaipėda Maritime Chamber of Commerce, including maritime business representatives from the Urbo Bankas, VMGcorp, Adoris, Marsh Lietuva, Baltkonta, Klaipėdos Smeltė, Klaipėdos energija, KN Energies, Siampeksas ir Co, Passer Sidc Group, Klaipėdos energetika, Lithuanian Shipowners Association, Association of Lithuania Shipbuilders and Repairers, and Association of Lithuanian Stevedoring Companies	• Presentation of the project requirements and objectives • Discussion of opportunities for local supply chain participation • Exploration of alternative fuel and electric charging solutions for maritime operations
May 2024–ongoing	Engagement with the educational institutions	Schools in Klaipėda, Kretinga, and Šilutė	• Interactive educational sessions on modern energy sources for students (part of the #EnergySmartStart program) • Hands-on activities demonstrating WTGG technology • Promotion of renewable energy awareness and engagement among young learners
Feb 2025	Informal briefings with communities adjacent to the onshore export cable corridors, including Darbėnai and Laukžemė	Darbėnai Alderman's office Darbėnai citizen community Laukžėmė community Mažučiai community Japanese Garden director	• Presentation of the "CN OWF project, including objectives and progress updates • Discussion of potential community funding initiatives and support measures • Open dialogue to gather stakeholder expectations, feedback, and suggestions
March 2025–ongoing	Bilateral telephone consultations for ongoing monitoring of community concerns and feedback	All coastal and onshore communities affected by the project	• Monitoring and recording community concerns, questions, and feedback • Reporting stakeholder inputs and emerging issues to the project director for follow-up and resolution
June 2025	Community meeting	Klaipeda city and the prominent Klaipeda seaside regional community members (Karklė)	• Presentation of the project using an exhibition-style format to enhance understanding

Timeframe	Type of engagement	Organisations involved	Contents covered in the meetings
			• Discussion of community funding opportunities and initiatives • Facilitation of open dialogue to capture stakeholder expectations, questions, and feedback
June 2025	Community meeting	Palanga City community members	• Exhibition-style presentation of the project to visually communicate key aspects and progress • Discussion of community funding programs and potential local benefits • Open dialogue to gather stakeholder expectations, address concerns, and collect feedback

11.3.2.1. Summarised stakeholder concerns

Table 11.2.3. provides a summary of the principal concerns, questions, and recommendations raised by stakeholders throughout the engagement activities.

Table 11.2.3. Stakeholder feedback summary

Stakeholder	Feedback / Questions	Response
Coastal communities	Community members expressed broad support for OWF development while highlighting concerns about potential impacts on marine ecosystems, including flora and fauna in the Baltic Sea.	The EIA report details measures to protect the Baltic Sea ecosystem, including the use of DBBC to mitigate underwater noise impacts and the implementation of artificial reef technologies to enhance seabed habitats. Feedback from the community on these initiatives is actively being considered and integrated into project planning.
	Residents expressed concerns regarding elevated electricity costs and sought clarification on whether the project could contribute to lowering electricity prices.	Recent studies suggest that increasing electricity production within a country can enhance energy independence and potentially lower electricity costs.
	Community members and commercial fishermen expressed concerns about the potential disruption and preservation of traditional fishing areas within the OWF development zone.	Consultations have been conducted with commercial fishing representatives to address concerns regarding the OWF area, and ongoing discussions are planned to identify mutually acceptable mitigation measures and operational arrangements.
	Coastal community members were briefed on the community support mechanisms, including the generational fee, which will be implemented and allocated in accordance with applicable government legislation.	
Onshore communities along the onshore export cable corridors	Communities of Darbėnai and Laukžemė welcomed the internal briefings and expressed a willingness to cooperate. Their primary concerns related to construction-phase noise, the routes to be used by heavy-duty vehicles, potential vegetation removal, and inquiries regarding possible community financial support.	Feedback from the Darbėnai and Laukžemė communities has been acknowledged and shared with the onshore transmission project team. Ongoing engagement will continue through stakeholder briefings and landholder sessions prior to construction, ensuring that concerns regarding noise, heavy-duty

Stakeholder	Feedback / Questions	Response
		vehicle's routes, vegetation removal, and community financial support are addressed effectively and communicated through the preferred channels.
Local Coastal Municipalities	The municipalities of Palanga, Klaipėda, and Šventoji expressed overall support for the project while seeking clarification on the allocation of community support funds generated through the generation fee.	The Governmental Regulation is currently under revision; however, community support will be provided through the dedicated generation fee, which will be distributed directly to coastal communities.
	Kretinga Municipality also supported the project but raised objections to the Governmental Regulation governing the distribution of the generation fee, as it excludes Darbėnai – where the OWF's onshore infrastructure will be located – from receiving community support.	Four informal meetings were conducted with Kretinga Municipality to explore potential alternative solutions. While no immediate alternatives have been identified, discussions with governmental regulators are ongoing. In parallel, direct engagement with the Darbėnai community continues to address local concerns and ensure transparent communication.
Local Supply Chain	Supply chain requirements: the need to ensure alignment of supply chain operations with cybersecurity and sustainability standards.	Following supplier selection, the project team will provide comprehensive guidance on compliance with cybersecurity and sustainability standards. Tailored support will be offered during contract negotiations to ensure proper integration.
	Project timeline: uncertainty about whether the CN OWF project will be fully commissioned and operational by 2030.	The project remains on track and continues to align with the approved planning and commissioning schedule.
	Disaster management and resilience: questions regarding the project's preparedness for extreme weather events and its disaster management strategies.	Risk assessments, including disaster preparedness and mitigation strategies, are being incorporated into project studies to ensure operational resilience under extreme weather conditions.
Local Fishermen Associations	Fishermen requested regular updates on ongoing project activities in the Baltic Sea	Key Project timelines and study schedules have been communicated to fishermen via email, with ongoing channels maintained for continuous updates.
	Fishermen sought access to environmental monitoring results, specifically regarding bird migration patterns, ecosystem health, and fish populations following construction.	Relevant environmental research is being shared, and further collaboration with Klaipėda University's Aquaculture Department is being pursued.
	Fishermen inquired about potential financial support measures for those whose livelihoods may be impacted by the project.	Preliminary findings will be incorporated into the Fishermen's Management Plan, scheduled for release in late 2026.
Local Environmental NGOs (ENGOs)	Environmental NGOs (ENGOs) requested detailed information on environmental protection measures, with particular emphasis on marine biodiversity conservation and avian monitoring programs.	Discussions addressed a range of conservation strategies, including habitat enhancement and the installation of "fish hotels" to support endangered and sensitive species. These measures are detailed in the EIA report, and ongoing dialogue with ENGOs will continue to ensure their concerns are considered.
Military and Naval Authorities	Stakeholders raised questions regarding the Project scope, planned activities, and	A formal cooperation framework has been established to enable information sharing

Stakeholder	Feedback / Questions	Response
	opportunities for collaboration in maritime security.	and coordinate maritime security measures related to the CN OWF.

11.3.2.2. Grievance Mechanism

At the Group level, PEA developer maintains a Trust Line[132] and whistleblower protection mechanisms. The Trust Line provides a confidential and anonymous channel for reporting legal violations by employees or business partners that may affect public interests.

For the CN OWF project, the stakeholder manager currently handles grievances received via telephone or the community e-mail box. A dedicated grievance mechanism is being developed for all coastal communities, landowners, and residents within the project area. This mechanism will provide a structured process for reporting, addressing, and resolving issues, complaints, or disturbances, particularly during the construction phase.

The Grievance Mechanism includes the following components:

- Communication channels for submitting grievances: a dedicated grievance phone number will be published on the project website. An online grievance form will also be available on the CN OWF website, allowing community members and other stakeholders to submit concerns or report issues. Grievances submitted by mail or formal letter can be addressed during designated drop-in office hours held at local municipalities and project offices. The schedule and locations for these sessions will be published on the website.
- Grievance phone line management: the Trust Line service will manage the grievance phone line. Trained personnel will receive and document all incoming grievances. While Trust Line staff are not responsible for resolving grievances, they will ensure that each submission is accurately recorded and forwarded to the stakeholder manager daily.
- Grievance documentation, monitoring, and implementation: all grievances will be recorded in the Stakeholder Engagement Database and documented within the CN OWF document management system. Each entry will include:
    - Details of the grievance
    - A unique grievance identification number
    - A summary of the grievance
    - Related correspondence, including actions taken and follow-up

An annual review of the grievance mechanism (GM) will be conducted to assess its effectiveness and identify areas for improvement. This review will draw on data from meetings, stakeholder feedback, grievance records, outreach activities, and participation levels.

The grievance mechanism will undergo an annual review to evaluate its effectiveness and identify potential improvements. This review will consider information from stakeholder meetings, feedback received, grievance records, outreach activities, and participation metrics.

11.3.2.2.1. Roles and responsibilities

- The Project Director of the CN OWF project holds ultimate responsibility for approving solutions to grievances and is accountable for any associated risks.
- The Grievance Committee comprising the Stakeholder Manager, relevant Package Lead (depending on the grievance), Technical Project Manager, HSSE Lead, Construction Managers (onshore and offshore), Offshore O&M Manager, and Project Manager, reviews Grade 2 and Grade 3 grievances. The committee is responsible for proposing solutions, which are submitted to the Project Director for approval. If the Project Director does not approve a proposed solution, the Grievance Committee must revise and resubmit it. Grade 1 grievances requiring corrective action may also be escalated to the Grievance Committee at the Stakeholder Manager's discretion.
- The Stakeholder Manager receives grievance submissions, assigns a unique identification number, and determines the grievance grade. The Stakeholder Manager prepares and forwards the grievance to the Project Director or Grievance Committee based on its classification. Responsibilities include arranging relevant meetings, tracking company communications and procedures, and liaising with the complainant. All written decisions communicated to the complainant are based on the latest Project Director-approved solution. The

[132] Trust Line

Stakeholder Manager ensures that the process considers the needs and concerns of affected individuals and communities, with particular attention during the construction phase.

11.3.2.2.2. Grievance handling steps

1. Receive the grievance
   - Grievances can be submitted via the online form or dedicated grievance phone line. Submissions received through the Trust Line will be redirected to the email address: communities@curoniannord.com.
   - The Stakeholder Manager will screen and assess the grievance within three working days of receipt. Each grievance will be assigned a unique identification number and recorded in the dedicated CRM database.
   - For grievances submitted by on-site workers during the construction period, the grievance should be directed to the on-site Construction Manager, who will register it and report it to the Stakeholder Manager. The Stakeholder Manager will then forward the grievance to the Grievance Committee for review.
2. Acknowledge and organise the Grievance
   - Upon submission, an automatic acknowledgment email will be sent from no-reply@curoniannord.lt, informing that grievance is received and will be adhered.
   - Grievances deemed invalid (e.g., submissions that violate project or shareholder corporate policies) will be dismissed. The complainant will receive written notification explaining the reasons for dismissal after consultation with the Project Director and Stakeholder Manager.
   - Valid grievances will be classified according to their severity:
     - Grade 1: Low potential impacts, quickly resolvable (e.g., minor property damage caused by project vehicle).
     - Grade 2: Widespread and repeated issues affecting multiple stakeholders (e.g., noise or dust from project activities).
     - Grade 3: Severe breaches of national laws, regulations, or international standards with significant impacts on the government or project reputation (e.g., waste management violations, electricity breaches).
3. Investigate and propose resolution
   - Following classification, the Stakeholder Manager forwards the grievance to the Grievance Committee and informs the Project Director. A dedicated meeting is then arranged to present the grievance to the Grievance Committee.
   - The Grievance Committee is responsible for investigating the grievance and proposing an initial resolution within five days of receipt, with timelines adjusted according to the severity of the issue.
   - The Project Director oversees the management of:
     - Grade 2 and Grade 3 grievances
     - Grade 1 grievances with significant business implications, and
     - Grade 1 grievances requiring input from the Grievance Committee.
   - The resolution process between the Grievance Committee and Project Director may be iterative; initial proposals may be revised or supplemented with alternative solutions before final approval.
4. Handle non-project-related complaints or disapproved resolutions
   - If a complaint is determined to be unrelated to the Project, the Grievance Committee and Project Director will provide the complainant with a written explanation or a phone notification detailing the reasons for the decision.
5. Implement the solution
   - Simple or short-term grievances should be resolved within 30 days of determination. For complex or long-term issues, the Stakeholder Manager will provide regular updates to the complainant – at least once per month – until the grievance is fully addressed.
   - The resolution will be communicated to the complainant through their preferred channel, such as email, letter, or telephone.

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13. ANNEXES