

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
NON-TECHNICAL SUMMARY
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 Summary

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.

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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
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
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 ₂ e	metric tonnes of carbon dioxide equivalent

1. INTRODUCTION

Environmental Impact Assessment (hereinafter – EIA) is 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" with the 330 kV substation in Darbėnai.

On 12 October 2023, UAB "Ignitis Renewables" was declared the successful bidder for using a marine area dedicated to the development and operation of an OWF, as decided by the National Energy Regulatory Council (hereinafter – NERC). The developer will 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. The resolution defines eligible marine areas and sets maximum and minimum OWF capacities.

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 covers 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 will 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.

According to Resolution No. 171, 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 was approved by 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 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.

A Strategic Environmental Assessment (hereinafter – SEA)¹ 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 2024². The finalised solutions of the Engineering Infrastructure Development Plan were presented to the public between January and March 2025.

Legal Basis of Environmental Impact Assessment

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).

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 –

¹ 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.

² 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=-aj6u7wxf>.

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.

Strategic Importance

The project contributes to the National Energy Independence Strategy, aiming to expand renewable electricity production and reduce dependence on imports. By 2030, Lithuania plans to develop two OWFs with a combined capacity of 1.4 GW, expected to generate about 6 TWh annually.

Main objectives of EIA

The EIA seeks to:

- Identify and assess potential direct and indirect impacts of the OWFs and related infrastructure on the environment, biodiversity, cultural heritage, and public health.
- Propose measures to avoid, reduce, or compensate for negative impacts.
- Evaluate risks linked to extreme events or emergency situations.
- Ensure compliance with environmental, health, safety, and cultural heritage requirements.

Participants of the EIA process

The responsible authority for the EIA is the Environmental Protection Agency (hereinafter – EPA).

Participants include:

- The developer (Ignitis Renewables), EIA documentation authors, and designated EIA entities.
- Relevant ministries and agencies (environment, health, fire and rescue, cultural heritage, protected areas).
- Municipalities along the Lithuanian Baltic Sea coast.

The interested public, which has the right to participate, provide comments, and receive information throughout the process.

2. INFORMATION ABOUT THE PROPOSED ECONOMIC ACTIVITY

2.1. Description of Proposed economic activity

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 concept³ 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).

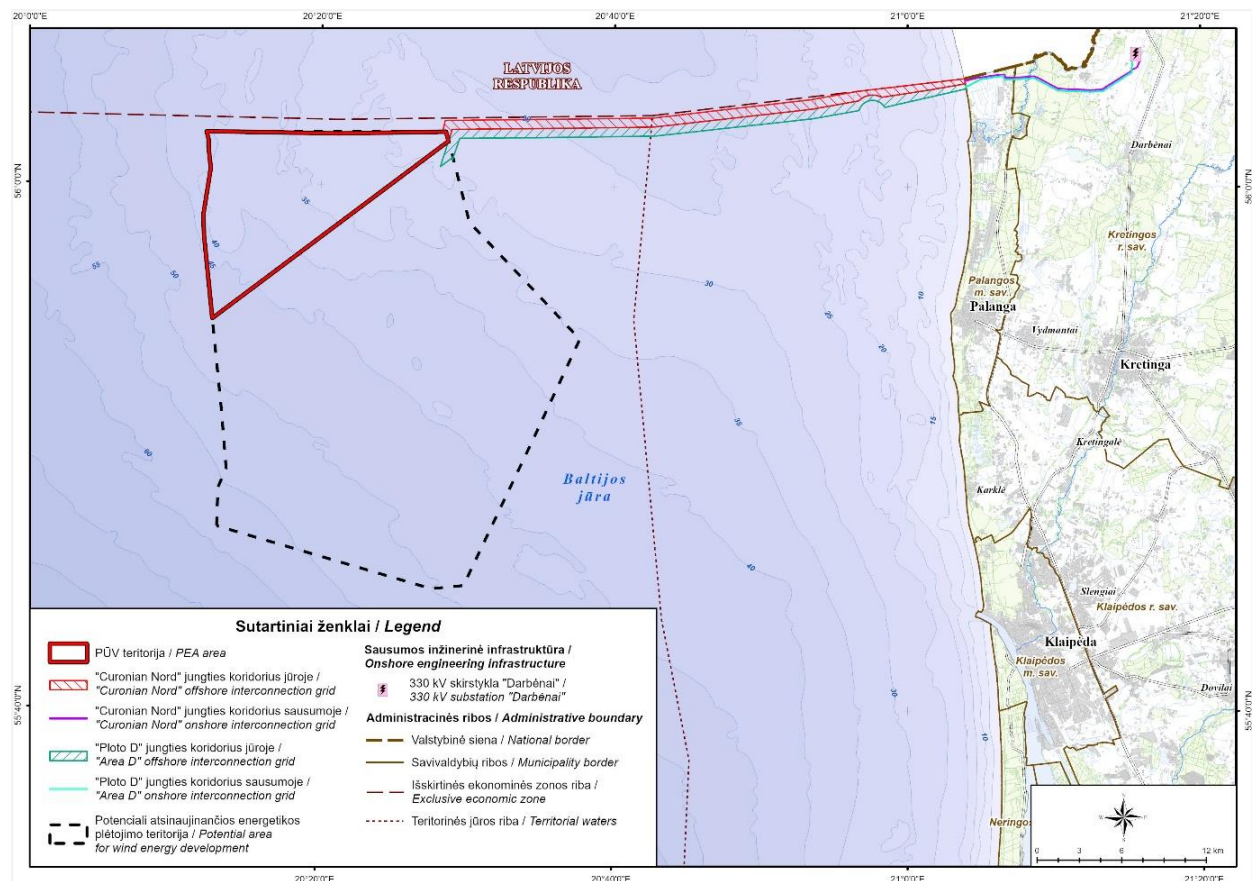


Fig. 2.1.1. Layout of the planned OWF area within the part of the territorial sea of the Republic of Lithuania and/or the Republic of Lithuania's EEZ in the Baltic Sea, where it is appropriate to organise tenders without applying support measures for the development and operation of power plants using 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.

³ Approved on 16 September 2024 by Order No. 1-161 of the Minister of Energy of the Republic of Lithuania.

Physical and technical characteristics of the proposed economic activity

The Curonian Nord offshore wind farm (CN OWF) is planned with an allowable generation capacity of 580–700 MW. The turbines under consideration will each have a capacity of up to 20 or more MW, hub heights up to 170 m, tip heights up to 350 m, and rotor diameters up to 300 m. Minimum blade clearance above sea level will be 23 m, with turbine spacing at least three rotor diameters.

All turbines will be connected to an offshore substation (OSS), from which electricity will be transmitted via offshore and onshore export cables to the 330 kV Darbėnai switchyard in Kretinga District. The “Area D” OWF will also connect to the same switchyard.

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:

- **Foundation.** This is the structure embedded into 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, 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.

WTG foundation structures

The choice of foundations depends on turbine size, seabed conditions, water depth, and hydrodynamics. Three main types are considered:

- **Monopile** – bottom diameter 9–11 m, length 57–90 m, weight up to 2,900 t; embedded 20–38 m; footprint ~63–95 m². Installed by pile driving (6–7 h).
- **Jacket** – pile diameter 2–4 m, length 35–47 m, pile spacing 24–30 m; embedded 30–44 m; footprint ~500–1,200 m². Pile driving or drilling (2–3 h).
- **Gravity-based** – diameter ~45 m; footprint ~1,600 m². Installed on prepared seabed with gravel layer.

In all cases, seabed boulders may be cleared using ploughs or ROVs. Scour protection (stones, geotextile bags) will be installed, with affected seabed areas extending up to 45 m around monopiles.

OSS

The OSS will collect electricity from wind turbines via inter-array cables, transform it from 66 kV to 220 kV, and transmit it to the onshore grid. It will also supply power for its own systems.

It will be installed offshore on monopile, jacket, or gravity-based foundations, depending on seabed conditions. Typical sizes: monopiles ~90 m length, 13–14 m diameter; jacket foundations with 4–8 piles (~60 m each) occupy ~675 m²; scour protection may cover up to 5,000 m².

The topside, lifted by heavy-lift vessels, will house transformers, switchgear, backup generators, control/monitoring systems, and safety/communication equipment. Although operated remotely, it can accommodate up to 12 workers for inspections and maintenance, accessed by vessels, gangways, or helicopter in emergencies.

Safety and environmental protection systems include fire detection and suppression, emergency power supply (diesel and UPS), and spill prevention (drip collection, closed drainage, oil–water separation).

Electricity transmission solutions

The offshore wind farm's (OWF) electrical infrastructure ensures transmission of electricity to the national grid operated by Litgrid AB. It consists of subsea and underground export cables, step-up transformers, and substations (Fig. 2.2.2).

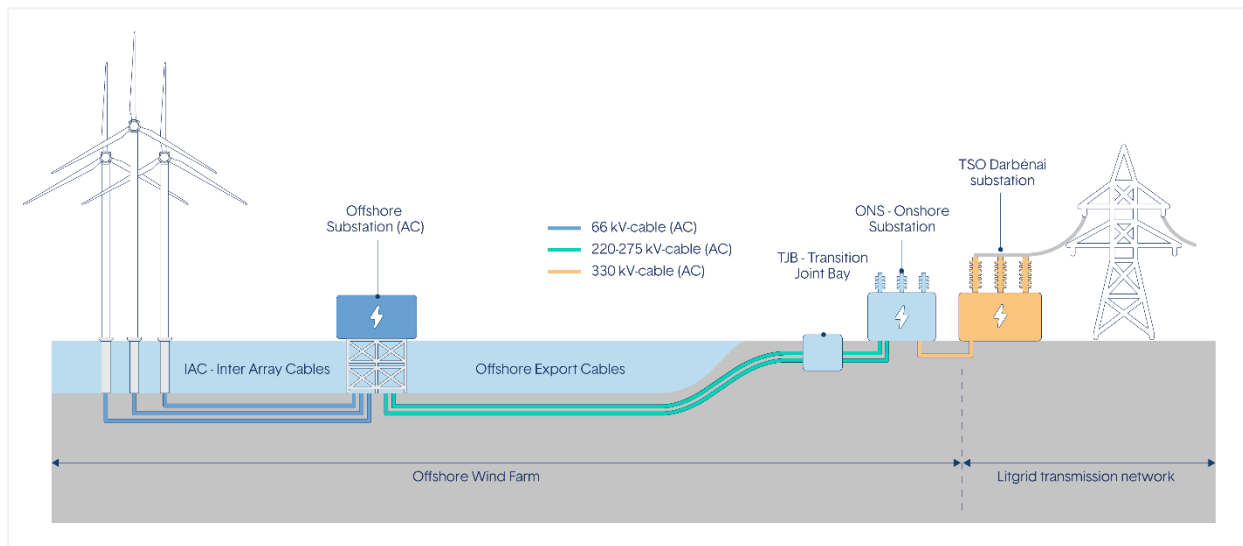


Fig. 2.2.2. General scheme of transmission of electricity generated by OWF to onshore networks.

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

- Inter-array cables (IAC): 66 kV three-core cables with integrated optical fibre will connect the wind turbines to the offshore substation (OSS), transmitting both power and data.
- Export cables: From the OSS to shore, two 220 kV three-core subsea cables with optical fibre are planned, with onshore connections using single-core cables. The preliminary route length is about 48 km offshore and 14 km onshore for Curonian Nord OWF, and 38 km offshore and 14 km onshore for "Area D."

Cable installation methods will include trenching, horizontal directional drilling (HDD), or other protective technologies depending on seabed and land conditions. On agricultural land, open trenching will be applied, while sensitive areas will use trenchless methods.

Export Cable Laying Technology

Inter-array cables

Wind turbines will be connected to the OSS using three-core 66 kV cables with aluminium or copper conductors, typically 115–210 mm in diameter. The total cable length is estimated at 100–135 km.

Cables will be installed using specialised cable-laying vessels supported by auxiliary ships. Before installation, seabed clearance will be carried out to remove debris and relocate larger boulders. Cables will generally be buried 0.3–1.2 m into the seabed; in stable conditions, burial depth will reach ~1.0 m. Where burial is not possible, protective measures such as rock placement, gravel bags, or concrete mattresses will be used.

Trenching will be performed with remotely operated vehicles (ROVs) using jetting or mechanical cutting tools, depending on seabed conditions. Approximately 10% of routes may require additional interventions, such as excavation, seabed levelling, or trench backfilling.

The overall installation period for inter-array cables is expected to take around six months, subject to weather conditions.

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

Electricity from the OSS will be exported via two parallel 220 kV three-core submarine cables with integrated optical fibre. At the shoreline, they will connect to onshore 220 kV cables through transitional joints.

Prior to laying, seabed surveys and clearance will be carried out, including removal of debris and relocation of large boulders. Cables will generally be buried 0.3–1.2 m into the seabed using ploughing, jetting, or mechanical cutting.

Where burial is not feasible, protective measures such as rock dumping, concrete mattresses, or gravel bags will be applied.

Intersections with other seabed infrastructure will be safeguarded with protective layers in coordination with asset owners. It is estimated that about 20% of cable routes will require additional interventions, such as seabed excavation, trenching, or backfilling.

The cable corridor width will range from ~624 m in deeper waters to ~440 m in shallower areas, with a reduced minimum of 360 m where repair zones are not feasible. Final methods and protective measures will be selected during detailed design, based on seabed conditions and risk assessment.

Landfall

For cable installation in the Lithuanian coastal zone, a trenchless installation method is planned, specifically employing HDD. HDD allows underground tunnels 300–1,200 m in length to be drilled beneath sensitive areas, enabling cable installation without surface disruption.

This method will be applied at the Būtingė Geomorphological Reserve, the Šventoji River and valley, and where export cables cross key infrastructure such as pipelines and roads. HDD involves three stages: pilot drilling, borehole enlargement, and pipe/cable insertion. Transition joints between subsea and onshore cables will be installed just beyond the beach zone, each requiring about 100 m².

The HDD method offers multiple advantages: reduced construction time and costs, lower risk of emergencies, minimal disturbance to existing infrastructure, and preservation of natural landscapes with significantly less environmental impact compared to open-trench methods.

Technological solutions and corridor widths for export cable installation onshore

Onshore, export cables will be installed within a 20-meter-wide corridor, using both trenching and trenchless techniques at road and utility crossings. Works include route marking, trench excavation with topsoil preservation, cable laying on sand bedding, installation of joints and protective concrete slabs, backfilling, and final surface restoration.

Construction will ensure soils and vegetation are reinstated to pre-construction condition, with excess material removed from site. The total duration of onshore cable installation is estimated at up to 16 months, excluding potential weather delays.

Onshore Interconnection Cables

From the landfall, 220 kV export cables will connect to the new Pelėkiai Transformer Substation (Fig. 2.2.3.), and from there to the existing Darbėnai switchyard (Fig. 2.2.4) via 330 kV cables. Each interconnection will consist of two export circuits with optical fibre for communication. Joint manholes or connection pits will be installed along the route for cable joining and maintenance.

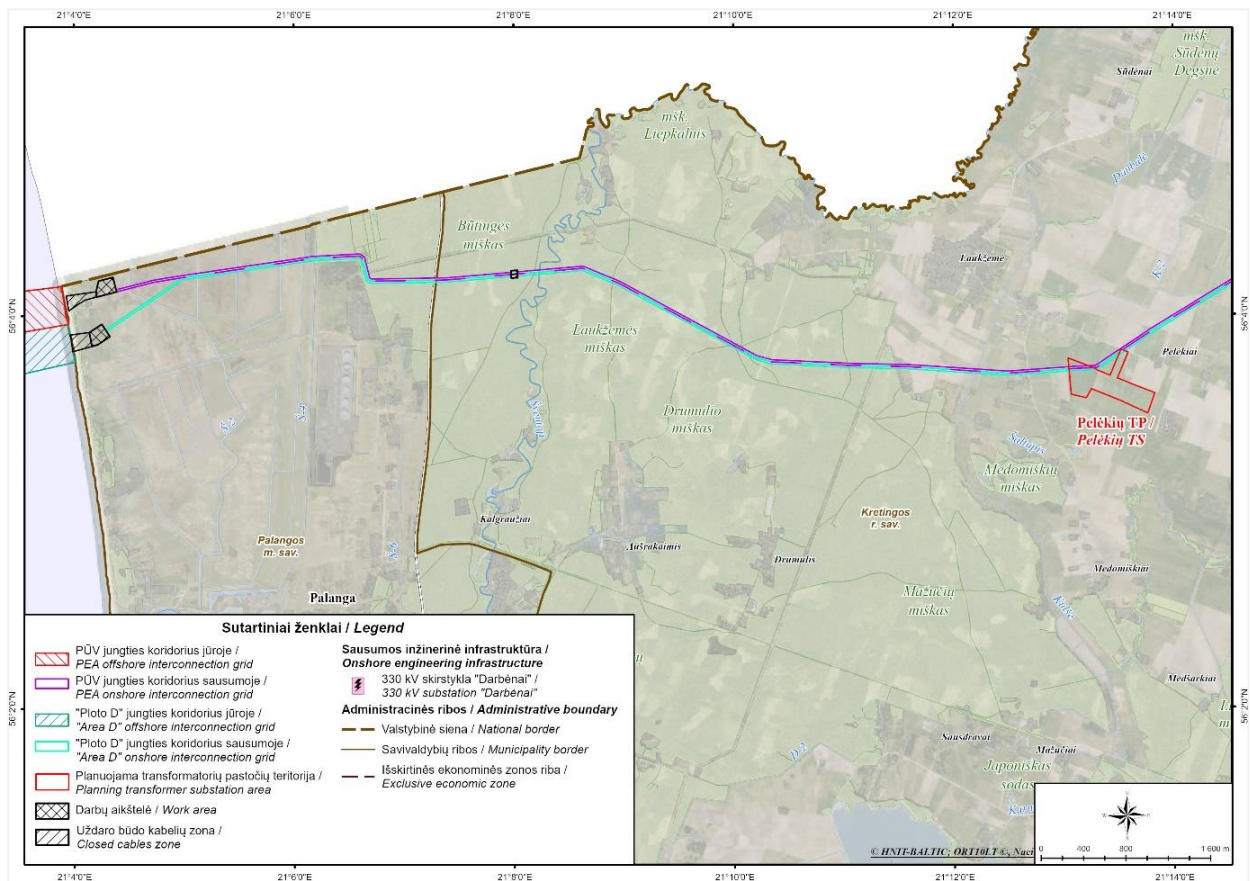


Fig. 2.2.3. Connection cable routes from the landfall area to the Pelėkiai Transformer Substation.

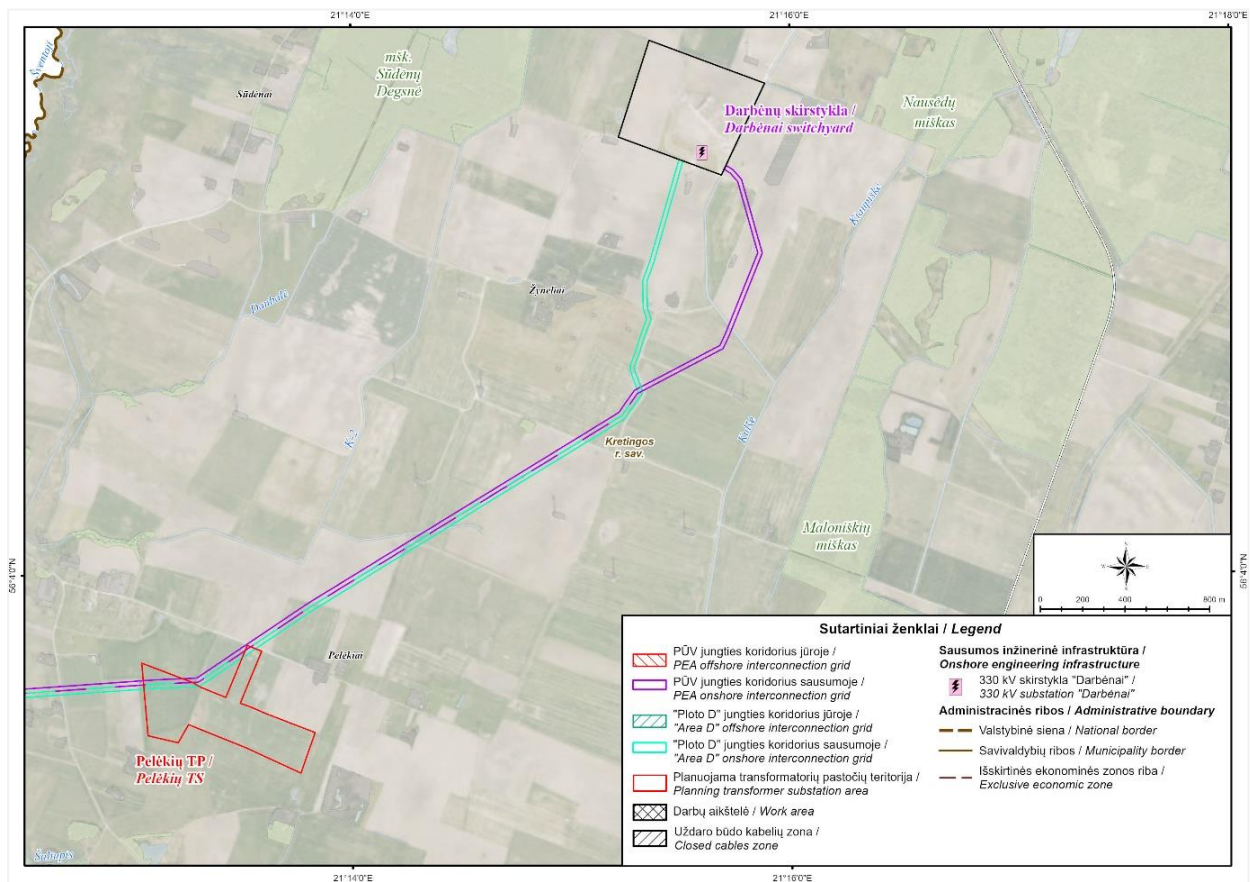


Fig. 2.2.4. Cable routes from the Pelėkiai Transformer Substation to the existing Darbėnai switchyard.

Cables will mainly be installed using the open-trench method with burial depths of 1.5–2.0 m, while trenchless methods such as HDD will be applied at sensitive crossings (e.g. Šventoji River, major infrastructure). In Natura 2000 sites, strict mitigation measures will be implemented, including timing restrictions to avoid fish spawning and sediment control.

The planned cable corridor is 20 m wide, with protective conduits, joint structures, and thermal backfill where required. Cable installation techniques will be selected according to soil and environmental conditions to ensure reliability and minimise ecological impacts.

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. 2.2.5).

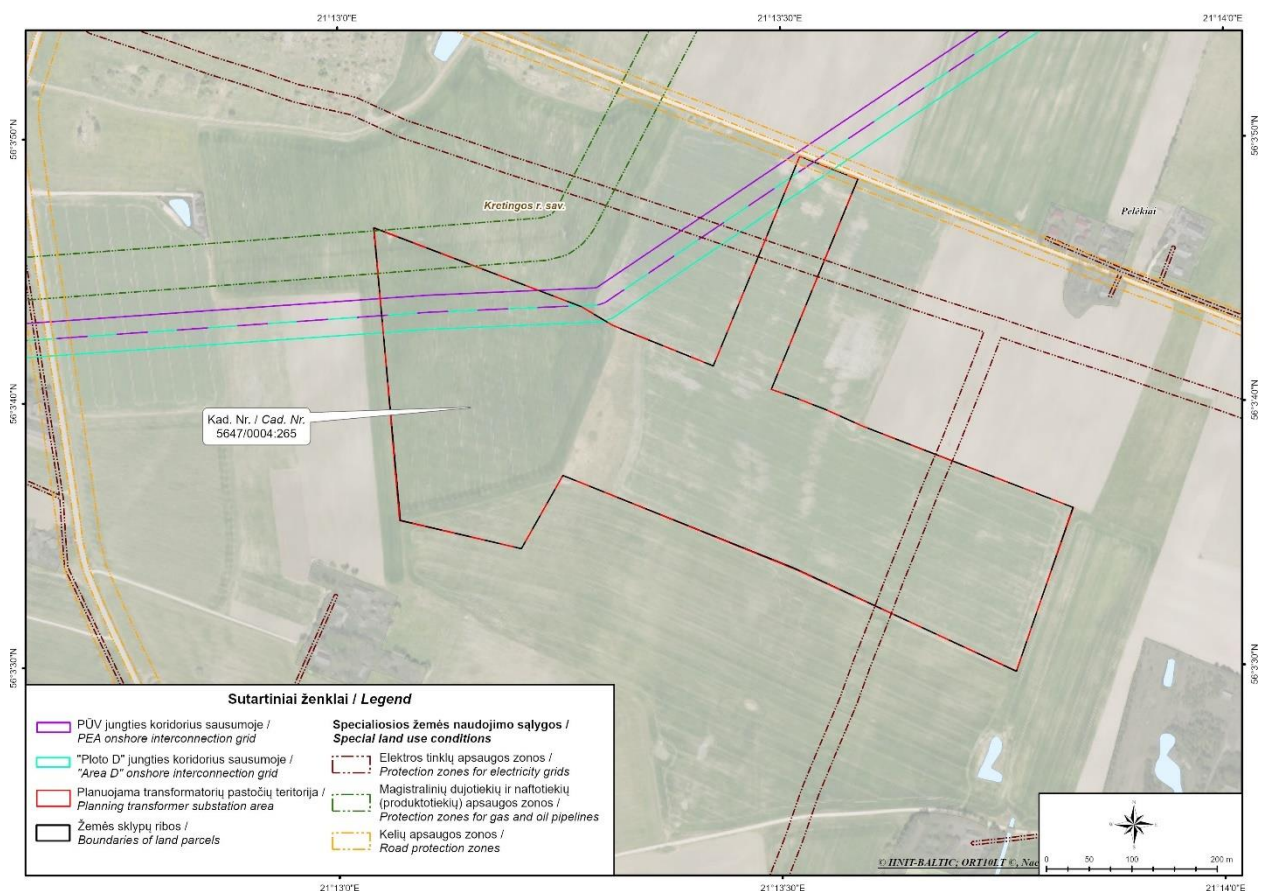


Fig. 2.2.5. The area planned for the installation of the Pelėkiai Transformer Substation.

The Pelėkiai 220/330 kV Transformer Substation will be constructed on designated agricultural land plots in Kretinga District, near Darbėnai. The substation will include high-voltage equipment, auxiliary or backup power systems, and may integrate a solar plant as an additional power source. The territory will be fenced, equipped with security and fire safety systems, and connected via existing local roads, which may be upgraded if required.

The land plots are subject to special land use conditions related to reclaimed land, road safety zones, electricity networks, and pipelines. Construction activities will be coordinated with the relevant authorities to ensure compliance. Restrictions apply to activities in reclamation areas, road protection zones, and pipeline corridors (e.g. excavation, construction, storage of materials, or vegetation planting near pipelines).

Overall, the substation will be developed in accordance with legal requirements and coordinated with infrastructure managers to avoid disruption of reclamation systems, pipelines, and other utilities, while ensuring environmental and operational safety.

2.2. Stages of project implementation and operation

Main planned installation works

The main construction and installation activities will include the transport of components to the construction port and site, followed by offshore installation of foundations, towers, nacelles, and blades. Each wind turbine will be assembled using specialised jack-up vessels to ensure stability during lifting operations. Medium-voltage IAC will be installed to connect turbines to the OSS. The OSS itself will be transported from the fabrication yard and installed offshore using heavy-lift vessels.

Electricity transmission infrastructure will be established through the installation of subsea export cables from the OSS to landfall, employing trenching, jetting, or HDD depending on seabed and coastal conditions. Onshore, high-voltage cables will be installed mainly by open-trench methods, with trenchless techniques applied at sensitive crossings, such as rivers and infrastructure.

In parallel, the Pelėkiai Transformer Substation will be constructed onshore. Here, electricity from the OWF will be stepped up to 330 kV and connected to the Darbėnai switchyard, ensuring integration into Lithuania's national transmission grid.

A similar approach will be applied for the "Area D" OWF export cable connections.

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.

Decommissioning stage

The decommissioning phase involves the removal of offshore infrastructure following the conclusion of its useful service life, along with the disposal of equipment. The primary components slated for removal during the OWF decommissioning process include WTGs, foundations and transition elements, submarine cables (both intra-OWF and export cables to shore), 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.

2.3. Materials to be used

For the construction and operation of the OWF, only certified products that comply with EU standards will be used. Components will be assembled and installed on site, with preference given to recyclable materials.

No hazardous chemicals, radioactive substances, or industrial accident-classified materials will be used or stored during the project. The only substances applied in operation are lubricating oils, transformer oils, and cooling fluids in turbines and substations. These include synthetic lubricants (approx. 450 litres per turbine), biodegradable ester-based transformer oil (approx. 140,000 litres in the OSS), and ethylene glycol-based coolant (approx. 1,800 litres in the OSS).

These oils and fluids are not classified as flammable or hazardous to the aquatic environment, and biodegradable alternatives will be prioritised. All substances will be handled in line with safety data sheet requirements to minimise environmental risks.

2.4. Waste management

Waste will be generated during all stages of the project – construction, operation, and decommissioning – and will be managed according to the waste management hierarchy defined in Directive 2008/98/EC: avoid, reduce, reuse, recycle, recover, and dispose as a last resort. A detailed waste management plan will be prepared at the technical design stage.

During **construction**, small amounts of municipal, inert, recyclable, and hazardous waste will be produced from installation works, cable laying, and site preparation. Waste will be sorted at temporary onshore facilities or service ports, stored in designated containers, and handed over to licensed waste handlers. Records will be maintained in line with national accounting requirements.

During **operation**, waste is expected to be minimal, mainly arising from maintenance activities such as replacement of oils, filters, or electronic components. All such waste will be transported to ports and transferred to authorised handlers.

During **decommissioning**, dismantled turbines, substations, cables, and related infrastructure will be transported to shore for reuse, recycling, or disposal in line with Lithuanian regulations. Metals and recyclable components will be prioritised for recovery, while hazardous fractions will be handed over to specialised waste managers.

Mitigation measures will include waste segregation, minimising storage times, covering or isolating waste when necessary, monitoring storage areas for leaks, and ensuring personnel training and coordination with contractors.

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.

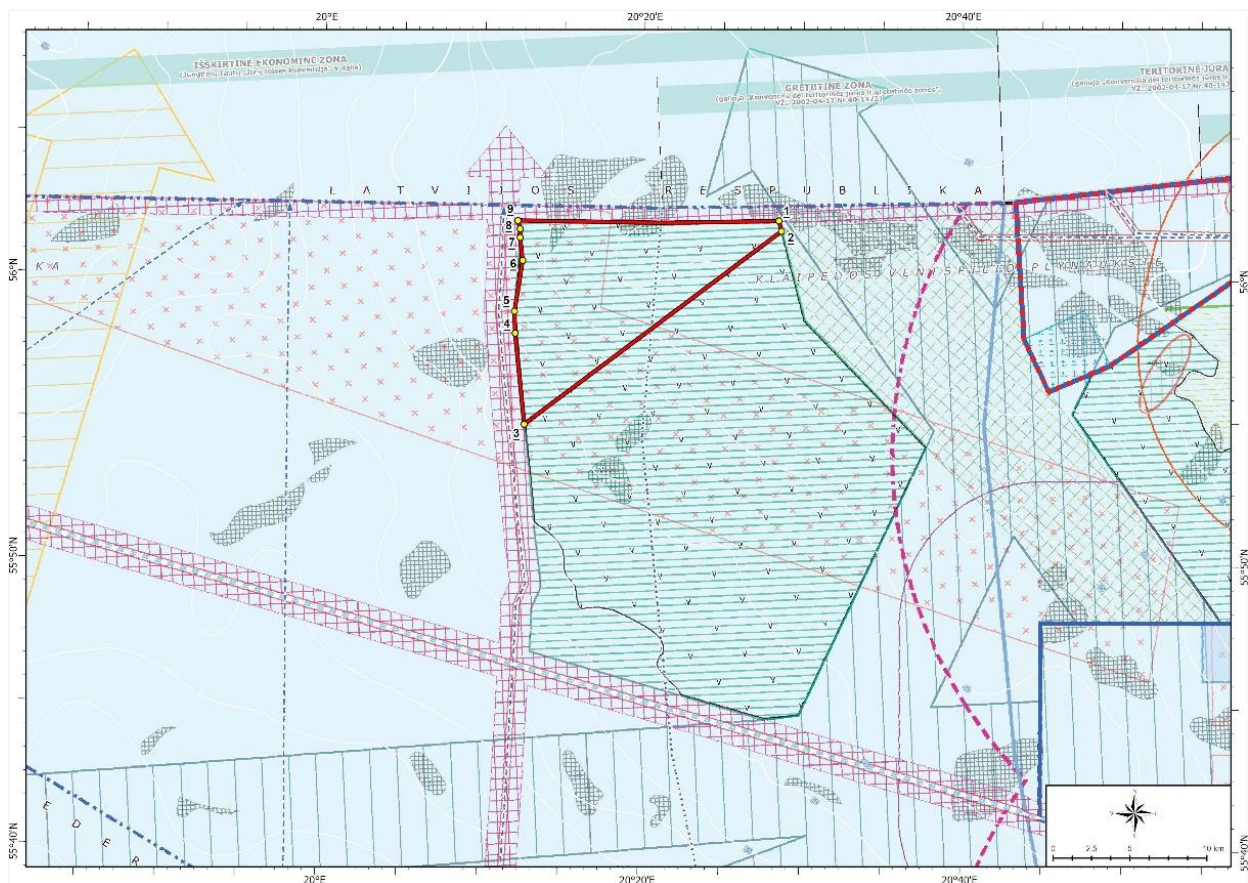


Fig. 3.1.1. The territory of the OWF in the Baltic Sea, approved by the Resolution No. 171 of the LRV (excerpt from Resolution No. 171⁴ of the LRV).

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

⁴ <https://www.e-tar.lt/portal/lt/legalAct/39556540c6ed11ed9978886e85107ab2>

Area points 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 56°1.406`N	X-6216430.60; 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 km².
- 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.

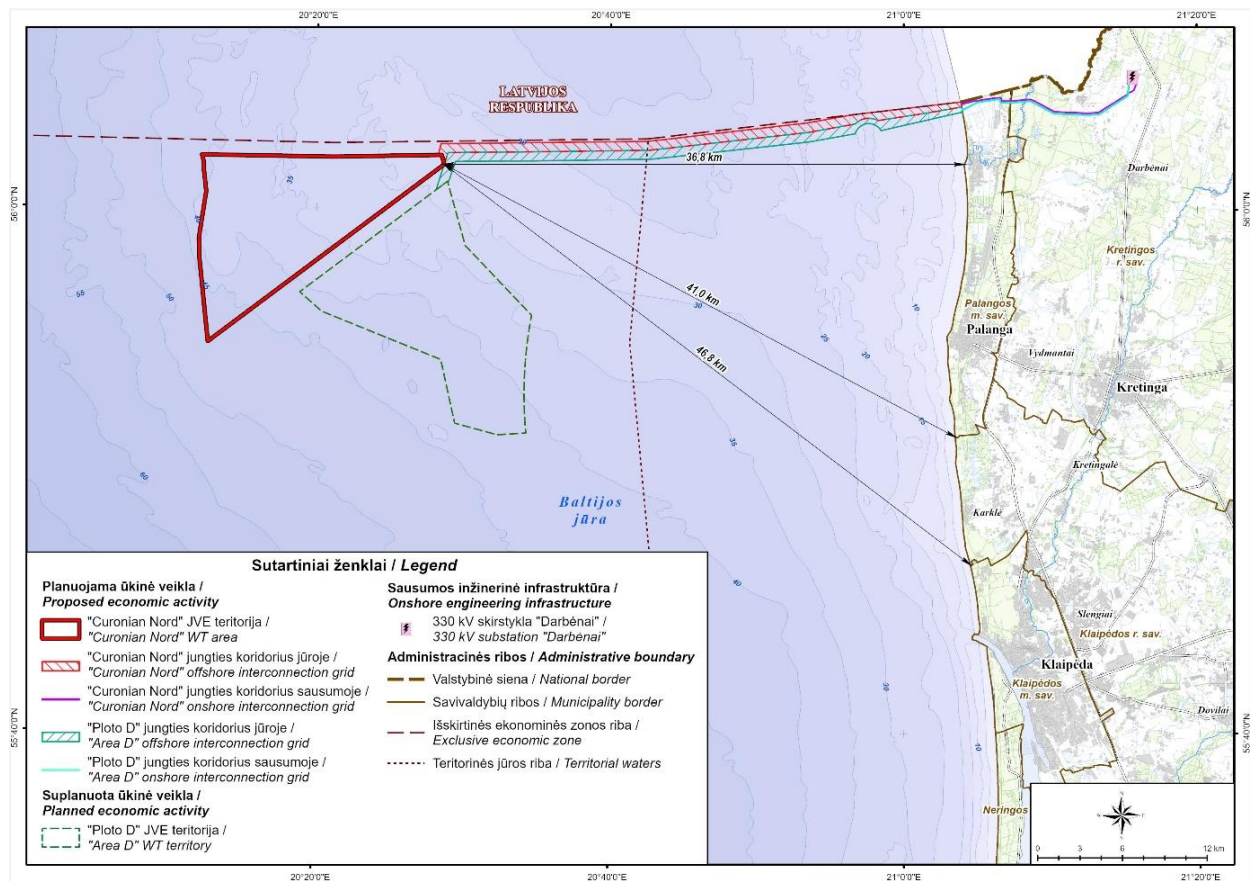


Fig. 3.1.2. Geographical and administrative location of PEA objects.

An Engineering Infrastructure Development Plan of special national importance has been prepared to define connection corridors for integrating offshore renewable energy projects into Lithuania's electricity grid. The plan, which has undergone strategic environmental assessment, designates cable landfall points and the connection to the 330 kV Darbėnai substation within Palanga City and Kretinga District municipalities.

3.2. Current use of the area

Lithuania's Exclusive Economic Zone (EEZ) and territorial sea are used for navigation, fishing, engineering communications, sand extraction, renewable energy, military activities, and recreation. The coast is important for tourism and includes several protected areas and Natura 2000 sites, such as Curonian Spit National Park, Coastal Regional Park, and the Baltic Sea Thalassological Reserve.

The planned OWF area does not overlap with international shipping routes or anchorage zones, although export cable corridors will cross existing navigation lines. Fishing remains the main activity in the area, though its intensity has decreased due to the cod fishing ban. The territory also partly overlaps with zones of former minefields and areas where security restrictions may apply to tall structures.

Onshore, the connection corridor crosses Palanga City and Kretinga District municipalities, linking to the 330 kV Darbėnai substation.

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

The project is consistent with Lithuania's territorial and strategic planning framework. The **General Plan of the Republic of Lithuania** identifies the Baltic Sea as a priority area for renewable energy development and highlights the need for offshore wind farms and transmission grid expansion. The **Engineering Infrastructure Development Plan** further divides maritime areas into plots designated for renewable energy, marking the Curonian Nord OWF site as "Area A."

The project also supports national strategies: the **Sustainable Development Strategy** (efficient resource use, substitution of hazardous substances), the **Environmental Protection Strategy** (sustainable use of resources with RES in all sectors by 2050), the **Energy Independence Strategy** (increasing RES share to 45% by 2030 and 100%

by 2050), and the **Climate Change Management Policy Strategy** (reducing greenhouse gas emissions and building a low-carbon economy).

At the municipal level, the **Palanga City Master Plan** reserves infrastructure corridors for state needs, while the **Kretinga District General Plan** allows energy and infrastructure development in designated functional zones, including forest land. Planned connection routes align with these territorial planning decisions.

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

The analysed project area is part of a maritime territory divided into four plots designated for renewable energy development.

In Territory No. 1, an EIA was completed in 2022–2023, and the Environmental Protection Agency (EPA) issued a positive decision in October 2023, confirming compliance with environmental, cultural heritage, safety, and public health requirements.

In Territory No. 2, an EIA was also carried out for an offshore wind farm planned by UAB AVEC. In March 2022, the EPA extended the validity of the EIA decision for this project within the broader renewable energy development zone defined by the Engineering Infrastructure Development Plan.

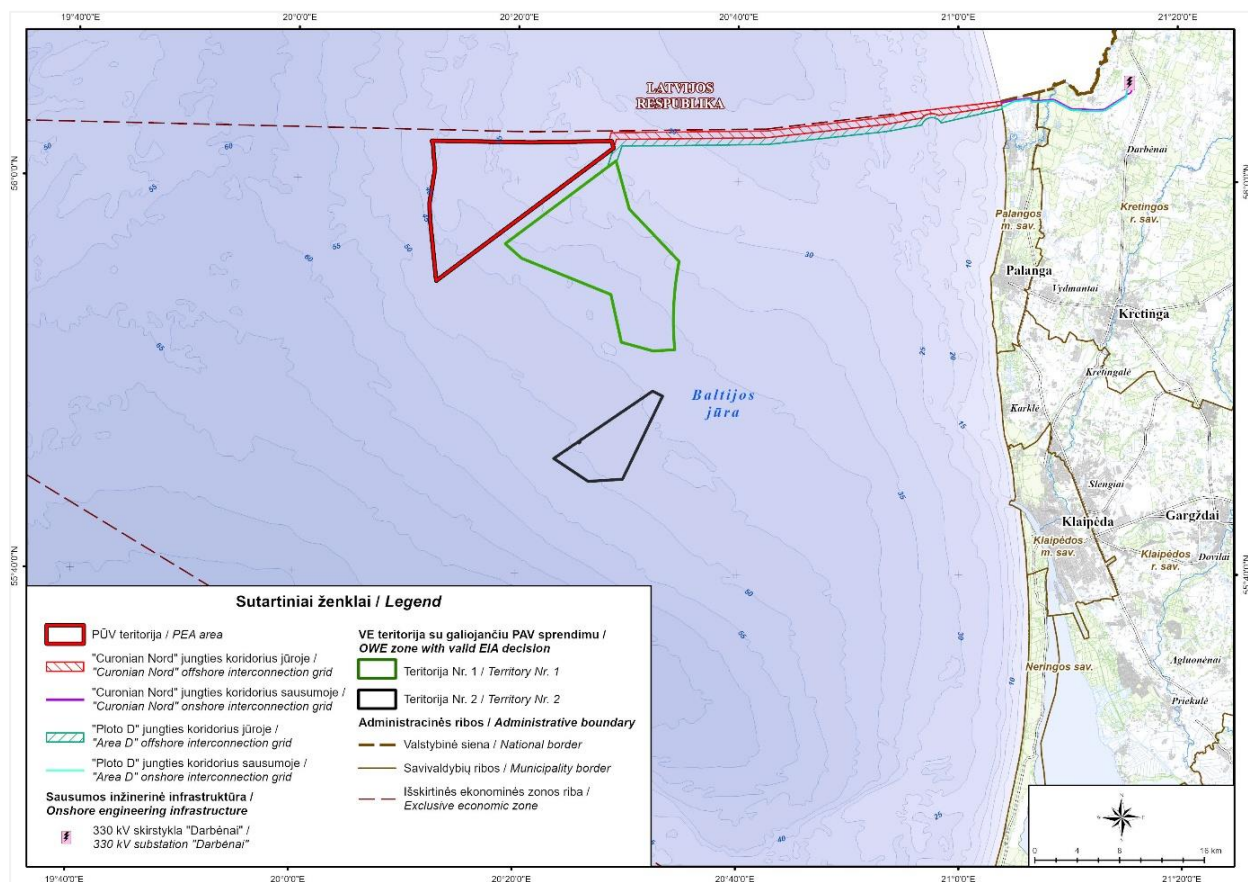


Fig. 3.4.1. OWFs planned in adjacent territories.

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 20 MW or more. Such turbines could reach heights of up to 350 meters.

According to Government Resolution No. 171, the maximum allowed electricity generation capacity delivered to the grid is 700 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

Principles of WTG layout in the PEA area

Two development alternatives were analysed:

- **Maximum development** – up to **68 WTGs** arranged across the full project area (see Fig. 4.1.1).
- **Optimal development** – up to **55 WTGs**, with a 2 km setback from the Natura 2000 Special Protection Area and consideration of seabed habitats (see Fig. 4.1.2).

The final layout and turbine numbers will be refined during the technical design stage, based on the selected turbine model and EIA results.

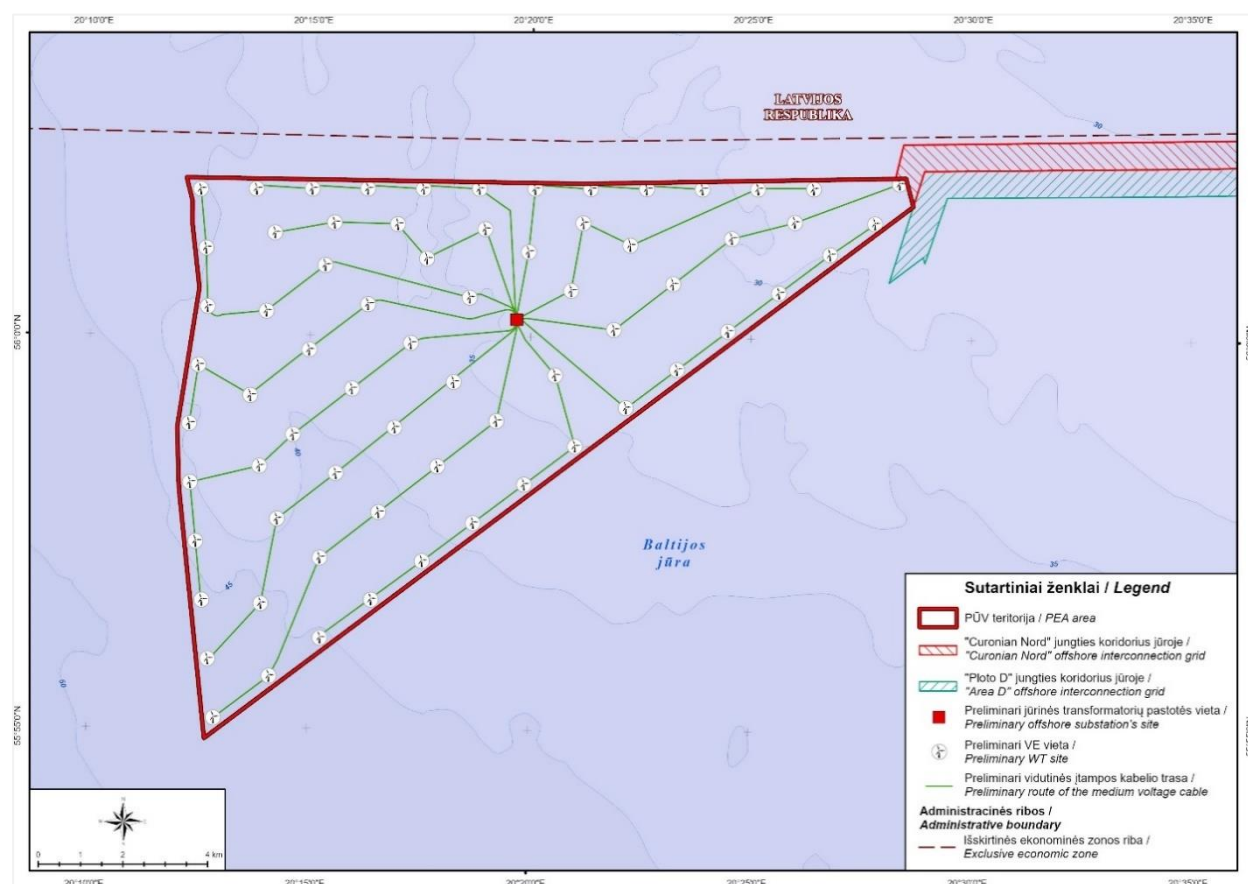


Fig. 4.1.1. Preliminary layout of WTGs in the first maximum development alternative of the CN OWF.

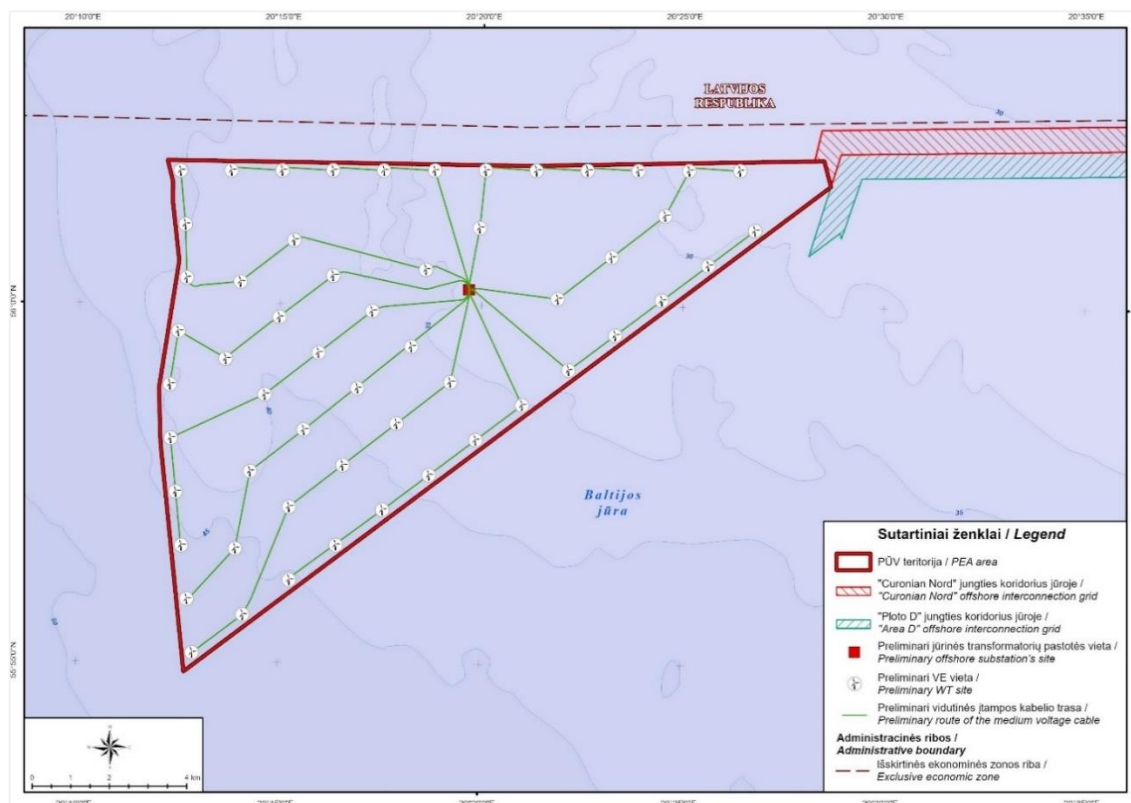


Fig. 4.1.2. Preliminary layout of WTGs according to the second optimal development alternative of the CN OWF.

OSS installation solutions

According to the Engineering Infrastructure Development Plan, several alternative OSS locations have been proposed (see Fig. 4.1.3)., with the final choice to balance technical efficiency and environmental considerations.

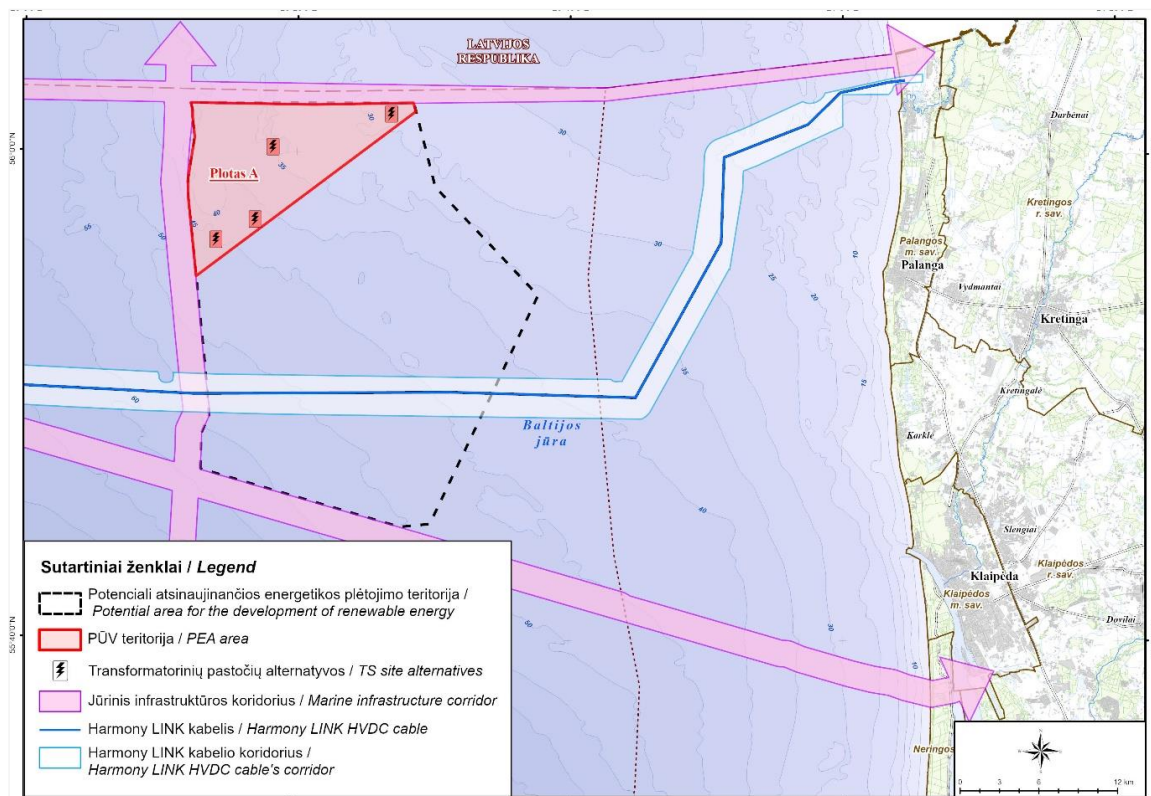


Fig. 4.1.3. Alternatives for the OSS locations of the CN OWF considered in the Engineering Infrastructure Development Plan.

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 of EIA report) and analysed in the SEA report.

For the "Area D" OWF, four marine route alternatives were evaluated, and for the Curonian Nord OWF (Area A) four routes were assessed. Also 24 onshore connection alternatives were analysed. Based on the SEA results, the B1–C2 alternative was selected for the Curonian Nord OWF (see Fig. 4.2.1), and the A1–C1 alternative for the "Area D" OWF (see Fig. 4.2.2). These routes, connecting to the 330 kV Darbėnai switchyard substation, are further assessed in this EIA report, while other options are no longer considered.

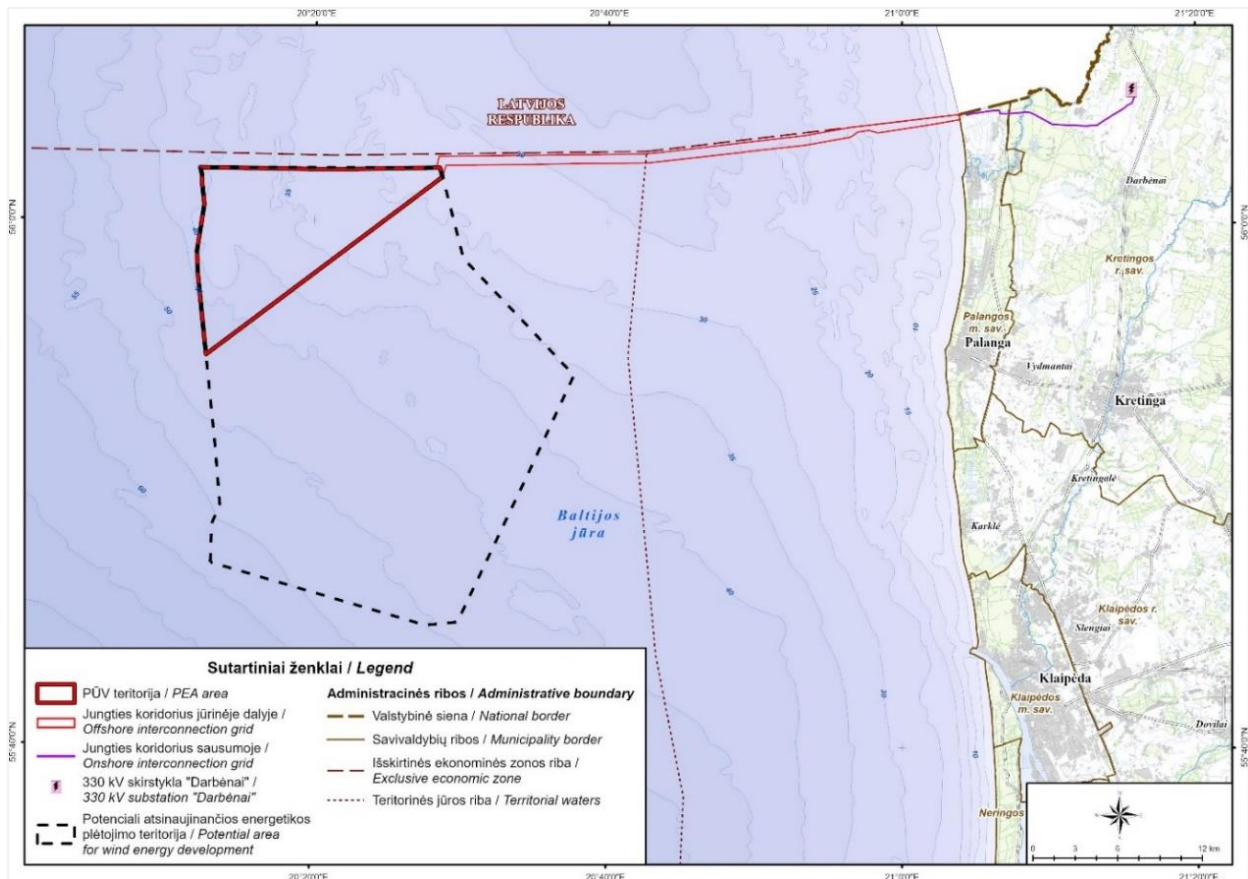


Fig. 4.2.1. Planned connection alternative of the CN OWF situational map for the offshore and onshore.

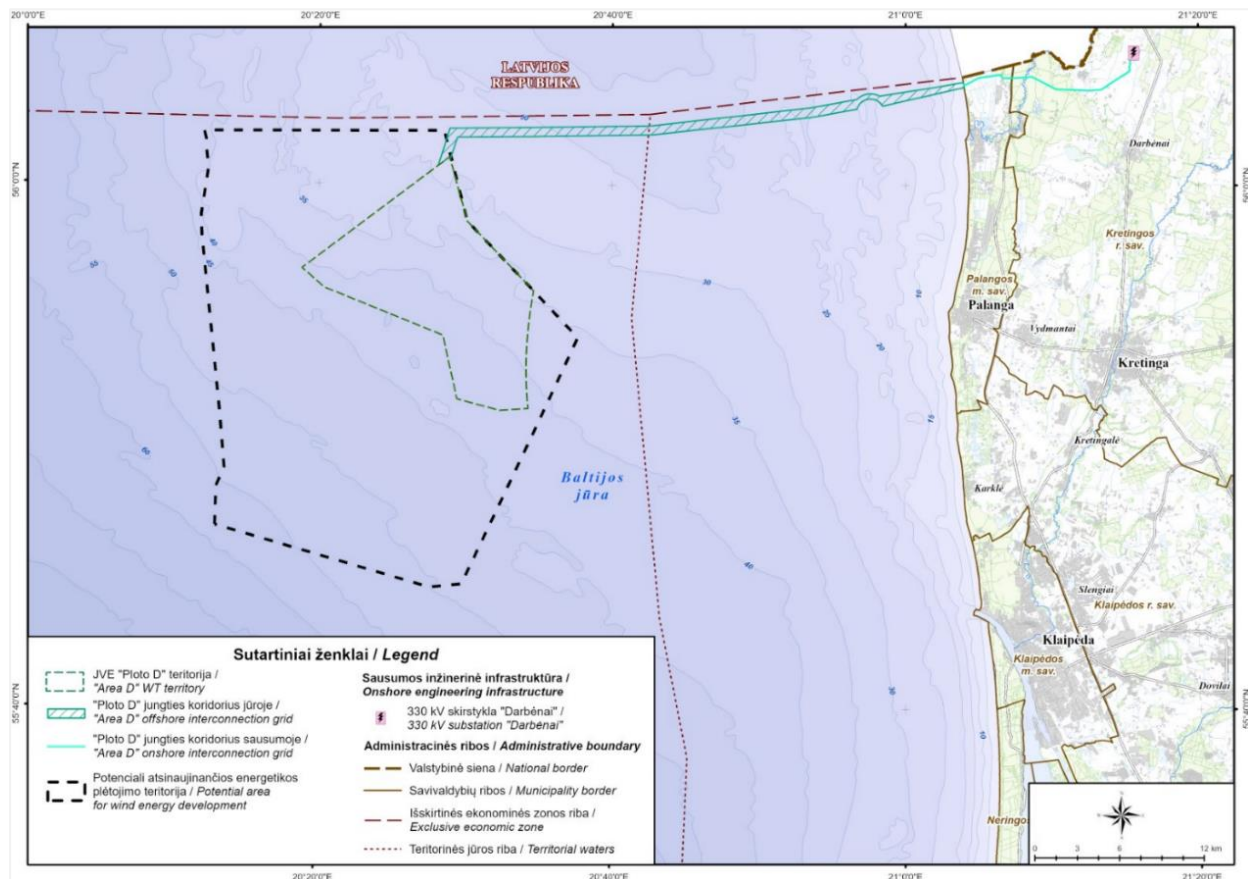


Fig. 4.2.2. Planned connection alternative of the "Area D" OWF situational map for the offshore and onshore.

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

5.1 Water

Research methods and study area

The assessment of surface and groundwater conditions in the project area considered hydrological, hydrodynamic, and hydrochemical factors in the Baltic Sea and rivers intersected by the onshore connection route. Data sources included measurements from a LiDAR buoy deployed in 2024–2025, hydrological and hydrochemical field campaigns, the *MetOcean Study for Curonian Nord* (Deltares, 2024), Copernicus Baltic Sea models, and EPA monitoring data.

Seawater quality was evaluated using samples collected in 2024 and historic monitoring results (2014–2019). Analyses covered petroleum hydrocarbons, polyaromatic hydrocarbons (PAHs), and heavy metals, conducted in accredited laboratories.

Potential impacts on water were assessed in terms of:

- Hydrological and hydrochemical changes from foundation and cable installation.
- Possible pollutant inputs and their effect on the good environmental status of the sea.
- Hydrodynamic and chemical changes during construction, operation, and decommissioning.
- Compliance of cable-laying activities onshore with Special Land Use Conditions.

The research covered the present state and potential impact zones both offshore and onshore.

Marine area. The assessment focused on measurements within the PEA territory and interconnection grid zones. Data collected in 2024 were complemented by modelling results for a surrounding 10–20 km radius, as well as general hydrodynamic and hydrochemical conditions of the southeastern Baltic Sea.

Continental area. Onshore surveys examined territories along the planned export cable route. Special attention was given to groundwater bodies and their protection zones, as well as areas relevant to flooding and inundation risk.

Current state

Offshore

The PEA area, located in the southeastern Baltic Sea, reflects typical hydrological and hydrochemical conditions of the region.

Hydrodynamics and Waves. The wave regime is wind-driven, with average annual wave height of ~0.7 m. Extreme waves (>5 m) occur roughly once per decade nearshore, but recent buoy data (2024–2025) recorded exceptional storms with wave heights above 10 m. Model simulations (1979–2023) confirm prevailing W–SW wave directions, significant wave heights around 1.3 m, and maxima up to ~9 m, with higher waves in autumn–winter.

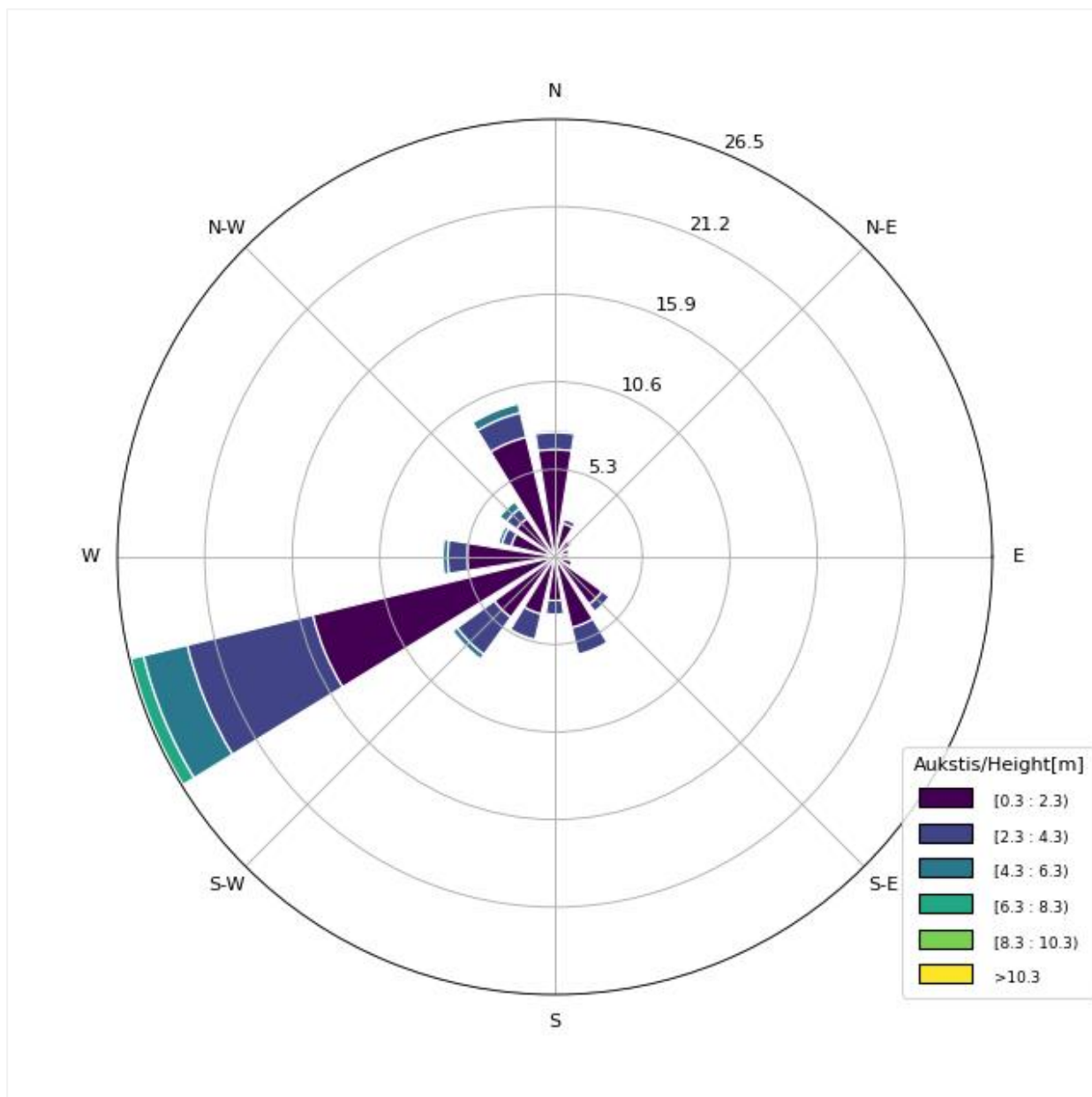


Fig. 5.1.1.1. Wave rose compiled from the raw SWLB94 buoy data.

Currents. Currents are generally weak (<0.3 m/s), shaped by cyclonic circulation. Long-term data show predominantly northward surface flows, influenced locally by the Curonian Lagoon. Recent buoy data (2024–2025) recorded average current speeds of 5–10 cm/s, with rare peaks >1 m/s. Seasonal model data confirm strongest currents in autumn–winter, weakest in spring.

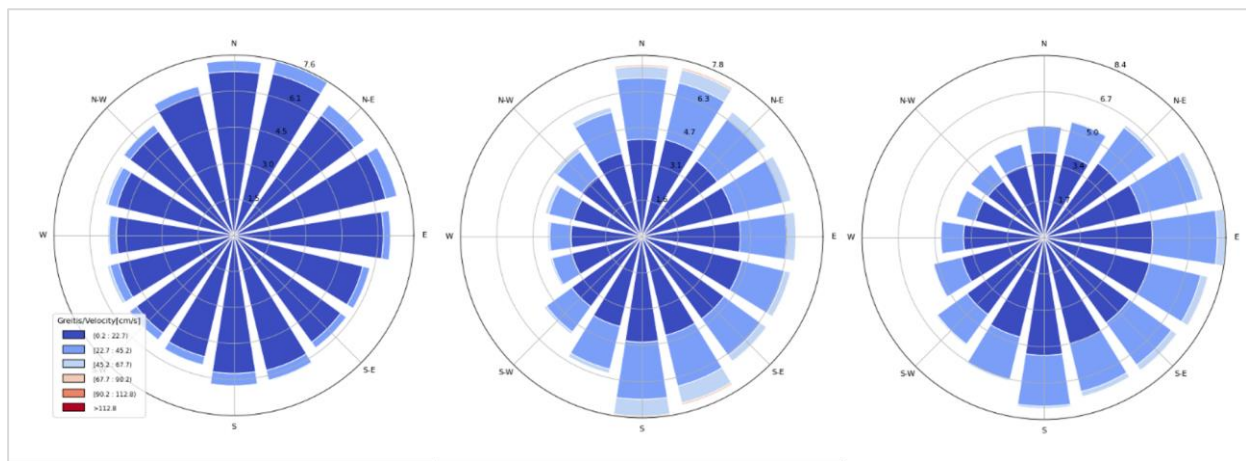


Fig. 5.1.2. Currents rose compiled from the raw SWLB94 buoy data (left – at 2 m depth, middle – 20 m depth, right – bottom layer, 39 m depth).

Temperature and Salinity. Waters are highly responsive to seasonal variation: winter $\sim 0^{\circ}\text{C}$, summer surface up to $\sim 28^{\circ}\text{C}$. A seasonal thermocline forms at 10–40 m. Salinity averages $\sim 7\text{‰}$ at surface and $\sim 7.4\text{‰}$ at the bottom, with slightly lower values nearshore due to freshwater input.

Ice Cover. Ice forms only in cold winters, typically close to shore. In the PEA area, ice cover was observed sporadically between 2011–2021, reaching max thickness of ~ 12 cm. The frequency and duration of ice events are declining due to climate change.

Water Quality. State environmental monitoring (2014–2019, 2020–2021) shows good chemical status in waters and sediments, meeting national and EU standards. Occasional exceedances of PAHs and mercury were recorded, mainly linked to regional sources (e.g., Būtingė terminal), but overall pollution is low. EIA sampling in 2024 confirmed generally low concentrations of heavy metals and hydrocarbons, with a single Hg exceedance ($0.26 \mu\text{g/l}$ vs. MAC-EQS $0.07 \mu\text{g/l}$) at one station. Other pollutants were below detection limits or well within thresholds.

Onshore

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. 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.

Cable corridor was selected to bypass groundwater abstraction sites and protection zones. Within Palanga and Kretinga municipalities, numerous groundwater wells exist, but the project design ensures no expected impact on groundwater resources. EPA flood hazard and risk maps indicate a low probability (0.1%) flood risk along the coastal section at the Baltic Sea. According to the Special Land Use Conditions (SLUC), this does not impose restrictions on the construction of export cables.

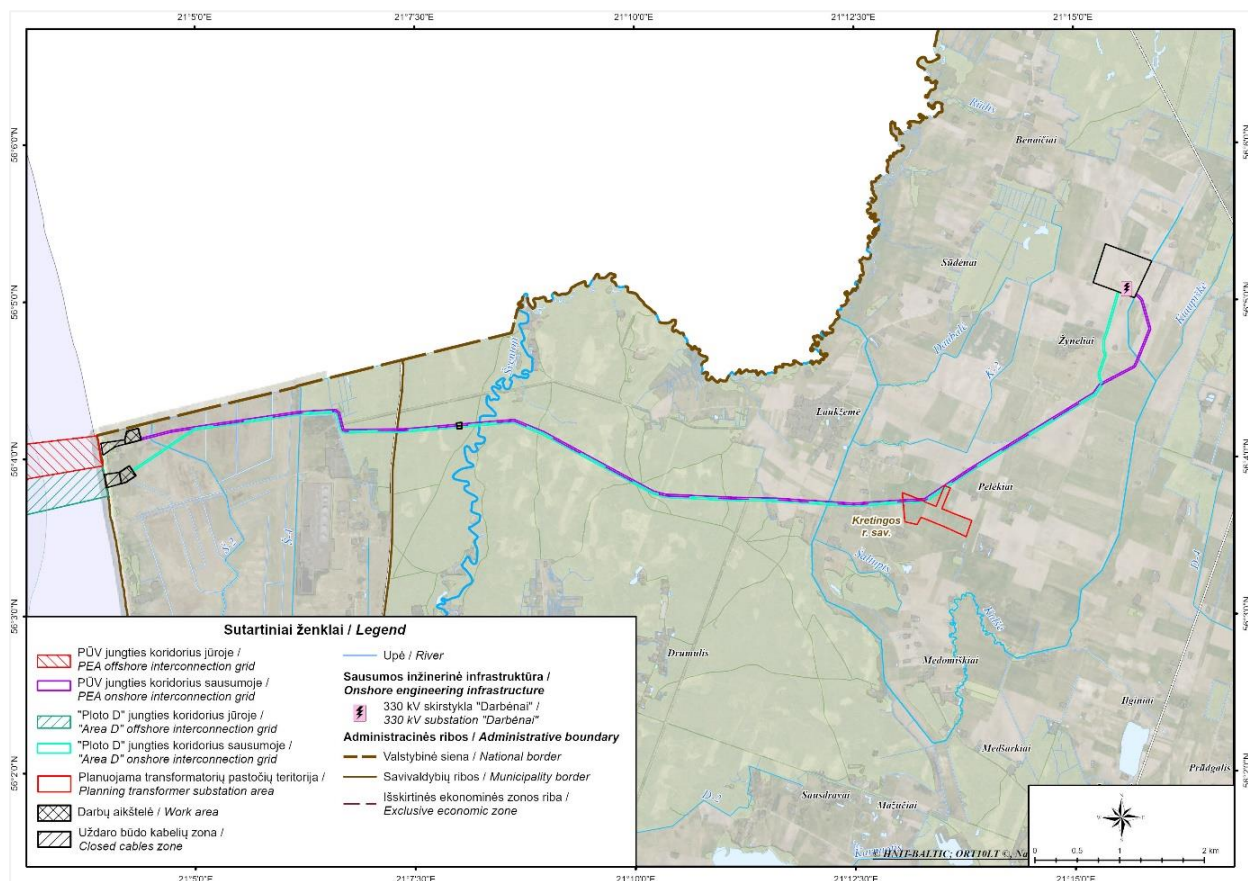


Fig. 5.1.3. Surface water bodies in relation to the planned onshore export cable route.

Potential impact on water

Offshore

The installation of OWTs and export cables is not expected to cause significant changes in the hydrodynamic regime of the Baltic Sea. Monopile foundations with diameters of 10–12 m and spacing of more than 1 km have only negligible effects on water currents, while gravity-based structures may cause minor local disturbances near the seabed. Overall, studies and modelling indicate that impacts on wave height, direction, and current velocity will remain very small and localised. Cable-laying activities may temporarily affect bottom relief and nearshore wave and flow conditions, but the seabed is expected to recover naturally in a short period.

Construction and decommissioning works may lead to short-term increases in suspended matter (turbidity) in the water column. However, the predicted levels will remain within the natural variability of the Baltic Sea and will be confined to the immediate vicinity of the works. Similar projects in the region have shown no significant long-term changes in turbidity.

Secondary pollution of seawater due to sediment disturbance is unlikely, as the project area is dominated by sands, gravel, and moraine deposits without notable historical contamination. During operation, the OWF is not expected to affect seawater quality. Potential pollution risks are mainly linked to accidental spillages of lubricants, hydraulic fluids, or transformer oils. These risks are minimised by modern turbine design, which includes sealed systems and collection reservoirs.

The OSS may generate surface runoff from rainwater, which could contain oil residues. To mitigate risks, the OSS will be equipped with oil–water separation and treatment systems, ensuring compliance with Lithuanian regulatory standards before discharge into the marine environment. Additional containment measures will be applied to prevent accidental releases.

Onshore

Most of the onshore export cable will be installed using open trenching at depths greater than 1.5 m. Smaller rivers (Š-2, Š-4, Kulšė) and drainage channels will be crossed using submerged cable technology, which may temporarily increase turbidity and disturb riverbeds. These impacts are expected to be localised and short-term.

At crossings with larger and environmentally sensitive rivers, such as the Šventoji (a Natura 2000 area), HDD will be applied. This closed method avoids direct excavation in the riverbed and ensures that boreholes remain at least 1 m below the natural bottom level. As a result, no significant impacts on the hydrological or hydrodynamic regimes of the water bodies are anticipated.

All works will comply with national land use and water protection requirements (SLUC), including restrictions on shoreline alteration, vehicle access in protection zones, and earthworks in sensitive areas. Cable corridor routes have been designed to bypass groundwater aquifers and their protection zones, eliminating risks to groundwater. Overall, no significant adverse impacts on surface or groundwater are expected from the planned cable installation works.

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.

Considering that the installation of other OWFs is planned in distinct phases rather than simultaneously, a cumulative impact assessment on water quality is not currently deemed necessary. By coordinating the individual OWF installation projects and their locations, in line with territorial planning document solutions, the cumulative impact should be controlled and is not expected to result in significant negative consequences.

Preventive, mitigation and compensatory measures for impacts on water

Offshore

The wide spacing of WTGs (1,100–1,300 m) and their installation in deeper waters on stable seabed conditions mean that impacts on hydrodynamics will be minimal. Local and temporary turbidity increases may occur during foundation and cable installation but will not cause significant long-term changes to water quality or the Palanga coastline. Continuous current monitoring is recommended, and pollutant monitoring should be carried out before, during, and after construction. To minimise risks of chemical pollution, eco-friendly corrosion protection methods – such as metallic and organic coatings – should be applied to turbine foundations.

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 5.1.1. 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.
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	Insignificant	Not applicable.

				activity, later stabilizes.		
	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

	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 5.1.2. 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

	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.

5.2. Ambient air and climate

The planned OWF will make a significant contribution to climate change mitigation by reducing greenhouse gas (GHG) emissions in the energy sector. By replacing fossil fuel-based electricity generation with renewable energy, the project will decrease CO₂ and other air pollutant emissions, thus supporting both national and regional climate objectives.

No stationary sources of air pollution are expected during the operation of the OWF. Temporary emissions may occur during construction, maintenance, and decommissioning phases, primarily from vehicles and construction machinery. These impacts are short-term and localized.

Research methods and study area

Research methods included long-term wind modelling and wind speed measurements conducted between 2022 and 2024, including Fugro LiDAR data. The assessment of potential impacts applied the principle of avoided CO₂ emissions and life-cycle analysis, using the GHG emissions study prepared by Tetra Tech RPS Energy (2024). Additional data on Baltic Sea surface temperature, sea level rise, and wind speed were sourced from international literature, while climatic conditions in the continental part of the study area were assessed using long-term observations from the Lithuanian Hydrometeorological Service.

The study area covers both marine and terrestrial zones: the Lithuanian territorial waters and exclusive economic zone, the nearshore area, and land territory within Palanga city and Kretinga district municipalities, where the OWF and related infrastructure are planned.

Current state

The climatic conditions of the project area are strongly influenced by global climate change, particularly in the Baltic Sea region. The Baltic has been identified as one of the fastest-warming semi-enclosed seas in recent decades. Between 1982 and 2006, sea surface temperature increased by 1.35°C, heightening the risk of marine heatwaves and altering local biogeochemical processes (Dutheil et al., 2022). In parallel, data from the European Space Agency (2021) show that average sea level in the southern Baltic Sea has risen by 2–3 mm annually between 1995 and 2019. Offshore wind conditions remain favorable, with Marine Wind Parks (2023) reporting average wind speeds near the Lithuanian coast of 8.1 m/s at 100 m altitude and 8.9 m/s at 250 m altitude, reaching maximum annual speeds of up to 22.8 m/s. Long-term modeling and LiDAR measurements (2022–2024) confirm that wind speeds in the CN OWF area can reach 8.6 m/s at 200 m altitude.

Klaipėda region (Palanga and Kretinga municipalities experiences higher average air temperatures, precipitation, and wind speeds compared to Lithuania overall. Average annual air temperature in Klaipėda is 8.2°C compared to 7.4°C nationwide, while average annual precipitation reaches 761 mm compared to 695 mm. Wind conditions are also stronger, with average speeds of 4.1 m/s (versus 3.1 m/s nationally) and approximately twice as many days with maximum wind speeds ≥15 m/s (51.8 versus 23.8 days).

Potential impacts on ambient air and climate

Ambient air pollution and climate impact during construction and installation

The installation of offshore elements of the CN OWF is expected to cause short-term and localized impacts on ambient air quality during construction, repair, and servicing activities. Emissions will originate from ships' combustion engines, including carbon monoxide, nitrogen oxides, volatile organic compounds, sulphur dioxide, and particulate matter. These emissions were converted into carbon dioxide equivalents using a factor of 2.77 kg CO₂e per litre of marine fuel.

Emissions from ships are regulated by MARPOL Annex VI and by US EPA standards, which set limits for nitrogen oxides, particulate matter, hydrocarbons, and carbon monoxide, depending on engine type, power, and year of manufacture.

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. Emissions will result from vehicles and machinery with internal combustion engines, including carbon monoxide, nitrogen oxides, volatile organic compounds, and particulate matter. Construction will require excavators, dump trucks, a front-end loader, a vibrating roller, and other machinery, assumed to operate 12 hours per day over 480 days, with an estimated fuel consumption of 1 tonne of diesel per day.

Air pollutant emissions were calculated according to the EMEP/EEA air pollutant emission inventory guidebook (2023) using the CORINAIR Tier 1 methodology. The estimated annual emissions from mobile sources are 5.17 t of carbon

monoxide, 15.66 t of nitrogen oxides, 1.62 t of volatile organic compounds, and 1.01 t of particulate matter, totalling 23.46 t of pollutants per year.

For export cable installation in forested areas, a 20 m wide engineering corridor will be cleared, resulting in vegetation removal of approximately 11.3307 ha for the CN OWF connection and 11.2648 ha for the "Area D" connection. Based on FAO (2020) data, this corresponds to carbon releases of 2,223 tCO₂e for CN OWF and 2,216 tCO₂e for Area D.

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 CO₂ 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 gCO₂eq/kWh. The global warming potential of OWFs ranges from 25 to 133 g CO₂eq/kWh, depending on the technological parameters of the OWF. This is significantly lower than the emissions associated with fossil fuel energy production.

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.

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 5.2.1. 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						
	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.					

5.3 Seabed, subsurface, and soil

Research methods and study area

Methods for assessing the current state include:

- 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 (0–10 m depth) and multi-channel seismic systems (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.
- 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:

- Hydrographic-geophysical seabed surveys in three stages: (1) mapping seabed morphology, sediment distribution, magnetic anomalies, and shallow structure; (2) seabed sampling to interpret sonar data; (3) multi-channel seismic surveys down to 50–60 m.
- Geo-engineering surveys: vibro-coring (3–5 m), CPT, sediment collection with Van Veen grab, laboratory analysis of lithological and geomechanical properties.
- Geochemical analysis of contamination levels along OWF construction and export cable areas. The methods and scope of the conducted studies are detailed in the main reports, which served as the basis for the EIA:

Reference reports: Fugro Netherlands Marine B.V. (2024) – Geophysical Survey Results; Geo (2024) – Geotechnical Survey; Fugro Netherlands Marine B.V. (2024) – Geotechnical Survey Baltic Sea Operations; PTPI (2023) – Seabed Surveys; Geobaltic (2025) – Geotechnical investigations of export cable corridor.

Methods for potential impact assessment focused on:

- Seabed stability in areas of WTG foundations and export cable trenches.
- Lithological composition and diversity of surface sediments, and the extent of disturbance from construction works.
- Interactions between OWF construction and potential oil or mineral resource extraction, as well as safety considerations related to seismic activity and tectonic fault systems.

Current state

Marine Area

Depths and Morphology. The seabed relief of Lithuania's Baltic Sea territory was shaped by Pleistocene glaciations, glacial retreat, and subsequent sea-level fluctuations. Main geomorphological structures include the Klaipėda-Ventspils and Sambian-Curonian plateaus, the Gdańsk and Gotland depressions, the Klaipėda Bank, and the Nemunas paleo valley. In the CN OWF area, water depths range from 27.0 to 49.0 m with seabed slopes between 0°–20°, locally exceeding 60°. Seabed terrain is complex, with asymmetrical hills, sand bars, boulder fields, and glacial plains. In the export cable corridor, depths range from 0 to 39 m and morphology is divided into four parts: western rugged moraine relief; central smooth plain-like relief with shoals; eastern complex zone with relict moraine ridges; and nearshore sandy plains with dynamic shoals.

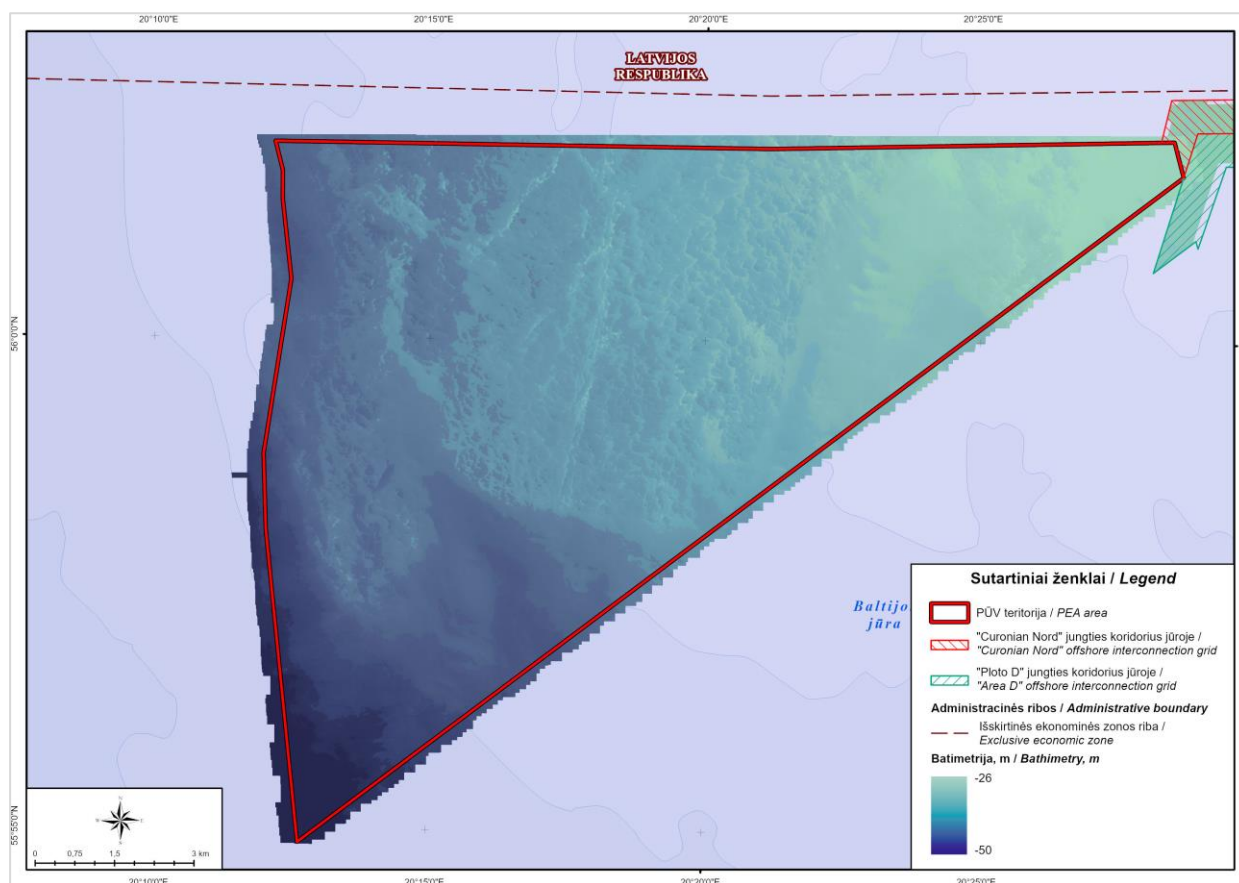


Fig. 5.3.1. Sea depth in the planned OWF area.

Seabed Sediments. Lithuanian seabed sediments consist of relict deposits (washed moraine, boulders, gravel, pebbles, sand) and modern sediments (fine sand, silt, mud). Relict deposits dominate the Klaipėda-Ventspils Plateau, including the OWF area, with unsorted moraine materials overlain by sandy loams and loams. Modern sediments (sand, silty sand, clayey sand) occur in depressions and along slopes. In the export cable corridor, nearshore areas are dominated by fine and medium-grained sand; eastern and western areas contain glacial-origin clay and sandy clay overlain by gravel and boulders; and the central zone is dominated by coarse-grained soils under strong hydrodynamic conditions.

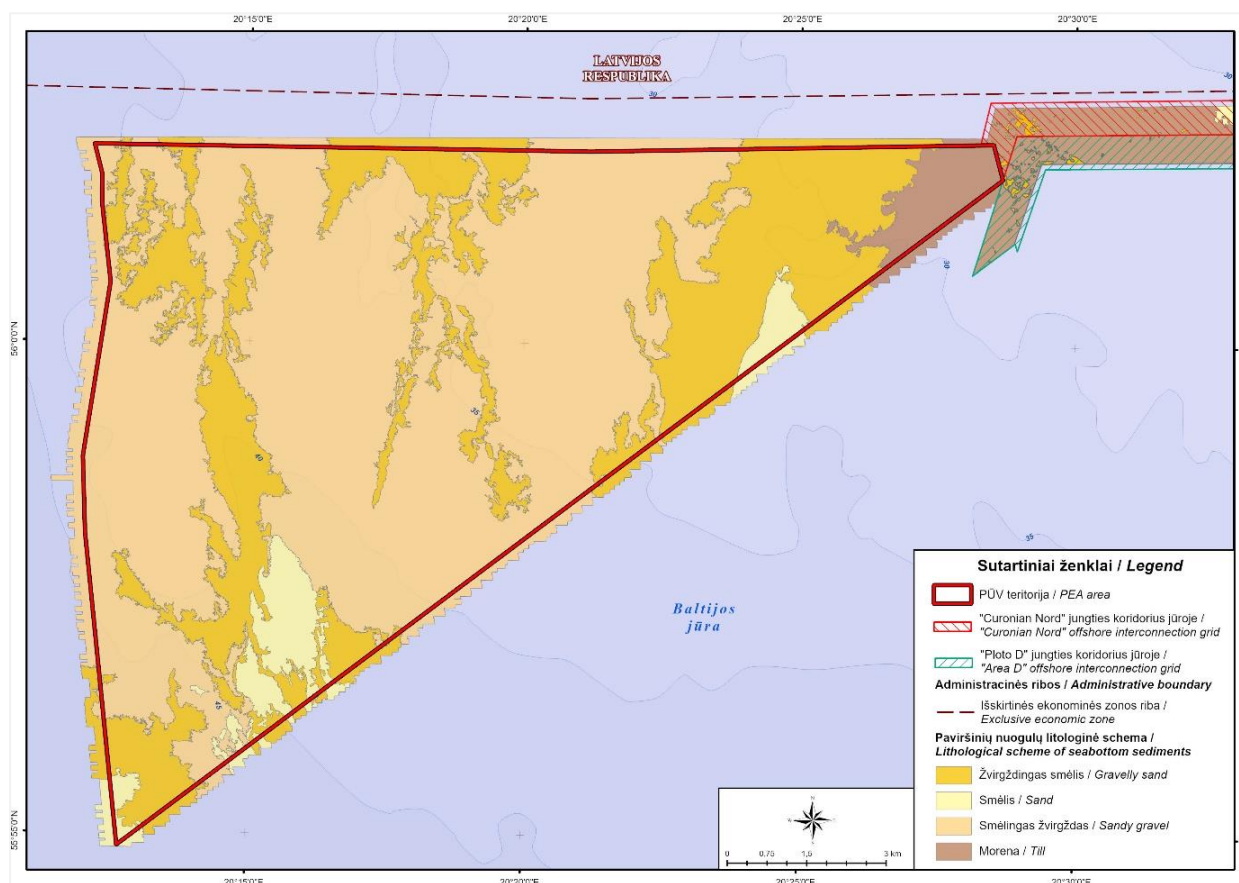


Fig. 5.3.2. Lithological composition of seabed sediments in the planned OWF area (Source: Fugro Netherlands Marine B.V, 2024. Geophysical Survey Results Report).

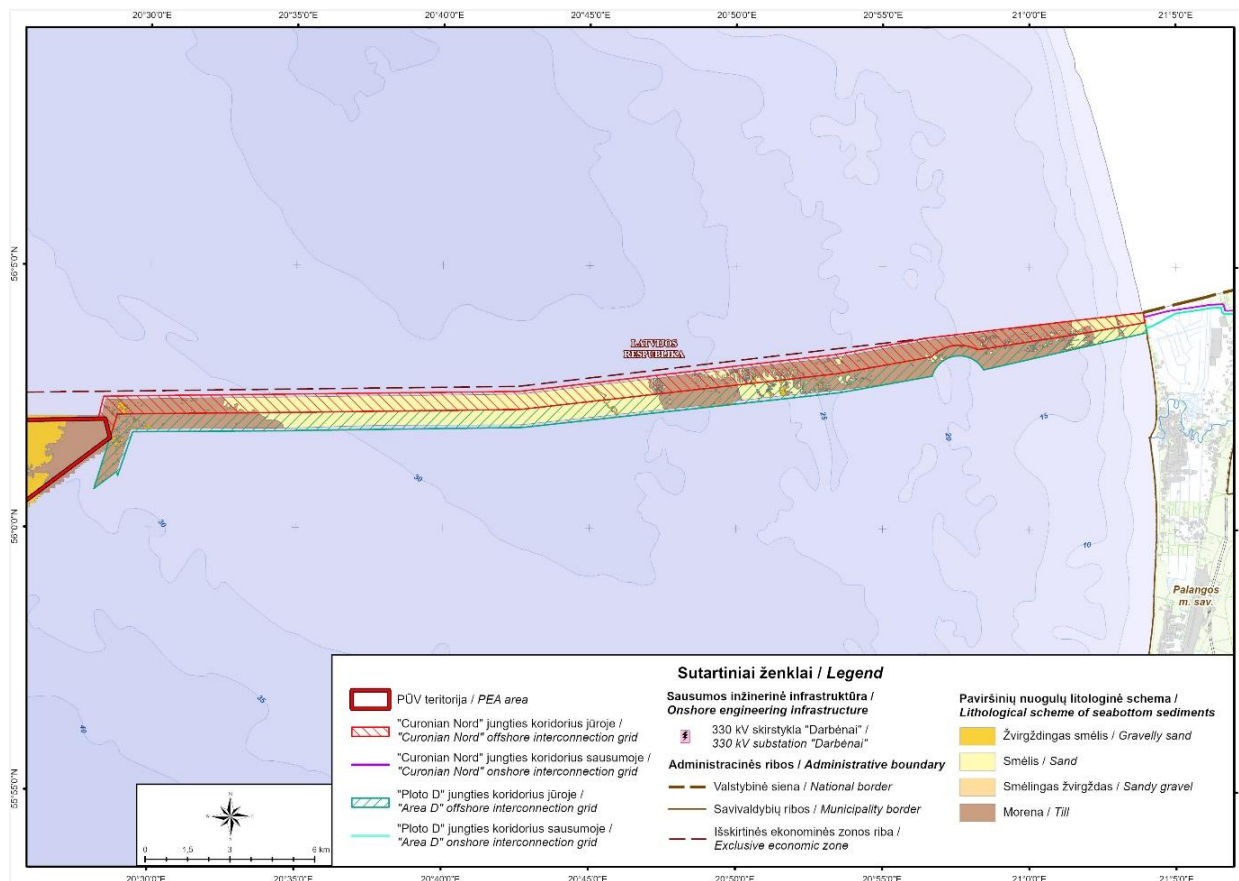


Fig. 5.3.3. Lithological composition of seabed sediments in the planned export cables corridor.

Pollutants in Seabed Sediments. Heavy metal analysis showed no significant pollution in the OWF area or cable route, except at Station 102, near a wreck, where arsenic concentration (42 mg/kg) exceeded the environmental threshold by 14 times. Additional investigations disproved widespread contamination, with only slightly elevated copper at one station. Other heavy metals were below detection limits or thresholds. No petroleum hydrocarbons (C10–C40) were detected, and PAH levels were low. Fluoranthene concentrations ranged 1.1–8.7 µg/kg; naphthalene was mostly below detection. The highest PAH values were recorded near the wreck but remained 6–700 times lower than GES thresholds. Overall, the chemical status of sediments in the study area is assessed as good.

Geologic Structure. The Lithuanian marine area has a sedimentary rock sequence up to 2 km thick. The upper part consists of Quaternary deposits (5–10 m on plateaus, >100 m in paleo-incisions) underlain by Devonian, Permian, Triassic, Jurassic, and Cretaceous formations. Three Quaternary lithostratigraphic complexes are present: Pleistocene glacial deposits, Post-glacial and Holocene sediments, and Modern marine sediments. In the OWF area, Quaternary deposits are 20–30 m thick, underlain by Triassic deposits and locally by Permian deposits in paleo-incisions.

Natural Resources. Lithuania's EEZ may contain 40–80 million tons of oil, with the OWF area overlapping the southern part of the prospective E2 oil-bearing structure. Offshore oil and gas regulation is not yet fully implemented in Lithuania. Sand resources are identified on the Klaipėda-Ventspils and Curonian-Sambian plateaus, with layer thicknesses exceeding 1–3 m, but are not registered as exploitable resources. Some sand areas are used for beach nourishment (e.g., Preila–Juodkrantė). No exploitable sand or gravel resources are confirmed within the PEA area. Lithuania does not have significant amber deposits, and none exist in the project area.

Tectonic Activity and Seismicity. The Baltic Sea lies on the tectonically stable Eurasian lithospheric plateau. Lithuania's Baltic Sea area belongs to the East European Craton. Seismic activity is the lowest in the region, influenced by glacioisostatic processes and distant seismic zones. The strongest nearby events occurred in the Kaliningrad region in 2004 (4.8 and 5.2 magnitude). Vertical crustal movements reach up to 2 mm/year. Tectonic faults include older Caledonian-age structures and younger faults reaching Permian and younger deposits, which must be considered when assessing seismic risk.

Onshore

Distribution of Surface Sediments. The onshore study area is dominated by Pleistocene glacial and post-glacial deposits formed during glacier retreat. The main lithocomplexes include:

- Moraine deposits: mixed sediments of clay, sand, gravel, and boulders, often forming stable bases with low-permeability clay or loam layers.
- Marginal glacial formations: sands of varying coarseness and moraine loam, deposited at glacier edges.
- Glaciofluvial deposits: accumulations of sand, gravel, and pebbles formed by glacial meltwater.
- Glaciolacustrine deposits: clayey sands typical of former glacial lake bottoms.

Subsequent processes formed additional deposits:

- Lake sediments: clayey sand and sapropel in lowlands and former swamp areas.
- Alluvial deposits: sand, silt, and clay in river valleys.
- Swamp deposits: peat layers in waterlogged depressions.
- Eolian formations: coastal and dune sands shaped by wind.
- Litorina and Post-Litorina Sea sediments: sands from ancient coastal and wave action zones near the shore.

Closer to the coast, terrain is flat and sandy with swampy areas, while further inland toward Darbėnai, elevations with moraine forms, sandy, and loamy deposits dominate.

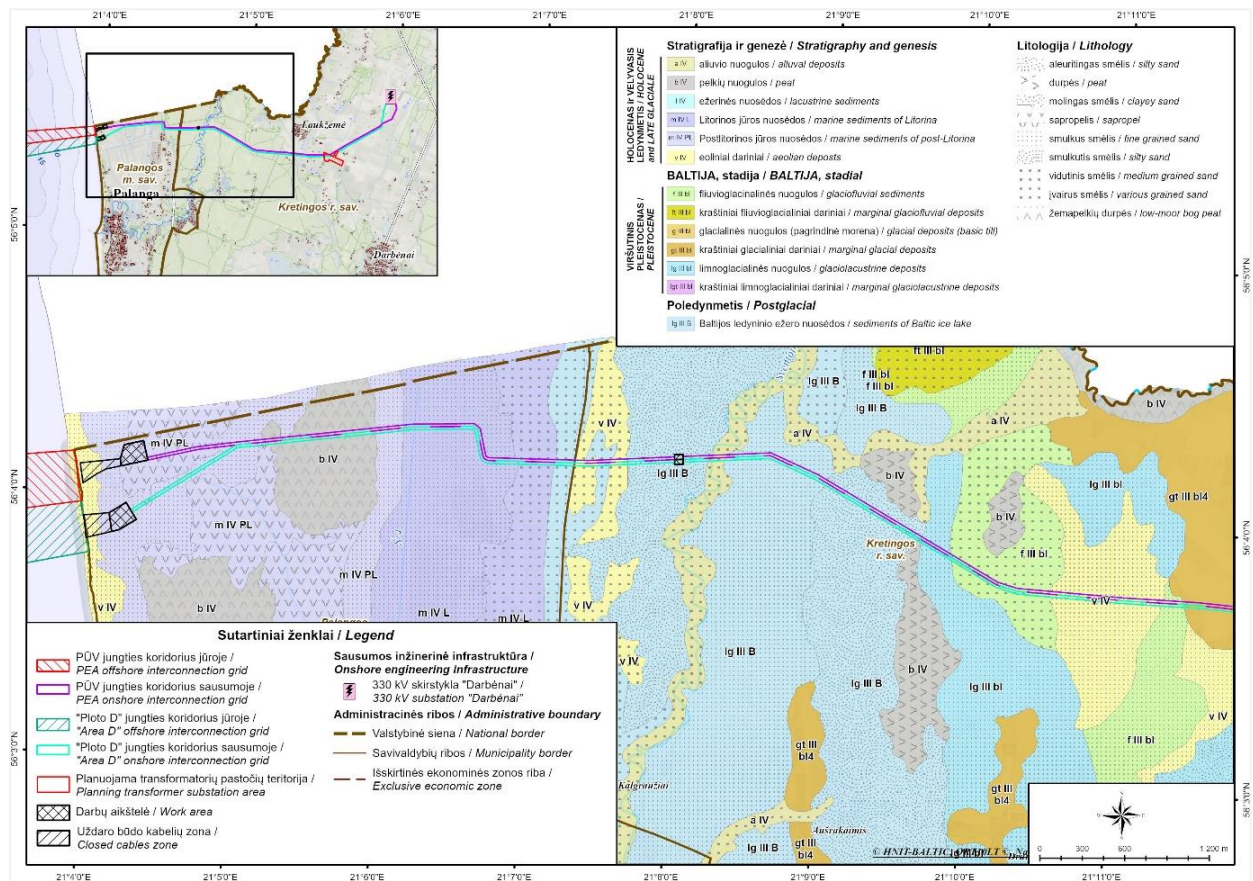


Fig. 5.3.4 a. Surface sediment distribution scheme (1 of 2).

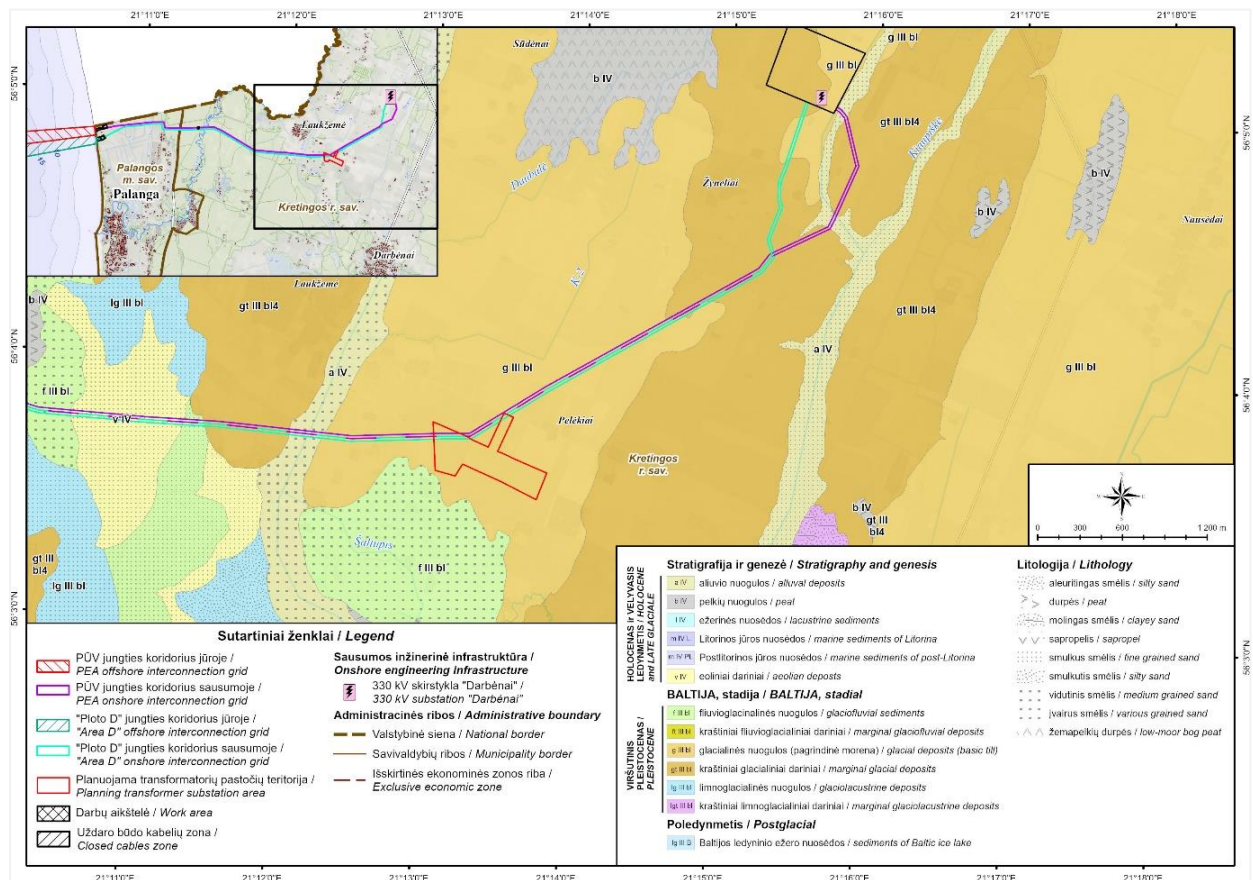


Fig. 5.3.4 b. Surface sediment distribution scheme (2 of 2).

Soils. Several soil groups of high ecological and agronomic value occur along the export cable route: Mollisols, Podzols, Histosols, Arenosols, clays, and loams. In the coastal zone (beaches and dune ridge), closed-type technology (e.g., HDD) will be applied, preventing direct disturbance. Within Palanga City Municipality, soils include peat, podzolic soils, gleisil, and sandy soils. In Kretinga District, eluviated soils predominate, with albic soils, floodplain soils, and gleisil interspersed.

Deposits of Mineral Resources. The export cable corridor may cross the northern boundary of the Šventoji oil deposit (No. 2165, forecasted resources), but no impact on extraction is expected. The nearest other resources are the Vanagupė peat deposit (No. 954, forecasted) and a gravel deposit (No. 2299), both located about 5 km south of the planned cable routes.

Potential Impact on the Seabed

Seabed impacts are divided into two categories: (1) impacts from the installation of OWFs during construction, and (2) impacts on OWFs and associated infrastructure resulting from seabed geological conditions.

Overall, impacts on the seabed are expected to be local and relatively minor. The main negative effects are associated with partial disturbance of the seabed and secondary sedimentation at foundation and cable installation sites. Additional risks include potential damage to valuable seabed habitats if works are carried out in sensitive areas.

For OWF infrastructure, stability of seabed geological structures, excavation feasibility for cables, and risks of secondary erosion must be considered. Objects located on the seabed must also be assessed for potential risks to installation safety and design.

As the project area lies more than 36.8 km offshore, it will not affect shoreline stability or sediment transport, which mainly occurs within a 1–1.5 km nearshore strip.

Greater sensitivity exists in the northeastern part of the area, where coarse sediments support valuable *Mytilus* crustacea communities. To avoid damaging this habitat, WTGs should not be placed near the southwestern boundary of the protected area or further seabed surveys should be undertaken to map and avoid these habitats.

The OWF area overlaps with one potential oil structure but no valuable sand or mineral deposits. Since offshore oil extraction is unregulated in Lithuania, no conflict with natural resources is expected.

Scour formation in sandy sediments around pile foundations is a design concern for OWF stability. Preventive measures include reinforcement with gravel or boulders. Scour can also occur in cable trenches, making post-construction and operational monitoring necessary.

Cable installation methods include trench excavation or direct seabed laying with protective covers (concrete mats or gravel/sand). Trenches are typically up to 2–3 m deep and wide. If marine ploughs are used, trenches are backfilled immediately with the excavated material. Cable covering methods are applied only when trenching is not feasible.

Potential impact on soil during onshore cable installation

Most protected soils in Lithuania include Mollisols (Chernozems), Histosols (Peaty and Marshy Soils), Arenosols (Sandy and Loamy Sands), and Podzols (Sod-Podzolic Soils). Of these, only Mollisols are absent in the study area. The export cable route will cross 1.9 km of peat soils (Histosols) and 0.11 km of sandy soils (Arenosols). Podzols are present in the region but not crossed by the cable corridor.

- Podzols: important for forest ecosystems; disturbances should be minimized, preserving litter and avoiding soil acidification.
- Histosols: high in organic matter, important for climate regulation; drainage and excavation should be avoided to prevent peat decomposition and CO₂ emissions.
- Arenosols: prone to erosion and nutrient leaching; intensive tillage and disruption should be avoided.

The Law on Soil Protection of the Republic of Lithuania regulates soil use and preservation.

Soil and subsoil may be affected by earthworks during installation of construction sites, ONSs, cables, and access roads. Fertile topsoil must not be destroyed; removed topsoil will be stored within designated areas and later used for land reclamation. Contractors must use sound machinery to prevent fuel and lubricant leaks, and oil-absorbing materials must be available to manage accidental spills.

No significant negative impact on soils is expected during the operational phase.

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.

Preventive, mitigation, and compensation measures for impact on the seabed, subsoil, and soil

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 soil 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 soil.
- Only technically sound machinery should be used to ensure no fuel or lubricant leaks, preventing soil 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 5.3.1. 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

	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 5.3.2. 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 Lithuania⁵. 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 ⁶and in Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds⁷.

Research methods and study area

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 Areas⁸.

The survey area covers the geographical extent of the planned economic activity (PEA), including both onshore and offshore territories and surrounding areas potentially affected.

- **Offshore:** Analysis included state-protected and "Natura 2000" marine areas bordering the OWF development zone, as well as areas crossed by the export cable corridors.
- **Onshore:** Analysis included state-protected, and "Natura 2000" areas intersected by the export cable corridors.

Current situation

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 cross 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).

⁵ <https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.5627/asr>

⁶ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31992L0043>

⁷ <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009L0147>

⁸ Website of Cadaster: <https://stvk.lt/>

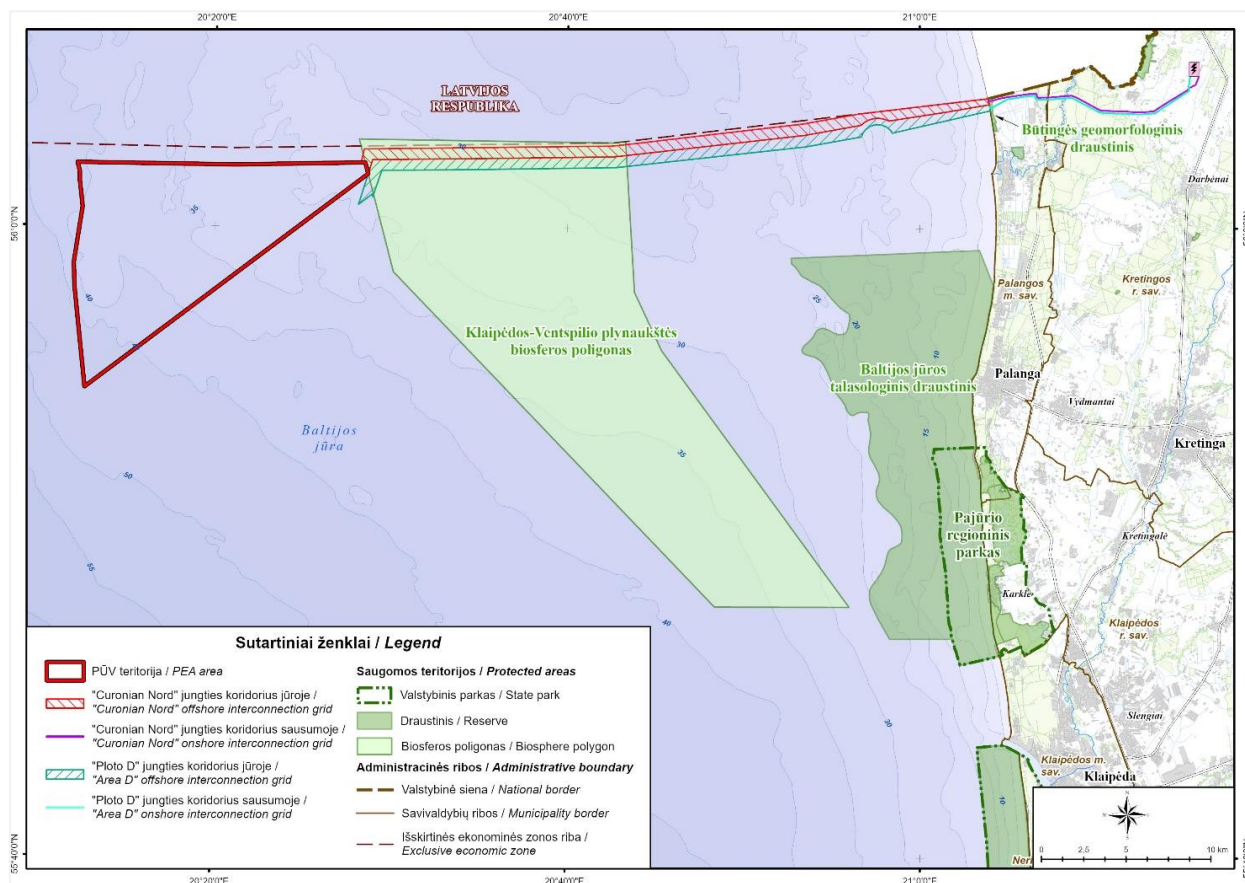


Fig. 5.4.1. State protected areas closest to the PEA territory.

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 (<i>Melanitta fusca</i>); - ensure favourable conservation status of the areas of wintering and migration aggregations of razorbill (<i>Alca torda</i>) and long-tailed duck (<i>Clangula hyemalis</i>).	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			
		- 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.

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).

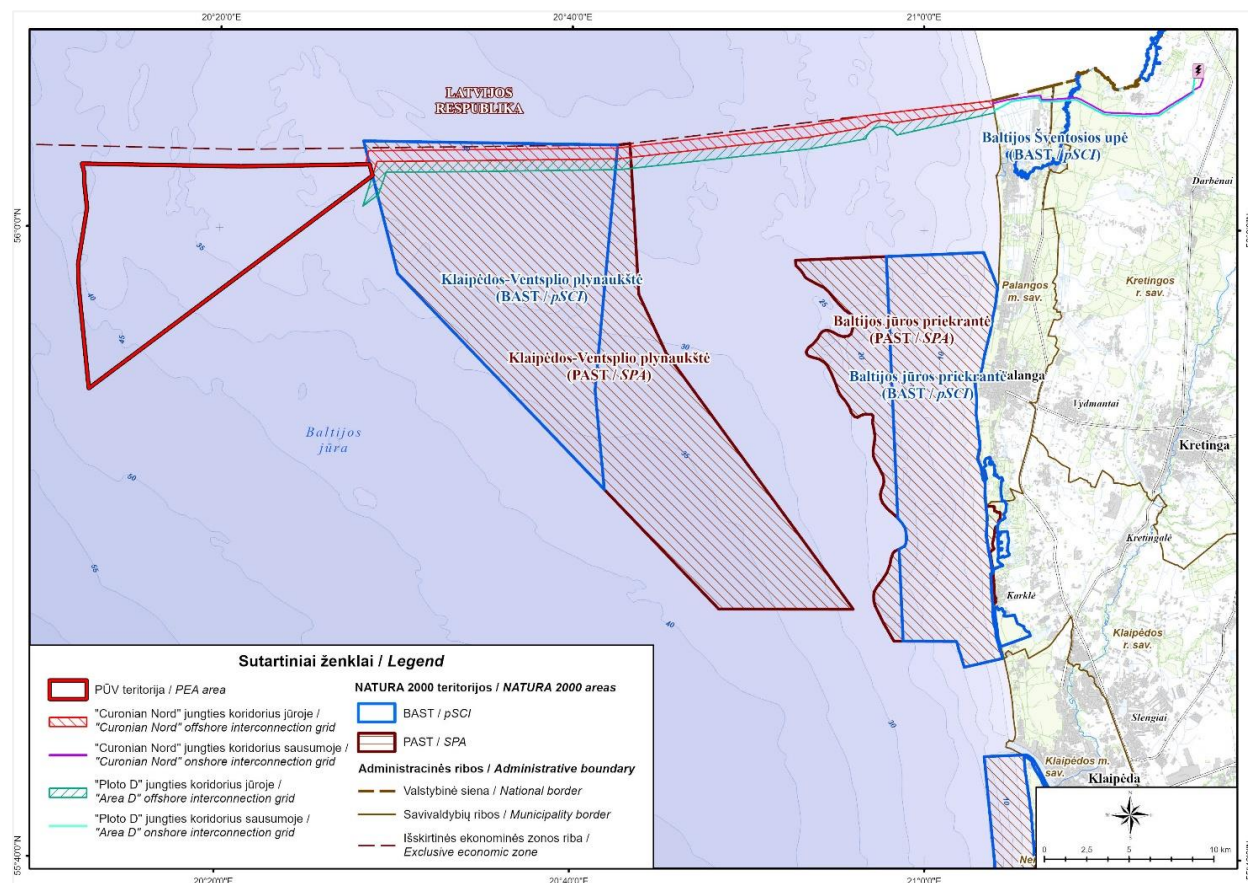


Fig. 5.4.2. "Natura 2000" areas closest to the PEA area.

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 ^{9,10}	Distance from the boundary of the planned area
Offshore					
“Natura 2000” SPA Klaipėda-Ventspils Plateau	31,949.31	Velvet scoter (<i>Melanitta fusca</i>)		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 export cable corridor approximately 15.2 km*.
Onshore					
“Natura 2000” SAC Baltic Šventoji River	27.14	European river lamprey (<i>Lampetra fluviatilis</i>)		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 (<i>Unio crassus</i>).		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.

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

Offshore

The OWF area does not fall within protected territories but borders the Klaipėda-Ventspils Plateau Biosphere Reserve and the overlapping Natura 2000 SPA and SAC along ~700 m on its eastern side.

Export cable corridors cross:

- Klaipėda-Ventspils Plateau Biosphere Reserve and SPA: ~15.7 km (CN route) and ~16.1 km ("Area D").
- Natura 2000 SAC Klaipėda-Ventspils Plateau: ~14.9 km (CN route) and ~15.2 km ("Area D").

Within the SAC, habitat type 1170 Reefs (circumlittoral boulder fields and biogenic reefs) is present. Cable installation may disturb boulders and associated biota, but the affected area (0.37 km², or 0.56% of reef habitat) remains below the 1% threshold for significant impact.

⁹ 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"

¹⁰ 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).

Potential bird impacts concern wintering and migrating species (velvet scoter *Melanitta fusca*, razorbill *Alca torda*, long-tailed duck *Clangula hyemalis*) due to disturbance and displacement from feeding areas. Scaring effects may result from increased ship traffic during construction and servicing.

Reef restoration potential is high: mussel and barnacle communities typically recolonise within 12 months if hard substrate remains.

Onshore

Export cables will be installed using trenchless methods (e.g. HDD), avoiding disturbance of the Būtingė Geomorphological Reserve.

In the Šventoji River, potential impacts include:

- River lampreys (*Lampetra fluviatilis*): risk of displacement during October–May migration/spawning; shallow cable burial (<3 m) could create an electromagnetic barrier.
- Thick-shelled river mussels (*Unio crassus*): risk from accidental drilling fluid leakage; large uncontrolled spills could affect lamprey and salmonid spawning grounds 2–2.5 km downstream.

To minimise risks, trenchless crossing will be used at the Šventoji River; open trench at the Kulšė River will include sediment retention measures.

Sensitive periods when cable works must be avoided:

- Salmonids: October 1 – January 15.
- River lampreys: April 1 – May 15.

Preventive, mitigation and compensatory measures for impacts on protected areas

Offshore

- Leave displaced boulders and coarse material in place; use similar material when backfilling trenches.
- Large boulders with mollusc colonies should be pushed aside, not removed.
- Cover plates ($\geq 1 \times 1$ m, porosity 30–50%, limestone) may act as artificial reefs.
- OWF layout: ≥ 2 km distance from protected areas.
- 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.
- 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).

Onshore

- Use alternative or natural drilling fluid additives to minimise risk of pollution.
- Cables must be buried ≥ 3 m under riverbeds to avoid EMF barrier effects.
- Avoid HDD works in Šventoji River during salmonid (October 1–January 15) and lamprey (April 1–May 15) sensitive periods.

Table 5.4.1. 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.

		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 5.4.2. 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

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

Benthic invertebrate communities

Macrozoobenthos (≥ 0.5 –1 mm) are low-mobility, long-lived organisms that act as reliable biological indicators of environmental change. Communities in the study area include:

- Marenzelleria spp. community (12 taxa) in sandy sediments (3–45 m depth), with *Bathyporeia pilosa* and *Hediste diversicolor* in shallows, and *Pygospio elegans* and *Oligochaeta* in deeper areas.
- *Macoma balthica* community in sandy/silty bottoms of the central Baltic Sea, dominant (>70–80% biomass). Diversity is higher in shallow areas (<30 m), while deeper zones show higher biomass (>100 g/m²) but lower diversity, with large *M. balthica* and *Saduria entomon*.
- Pontoporeia communities near 50 m depth: *Monoporeia affinis* dominates shallower muddy areas (avg. 8 species); *Pontoporeia femorata* dominates deeper muddy areas (2–4 species). Amphipods generally represent <50% biomass, indicating dynamic community composition.
- Hard-substrate communities: *Mytilus edulis trossulus* and *Amphibalanus improvisus* form colonies on boulders; perennial algae contribute to biofouling.

Survey methods and study area

Methods for assessing the current state

- Data sources: reef monitoring (2021–2023) and benthic surveys (2024) in the OWF area and cable corridors.
- Applied standards: EU MSFD, Habitats Directive (92/43/EEC), Water Framework Directive (2000/60/EC), HELCOM indicators, Lithuanian Environmental Monitoring Program (2018–2023).
- Methods: side-scan sonar (SSS), multibeam echosounder (MBES), drop-down video (DDV), dredge and grab samplers.
- 26 video stations in the OWF area, 6 in cable corridors; 49 stations sampled for sediments/zoobenthos (91 samples total: 66 grabs, 25 dredges).
- Parameters assessed: substrate composition, % coverage of mussels and algae, presence of key macrozoobenthos species, habitat area estimates.
- Laboratory analysis: taxonomy to lowest possible level (ERMS/WoRMS nomenclature), abundance and biomass per m², species density and biomass, wet weight, size measurements (*M. balthica*, *M. edulis trossulus*).

Methods for assessing potential impacts

- Legal framework: EC guidance on wind energy and nature protection, Lithuanian Order No. D1-406 (2023) criteria for significant effects, Order No. D1-317 (2018, amended 2025) on Sites of Community Importance, and EC Communication C/2024/2078 on MSFD thresholds.
- GES (Good Environmental Status) criteria applied:
 - **D6C4 – habitat loss:** threshold <2% destroyed.
 - **D6C5 – habitat disturbance:** threshold $\leq 25\%$ (including D6C4).
- Assessment includes: benthic community change analysis, risk to structure and function, natural recovery potential, and quantitative/qualitative zoobenthos indicators.
- Impacts are considered significant if they compromise habitat structure, function, or recovery capacity.

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.

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.

The collected data will be used for pre-/post-construction comparisons, structural community change analysis, and cumulative effect assessments.

Current situation

Seabed habitats

Lithuanian marine waters are classified into three zones:

- Infralittoral (0–15 m): euphotic zone, perennial macroalgae communities (e.g. *Furcellaria lumbricalis*).
- Circalittoral (15–70 m): insufficient light for algae; dominated by benthic invertebrates (*Mytilus edulis trossulus*, *Macoma balthica*).
- Deep circalittoral (>70 m): aphotic, halocline formation, oxygen deficiency, influenced by North Atlantic inflows.

Within these zones, 13 dominant habitat types have been identified under the EUNIS and HELCOM classifications, ranging from boulder habitats to coarse, mixed, sand and mud sediments. Six of these types are relevant for the OWF development and cable corridors, including circalittoral reefs (1170), a habitat of Community importance under the Habitats Directive. Approximately 194 km² of such reef habitats are located within Lithuanian Natura 2000 sites, with the Klaipėda-Ventspils Plateau accounting for 15.7%.

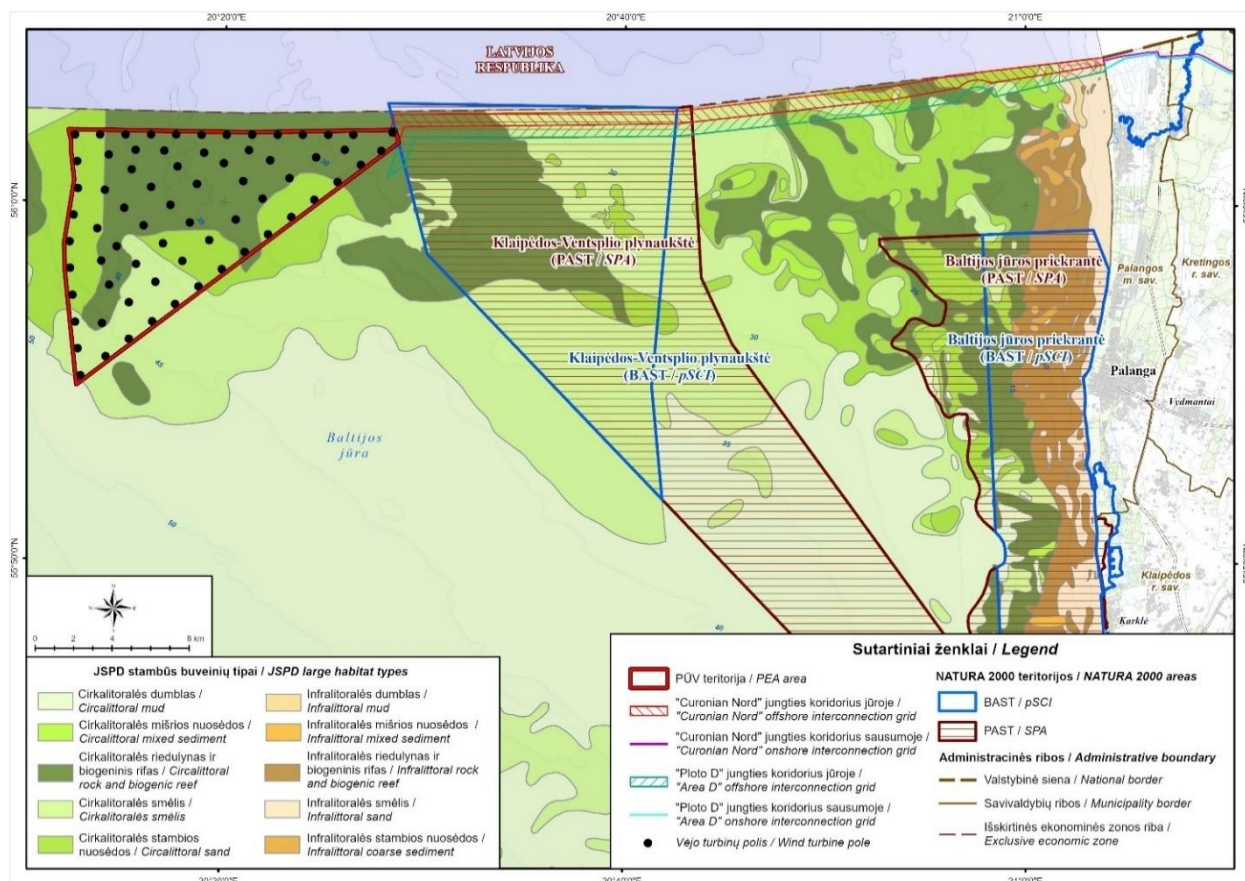


Fig. 5.4.3. Distribution of the main MSFD habitat types in Lithuanian marine waters (according to "Renewal of the Lithuanian Baltic Sea Environmental Management Strengthening Documents (condition assessment)"¹¹ and the preliminary locations of WTGs in an OWF.

National monitoring of circalittoral reefs in 2022–2023 covered 357 km² and showed that these habitats are primarily composed of stable substrates such as boulders and cobbles, although sand fractions increase at the margins. In the

¹¹ 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.

Klaipėda Bank region and western Klaipėda-Ventspils Plateau, reefs are sparse and often sand-dominated. Mussel (*Mytilus edulis trossulus*) coverage reached up to 70% in eastern and northern areas, with mean coverage of 30% in the Klaipėda-Ventspils Plateau, 27% in eastern reefs, and 17% in the Sambian Plateau. No significant changes (>1%) in reef-defining features were detected over 2021–2023, confirming that the reefs currently meet Good Environmental Status (GES) requirements under MSFD Descriptor 6C4.

Zoobenthos surveys in 2024 recorded 37 species across eight phyla, with 13 taxa occurring in more than 40% of samples. Communities were dominated by *Mytilus edulis trossulus*, often forming dense clumps on coarse substrates, and by *Macoma balthica* in sandy sediments. In the OWF area, *M. edulis trossulus* densities reached over 5000 ind./m² with biomass above 250 g/m², while *M. balthica* densities exceeded 400 ind./m² with biomass up to 129 g/m² in Natura 2000 stations. Colonial organisms such as the bryozoan *Einhornia crustulenta* and the hydrozoan *Gonothyraea loveni* were consistently present. The age structure of mussel populations indicated both young (<10 mm shell length) and mature (>10 mm) cohorts, suggesting continuous recruitment and stable community persistence.

The ecological status of circalittoral sandy bottoms was evaluated using the Benthic Quality Index (BQI). Although two stations did not meet the threshold, the average BQI across sites was 3.0 (±0.5), above the GES target of 2.9, indicating overall good status. In the Klaipėda-Ventspils Natura 2000 area, mussel coverage along 21 transects ranged between 5% and 60%. Grain-size analysis confirmed a correlation between coarser sediments and higher mussel densities, particularly at station 38.

The most valuable seabed habitat zones were identified within the CN OWF boundaries, defined by biomass above 400 g/m², abundance above 5000 ind./m², and species richness between 11 and 20 taxa. These areas host the most diverse and productive benthic communities, and it is recommended that turbine placement and cable trenching be avoided or minimized in these zones where technically feasible.

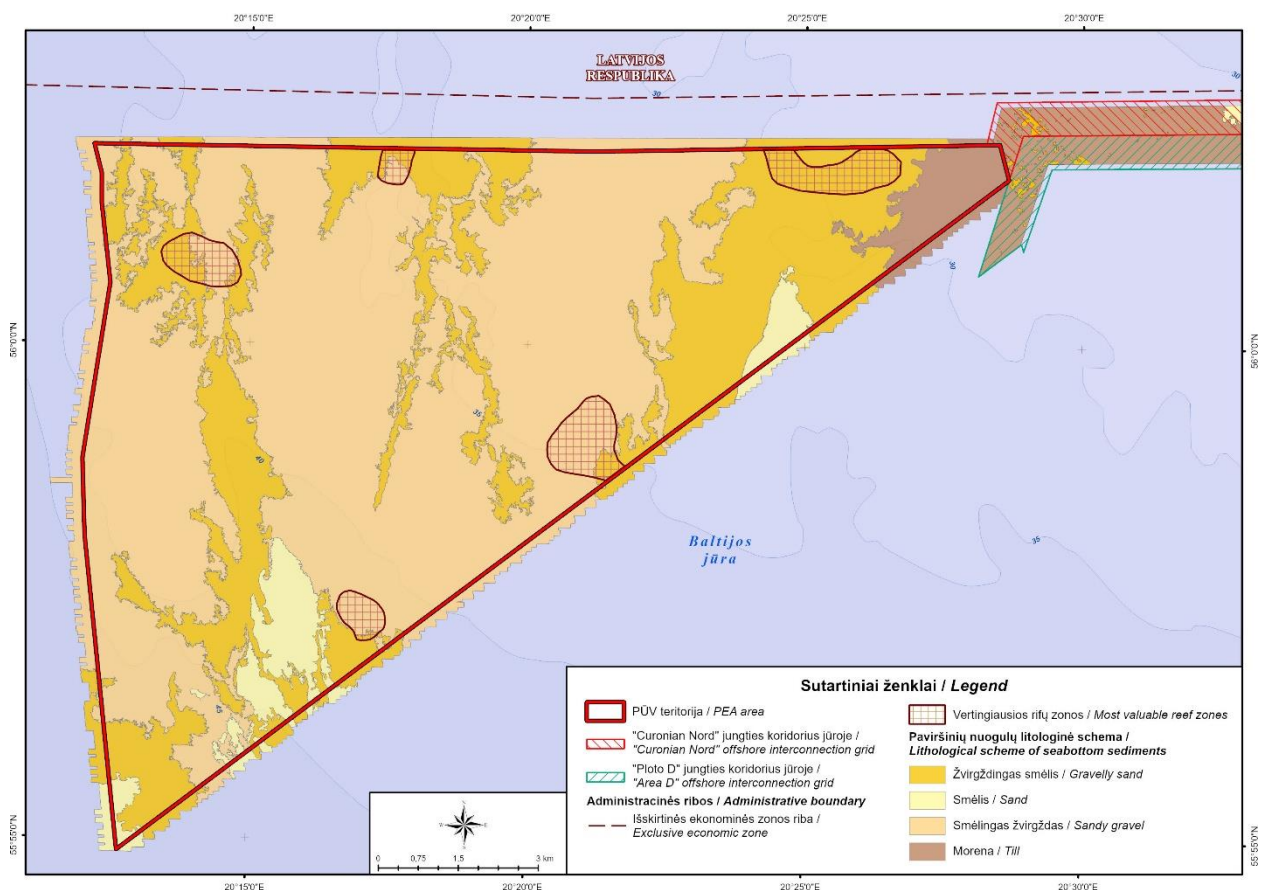


Fig. 5.4.4. Most valuable seabed habitats within the CN OWF area.

Potential impact on benthic habitats

The potential impacts on benthic habitats are assessed in accordance with the MSFD, WFD and Habitats Directive, with a focus on two main aspects: habitat area and the internal structure and functions of habitats. Impacts are divided into two types: physical loss and disturbance.

Physical loss can be sealed, when permanent structures such as turbine foundations or scour protection cover the seabed, or unsealed, when alterations result from activities like uncovered cable laying or artificial reef effects from offshore structures. Disturbance refers to temporary impacts that do not alter habitat type but may affect structure, function, or community composition through seabed disruption, sediment resuspension, turbidity, mechanical pressures, noise, vibration, or chemical effects.

The main elements of assessment are impacts on the reef habitat itself and on associated fauna and flora. The scale of impacts depends on foundation type (monopile, jacket or gravity), scour protection requirements, and cable installation methods, which are influenced by depth, shoreline proximity and seabed lithology. During cable installation, trenches will be backfilled with natural sediments, while boulders, gravel and pebbles will be relocated locally to ensure that seabed morphology and hydrodynamic conditions remain essentially unchanged. At landfall, HDD technology will be applied, eliminating impacts in the coastal zone. Depending on technology, the estimated disturbance widths per cable are 12 m (gravel cover), 15 m (trench excavation), and up to 35 m (boulder clearance). Approximately 20% of total cable length may be subject to irreversible loss, while around 80% will experience temporary disturbance.

The most vulnerable component of circalittoral reef habitats is the *Mytilus edulis trossulus* community, which consists of slow-growing, long-lived individuals and rare associated species. During installation and decommissioning, both irreversible seabed loss (D6C4) and disturbance (D6C5) are expected. Sandy seabed biotopes will also be affected through increased turbidity and sedimentation, with potential effects on pelagic larvae. In the operational phase, impacts may be twofold: positive through artificial reef formation and enhanced biofiltration on structures, and negative through the permanent loss of natural reef habitat and risks of invasive species introduction.

The extent of loss and disturbance depends on foundation type. Monopiles with scour protection may result in losses of up to ~0.0016 km² and disturbance of ~0.124 km² per unit, while gravity foundations are associated with larger losses (up to 0.0056 km²) and disturbances over 0.12 km². Jacket-type foundations result in negligible loss and minor disturbance. Offshore substations contribute additional losses depending on type, up to ~0.0056 km² with associated disturbance areas exceeding 0.12 km².

Export cable corridors cross circalittoral reef (1170) and circalittoral sand habitats within the Klaipėda-Ventspils Plateau SAC. For the reef habitat, maximum loss and disturbance in the CN corridor is estimated at ~0.37 km² (0.56% of the total SAC reef habitat area), and in the "Area D" corridor at ~0.45 km² (0.67%). For circalittoral sand habitats, the maximum potential impact area is ~0.61 km², representing ~0.6% of the total SAC sand habitat area. Both values remain below thresholds set for significant impacts.

The assessment of impacts is benchmarked against GES thresholds. Under Commission Communication C/2024/2078, loss of dominant benthic habitats (D6C4) should not exceed 2% of natural extent, while disturbance (D6C5) may not exceed 25%. Additional Baltic Sea-specific criteria set maximum thresholds of 1% for dredging and sand extraction and 10% for bottom trawling. No thresholds are currently set for long-term offshore wind farm structures.

Comparison of project alternatives based on their impact on benthic habitats

Alternative 1 (maximum scenario: 68 WTGs and 1 OSS):

- Habitat loss occurs mainly from cable scour protection (12 m trench width, 20% permanent loss).
- Disturbance from cable installation assessed within a 35 m corridor.
- Infralittoral mud habitat (<2 km²) affected locally: 0.18% loss, 2.49% disturbance.
- Impacts on circalittoral and infralittoral reefs (1170) do not exceed EU threshold values.

Alternative 2 (optimal scenario: 55 WTGs and 1 OSS):

- Reduced by 13 WTGs (31.7%) compared to Alternative 1.
- Export cable length reduced by 38.4 km.
 - Circalittoral reef (1170): -35.56 km (-28%).
 - Circalittoral coarse sediments: -1.81 km (-4.3%).
- Sand habitats: -1.05 km (-2.0%).
- Lower overall impact on sensitive reef habitats (1170).

Both alternatives remain below EU thresholds for habitat loss/disturbance. Alternative 2 results in lower impacts, particularly for circalittoral reef habitats, due to fewer turbines and shorter cable routes.

Cumulative impact

The cumulative impact assessment focuses on two main aspects: (1) the circalittoral sand habitat, already affected by seabed dredging and dumping, and (2) the combined impact of CN and "Area D" export cable corridors on the same "Natura 2000" reef habitats.

Impact on the circalittoral sand habitat

At present, physical loss and disturbance in the circalittoral sand habitat covers about **21.31 km²**, equivalent to **0.9%** of its total area (2,360 km²). This remains within the GES threshold of **≤1%** set under criterion D6C3. With the additional contribution of the OWF project, the cumulative maximum loss would reach **0.92%**, still below the allowable limit.

Cumulative impact of export cables from planned OWF

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.

For circalittoral sand habitats, the combined impact of both corridors would not exceed **0.61 km² (0.6%)** in either case. When combined with other pressures, such as dumping and sand extraction, the total effect still remains below the **1% GES limit**.

Invasive and non-native species

OWF structures may act as artificial reefs, creating suitable conditions for benthic invertebrates but also increasing the risk of invasive species spreading. Surveys in 2024 confirmed that no invasive species, including *Dikerogammarus villosus*, were present in the development area. However, rare species such as the polychaete *Boccardia proboscidea* were recorded within cable corridors, marking sensitive points that require attention during construction.

Measures for preventing, mitigating and compensating impacts on benthic habitats

When assessing potential impacts on benthic habitats, two distinct components must be considered: the reef as a benthic habitat and the fauna and flora associated with it (flora relevant only in the infralittoral zone).

The scale and nature of impacts will depend on the selected technical solutions, the type of foundation, and the scour protection requirements. Monopile (MP) foundations typically require scour protection, which can result in greater habitat loss. Jacket foundations usually do not require such protection, so habitat loss is expected to be lower. Gravity foundations require scour protection, leading to a comparatively larger extent of seabed habitat loss.

Additional effects will be influenced by the chosen cable installation technology, which will vary depending on seabed depth, proximity to the shoreline, and lithological characteristics. During cable installation, trenches will be excavated and backfilled with the same sediments. Hard substrates will not be destroyed; boulders, if encountered, will be relocated only a few meters, while gravel and pebbles will be returned to the trench. This ensures that seabed morphology and hydrodynamic conditions remain essentially unchanged after installation.

Short-term, local increases in water turbidity may occur during trench excavation. The scale of turbidity will depend on seabed type (higher over muddy and sandy bottoms, lower over hard substrates) and local hydrodynamics (currents, wave action). If works are conducted under favourable weather and sea conditions, turbidity increases will remain limited in both time and space, requiring no additional mitigation measures.

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 or alternative characteristics with scientifically proved ecological performance and be composed of limestone. The porous structure and calcium-enriched substrate attract mussel larvae, thereby accelerating mussel colonization and growth.^{12 13}

In the coastal zone, the landfall of the subsea cables will be carried out using a trenchless method, such as HDD or similar technology. As a result, no impact on benthic habitats is anticipated.

¹² 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.

¹³ Swift, V. (2024). The effects of coastal artificial reefs on biodiversity, aquatic food security and ecosystem services.

Table 5.4.3. 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

	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 5.4.4. 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 works)	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 twenty seabird species regularly occur in Lithuania's Baltic Sea region, with numbers increasing during spring and autumn migration. Geese, ducks, swans, herons, and many passerines are commonly recorded. The area is particularly important for wintering seabirds, hosting large concentrations of Velvet Scoters (*Melanitta fusca*), Long-tailed Ducks (*Clangula hyemalis*), Razorbills (*Alca torda*), Common Guillemots (*Uria aalge*), Red-throated Divers (*Gavia stellata*), and Great Crested Grebes (*Podiceps cristatus*). Benthic feeders such as diving ducks usually forage at 5–35 m depths, sometimes reaching 40–50 m, while migratory species like divers and auks can dive up to 50–60 m. Seabird distribution is determined by food availability, depth, and proximity to shore. The Baltic Sea is also a key migration route for wildfowl, cranes, divers, passerines, and other species, flying at altitudes from near the surface up to several hundred meters. During summer, only a few species remain, including Great Cormorants (*Phalacrocorax carbo*), Common Terns (*Sterna hirundo*), and various gulls, with Common Guillemots and Little Gulls (*Hydrocoloeus minutus*) occurring offshore.

Survey methods and study area

Birds were studied through resting bird surveys and migrating bird monitoring.

- Resting birds:
 - *Ship-based transect surveys* (May–October, monthly), using ESAS methodology and BSH StUK4 guidelines. Birds on the water surface were counted along transects.
 - *Aerial digital transect surveys* (January–April and November–December, monthly), using HiDef digital video technology mounted on a twin-engine aircraft flying above 500 m. Four high-resolution cameras recorded at 7 frames per second with 2 cm resolution at sea level.
- Migrating birds:
 - *Visual monitoring*: from stationary ship positions, during spring (late Feb–late Apr) and autumn (late Aug–early Dec). Observations from sunrise to sunset, two 15-minute sessions per hour, following BioConsult SH methodology. Flight heights, directions, and other parameters were recorded.
 - *Vertical radar monitoring*: radar operated within 1,500 m radius, continuously tracking migration flow, adjusted if the ship's direction changed. Radar screenshots were captured every few minutes, supplemented with meteorological data.
 - *Nocturnal monitoring*: from stationary vessel positions, spring and autumn. Audio recorders and direct listening were used after sunset with two 15-minute observation periods per hour.

The assessment followed the EU Birds Directive (2009/147/EC), Habitats Directive (92/43/EEC), and the Lithuanian Order No. D1-406 (2023). Criteria included:

- Species composition and abundance of resting and migrating birds.
- Mean densities of resting birds across survey months.
- Spatial distribution mapping of resting bird densities.
- Flight altitudes, assessed visually and with radar (day and night).
- Migration traffic rate modelling for spring and autumn, identifying peak migration intensity.
- Review of literature on species' ecological behaviour to identify main threats and potential impacts.

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. 5.4.5).

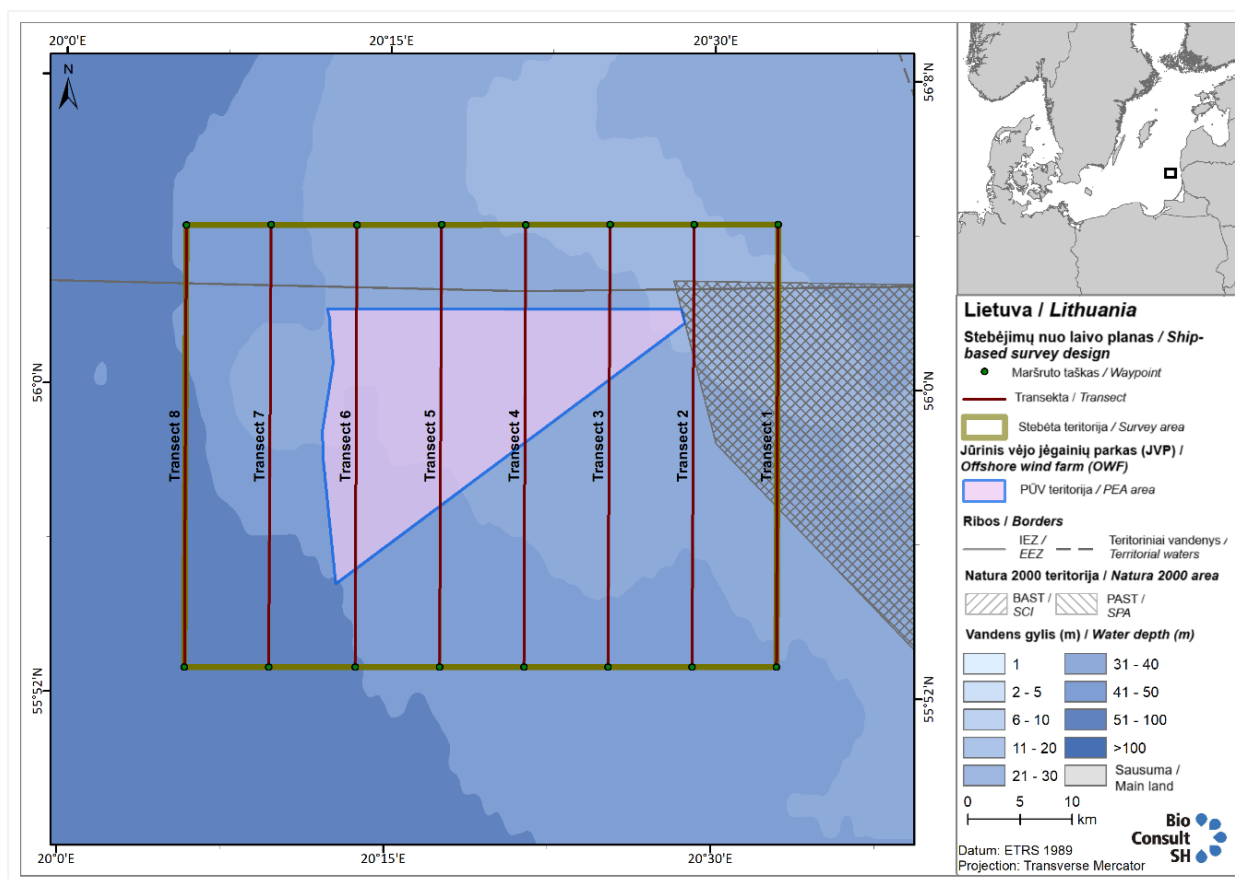


Fig. 5.4.5. Transect design for ship-based resting bird monitoring from May to October 2024.

Aerial digital transect surveys. Between Nov 2022–Apr 2023, 13 transects totalling 583.28 km and 2,340 km². From Nov 2023–Jan 2025, 19 transects covering 23,457 km², including the OWF and adjacent areas (Fig. 5.4.6).

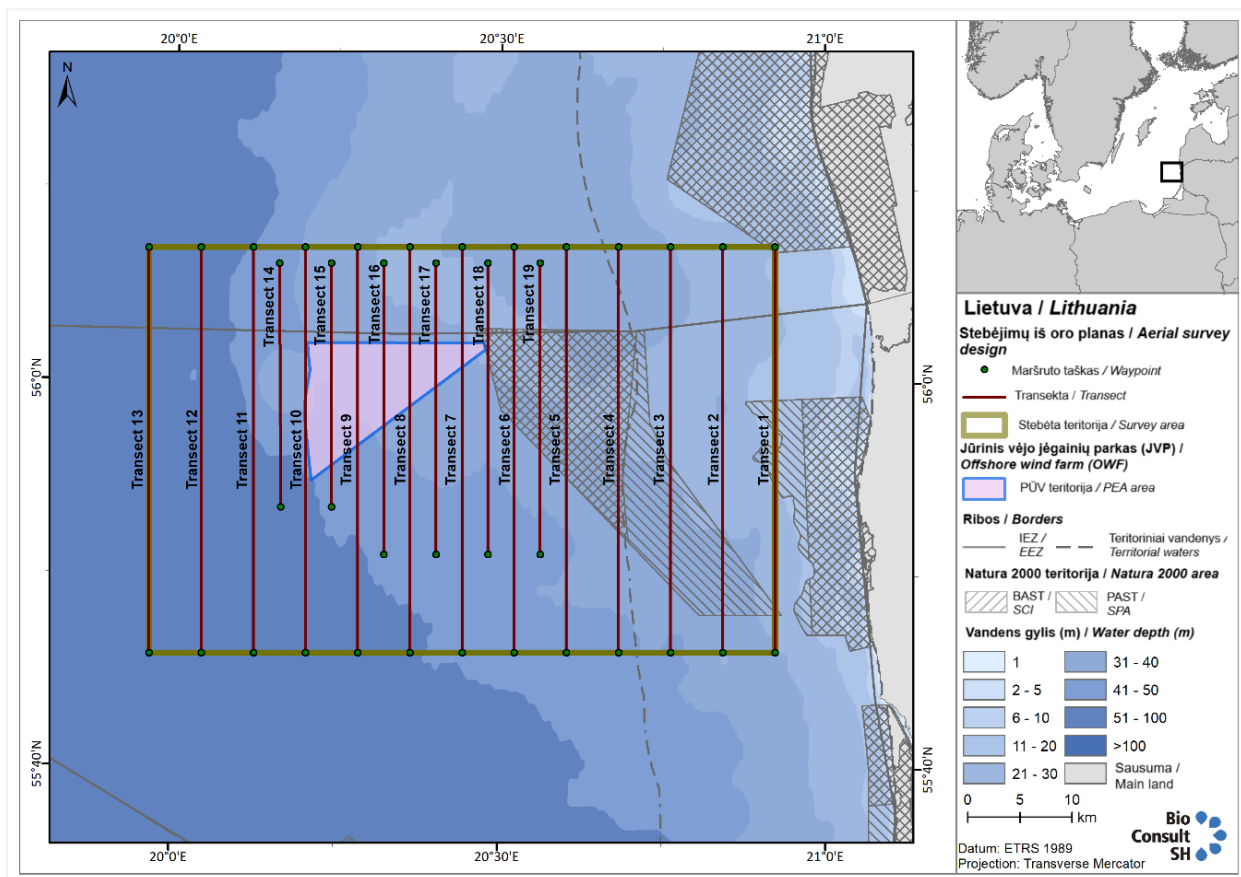


Fig. 5.4.6. Aerial survey transect design for the survey area November 2023–January 2025.

Stationary migration observations. Conducted from anchored vessels, with one spring (2023) and one autumn (2023) observation site, plus both spring and autumn monitoring in 2024. Radar detection range: 1,500 m. Visual detection range: up to 3,000 m, depending on species.

Current State

Resting birds

Vessel-based transect surveys. Between May and October 2023–2024, twelve ship-based surveys were conducted monthly. In 2023, 1,675 birds of 34 species were registered, compared to 3,014 birds of 44 species in 2024. Within the transects, 1,262 resting birds were analysed in 2023 and 1,718 in 2024, representing 16 and 18 species respectively.

The most numerous species were the Little Gull, making up 44% of all resting birds in 2023 and 33.6% in 2024, and the Common Guillemot (20.8% in 2023 and 25% in 2024). The European Herring Gull followed, with 15.4% in 2023 and 17.8% in 2024. Together, these three species accounted for over 80% of all observations in 2023 and more than 76% in 2024.

Group-level patterns showed that gulls and auks dominated the surveys. In 2023 they comprised 66.1% and 21.1% of observations respectively, while in 2024 these groups accounted for 61.1% and 27.6%. Divers were particularly numerous in spring 2024, reaching 5.1% of all birds, while cormorants remained stable at around 2.5–3% across both years.

Densities also reflect these patterns. The Little Gull reached peak densities of 6.36 individuals/km² in July 2023 and 6.65 individuals/km² in July 2024. In August, densities were also high (2.7 ind./km² in 2023 and 2.2 ind./km² in 2024). Common Guillemots peaked in August 2024 with 3.6 ind./km², while the Herring Gull exceeded 1 ind./km² in several summer and autumn months. Other species recorded above this threshold included Black-throated Divers (1.1 ind./km² in May 2024) and Velvet Scoters (1.1 ind./km² in October 2023).

Aerial digital transect surveys. Aerial monitoring was carried out over three consecutive winters (2022–2025). Across all surveys, 9,478 resting birds were recorded in 2023, 6,616 in 2024, and 5,661 in 2025.

Sea ducks were consistently the dominant group, accounting for 41% in 2023, 45% in 2024, and 53% in 2025. Among them, the Velvet Scoter was the most abundant species, forming 26.5% of all birds in 2023, 31.3% in 2024, and 45.2% in 2025. The Long-tailed Duck followed with 12.7% in 2023, 9.7% in 2024, and 6.7% in 2025.

Other groups included gulls (17–26%) and auks (25–29%), while divers made up between 4% and 10% of the totals. Densities peaked for Velvet Scoters in January 2025 (7.16 ind./km²), with additional winter peaks in 2023 and 2024 (2–3.7 ind./km²). The Little Gull was highly abundant in November 2022 (4.1 ind./km²), while Long-tailed Ducks peaked in January 2023 (2.1 ind./km²) and January 2025 (1 ind./km²). Common Guillemots reached 2 ind./km² in January 2025, while Red-throated Divers peaked at 1.06 ind./km² in March 2024.

Migrating, flying birds

Visual monitoring. A total of 14,400 migrating birds were recorded across 48 surveys (2023–2024). Spring migration accounted for 9,690 individuals, while autumn migration totalled 4,710.

Gulls were the most numerous group (6,091 birds; 42.3% of all), dominated by European Herring Gull (over 4,000 individuals, two-thirds of all gulls). Lesser Black-backed Gulls (1,058) and Common Gulls (720) followed, while Little Gulls were comparatively scarce in flight (134 individuals).

Ducks were the second largest group (3,066 birds; 21.3%), with Long-tailed Ducks leading (1,029 birds, mostly in spring 2024). Velvet Scoters (754) and Common Scoters (452) followed, with additional smaller records for Wigeon, Mallard, and Greater Scaup.

Passerines totalled 1,461 birds (10.1%), most frequently thrushes, skylarks, starlings, tits, and finches.

Auks reached 1,335 individuals, led by Razorbills (894, nearly 67% of auk records).

Other groups such as geese (682), cranes (91), divers (213), and swans (110) were present in lower numbers.

Flight altitudes. Most migrating birds were observed at safe altitudes (below 25 m or above 271 m). However, some vulnerable groups often flew within the sensitive turbine swept zone (26–270 m): cranes (100% of their flights), geese (66%), gulls (40%), herons (38%), and divers (30%). By contrast, passerines (96%) and most ducks (85%) were observed at safe heights.

Radar monitoring. Vertical radar surveys (2023–2024) detected relatively low numbers of flight signals compared to other Baltic Sea regions: about 3,800 signals in spring 2023, 3,500 in spring 2024, and fewer than 2,000 in each autumn season. Most birds flew within 1,000 m of the radar and at altitudes up to 200 m, though signals extended up to 400–500 m during spring. These results confirm that migration intensity over the Lithuanian part of the Baltic Sea is relatively low, with the majority of birds using coastal land routes.

Nocturnal monitoring of migrating birds

Night-time surveys confirmed that passerines were the only group regularly detected, including skylarks, thrushes, robins, finches, tits, and starlings. Migration was not particularly intense, though most calls were heard during spring. Artificial lighting on survey vessels attracted some birds, making abundance estimates unreliable.

PEA territory analysis by sensitive bird groups or species

In total, 38,969 birds were recorded across all methods. Sea ducks, auks, and gulls were the dominant groups, with particularly high numbers recorded during aerial surveys. The study area overlapped with the Klaipėda–Ventspils Plateau SPA, a designated wintering ground for Long-tailed Ducks, Velvet Scoters, and Razorbills.

Sea ducks. Velvet Scoters were the most abundant, with 8,031 individuals (2,958 in 2023; 5,073 in 2024), while Long-tailed Ducks reached 3,266 individuals (1,437 in 2023; 1,829 in 2024). Both species concentrated in SPA waters, with peaks in January–February. Velvet Scoters showed weak avoidance behaviour near OWFs, while Long-tailed Ducks are known to strongly avoid turbine areas and may be displaced by up to 2 km.

Auks. Common Guillemots (3,717) and Razorbills (2,484) were numerous, with additional individuals classified only as unidentified auks. Guillemots peaked in summer–autumn, Razorbills in late autumn and winter. Both species are sensitive to disturbance: reductions of 50–80% in their presence near OWFs have been documented elsewhere.

Divers. Red-throated Divers (1,516) and Black-throated Divers (260) were observed, with most Red-throated Divers recorded in aerial counts. Although densities were relatively low (<1.2 ind./km²), divers are highly sensitive and may avoid OWFs by distances of up to 10–15 km.

Little Gull. A total of 3,989 were recorded across the surveys, with strong seasonal peaks in summer (ship-based counts) and November (aerial counts). The species shows weak avoidance but may face collision risks, with about 5% flying at turbine swept heights.

Overall, the proposed OWF area overlaps with habitats of several sensitive seabird species, especially wintering sea ducks, divers, and auks. Given the SPA's proximity, displacement effects are highly likely unless careful siting and seasonal restrictions are applied.

Potential impact on birds

Potential impact of the planned OWF

The planned OWF may affect birds through collision risk, displacement from foraging or wintering areas, barrier effects on migration routes, and disturbance during construction and maintenance. Direct collisions are most likely to occur among gulls, cranes, and nocturnal passerines, particularly under adverse weather such as fog.

Seabird distribution is wide but shows seasonal concentration. Velvet Scoters were mostly recorded between November and March, with densities reaching up to 7.16 ind./km² in winter months. Long-tailed Ducks peaked from December to April, with maximum densities of 2.08 ind./km² in January 2023. Razorbills were abundant in winter and early spring, with densities of 0.7 ind./km² and occasional peaks, such as 0.96 ind./km² in November 2023. These species are particularly sensitive to displacement, which may extend up to 2 km from the OWF. As the site borders an SPA, this effect could reduce protected seabird numbers in the area.

Construction activities, especially pile driving, will generate noise and disturbance. Increased vessel traffic and underwater noise are expected to temporarily drive birds away from foraging and resting grounds. 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.

Potential impact of the export cable corridors installation offshore

The installation of export cables will mainly cause disturbance and temporary displacement. These impacts are associated with vessel traffic, noise, vibration, and sediment resuspension, which may hinder feeding of piscivorous species. Destruction of benthic communities along the cable route may also reduce foraging opportunities for benthivorous birds.

The effects are expected to be short-term and localised, ceasing once construction ends. For key wintering species such as Long-tailed Ducks, Velvet Scoters, Razorbills, Common Guillemots, and divers, the impact significance is assessed as low. Nevertheless, timing is critical, and cable works should also be avoided during the **15 November to 15 April** period when seabird abundance is highest.

Potential cumulative impact of various ongoing and planned activities (e.g., fishing, shipping) in the analysed area and its surroundings

Seabirds in the Baltic Sea face multiple pressures beyond the OWF project. Fishing is a major threat: between 1,000 and 3,000 seabirds die annually in Lithuanian coastal waters due to entanglement in nets, particularly Long-tailed Ducks and Red-throated Divers. Studies show that 5% of Long-tailed Ducks caught in nets had ingested plastic or metal fragments.

Shipping further disturbs seabirds, as ducks, divers, and auks avoid busy shipping lanes. Construction and maintenance of the OWF will temporarily increase vessel traffic, adding to this disturbance.

Invasive species such as the Round Goby (*Neogobius melanostomus*) alter food availability by preying on mussel communities, forcing sea ducks like the Long-tailed Duck to switch diets, with energetic costs.

While seabirds adapt through shifts in distribution and feeding behaviour, cumulative pressures are strongest on benthic-feeding species. Velvet Scoters and Long-tailed Ducks are expected to experience the most significant combined impacts, while effects on other bird groups remain comparatively minor.

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.

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.

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.

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.

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).

Table 5.4.5. 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

	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 5.4.6. 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						
	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.					

5.4.4 Bats

Survey methods and study area

Recording bat migrations and flight intensity with ultrasound detectors was central for assessing activity. While current legislation does not require bat surveys for OWFs located more than 15 km offshore, such surveys were recommended and therefore carried out. Both existing data and new field surveys were used to evaluate bat activity in the Baltic Sea and along the coast during migration periods. Additionally, trees in the onshore section of the planned cable route were inspected for potential bat breeding sites, but no suitable tree holes were identified in spring–summer 2023.

Field surveys were conducted during both spring and autumn migration periods. In May 2022 and 2024, spring surveys from a vessel recorded bat activity in the middle of the PEA territory. In autumn 2022, bat detectors were deployed at three locations:

- Palanga bridge (about 0.3 km from shore), active from July 28 to October 15.
- Near Būtingė (5–7 km offshore), from a vessel, active from August 18 to October 15.
- Open sea platform (30–35 km offshore), active from early July to October 15.

In autumn 2024, two coastal points were surveyed:

- Palanga bridge (PALANGA2), 0.3 km offshore.
- Palanga lifeguard station (PALANGA1), located at the beach near the shoreline. Both detectors operated from July 28 to October 15.

Data were collected using SM4BAT FS stationary detectors with U2 microphones (range 50–100 m depending on species). The devices automatically activated 30 minutes before sunset and recorded until 30 minutes after sunrise. Data were analysed using Kaleidoscope Pro software, with results verified through auto-identification checks, and further statistical analysis carried out in RStudio and Microsoft Excel.

Potential impacts on bats were assessed by analysing:

- **Species composition**, during breeding and migration periods.
- **Migration intensity**, both annually and diurnally, to identify peak migration periods.

Survey points were chosen to ensure full spatial coverage of the **coastal zone, nearshore waters, and open sea** where the OWF is planned. This design allowed comprehensive monitoring of potential bat presence and activity patterns (see Fig. 5.4.7).

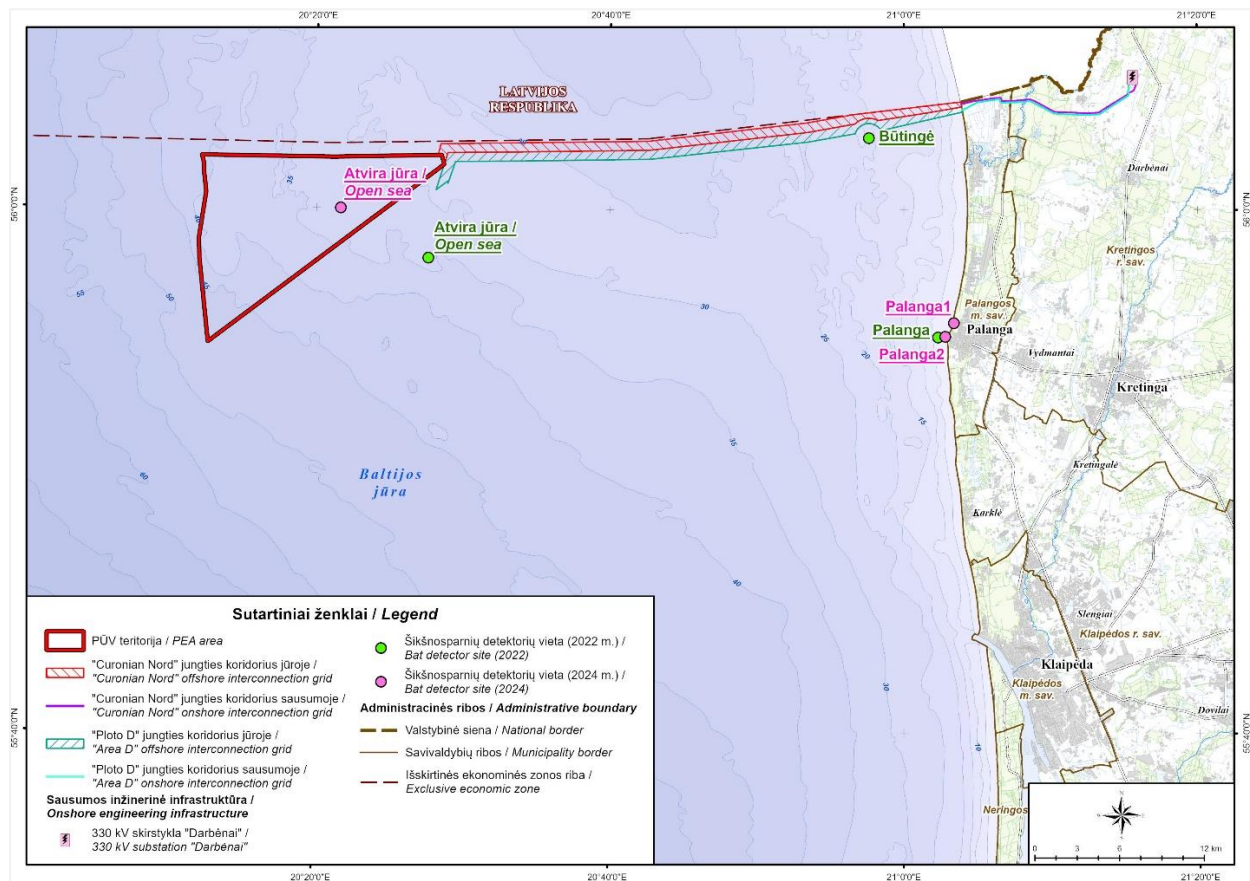


Fig. 5.4.7. Locations of migrating bat surveys and the area under impact assessment.

Current State

Bats in Lithuania display strong seasonal variation in behaviour, with activity peaking in summer during feeding, breeding, and migration, and declining sharply in winter when only 9 of the 14 registered species remain. Peak migration occurs in August, when juveniles become independent and migrate to wintering grounds further south. Past ringing studies have confirmed that *Nathusius's* pipistrelles from Lithuania winter in the UK, indicating that individuals migrate over the Baltic and North Seas. Based on EUROBATs classification, species such as the Parti-coloured bat, Common noctule, Leisler's bat, and *Nathusius's* pipistrelle are at high risk from wind turbines, while pipistrelles, Northern bats, and Serotine bats are considered medium risk. Species such as Daubenton's bat, Pond bat, and Brown long-eared bat are categorized as low risk due to their sedentary habits and low flight altitudes.

Observation Results

Spring migration surveys in the PEA territory recorded no bat activity. In autumn 2022, 11,838 bat passes were recorded at the Palanga bridge (covering 12 species), compared with 515 passes at Būtingė (8 species), and just 12 detections offshore on the open sea platform (3 species). Bat activity was therefore over 22 times higher at Palanga than at Būtingė, and nearly 1,000 times higher than offshore.

At Palanga, the Northern bat was dominant, representing more than 52% of registrations, followed by Lesser noctule (23%), *Nathusius's* pipistrelle (11%), and Common noctule (5%). In Būtingė, the species composition shifted: Lesser noctule comprised 43%, *Nathusius's* pipistrelle 18%, Common noctule 15%, and Serotine bat 13%.

Migration intensity peaked in mid-August, with nightly counts at Palanga ranging from 300 to 1,093 passes between August 10 and 29. By September, activity decreased tenfold, with around 1,053 registrations in total. At Būtingė, the peak in the first half of August produced 427 recordings, dropping to just 72 in September. Offshore, only 13 passes were recorded in total, mainly *Nathusius's* pipistrelle, Serotine bat, and Northern bat. Observations suggest these were isolated individuals, possibly attracted by the monitoring platform.

A comparative analysis shows that Būtingė registered only 9.6% of the bat activity recorded at Palanga, confirming that migration intensity diminishes rapidly with distance from shore. In the OWF project area, located 30–40 km offshore, only 13 passes were registered during autumn migration—just 0.1% of Palanga's total—indicating negligible migration activity so far from the coast.

In 2024, surveys were expanded to two coastal sites: Palanga bridge (Palanga2) and the Palanga lifeguard station (Palanga1). At Palanga1, located 30 m from the sea, 26,227 bat passes were recorded, dominated by Nathusius's pipistrelle (14,825 passes, 56.5%) and followed by Lesser noctule (3,396 passes) and Soprano pipistrelle (2,760 passes). At Palanga2 on the bridge, Daubenton's bat was most frequent (1,430 passes, 48%), with Northern bats (470 passes) and Lesser noctules (394 passes) also common.

Peak migration in 2024 occurred between August 15 and September 8, with nightly counts ranging from 1,000 to 2,350 passes, mostly Nathusius's pipistrelles. Migration continued until about September 24, after which activity declined. Species activity typically began in the second hour after sunset and continued until an hour before sunrise. Nathusius's pipistrelle reached activity levels above 1,800 passes per hour, while Soprano pipistrelles peaked at around 450 passes per hour, and Lesser noctules maintained steady levels throughout August and September.

Technical issues limited offshore data collection in 2024: the buoy-mounted detector failed in April, and one of the Palanga detectors malfunctioned after September. However, coastal monitoring still revealed consistent patterns.

Across both years, the data clearly indicate that bat migration is concentrated along the coastal strip, particularly near dunes, while activity decreases dramatically with distance from shore. During the research period (July–October), up to 26,000 passes were recorded 30 m from the coast, compared with 12,000 at Palanga bridge (300 m offshore), 515 passes at Būtingė (5–7 km offshore), and just 13 passes 30–35 km offshore. This pattern demonstrates that bats do not intentionally migrate across open sea near Lithuania. Offshore individuals likely represent disoriented bats carried by wind, at high risk of mortality from exhaustion or predation.

Given this evidence, the planned OWF at 30–40 km offshore is unlikely to overlap with significant bat migration routes and is therefore not expected to have a major impact on bat populations.

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.

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.

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.

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 determine bat species composition and relative abundance in offshore areas during the construction and operational phases, and to identify environmental conditions under which bat activity occurs at sea.

During construction. It must be ensured that bat migration can be monitored during the construction and operation of the OWF. Monitoring must be carried out using ultrasonic detectors installed on vessels during construction and on wind turbines and the substation during OWF operation. During construction, detectors must be installed on at least two vessels involved in building the OWF from April to October. The data collected during construction must 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 tree felling is planned for cable installation, prior to felling, the identification of day roosts of breeding bats must be repeated (as bats could have settled in new sites since the initial assessment was carried out). If breeding sites are identified, they must be preserved, or tree stumps with hollows and cavities must be relocated to adjacent forest areas so as not to deteriorate the living conditions of species listed in the Habitats Directive. Relocation must 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.

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 must 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 must 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.

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 forest 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.

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 5.4.7. 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	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
Decommissioning					at sea, which would likely die anyway		
	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.
	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

	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.

5.4.5 Marine mammals

Survey methods and study area

Marine mammals in the OWF area were monitored seasonally: during the warm season, vessel-based surveys were conducted alongside bird monitoring from May to October (once per month), while in the cold season, aerial digital surveys were carried out. Additionally, passive acoustic monitoring (PAM) of harbour porpoises was undertaken from September 27, 2023, to February 11, 2025, with five deployment cycles covering the entire period.

Harbour porpoises were detected using F-POD acoustic loggers which continuously record echolocation clicks. Eight F-PODs were deployed across the OWF area in a 4.5 km grid, exceeding the minimum monitoring requirements under StUK4 (BSH, 2013). Each device, suspended 3–10 m above the seabed, covered a radius of about 400 m. This set-up produced 2,052 total deployment days, including over 1,140 days of active recording time, thereby ensuring robust detection and reducing the risk of data loss.

Acoustic data were processed with FPOD.exe v2.06 and the KERNO-F 1.0 classifier. Click trains of narrow-band high-frequency origin, characteristic of harbour porpoises, were retained only when classified as high or moderate probability, in line with BSH guidelines.

To evaluate potential effects of OWF development, underwater noise measurements were carried out from December 2023 to February 2025. Noise monitoring used SoundTrap ST600STD recorders (20 Hz–60 kHz range), deployed 3 m above the seabed, operating in continuous mode with 5-minute file intervals.

Four main measurement campaigns were completed, generating tens of thousands of data files. For example, one campaign between March and July 2024 produced over 34,000 recordings. Broadband SPL values were calculated for the 20 Hz–20 kHz range, with emphasis on 63 Hz and 125 Hz bands as descriptors of ambient sea noise under MSFD.

Environmental parameters (temperature, salinity, depth) were measured concurrently with CTD profilers to model sound velocity profiles. These data fed into numerical modelling of underwater noise propagation using the MIKE-UAS simulator (DHI, 2017).

The model accounted for bathymetry, water column conditions, seabed geoacoustic layers, and sound source characteristics. Pile-driving scenarios simulated 6.16 hours of piling with 9,243 strikes, producing a cumulative sound exposure level (SEL) approximately 39.7 dB higher than a single strike. Modelling covered 72 azimuthal transects up to 200 km distance, with special focus on potential impacts to sensitive species such as harbour porpoises (*Phocoena phocoena*), seals (*Phocidae*), and swim-bladdered fish.

The PAM network, consisting of eight F-PODs and two underwater noise recorders, was deployed across the OWF site in a regular 4.5 km grid. Devices were also co-located at stations in the centre and northwest corner for redundancy. Vessel-based surveys followed parallel transects spaced 4 km apart, covering the OWF and adjacent regions.

The design of this monitoring system—denser than international guidelines require—ensures strong spatial coverage, redundancy against device loss, and a high likelihood of detecting both porpoise presence and variations in underwater noise levels.

Current state

Three species of seals inhabit the Baltic Sea: grey seal (*Halichoerus grypus macrorhynchus*), ringed seal (*Phoca hispida botnica*), and Atlantic harbour seal (*Phoca vitulina vitulina*). Of these, only the grey seal is formally listed in the Lithuanian Red Book. While all three species may occur in Lithuanian waters, grey seals are the most regularly observed. Historically, seals were frequent along the Lithuanian coast but declined during the 20th century. Since 2000, grey seal sightings have increased.

In 2021, the Baltic grey seal population was estimated at ~42,000 individuals counted, with a total population size of ~60,000 animals after correcting for haul-out fraction. In the southern Baltic, approximately 7,000 individuals were estimated (HELCOM, 2023). Despite population growth and range expansion, the species has not yet reached good

environmental status, as health indicators such as blubber thickness and pregnancy rates remain below threshold values.

Harbour porpoises are represented by two populations in the Baltic Sea: the Belt Sea population and the Baltic Proper population. Lithuania's EEZ is considered of medium importance for harbour porpoises, with seasonal detection probabilities varying between 10% and 20%. Presence is highest in winter (November–April). The estimated population in the Baltic Proper is approximately 500 individuals (Carlén, 2018).

Seals. Vessel-based surveys conducted between June 2023 and October 2024 recorded 12 seals. Identification to species level was difficult, but most were presumed to be grey seals. Sightings were concentrated to the west and south of the OWF area, with only one individual observed within the EIA area in May 2024. Seal presence in the project area is therefore considered low.

Harbour Porpoise. Acoustic monitoring with F-PODs confirmed six harbour porpoise encounters in the CN OWF area between November 2023 and March 2025. Each detection was brief, typically one detection-positive minute (DPM) per encounter, making it impossible to analyse finer seasonal or daily trends.

Despite the low number of records, the timing and location align with broader Baltic Sea research showing porpoises are more dispersed in winter months. Importantly, detection probability modelling (SAMBAH data) indicates that the EIA project area has one of the highest probabilities of porpoise occurrence in Lithuania's EEZ during winter, especially in February, when occurrence peaks. Comparable or higher values are mainly found within protected "Natura 2000" sites such as SAC Sambian Plateau, SPA Kuršių nerijos pajūris, and SPA Klaipėda-Ventspils Plateau.

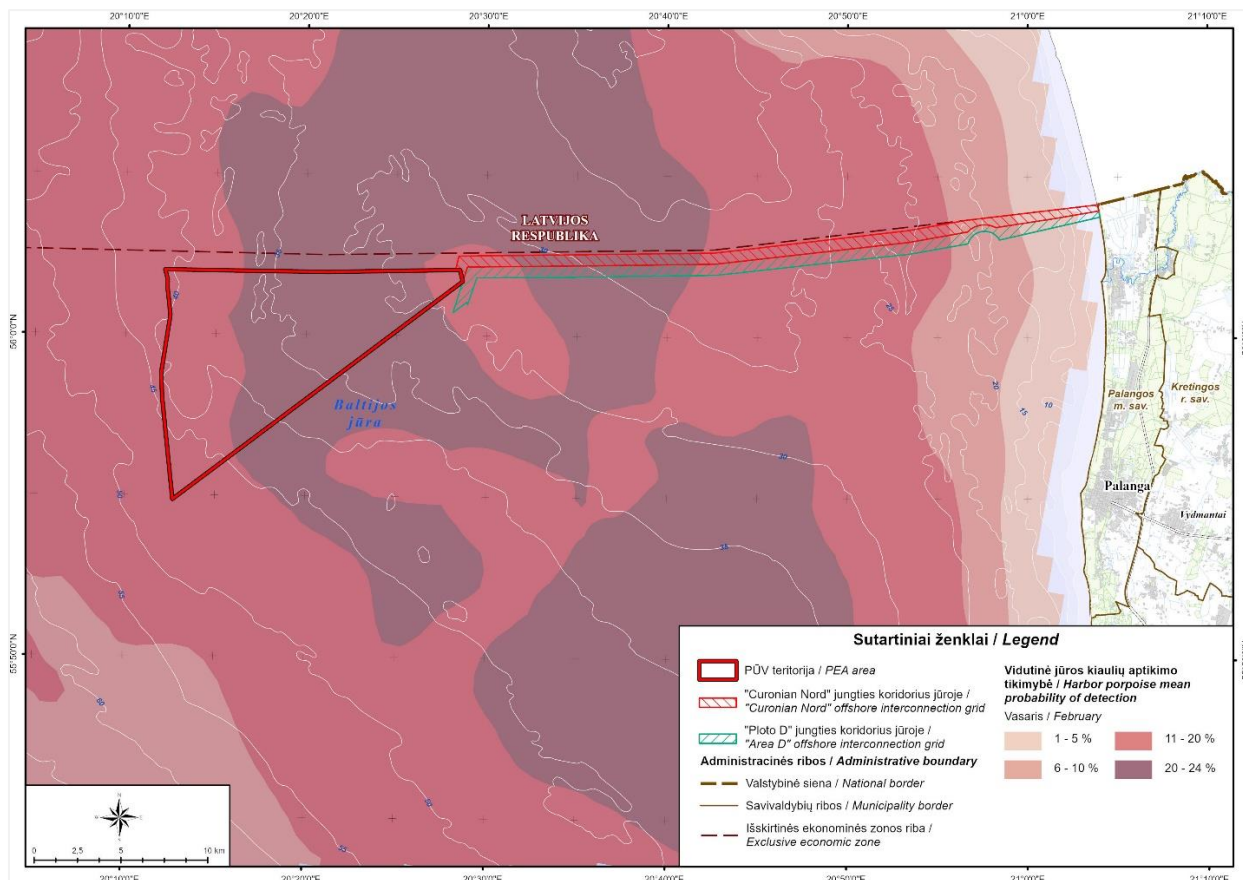


Fig. 5.4.8. Probability of Harbour Porpoise detection in February (according to Carlen et al. 2018).

This indicates that, although direct observations are scarce, the project area has high relative importance for harbour porpoises in the Lithuanian EEZ.

Potential Impact to Marine Mammals

Marine mammals rely heavily on sound for communication, navigation, feeding, and reproduction. Anthropogenic underwater noise is recognized as one of the most harmful pollutants, disrupting hearing sensitivity, physiology, and behaviour, while also masking echolocation signals.

During the construction phase, impact pile driving represents the most significant noise source. Stress waves transmitted through monopiles generate high-intensity, low-frequency noise (<500 Hz), leading to both behavioural disturbances and auditory impacts. These include temporary threshold shifts (TTS), where hearing sensitivity is temporarily reduced, and in extreme cases, permanent threshold shifts (PTS) causing irreversible inner ear damage.

For harbour porpoises, auditory injury thresholds are reached at 159 dB SELweighted, with temporary hearing loss possible from 144 dB SEL. Behavioural reactions occur from as low as 94 dB SEL. For seals, auditory injury is possible at 185 dB SEL, and behavioural disturbance occurs at 158 dB SEL. Estimated impact distances vary widely: porpoises may avoid pile driving sites up to 15–26 km, while TTS can occur within 0.4–87 km depending on exposure duration. Seals generally show higher tolerance, but TTS can extend up to 54 km under unmitigated scenarios.

During the operational phase, turbines emit continuous, lower-level noise, mainly from rotor vibrations. Although weaker than pile driving, this noise may still affect echolocation and communication, particularly in porpoises. However, evidence suggests porpoises and seals are frequently detected inside operational OWFs, possibly due to increased prey availability and the absence of gillnet fishing.

The decommissioning phase is expected to cause similar, though typically lower, impacts than construction. Key concerns include temporary noise pulses from pile extraction, displacement from feeding or breeding grounds, loss of artificial reef habitats, and disturbance from intensified vessel traffic.

Harbour Porpoises. Harbour porpoises are especially sensitive to high-frequency sounds. Even moderate construction noise can disrupt feeding behaviour. Studies show strong avoidance of pile driving areas, with documented exclusion distances of 15–26 km, and TTS occurring within 0.4–87 km depending on season and mitigation measures. Close to the pile-driving site (<2 km), hearing damage is possible. Despite this, no direct evidence of increased mortality during OWF construction has been found.

Seals. Seals demonstrate higher tolerance to noise compared to porpoises. Temporary or partial hearing loss is possible, but not necessarily lethal, as seals can continue to forage effectively. At the Nysted OWF in Denmark, seal abundance even increased during installation, likely due to the easier capture of disoriented fish. Impact distances for seals are generally smaller than for porpoises: TTS may extend up to 22–54 km without mitigation, but behavioural reactions are more localized, typically within 8–10 km.

Cumulative Impact

Cumulative effects may arise if multiple wind farms are constructed or decommissioned simultaneously in nearby areas. Such overlap could restrict access to feeding grounds, displace fish populations, and alter prey distribution. Harbour porpoises remain the most vulnerable species to cumulative underwater noise.

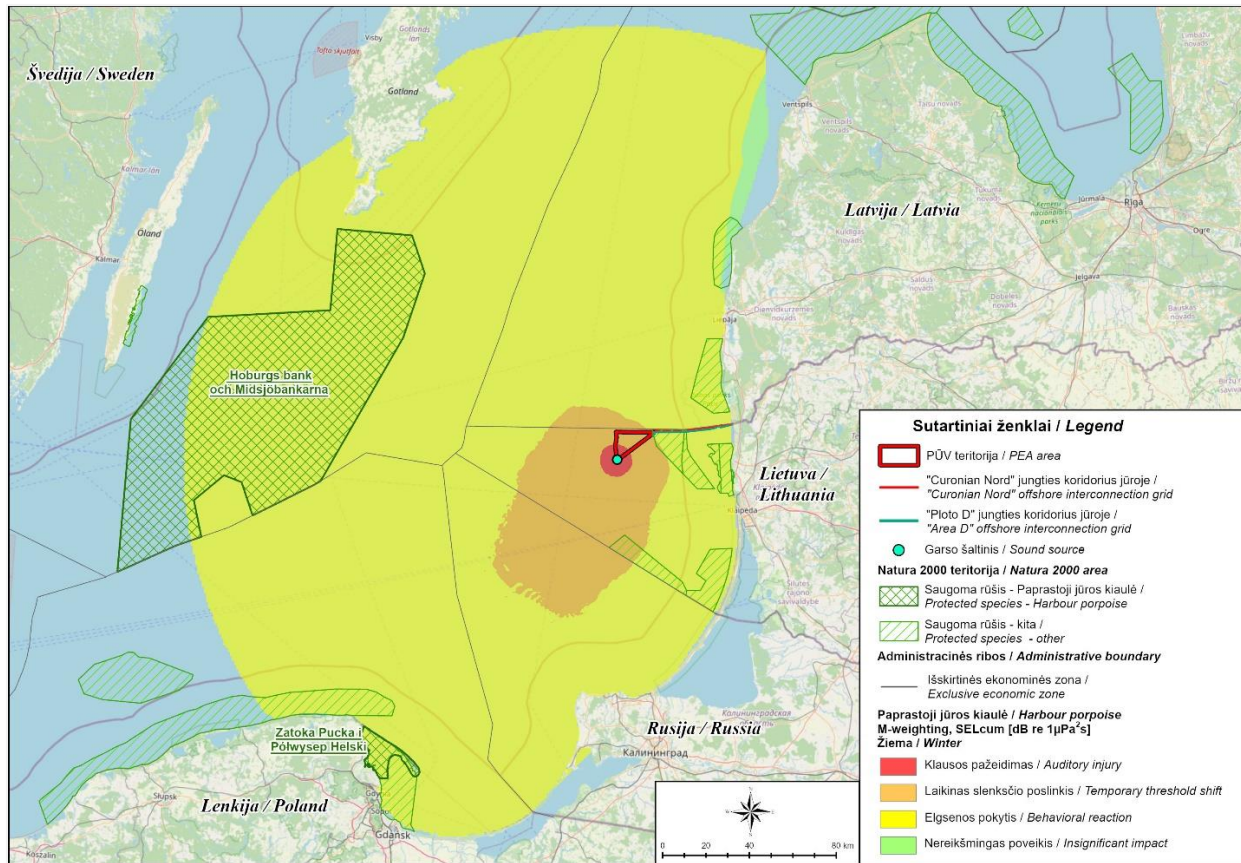


Fig. 5.4.9. Noise map of potential impact on harbour porpoises (*Phocoena Phocoena*) obtained based on the scenario of the unmitigated cumulative SELcum [dB re 1μPa²s] (VHF-weighted) for winter.

Operational OWFs may have both neutral or even positive impacts on marine mammals by reducing gillnet bycatch and enhancing prey availability due to fishing restrictions. However, uncertainties remain about long-term impacts of chronic operational noise on acoustic communication and foraging.

In summary, the most significant risks to marine mammals arise from pile driving during construction, particularly for harbour porpoises, with potential displacement extending tens of kilometres. Seals are more resilient but still affected. Operation and decommissioning impacts are less severe but must be managed to avoid cumulative stress on populations.

Mitigation, and compensation measures to address impact on marine mammals

Construction phase. During construction, the main source of impact on marine mammals is underwater noise from pile driving, particularly strong in winter when natural conditions enhance noise propagation. Therefore, foundation installation should, where possible, be scheduled outside the winter season, or additional mitigation measures applied.

Prior to pile driving, acoustic deterrence is implemented to prevent injuries such as hearing loss. This may involve deploying acoustic deterrent devices to drive animals away from the piling zone or applying the "soft start" method, where strike energy is gradually increased to allow animals to leave before harmful peak noise occurs.

Technical noise reduction measures may include:

- Double bubble curtains (DBBC): can reduce the impact distance on harbour porpoises by up to 90%.

- Hydro Sound Dampers (HSD): gas-filled balloons and polyethylene foam elements that absorb and scatter sound waves, often combined with DBBCs to meet strict regulations such as those of the German Federal Maritime and Hydrographic Agency (BSH).
- Additional methods: pile sleeves (isolating piles from direct water contact) and double-walled steel noise reduction screens with air gaps, often used in combination with DBBCs,
- And others.

Noise modelling for the CN OWF considered pile driving of a 10 m monopile using a 6,600 kJ hammer. Results showed:

- For harbour porpoises, sound exposure levels did not exceed injury thresholds. Cumulative exposure may cause temporary hearing threshold shifts (TTS) at 0.46–0.52 km, with behavioural reactions up to 2.44–2.64 km.
- For seals, exposure also remained below injury thresholds. Cumulative TTS could occur at 0.72–0.91 km, with behavioural reactions at 0.7–0.9 km.

According to BSH precautionary regulations (160 dB SEL, 190 dB SPL_{peak} at 750 m), modelling indicated that even with DBBC, sound levels reached 162–163 dB, slightly above the SEL criterion. Still, mitigation significantly reduces exposure: unmitigated broadband sound levels at 750 m were nearly 179 dB, reduced to ~164 dB with DBBC, and ~158 dB with DBBC+HSD. At 5 km, unmitigated levels of 164 dB fell to ~144 dB with combined mitigation.

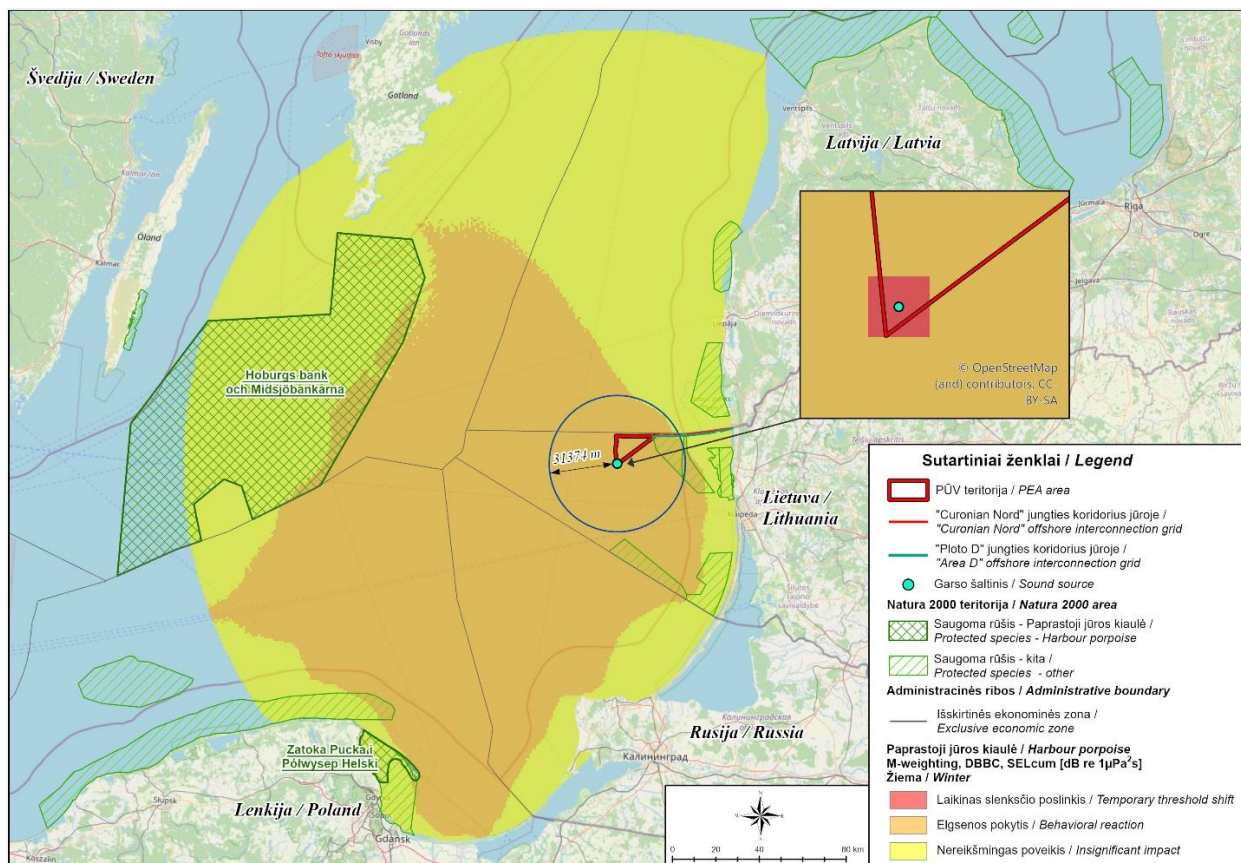


Fig. 5.4.10. Noise maps of potential impact on harbour porpoises (*Phocoena Phocoena*) obtained based on the scenario of the DBBC-mitigated cumulative SEL_{cum}, DBBC (dB re 1μPa²s) (VHF-weighted) for winter.

To further reduce disturbance, designated shipping lanes should be used during construction, concentrating vessel noise in defined areas and minimizing its spread into feeding habitats.

Operation phase. Noise generated during operation is significantly lower than during construction but can still affect marine mammals and fish. Mitigation options include:

- Low-noise turbine designs, such as direct-drive turbines without gearboxes, which minimize vibration.
- Use of damping materials and isolation techniques, such as rubberized or composite coatings on foundations, to absorb vibrations and reduce noise propagation.

Decommissioning phase. Decommissioning also generates underwater noise, though generally less intense than construction. Potential impacts include temporary hearing threshold shifts or, in extreme cases, auditory injury during monopile extraction. Elevated noise may displace animals from feeding grounds, disrupt communication, and reduce prey availability due to the removal of artificial reef structures formed by turbine foundations. Increased vessel traffic during decommissioning can further disturb behaviour and raise collision risks, particularly for echolocating species such as harbour porpoises.

Mitigation measures for decommissioning mirror those of construction: acoustic deterrents, soft-start piling, and DBBC/HSD systems. In addition, pile-cutting technologies such as **diamond wire cutting** can be employed, enabling foundation removal with minimal noise. If harbour porpoises are detected during the critical November–April period, dismantling works must be paused for one week after the last detection, or noise mitigation measures must be applied.

Table 5.4.8. 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 potentially increased abundance of prey items	Localised (within the OWF area)	Long-term (lasting until the end of the OWF operational phase)	Positive impact	Not applicable.
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

Survey methods and study area

The assessment of the fish community was based on several standardized scientific surveys conducted within the PEA area and adjacent waters:

- **Baltic International Bottom Trawl Survey (BITS):** Designed to evaluate demersal fish stocks, especially Baltic cod, flounder, and plaice. In Lithuania, trawling was carried out with a small standard TV3 trawl (TV3 520# specifications, 20 mm mesh size). Each haul lasted 30 minutes at 3 knots, in line with the BITS manual.
- **Baltic International Acoustic Survey (BIAS) and Baltic Acoustic Spring Survey (BASS):** Focused on clupeid fish stocks, mainly herring (*Clupea harengus*) and sprat (*Sprattus sprattus*). BIAS (October) targeted stock size, while BASS assessed abundance and distribution during spawning. Both used acoustic data from scientific echosounders (SIMRAD EK80, ES38-10 transducer at 38 kHz). Verification of species composition and size distribution was done with a pelagic trawl (12 m vertical opening, 10 mm codend mesh). Acoustic transects were conducted at ~8 knots, while fishing hauls lasted 30 minutes at ~3 knots.
- **Coastal fish community assessment:** Conducted using the HELCOM methodology, which standardizes data collection across the Baltic Sea. Nordic coastal multi-mesh gillnets (14–70 mm mesh sizes) were used to capture fish across different size classes, from juveniles to adults. This approach, aligned with HELCOM (2015) recommendations, provided a comprehensive overview of fish community structure and health.

Data on fish catches from stationary multi-mesh gillnets were also used, obtained under the Lithuanian National Fisheries Data Collection Program (DCP) and provided by the Marine Research Institute of Klaipėda University.

The assessment of potential impacts on fish was carried out by modelling noise exposure effects, applying the same methodology as for marine mammals.

The current state analysis focused on the PEA and adjacent waters where potential impacts on fish communities are most likely during construction. Data were examined from pelagic and acoustic trawl surveys carried out within the PEA and within a 5.5 nautical mile radius around it. All survey data correspond to ICES statistical rectangle 40H0 in Subdivision 26, a standardized spatial unit used for fish stock, habitat, and ecosystem assessments.

Current state

In Lithuanian waters of the Baltic Sea, a total of 65 cyclostome and fish species have been recorded. These include 21 freshwater species, 33 marine species, and 11 migratory species. Of these, 19 species are protected under the Habitats Directive, the Berne Convention, or CITES, 5 are listed in the Lithuanian Red Book, and 18 are considered very rare. Some species are common in Lithuanian marine waters, while others such as swordfish (*Xiphias gladius*), anchovy (*Engraulis encrasicolus*), and hooknose (*Agonus cataphractus*) have been observed only occasionally.

Among commercially important species, Atlantic herring (*Clupea harengus*), Atlantic cod (*Gadus morhua*), and European flounder (*Platichthys flesus*) are the most abundant quota-managed fish in Lithuania's Exclusive Economic Zone (EEZ). Herring eggs and larvae are concentrated particularly north of Palanga, and approximately 20% of juvenile herring biomass in the eastern Baltic is found in Lithuania's EEZ. While no distinct feeding areas are identified, suitable substrates for feeding are available throughout the zone. The CN OWF area is especially important as a feeding ground for Baltic flounder and Atlantic cod, with recent surveys showing an increase in smaller cod groups. Fishing intensity in this area has been very low over the past nine years, which further enhances its importance as a feeding ground.

The fish community in the CN OWF is dominated by Atlantic herring, Atlantic cod, and European flounder. Seasonal increases in biomass have been recorded for shorthorn sculpin (*Myoxocephalus scorpius*) and European smelt (*Osmerus eperlanus*). In the nearshore shallow-water zone, unique fish communities develop under the influence of fluctuating physical factors such as wind, wave height, and light. These shallow waters serve as critical feeding and nursery grounds for juveniles of many species, and as migration and feeding corridors for semi-migratory fish moving between the Curonian Lagoon and the Baltic Sea. Migratory species such as smelt, vimba, salmon, sea trout, whitefish, twaite shad, eel, and river lamprey are commonly found here, most of them remaining at depths of up to 20 m.

Fish community composition varies seasonally. During summer, marine and semi-anadromous species dominate; in autumn, anadromous species return to rivers for spawning. By November, sprat become abundant, along with river flounder and cod. Lithuanian EEZ and coastal waters also serve as spawning grounds for valuable species such as smelt and turbot, as well as migration routes for multiple fish stocks. Non-commercial species like gobies, eelpouts,

lumpfish, and sticklebacks also contribute to the ecosystem as prey for commercial fish. The Lithuanian coastal zone is especially important for sprat recovery, with approximately 20% of year-class biomass located in the EEZ.

According to BITS trawl data from 2020–2025, 16 fish species were recorded in Lithuania's EEZ, while 14 species were caught specifically in the CN OWF. On average, each trawl captured seven species. The dominant group remains the three commercial species, but occasional catches included twaite shad (*Alosa fallax*), a species of EU importance listed in Annex II and V of the Habitats Directive. Twaite shad spawns in rivers such as the Nemunas and later disperses to the Baltic Sea, with juveniles migrating to coastal waters in their first year.

The Shannon and Pielou indices used to evaluate species diversity and evenness remained low throughout the study. For example, H' values ranged from 0.72 to 1.22, while J' ranged from 0.48 to 0.57. Since typical communities show H' values between 1.5 and 3, these results indicate a strong dominance of one or two commercial species. Average fish sizes also align closely with those in the wider ICES 40H0 rectangle: herring at 18.46 cm (slightly smaller than 18.81 cm in 40H0), cod at 26.04 cm versus 26.14 cm, and flounder at 23.88 cm versus 23.99 cm.

Pelagic surveys (BIAS and BASS) confirmed that clupeids—mainly herring and sprat—dominate catches in the CN OWF, with sprat biomass ranging from 160 to 6,166 kg/hour and herring from 17 to 1,048 kg/hour. Twaite shad was not recorded in these pelagic surveys, underlining its rarity. These results confirm that the CN OWF and surrounding areas are important feeding grounds for cod, flounder, and herring.

Nearshore monitoring (2023–2024) revealed seasonal shifts in species dominance. In autumn and winter, herring and smelt prevailed, while in spring, flounder and round goby (*Neogobius melanostomus*) became dominant. Atlantic cod, smelt, flounder, gobies, and sculpins were consistently present as key subdominant or dominant species. The average size of herring in the nearshore zone was 18.89 cm, nearly identical to that in the 40H0 rectangle. By contrast, flounder, smelt, and goby were smaller in the nearshore than in the offshore zone, suggesting that nearshore waters may act as nursery areas for these species or that larger individuals are targeted more heavily by fisheries.

Finally, clupeid fish are noted as particularly sensitive to underwater noise due to their advanced auditory adaptations, which allow detection of frequencies up to 200 kHz. This makes them more susceptible to anthropogenic noise sources and explains why herring, sprat, and twaite shad are considered highly vulnerable in the context of offshore wind farm development.

Potential impact to Baltic Sea fish

Five types of direct OWF impacts on fish have been identified:

- **Noise impact during development phase.** High-intensity, low-frequency noise has been shown to cause developmental problems, increased mortality in larvae and juveniles, and reduced growth rates. It can also lead to hearing loss, internal injuries, elevated stress responses, and behavioural disruptions such as altered feeding and avoidance. Sensitivity to noise varies between species. Atlantic herring (*Clupea harengus*), European sprat (*Sprattus sprattus*), and twaite shad (*Alosa fallax*) are particularly sensitive, with peak sensitivity around 100 Hz. In contrast, Atlantic cod (*Gadus morhua*) primarily responds to sounds above 500 Hz. While some species show reactions to pile driving up to 15 km away, others display little response. Nevertheless, modelling indicates that without noise mitigation, temporary hearing threshold shifts (TTS) in clupeids could occur up to 64 km from the noise source, and permanent threshold shifts (PTS) up to 5.2 km. With mitigation measures such as double bubble curtains (DBBC) or Hydro Sound Dampers (HSD), the TTS effect is reduced to a radius of roughly 3–14 km and PTS to less than 1 km. For twaite shad, the largest clupeid in the project area, juveniles weighing 25–100 g were most commonly caught, and these smaller individuals are less sensitive, experiencing impacts similar to those in herring.
- **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. These effects primarily threaten larvae and juveniles by disrupting feeding or spawning conditions. However, turbidity typically disperses quickly, and since spawning areas are concentrated in the coastal zone rather than at the offshore wind farm site, the overall effect is expected to be minor. In some cases, predators such as cod and flounder may even take advantage of these conditions to feed on juvenile fish.
- **Impact of foundation structures on habitats.** While this results in localized loss of benthic feeding grounds for species such as cod and flounder, the footprint of each foundation is small compared to the available habitat. Moreover, the introduction of hard substrates creates new opportunities for colonisation, effectively forming artificial reefs. These structures are expected to increase habitat complexity, provide shelter, and expand prey availability, ultimately enhancing fish diversity and abundance during the operational phase.

- **Noise and Vibration generated by WTGs and OWF service vessels.** Although less intense than construction noise, turbine operation generates continuous low-frequency sound comparable to that of large cargo vessels. Studies have shown that Atlantic salmon can detect turbine noise at distances of 0.4 km and cod at up to 13 km under moderate wind conditions. Avoidance behaviour has only been observed within a few metres of turbines, and generally at higher wind speeds. Substrate-borne vibrations may affect benthic and demersal fish, but evidence suggests only local-scale effects without large-scale displacement. Overall, operational impacts are considered minor, and in many cases, positive effects from reef-like structures outweigh the negatives.
- **Impact of electromagnetic fields.** While theoretically these fields could interfere with fish orientation and prey detection, multiple studies in the Baltic Sea and elsewhere have found negligible or no significant effects. For example, eel migration patterns and juvenile flounder development were not measurably disrupted in field experiments. Still, cumulative EMF impacts from multiple cable networks in the Baltic warrant ongoing attention.

In summary, the greatest risks to Baltic fish are associated with construction noise, particularly for clupeid species with high auditory sensitivity. Modelling suggests that unmitigated pile driving could affect fish over tens of kilometres, but with appropriate mitigation technologies the impact radius is reduced to a few kilometres. Sediment disturbance and EMF are expected to have minimal effects, while artificial reef creation may even provide long-term ecological benefits. Decommissioning poses similar but typically lower risks than construction, with noise from foundation removal and increased vessel activity being the main pressures.

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.

Underwater noise propagation modelling for fish species with specialised hearing adaptations showed that the application of DBBC and HSD during monopile installation substantially reduces noise impact. Single-strike sound exposure levels remain below thresholds causing TTS or permanent hearing damage. Behavioural reactions may still occur, but only within 10.8–15.2 km. Under cumulative exposure conditions, the risk area is reduced more than tenfold, with PTS potentially occurring only within 0.33–0.42 km. In practice, these measures are often used together with ADDs, which help prevent sudden exposure to harmful acoustic stimuli.

During the operational phase, wind turbine foundations are expected to have a positive effect by forming secondary habitats. These structures provide reef-like conditions that support additional prey species, potentially benefiting fish populations. Avoidance behaviour has only been observed within a few meters of operating turbines and mainly at high wind speeds. Once construction or decommissioning activities end, fish are expected to return to their usual feeding grounds, making impacts temporary.

In the decommissioning phase, high-intensity noise may again be generated. To reduce potential harm, gradual ramp-up of noise (soft-start) should be applied, allowing fish to move away before full-intensity work begins. As with construction, ADDs can be used in parallel to reduce risks. Low-noise foundation removal technologies, such as diamond wire saw cutting, are recommended instead of blasting, as these produce significantly less underwater noise.

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 5.4.9. 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:	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.
	OWF foundations and electrical cables	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	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	Installation of submarine power cables at a burial depth of at least 3 m to minimize electromagnetic field exposure.

			fish in early developmental stages			species possessing 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

	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.

5.4.7. Hydrobionts/Fish of inland waters of Lithuania

Survey methods and study area

The current ichthyofauna status for the EIA was evaluated using data collected in 2022. These studies, undertaken by the Nature Research Centre, Klaipėda University, and the Lithuanian Hydrobiologists' Society, focused on analysing fish community composition as a measure of inland water ecological status.

Fish composition, abundance, and biomass in Lithuanian rivers were assessed through electrofishing, following the CEN standard for water quality monitoring (EN 14011, 2003). This method is also aligned with the "Methodology for Fish Stock Research," 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 (Order No. D1-767, 25 September 2012). Captured fish were placed in aerated containers, identified to species level, and measured for length and weight before being released back into the same waterbody.

Information on invasive species was obtained from the Invasive Species Information System (<https://inva.biip.lt/>), ensuring that the assessment also covered potential risks associated with non-native fish populations.

The assessment of potential impacts on the river ecosystem applied an integrated methodological approach. This included analysing current ecological status and identifying vulnerable elements such as spawning grounds or habitats of protected species. Key factors considered were the type, duration, and seasonality of construction works, as well as the distance to sensitive habitats. The scale and significance of impacts downstream from the planned activity sites were also evaluated to determine broader ecological risks.

The survey focused on the Šventoji and Kulšė rivers, as these watercourses will be intersected by the planned export cable corridors.

Current state

The lower Šventoji River functions as a migration and spawning ground for anadromous species such as salmon (*Salmo salar*), sea trout (*Salmo trutta trutta*), and river lamprey (*Lampetra fluviatilis*). It also supports rare and protected species including brook lamprey (*Lampetra planeri*), Ukrainian brook lamprey (*Eudontomyzon mariae*), European bullhead (*Cottus gobio*), bitterling (*Rhodeus sericeus*), and spined loach (*Cobitis taenia*).

Electrofishing in 2022 recorded 11 species in the middle reaches, with roach (*Rutilus rutilus*) and bitterling (*Rhodeus sericeus*) dominant in abundance, and northern pike (*Esox lucius*) in biomass. Other common species were bleak (*Alburnus alburnus*), stone loach (*Barbatula barbatula*), gudgeon (*Gobio gobio*), sunbleak (*Leucaspis delineatus*), perch (*Perca fluviatilis*), minnow (*Phoxinus phoxinus*), and rudd (*Scardinius erythrophthalmus*).

The export cable corridor also crosses the Kulšė River, an important sea trout spawning site with high parr densities, alongside species such as stone loach, minnow, and gudgeon.

Within the PEA, only Twaite shad (*Alosa fallax*) and European smelt (*Osmerus eperlanus*) were recorded, both rare. Smelt migrate to the Curonian Lagoon from November to March, with schools forming north of Klaipėda Strait at 6–40 m depth.

Potential impact to inland waters fish communities

Open-trench cable laying across rivers can increase turbidity and noise, negatively affecting sensitive aquatic species. During operation, subsea cables may generate electromagnetic fields detectable by fish, potentially disrupting orientation during critical migration periods.

Within the PEA, only Twaite shad (*Alosa fallax*) and European smelt (*Osmerus eperlanus*) were recorded, both in low abundance. While construction activities may temporarily alter migration routes or cause local aggregations due to turbidity or underwater noise, impacts on these species are considered negligible.

River lampreys (*Lampetra fluviatilis*) are more vulnerable. They migrate actively from the sea into rivers between October and December, often selecting the first suitable spawning river encountered. Because lampreys use electroreception, strong electromagnetic fields from cables could act as barriers, disrupting migration and potentially fragmenting populations. The greatest risk is during their coastal accumulation and peak upstream migration.

The main environmental risk of HDD is the possible release of drilling fluids through subsurface fractures. Additives such as sodium hydroxide, synthetic oils, and polyamine-based inhibitors may reach rivers, smothering benthic habitats and threatening spawning grounds for *Lampetra fluviatilis* and salmonids located 2–2.5 km downstream. However, continuous monitoring and emergency response protocols substantially reduce this risk. HDD-related noise is of low intensity and localized, making significant behavioural effects unlikely.

Overall, HDD is expected to cause only short-term, localized effects with no long-term or large-scale consequences if proper safeguards are applied.

In smaller watercourses such as the Kulšė River and associated ditches, the open-cut method will be used for interconnector cables. This approach, involving dredging and bank disturbance, may increase sediment runoff and reduce water clarity, with temporary negative effects on fish and benthic invertebrate communities.

Preventive, mitigation, and compensatory measures

At the Šventoji River crossing, the project will use HDD, avoid in-stream excavation and thus preventing turbidity, sedimentation, and habitat disturbance. The main risk is accidental release of drilling fluids; therefore, environmentally safe additives are recommended.

Some fish and aquatic organisms are sensitive to HDD-related vibrations; therefore, cable installation should be avoided during salmonid (October 1 to January 15) and river lamprey (*Lampetra fluviatilis*, April 1 to May 15) migration and spawning periods.

The cables across the Kulšė River will be installed using an open trench method. To reduce impacts on fish communities, works should be scheduled outside peak migration periods and supported by sediment control measures, such as retention screens or equivalent technologies, to limit washout and turbidity.

Table 5.4.10. 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

Survey methods and study area

In June 2024, vegetation surveys were carried out along the planned export cable corridors on non-forest land. Thirteen survey sites were established within a 200 m buffer zone on either side of the routes, covering representative vegetation types. At each site, dominant plant species were identified in 10×10 m plots, and habitats were classified using the EUNIS system.

Data sources included:

- Habitats of European Community importance, grasslands, pastures, and wetlands (geoportal.lt datasets).
- Forest data from the Forest Cadastre.
- Invasive species records from the Invasive Species Information System. Field surveys confirmed the presence of Canadian goldenrod near the route.
- Protected plantations from the SLUC database (2018), supplemented with surveys in June 2024 and January 2025.

Potential impacts were assessed through a vegetation and habitat vulnerability analysis. Impacts were quantified by calculating the disturbed area (length × width of crossings) in sensitive habitats. Recovery potential was evaluated based on scientific studies (Weber et al. 2016; Klimkowska et al. 2007; Kiehl et al. 2010) and expert judgement.

The study area is ecologically diverse. From the shoreline to Būtingė, cable routes cross semi-natural meadows and pastures; further inland, they pass through Būtingė and Laukžemė forests before reaching intensively farmed land. Eight survey sites were placed in grassland/pasture habitats and five in agricultural areas.

Vegetation-related aspects were analysed up to 500 m from the routes, with detailed assessments within 200 m buffers.

Current state

Vegetation. In non-forested areas, the export cable corridors cross agricultural land. Up to Būtingė Forest, habitats consist of wet and damp grasslands where stands of reeds and tall sedges are common. Beyond Laukžemė Forest, the land is predominantly cultivated with monoculture crop fields. The habitats identified along the cable routes include moist eutrophic grasslands, agriculturally improved grasslands, sedge beds without standing water, and disturbed or fallow arable land. Degraded patches were also recorded, characterised by disturbance-tolerant species such as chamomile and knotweed.

Habitats of European Community importance. Several EC habitats are located near or within the corridors:

- Coastal dunes (embryonic, white, grey) are found at distances of 63–145 m from the cable routes.
- Lowland hay meadows are situated about 250–270 m away.
- Wooded coastal dunes are directly crossed by both corridors. The CN OWF route requires clearance of ~0.20 ha, while the "Area D" route affects ~0.33 ha. These habitats are dominated by mature pines and spruces.
- Western taiga and bog woodland habitats lie in close proximity, 5–121 m from the corridors, but are not directly crossed.

Forests. The cable corridors pass through Būtingė and Laukžemė forests, requiring a 20-m wide working strip. In the Palanga Forest District, the CN OWF route will clear ~2.36 ha of recreational forest, mostly semi-aged pine and birch stands. In the Darbėnai Forest District, it will clear ~1.25 ha of protective forest (mostly semi-aged and mature spruce and pine) and ~7.7 ha of commercial forest. The "Area D" route affects a similar area: ~2.29 ha recreational, ~1.22 ha protective, and ~7.76 ha commercial forests. Both corridors also cross the "Natura 2000" Baltijos Šventosios upė site: the CN OWF route over ~560 m (1.13 ha cleared) and the "Area D" route over ~550 m (1.09 ha cleared).

Meadows, pastures, wetlands. Natural grasslands, pastures, wetlands, and spring-fed wetlands occur within 45–472 m of the cable routes.

Protected vegetation. Two protected sites are crossed:

- A mixed stand of birch with alder and spruce (~0.012 ha).
- A group of three mature linden trees along Miškas Street (~0.012 ha), one of which is heavily damaged by rot.

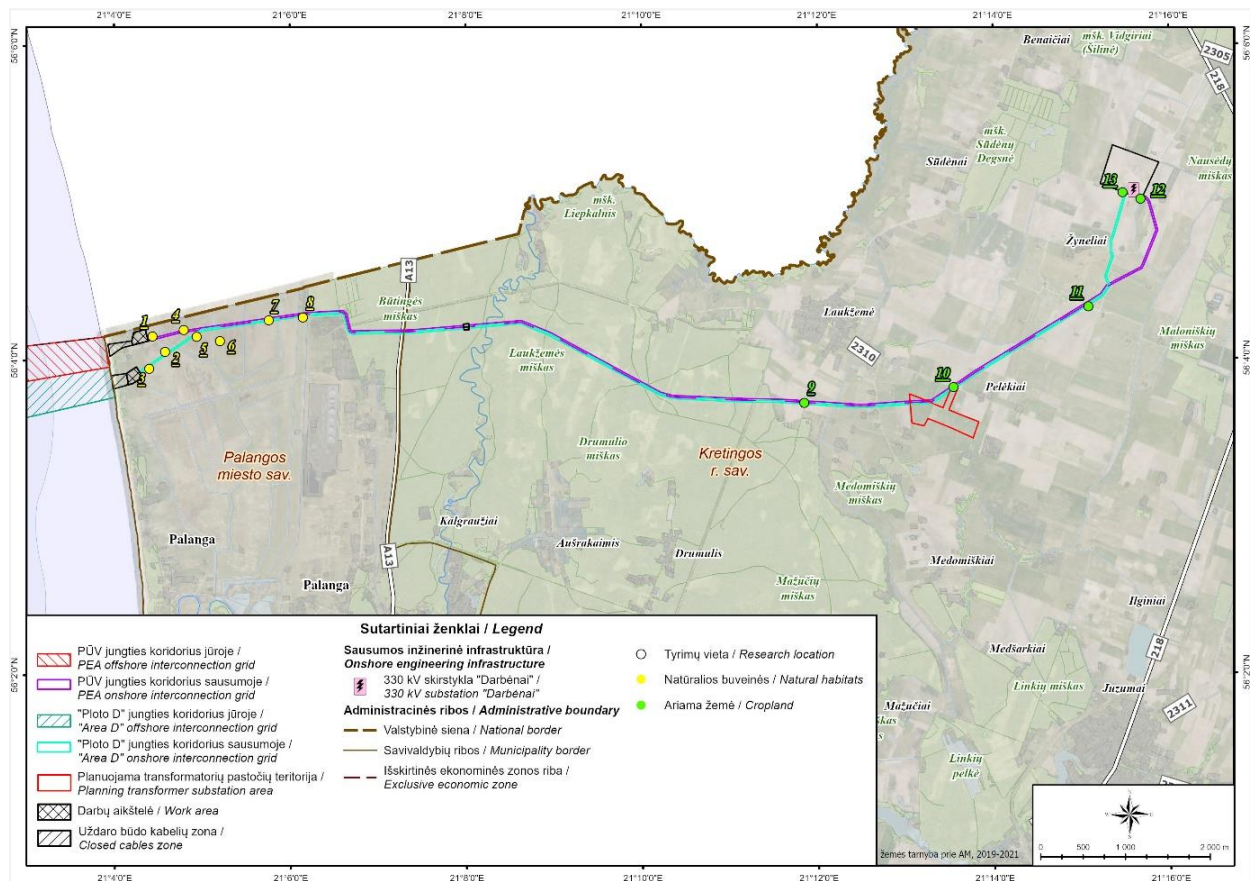


Fig. 5.4.11. Types of habitats identified according to the EUNIS classification.

Potential effects on vegetation and habitats

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.

Impact on habitats of European Community importance. The export cable landfall is 145 m from coastal sand dune habitats (2110, 2120, 2130), with trenchless installation ensuring no impact. In Būtingė Forest, the corridor crosses 2180 Wooded dunes, requiring ~0.53 ha of deforestation (151 m for CN OWF, 163 m for "Area D"). While herbaceous vegetation loss is temporary, forest removal is long-term, though post-construction reclamation may create ecotonal habitats beneficial for biodiversity. Other EC habitats (9010* Western taiga, 91D0* Bog woodlands) lie 5–121 m away and will not be directly affected.

Impact on forests. The export cable corridors will traverse the Būtingė and Laukžemė forests, requiring the clearing of a 20 m wide strip for each cable. In total, approximately 11.3 ha of forest will be cleared for the CN OWF corridor and 11.26 ha for the "Area D" corridor.

In the Palanga Forest District, this includes about 2.36 ha of recreational forest dominated by semi-aged stands, with smaller areas of young, semi-matured, and mature trees. In the Darbėnai Forest District, clearing will affect 0.12 ha of protective forest and 7.7 ha of commercial forest, mainly semi-aged and young stands, with smaller areas of semi-matured, mature, and over-matured trees. Additionally, within the "Natura 2000" Baltijos Šventoji upė site, about 2.22 ha of protective forest would be cleared if open trench technology were used.

Herbaceous vegetation will regenerate naturally after construction, so its loss is considered short-term. In contrast, deforestation is long-term and significant, as the forest will not return to its original state. However, after reclamation, the cleared areas may support ecotonal woodland and forest-edge communities, potentially enhancing biodiversity by benefiting species such as moths and other entomofauna.

At the Šventoji River crossing, two technological alternatives are foreseen. With open trench technology, deforestation would extend across the 20 m corridor, including access roads and storage areas, totalling over 2 ha of protective forest. With trenchless HDD technology, the cable would cross the river and Natura 2000 area underground, avoiding the need to fell any protective forest.

Impacts on natural grasslands, pastures, wetlands and spring-fed wetlands. These habitats are located at least 45 m and up to 472 m from the planned corridors. Since no works are planned within these areas, no direct impact is expected.

Impacts from invasive plant species. The nearest invasive plant population, Canadian goldenrod, is located 199 m from the corridor. Because it is outside the works area, construction is not expected to promote the spread of invasive species.

Impact on protected vegetation. Two types of protected vegetation will be affected. The corridor crosses a 0.14 ha mixed stand (birch, alder, spruce, with alder buckthorn and willows in the understory), which will be removed permanently. It also passes near a group of three mature linden trees (trunk diameters 60–120 cm). At least one linden may need to be felled, which would represent a long-term and significant impact.

Under the Lithuanian Law on Plantations, such removals require a municipal permit and compensation payment for the replacement value of protected trees. In this case, permission would need to be obtained from Kretinga District Municipality.

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:

- 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 plantations:

- 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 5.4.11. 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

	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.

5.4.9. Onshore fauna

Survey methods and study area

Breeding bird surveys were carried out along the planned export cable corridors from May to July 2024. To evaluate potential impacts, a 400 m buffer zone was defined (200 m on either side of the future cable route). The main focus was to identify the most sensitive and vulnerable bird species. Two types of surveys were conducted: searches for nests of birds of prey in the forests, and systematic breeding bird surveys along the planned cable alignment.

Additional data on fauna typical of the study area, including reptiles, amphibians, and mammals, were obtained from the national geoportal database. Information on invasive species was taken from the Invasive Species Information System.

Impact assessment relied on expert evaluation and integrated analysis of ecological status and sensitive components. Factors considered included the type, timing, duration, and distance of works in relation to habitats and nesting sites, as well as the potential scale of effects on areas downstream of the activity.

All forests within the 400 m buffer zone around the planned cable routes were surveyed for raptor nests. The broader fauna context was also analysed using Lithuanian National Atlas data, which classify the cable corridor and surrounding area within the Western European faunal complexes of mixed forests and agrarian landscapes. This includes the Baltic coastal sandy landscapes with halophilic elements, as well as the Samogitian–Curonian Highlands with spruce and mixed forests combined with agrarian habitats containing boreal fauna elements.

Current state

Birds. Breeding bird surveys were carried out from May to July 2024 within a 400 m buffer zone along the planned export cable routes. One nest of the Eurasian Sparrowhawk (*Accipiter nisus*) was found. In total, 76 bird species were recorded, with 649 territorial registrations. Passerines were most abundant, with Common Chaffinch (*Fringilla coelebs*) dominating in woodlands and Eurasian Skylark (*Alauda arvensis*) in open areas.

Among the recorded species, three are listed as Vulnerable by the IUCN (Northern Lapwing *Vanellus vanellus*, Common Redshank *Tringa totanus*, and Common Snipe *Gallinago gallinago*). Ten species are nationally protected, and 12 fall under Annex I of the EU Birds Directive. Sensitive meadow habitats in the western part of the study area supported rare species such as Citrine Wagtail (*Motacilla citreola*, n=6), Wood Sandpiper (*Tringa glareola*, n=2), and Northern Lapwing (*Vanellus vanellus*, n=14). Marsh and Montagu's Harriers (*Circus aeruginosus*, *Circus pygargus*) were observed showing territorial flights above reedbeds, though no nests were found. Activity of larger raptors, including Common Buzzard (*Buteo buteo*), European Honey Buzzard (*Pernis apivorus*), Eurasian Goshawk (*Accipiter gentilis*), and White-tailed Eagle (*Haliaeetus albicilla*), was noted, but no nests were detected.

Data from the national SRIS system indicate additional nearby records of protected species such as Common Merganser (*Mergus merganser*), Red-breasted Flycatcher (*Ficedula parva*), and Common Kingfisher (*Alcedo atthis*).

Mammals. Outside forests, the cable routes cross agricultural land and meadows that support small rodents, European hare (*Lepus europaeus*), badger (*Meles meles*), polecat (*Mustela putorius*), red fox (*Vulpes vulpes*), raccoon dog (*Nyctereutes procyonoides*), roe deer (*Capreolus capreolus*), and wild boar (*Sus scrofa*). Eurasian beaver (*Castor fiber*) and Eurasian otter (*Lutra lutra*) occur along rivers and canals. The surrounding forests provide habitat for red deer (*Cervus elaphus*), moose (*Alces alces*), and wild boar.

Amphibians and reptiles. Amphibian and reptile diversity is low but typical for the region. Common species include the common toad (*Bufo bufo*), common frog (*Rana temporaria*), and pool frog (*Rana lessonae*). Four reptile species are present: sand lizard (*Lacerta agilis*), viviparous lizard (*Lacerta vivipara*), grass snake (*Natrix natrix*), and slow worm (*Anguis fragilis*). Breeding occurs in spring in small ponds, wetlands, and bogs.

Invasive species. The only invasive mammal likely in the area is the American mink (*Neovison vison*), an introduced species that has spread widely in Lithuania. It inhabits riverbanks, wetlands, and coastal areas, preying on rodents, birds, amphibians, fish, and crustaceans. As the project does not alter habitats important for mink, no impacts are expected on its population.

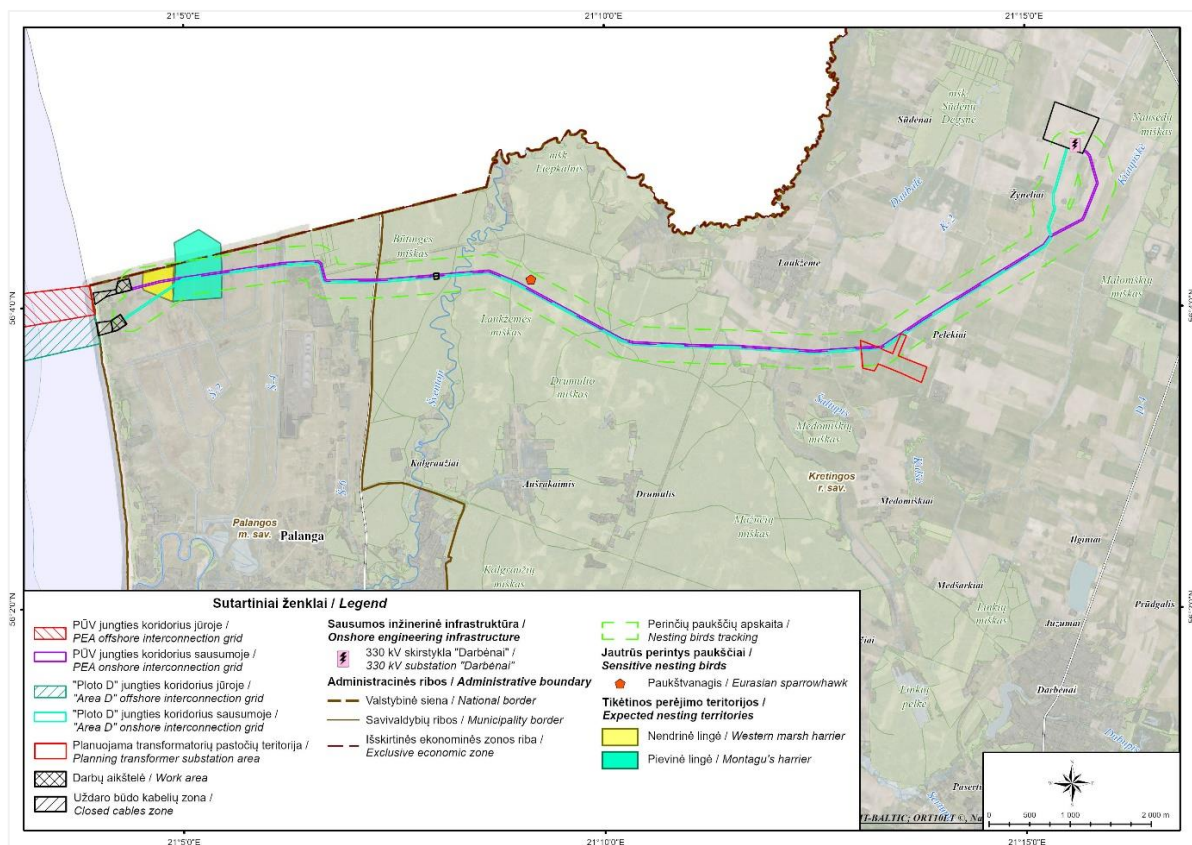


Fig. 5.4.12. Nests and possible breeding territories of Birds of Prey within survey area.

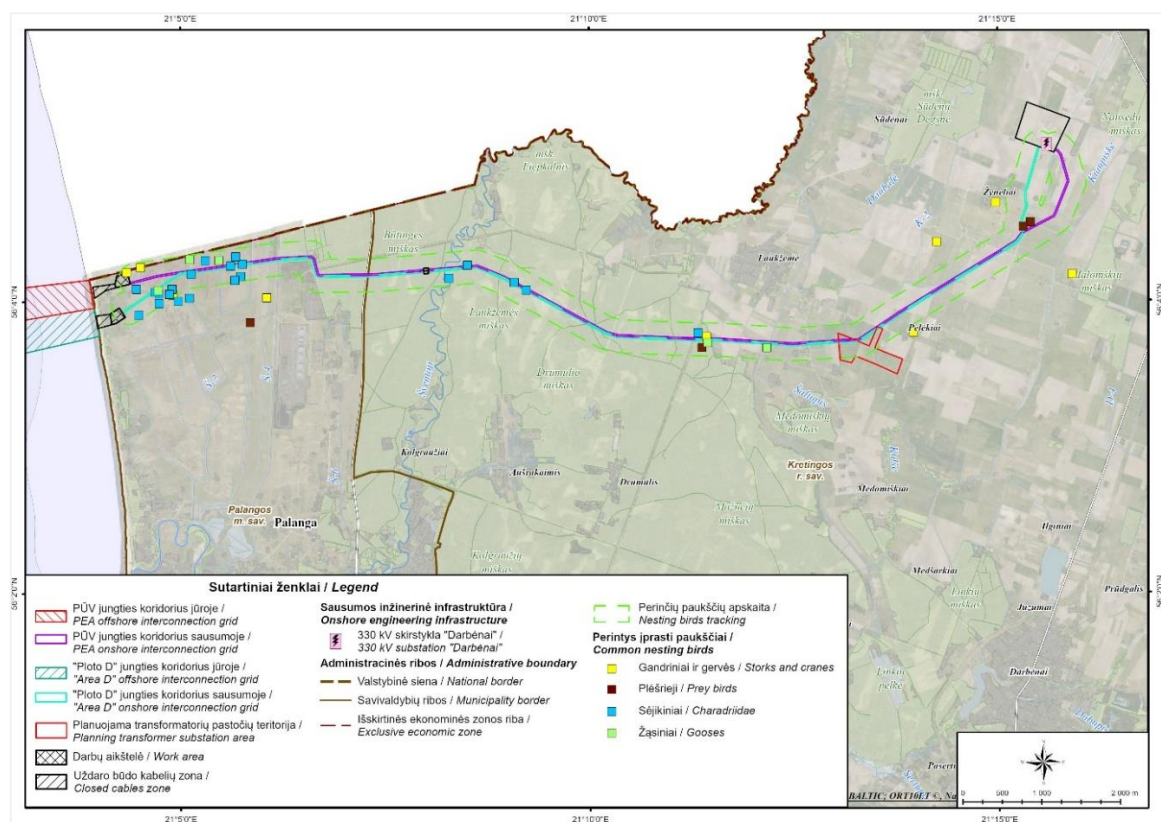


Fig. 5.4.13 a. Territorial bird registrations within survey area (1 of 2).

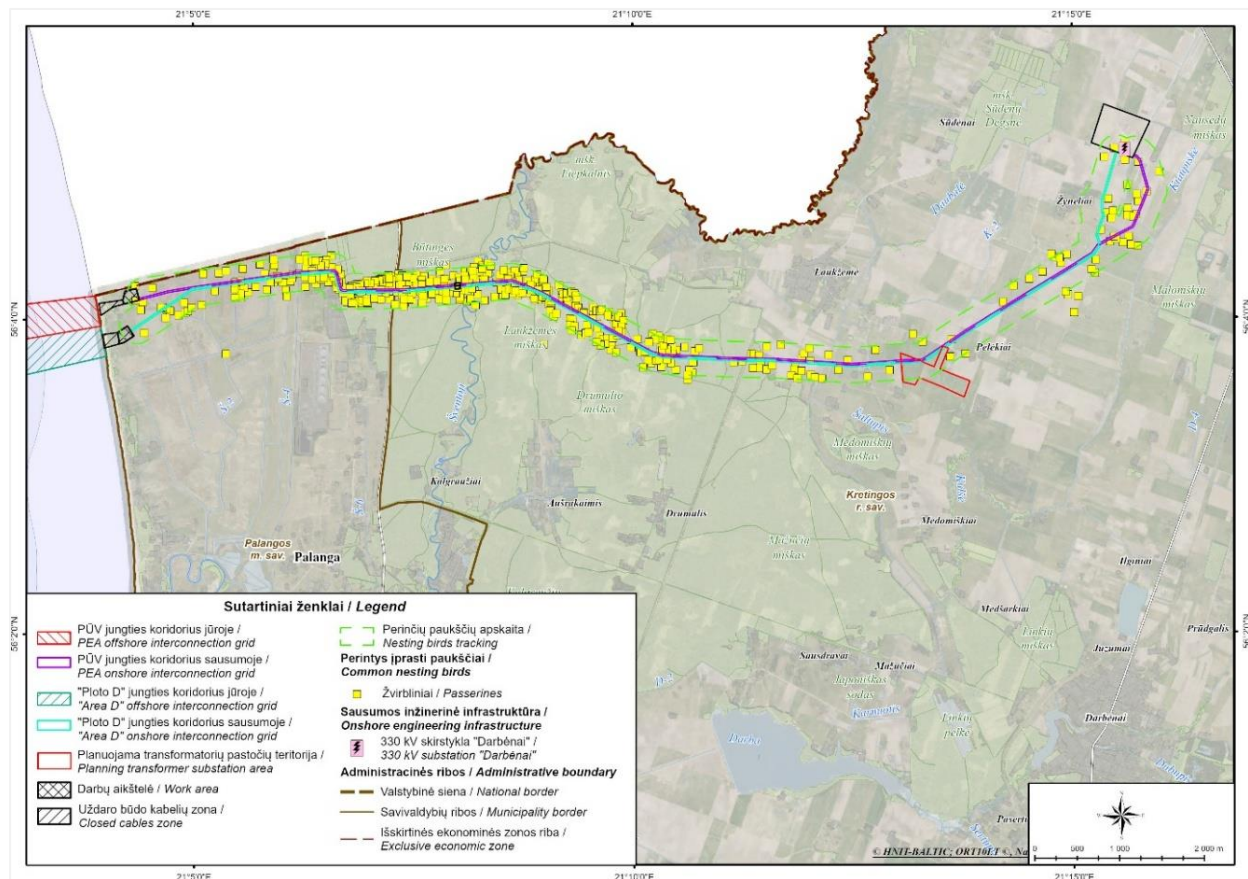


Fig. 5.4.13 b. Territorial bird registrations within survey area (2 of 2).

Potential Impact on onshore fauna

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.

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.

Game fauna and small mammals will mainly be affected by short-term disturbance. Larger mammals—especially predators tied to breeding sites—may be more sensitive. Disturbance during the breeding season (March–July), particularly early (March–April), could cause abandonment of offspring, leading to mortality. Roe deer, moose, and wild boar are also vulnerable to such impacts.

Preventive, mitigation and compensatory measures

Birds

- Maintain natural hydrological regime; if works affect it, schedule between November–February and restore immediately after cable installation.
- Check for Western Marsh Harrier and Montagu's Harrier nests before works; if found, restrict works within 500 m (April 1–August 31 for Western Marsh Harrier, April 15–August 31 for Montagu's Harrier).
- Carry out preparatory works (e.g., access roads) in the sensitive meadow zone only from November–February.
- Avoid tree and shrub cutting during the bird breeding season (March–July).
- If excavation is planned from March–July, first survey excavation and storage areas for breeding birds, conducted by a qualified ornithologist.

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.

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. Any works affecting it should be done November–February, and water levels must be restored immediately after cable installation.

Table 5.4.12. 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.

Stages	Impact	Nature	Scale	Duration	Importance	Mitigation measures
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 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.

Stages	Impact	Nature	Scale	Duration	Importance	Mitigation measures
	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.
	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 plankton community shows clear seasonality. In spring, phytoplankton is dominated by diatoms and dinoflagellates, with rotifers and copepods prevailing in zooplankton. In summer, cyanobacteria, green algae, and cladocerans (*Bosmina coregoni*) become abundant, while in autumn total biomass declines but diatoms may bloom again due to wind-induced mixing.

Survey methods and study area

Plankton was sampled in 2024 at eight evenly distributed stations within the PEA area.

- **Phytoplankton:** water samples collected from surface (0–10 m) and near-bottom layers, analysed with image-based flow cytometry.
- **Zooplankton:** samples from surface (0–25 m) and deep layers (to ~40 m) using standard nets, identified with automated image recognition.

The assessment considered:

- species composition across seasons,
- mean abundance and biomass (including size structure for zooplankton),
- comparison between surface and deeper layers.

Sampling was carried out at 8 stations on a 4.5 km grid, coinciding with F-POD recorders, covering the planned OWF area.

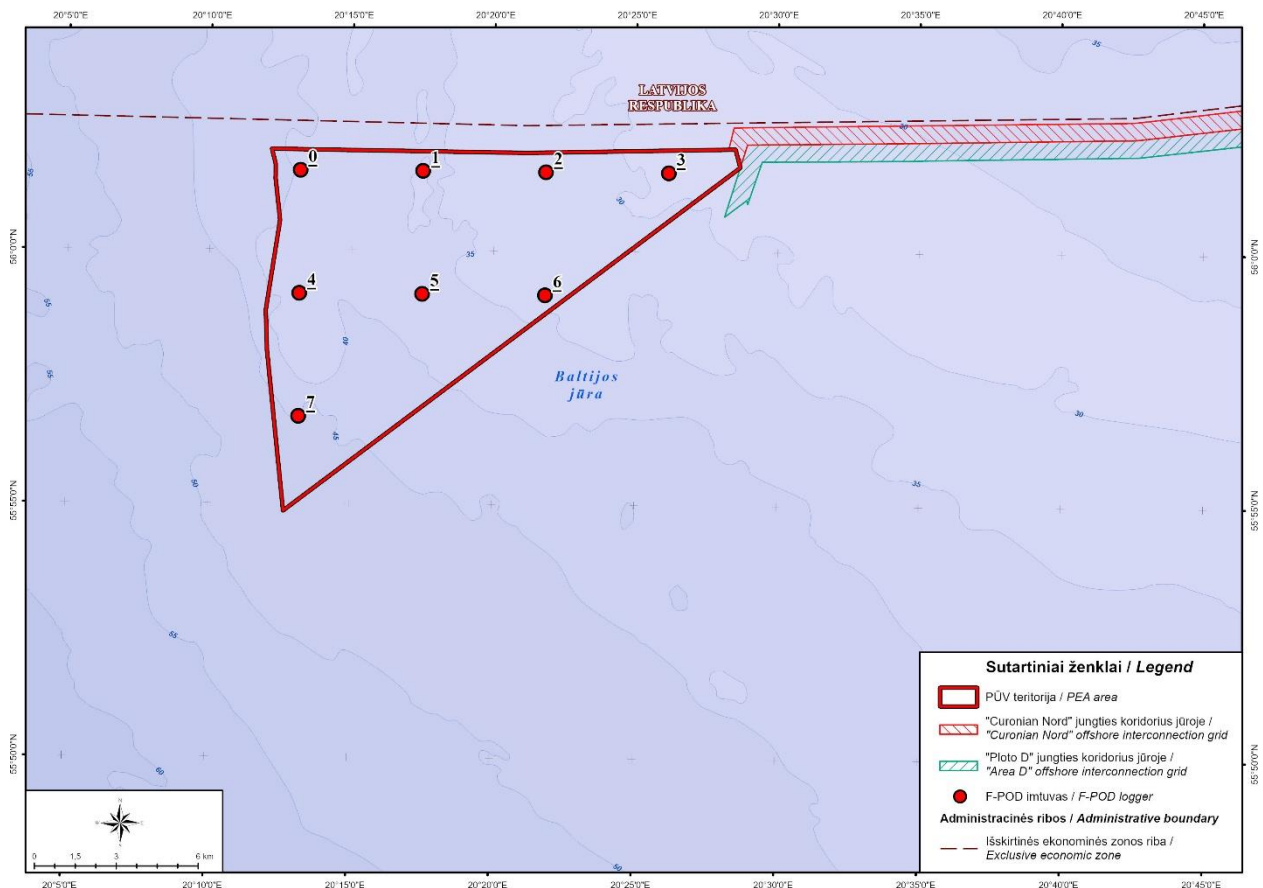


Fig. 5.4.14. Plankton sampling stations.

Current State

Phytoplankton. In summer (July 2024), phytoplankton was dominated by filamentous cyanobacteria, mainly *Nodularia spumigena* and *Aphanizomenon flosaquae*, forming surface blooms. These blooms significantly increased biomass in surface layers but were less represented at depth. Other groups (dinoflagellates, cryptophytes, green algae) were present in small amounts and grouped as "Others." Species diversity was similar across stations, with slightly higher biomass offshore than nearshore. In autumn (November 2024), diatoms dominated, mainly *Dactyliosolen*, *Cerataulina*,

and *Chaetoceros* spp. Biomass was lower overall, but mixing of the water column allowed uniform distribution between surface and bottom layers. No toxic diatoms were found, but high densities could affect fish gills or benthic organisms.

Zooplankton. A total of 12 zooplankton taxa were identified, mainly cladocerans (*Bosmina coregoni*) and copepods. *Bosmina* accounted for 50–90% of total abundance and was concentrated in the surface layer (0–25 m), reflecting favourable conditions above the thermocline. The community was dominated by small individuals (300–500 µm), with no organisms exceeding 1,000 µm.

Potential impact on plankton

Plankton dynamics are strongly influenced by water movements, light, and nutrient availability. Offshore wind farms can alter these factors, leading to localized but generally small changes compared to natural variability.

Potential impacts on phytoplankton:

- **Construction phase:** sediment resuspension increases turbidity, temporarily reducing light penetration but also releasing benthic algae into the water column. Impacts are short-term and minor.
- **Shipping:** turbulence, pollutants, and vibrations can affect phytoplankton directly or indirectly through food webs.
- **Operation phase:** turbines may alter currents, mixing, and stratification, affecting nutrient supply and phytoplankton distribution by up to ~10–20%. Shading reduces light, while underwater noise and reef communities on turbine structures may shift phytoplankton abundance and species composition.

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.

Potential impact on zooplankton

- **Construction phase:** Pile driving and cable installation generate impulsive underwater noise that can cause physiological damage or mortality in sensitive species, with studies showing zooplankton density reductions of up to 60% within 1 km of the source. Ship operations add further stress through underwater noise, turbulence, and pollutants, which may alter feeding, migration, and community composition. Combined effects can cascade through the food web, affecting higher consumers.
- **Operation phase:** OWFs may affect zooplankton indirectly through changes in hydrodynamics, stratification, and nutrient distribution, influencing food availability and biomass. Subsea cables generate electromagnetic fields, though effects on zooplankton remain poorly understood. Operational noise and vibrations are weaker than during construction but may still cause sublethal stress. Additionally, turbine foundations function as artificial reefs for filter feeders (e.g., mussels), which can reduce local phytoplankton and indirectly limit food resources for zooplankton.

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 International Maritime Organization (IMO), the EU Regulation on the use of biocides (528/2012).

Table 5.4.13. Summary of Potential Impact of the Offshore Wind Farm on phytoplankton and Impact Mitigation Measures for phytoplankton.

Phase	Activities	Impact	Type	Scale	Duration	Impact	Mitigation measures
Construction	Installation 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.
	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)	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
	Presence of OWF	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
		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.

Phase	Activities	Impact	Type	Scale	Duration	Impact	Mitigation measures
		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
		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 5.4.14. Summary of Potential Impact of the Offshore Wind Farm on zooplankton and Impact 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.

Phase	Activities	Impact	Type	Scale	Duration	Impact	Mitigation measures
		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 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.

Phase	Activities	Impact	Type	Scale	Duration	Impact	Mitigation measures
		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

	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

Survey methods and study area

The character and values of the local landscape, including recreational areas, were described using the National Landscape Management Plan, municipal general plans, biodiversity and conservation data, and relevant scientific and legal sources.

The assessment considered the extent of areas likely to be affected at sea, on the coast, and on land, as well as the importance of the affected landscapes and the scale of expected change. Key factors included the dimensions of new development compared to existing structures, impacts on unique protected areas, and potential changes to landscape diversity. Geo-ecological stability was evaluated by examining how the OWF relates to natural frameworks, while visual aspects focused on how the development might alter seascape perception in recreation and tourism areas.

Visual impact was assessed following Lithuanian methodologies (Abromas 2021; Kamičaitytė-Virbašienė & Godienė 2021) and international studies. The evaluation considered WTG height, location relative to the coastline, and sensitive viewpoints.

WindPRO 3.3 software was used to calculate vertical and horizontal viewing angles. Vertical Viewing Angle (VVA) indicates how much of the turbine is visible, while the Horizontal Viewing Angle (HOV) measures its spread across the view. For reference, values below 0.2° indicate very low visibility, while values above 2.8° are considered significant, and those above 5.7° very significant or dominant. Existing analogies, such as visibility of the Šilutė district wind farm from Juodkrantė and Nida, were also used for calibration.

The assessment was carried out at twelve selected observation points. The closest are Pape Beach in Latvia (36.8 km) and Palanga observation sites including the bridge and Fisherman's Daughters sculpture (37–38 km). Other key sites include Klaipėda Port (around 51 km), Juodkrantė beach (67 km), Nagliai Reserve (76 km), and Nida beach (83 km). These cover both regional panoramas and seascapes of high recreational value.

The report focuses on worst-case conditions: clear weather, peak tourist season, and maximum visibility. Under other conditions, impacts are considered negligible.

From a landscape perspective, the current state was assessed regionally, covering the OWF itself, the Lithuanian marine zone (territorial sea, Curonian Spit, Curonian Lagoon), and western Lithuanian coastal municipalities.

The OWF is located 36.8 km offshore in the Lithuanian EEZ, on the Klaipėda–Ventspils Plateau. Morphologically, the marine site lies within the East Baltic Shallow Sea submarine plateau seascape. On land, export cable corridors pass through the Western Baltic Lowlands (Seaside Lowlands) and the Curonian Spit, extending into the Western Samogitian Highlands.

Current state

Overall landscape character and values. The Lithuanian Baltic coastline is recognised in the National Landscape Management Plan as an area of high national-level aesthetic potential, with the most valuable stretches located at the Curonian Spit and Karklė. The coastal lowlands feature rare landscape types in Lithuania, including the forested Baltic coastal plain (0.27% of national territory), the protected Curonian Spit (0.16%), the Curonian Lagoon (0.64%), and the Nemunas Delta agrarian plain (1.23%).

The Curonian Spit, more than 50 km from the PEA, holds the highest landscape value, combining enclosed and open dune landscapes of strong vertical articulation. As both a National Park and a UNESCO World Heritage Site, it has global significance, with its silhouette and panorama from the Curonian Lagoon being central to its universal value.

Elsewhere, much of the coastal lowland east of the shoreline has only moderate visual quality. Views of the sea in Lithuania are scarce and exceptional, limited to beaches, the protective dune ridge, the Curonian Spit, Dutchman's Cliff, and dedicated observation sites. Coastal forests, which cover about 40% of the Baltic coastal plain, form the largest visual barrier. The protective ridge rises only slightly above its surroundings (10–12 m near Palanga, 2–4 m at Būtingė), limiting seascape visibility.

Currently, the Lithuanian Baltic Sea itself lacks permanent vertical structures; the horizon is shaped only by waves and passing ships, occasionally reaching heights of up to 70 m.

The natural framework of the Lithuanian Baltic Sea, its coastline, and shoreline. Lithuania's Natural Framework (NF) links ecological corridors, protected areas, and migration routes that maintain landscape stability. Regulations allow engineering infrastructure, including OWFs, within the NF.

The marine NF covers about 38% of Lithuania's sea area and consists of three geomorphological zones:

- Coastal slope and shallow nearshore (to 20 m depth): dynamic zone of sea–land interaction with valuable habitats.
- Elevations: such as the Klaipėda–Ventspils plateau and Curonian–Sambian rise, with shallower seabeds important for biodiversity.
- Depressions and valleys: including the Gdansk and Gotland depressions, which are deeper areas favourable for certain fish species.

On land, the Palanga City Master Plan identifies the export cable corridors as passing through weak geo-ecological pathways and regional migration corridors, while the Kretinga District Plan similarly shows crossings of regional pathways and corridors of differing ecological potential.

Existing recreational attractions. The Lithuanian coast has very high recreational and tourism value because most of the population lives far from the sea, making visits a relatively rare and special experience. The coast offers not only beaches but also elevated viewpoints and diverse seascape–landscape experiences. The westward orientation of Lithuania's coastline provides opportunities to observe sunsets directly over the sea, further enhancing its recreational appeal.

Potential impact on the landscape/seascape

Assessment of visual impact on the seascape. The planned OWF turbines could reach heights of up to 350 m. Two siting alternatives were analysed: a maximum deployment scenario and a more environmentally optimal layout. From the nearest observation points along the Lithuanian coast and at Pape beach in Latvia, the calculated vertical viewing angles (VVA) ranged between 0.43° and 0.47°. According to established thresholds, this is considered a low visual impact. At greater distances, such as Nida beach or Smiltynė quay, the OWF would not be visible or only marginally so. Under Lithuanian renewable energy legislation, such impacts are assessed as negligible.

The CN OWF will be located behind and further west than the already planned 700 MW "Area D" OWF. As a result, both wind farms will visually merge, making the CN OWF difficult to distinguish from existing offshore infrastructure.

Potential impacts on intrinsic landscape values. The OWF will occupy around 119.5 km² of marine space, which is only a small share of Lithuania's marine territory. However, it will introduce a new technogenic element into an otherwise open seascape. The wind farm will form part of the broader urbanised marine energy landscape emerging in the Baltic Sea, but its location within the submarine plateaus aligns with the priorities for marine area use set out in the Lithuanian General Plan.

Potential impact on the natural framework. Around 9,500 ha of the Klaipėda–Ventspils plateau, or 6.2% of this geomorphological unit within Lithuania, overlaps with the OWF site. As the project's density will not exceed 30% of any natural framework zone, impacts are expected to be insignificant.

Onshore, about 60% of the export cable route will pass through natural framework areas, including 4.8 km through the Būtingė and Laukžemė forests. Construction works such as excavation, spoil heaps, and material storage will cause temporary landscape disturbance. However, post-construction restoration is planned. Long-term effects will relate primarily to deforestation and habitat fragmentation, which may affect ecological connectivity and migration routes.

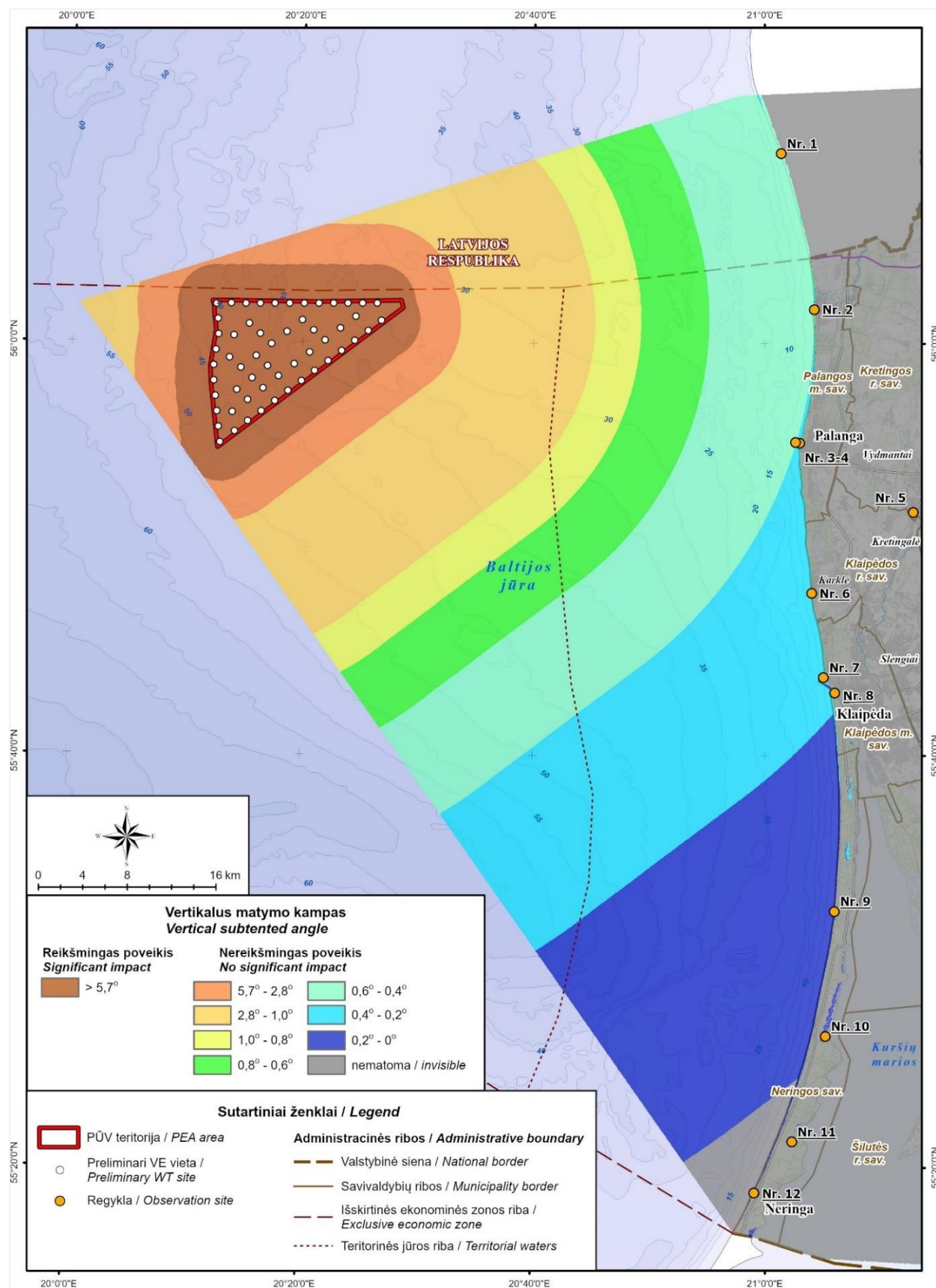


Fig. 5.5.1. Visual impact of 350 m total height WTGs based on the VVA (Alternative 2).

Cumulative impacts on the landscape

Future OWF projects planned in Lithuania and Latvia will add to the cumulative seascape changes. The CN OWF's horizontal viewing angle (HOV) from the Lithuanian coast is estimated between 13° and 20° in Palanga and Klaipėda areas, with slightly higher coverage when combined with "Area D" and other planned OWFs (up to 42–43° from Palanga viewpoints). The effect is most notable in Palanga during summer sunsets, when visitors observe the horizon. Elsewhere, such as Juodkrantė, Nida, and Smiltynė, the cumulative horizon coverage will be significantly smaller or absent.

Overall, while the CN OWF will contribute to the transformation of the open Baltic Sea into an emerging marine energy landscape, its direct visual impact is low, and cumulative changes will be most noticeable only at key coastal tourist sites.

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.

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.

Onshore

To minimise the potential impact on the landscape within the onshore PEA area, it is proposed to:

- Avoid placing temporary parking areas, soil storage, equipment, or construction material depots in or near pollution-sensitive areas (protected areas, wetlands, coastal strips, water protection zones).
- If vegetation removal is necessary, assess the need during technical design, minimize tree cutting, protect retained trees from damage, and restore disturbed areas after construction.
- After trenching, remove spoil heaps and stored materials, reclaim excavated areas with local tree species and grasses, and restore natural landforms.

5.6. Cultural Heritage

Survey methods and study area

The condition of underwater cultural heritage in the project area was assessed by reviewing whether any officially registered cultural heritage objects exist within or near the area, and whether other sunken objects of possible archaeological value are known. This included analysing registers of cultural heritage, nautical charts, and literary sources, such as notes from marine archaeologists on past battles and potential wreck locations. In addition, an archaeological assessment was carried out using side-scan sonar surveys in the OWF and export cable corridor, a field report on a discovered wreck possibly identified as submarine U-580, and video inspections using ROVs.

Registered immovable cultural heritage sites along the onshore corridor were identified using the Register of Immovable Cultural Properties. To check for unregistered assets, expert assessments and scientific background data were also used.

The evaluation follows the UNESCO 2001 Convention on the Protection of Underwater Cultural Heritage, ratified by Lithuania in 2006. Cultural heritage includes sites, structures, artefacts, vessels, aircraft, and prehistoric objects that have been underwater for more than 100 years. In practice, two main criteria are used when assessing a wreck: its age and whether it has significant cultural, historical, or archaeological value. According to Lithuanian law, only objects of such recognised value are subject to impact assessment. Modern anthropogenic objects without cultural or historical value are not considered.

The assessment focused on whether the export cable corridor intersects with registered cultural heritage properties and on identifying areas where archaeological supervision during earthworks will be required.

The study covered two zones: the 120.9 km² CN OWF site, located in waters 27–49 m deep, and a marine export cable corridor approximately 40 km long and 1 km wide, with depths ranging from 0–39 m. Geophysical surveys show the seabed is largely shaped by glacial and post-glacial processes, including ridges, boulder fields, sand ripples, scour marks, and depressions, indicating an active hydrodynamic environment. The onshore study analysed registered cultural heritage sites along the cable corridor, with a buffer of 500 m on either side.

Legal regulation

Under the United Nations Convention on the Law of the Sea (UNCLOS), States must protect archaeological and historical objects found at sea (Articles 149, 150, 303). In territorial waters, national laws apply; in the EEZ, only UNCLOS and general maritime law provisions are binding.

Lithuania also follows the UNESCO Convention on the Protection of the Underwater Cultural Heritage (2006), which prioritises in situ preservation, prohibits commercial exploitation, requires conservation of recovered heritage, and promotes international cooperation and non-intrusive access.

Nationally, the Law on the Protection of Immovable Cultural Heritage (1994, No. I-733) prohibits unauthorized detection, removal, or disturbance of underwater archaeological objects in Lithuanian waters, including the EEZ.

Onshore cultural heritage is also regulated by the same law, covering all immovable cultural values regardless of ownership. The Heritage Management Regulation PTR 2.13.01:2022 sets standards for when archaeological research is required, how it must be conducted, and how sites must be conserved, restored, or adapted.

Current State

The Baltic Sea seabed hosts numerous shipwrecks, remains of wooden ships, and natural relics such as subfossil trees and peat sediments that indicate Early Holocene habitation. Archaeological studies in neighbouring regions suggest potential for Stone Age finds, although no such sites are yet confirmed in Lithuanian waters.

Official sources list nine registered cultural heritage sites within Lithuania's marine territory, but none are located in the CN OWF area. The nearest registered site is the wreck "L-14" (ID 38471), 33.9 km away. A protected wreck "L-1" lies 1.9 km from the export cable corridor with a 500 m safety zone. Geophysical seabed surveys also identified one previously unrecorded shipwreck (ID 231123), later determined to lack archaeological value, though it remains a construction obstacle.

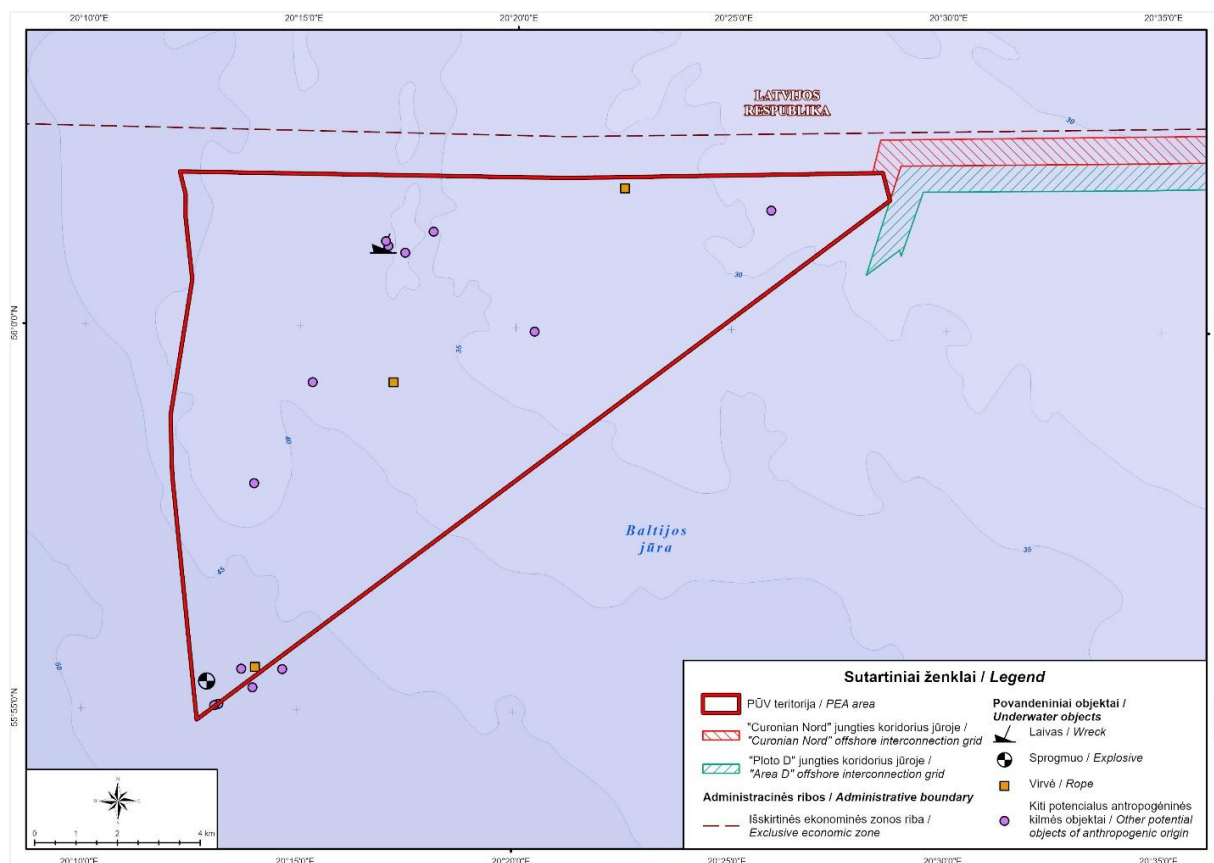


Fig. 5.6.1. Identified anthropogenic objects.

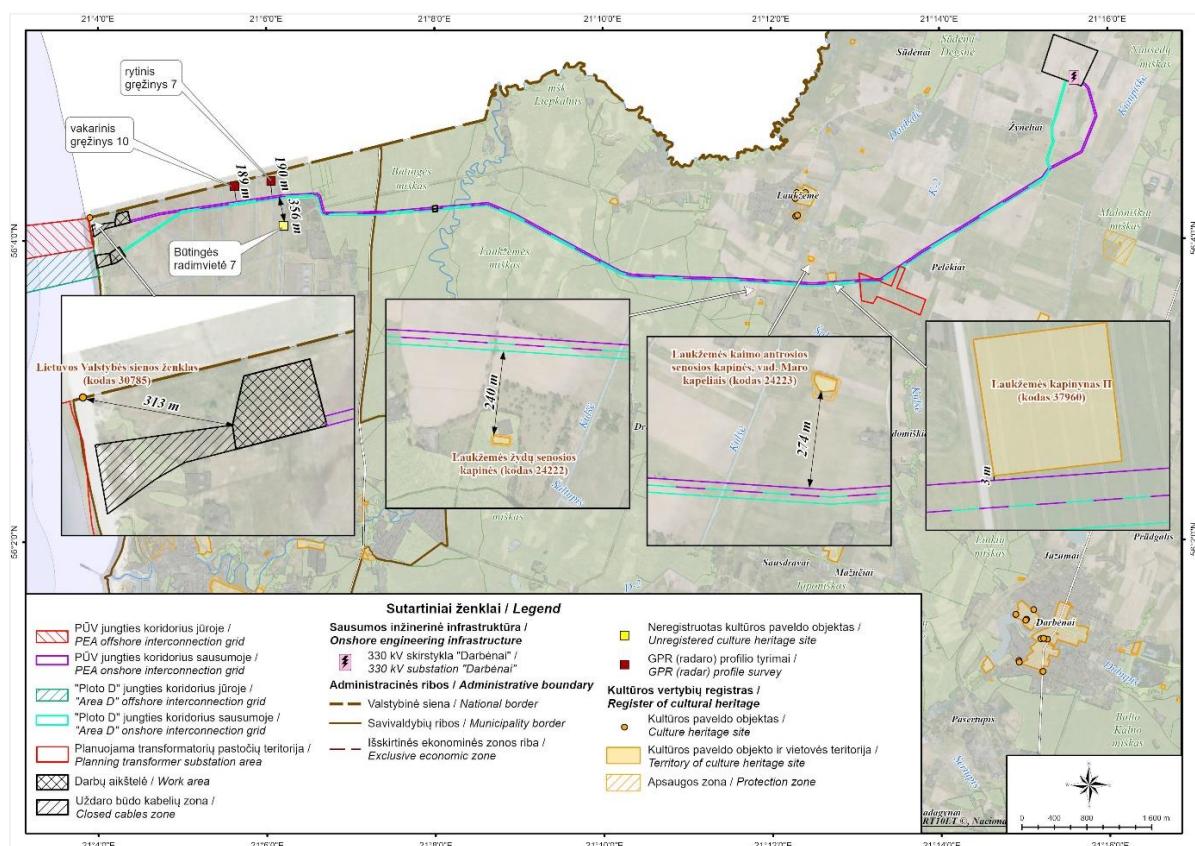


Fig. 5.6.2 Registered cultural heritage sites onshore.

Survey data recorded 5,783 magnetic anomalies; most were natural (boulders, ridges) or anthropogenic but insignificant (ropes, cables). Two linear features were confirmed as telecommunication cables. Overall, no valuable cultural heritage objects were found within the planned OWF site or cable corridor.

Onshore the planned export cable corridors do not cross registered cultural heritage sites but pass near three:

- Laukžemė Burial Ground II (ID 37960): The CN OWF route passes within 3 m of its southwestern edge. The site covers ~9,969 m², with disturbed cremation graves from past activities. Boundaries are unclear, requiring caution.
- Lithuanian State Border Marker (ID 30785): Located ~313 m from the planned landfall in Palanga, consisting of a reinforced concrete pillar with historic significance.
- Būtingė Site 7 (unregistered): Flint finds discovered in 2013 suggest an unprotected archaeological layer ~356 m from the "Area D" corridor. Archaeological research is recommended before major works.

Potential impact on cultural heritage values

Offshore, export cable corridors will not cross registered cultural heritage sites, and no negative impacts are expected. Most wrecks in Lithuanian waters are industrial vessels, though some wooden ship remains of scientific value exist. Based on registered property locations, known wrecks, and survey data, no destruction or loss of heritage value is anticipated.

Onshore, the export cable corridors and the Pelėkiai Transformer Substation will involve earthworks that could affect nearby heritage. The corridors do not cross registered cultural sites but pass within 3 m of Laukžemė Cemetery II (ID 37960) and ~340 m from the unregistered Būtingė Site 7.

To prevent impacts, archaeological investigations must be conducted during the design phase. Their scope will be defined by qualified archaeologists under Heritage Management Regulation PTR 2.13.01:2022. As construction affects more than 5 ha, archaeological surveys will be mandatory in all areas of topsoil removal.

Measures for the protection of cultural heritage values

Marine cultural heritage must be considered in planning activities. In the study area, no objects of cultural value or monument status were found. The only wreck discovered (ID 231123) is not an archaeological artifact, though its type and age remain undetermined. While not a protected heritage site, it poses a physical obstacle to the planned PEA. A protective buffer of at least 50 m around the wreck, based on sonar data, is recommended to ensure safe OWF and cable placement while preventing accidental damage.

Export cable corridors were selected to avoid areas with cultural heritage value. Activities that could physically damage or obstruct such objects are not planned. If archaeological finds or valuable features are discovered during earthworks, works must be halted and reported to the municipal heritage protection unit and the Department of Cultural Heritage, which may suspend activities for up to 15 days to assess and determine protection requirements.

Table 5.6.1. 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

	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 5.6.2. 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

	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.

5.7. Public health

According to the Law on Public Health Care of the Republic of Lithuania, any activity that may pose risks to human health must undergo an impact assessment. The objective is to identify and evaluate possible effects of the PEA on public health and propose mitigation measures.

Survey methods and study area

The nearest residential and public areas are in Klaipėda City, Klaipėda District, and Palanga. The closest settlement is Palanga, located 36.8 km from the OWF site. The OWF is located far from shore and residential areas. Since no sensitive receptors exist in the marine environment, no offshore public health impacts are expected.

Onshore the assessment used demographic and morbidity data from the Institute of Hygiene (July 2025). The nearest residential and public buildings along the cable corridor were identified through the Real Property Register. Noise dispersion from the planned ONS was modelled using CadnaA software in accordance with EU and Lithuanian standards. Electromagnetic field impacts were evaluated using data from analogous transformer substations. Potential impacts are assessed within Palanga City and Kretinga District, along the export cable corridors and at the Pelėkiai Transformer Substation. The closest receptors are located 75–732 m from the onshore cable route and 117–293 m from the substation.

Current state

The planned installation of the export cables and the Pelėkiai Transformer Substation may generate noise, electromagnetic fields, and air pollution, which could affect diseases of the nervous, circulatory, respiratory, and digestive systems. Sensitive groups include children, the elderly, pregnant women, and chronically ill residents. However, no residential or public buildings are located within the excessive impact zone of the planned facilities, meaning no local population is considered at direct risk. Occupational health and safety measures will apply to construction workers.

The export cables and substations are designed to maintain safe distances from residential, public, and recreational areas. The closest houses are located 55–732 m from the cable routes and 117–293 m from the substation boundaries. The nearest public facility is Laukžemė Church, about 812 m away. One planned residential area (Medomiškiai village) lies 38 m from the cable corridor and 193 m from the substation.

Potential impact on public health

Offshore. During construction, emissions to air will be limited to short-term, local outputs from construction machinery and vehicles. These will comply with legal requirements, and offshore conditions will ensure rapid dispersion, preventing any impact on coastal residential areas.

Temporary noise increases may occur during OWF and cable installation, but these will be localised and short-lived, with no expected health effects.

Onshore. The onshore corridors pass through Palanga City and Kretinga District. The planned export cable corridors and the Pelėkiai Transformer Substations may affect health through air pollution, noise, and electromagnetic fields. During construction, short-term and localised emissions from vehicles and machinery may slightly increase concentrations of carbon monoxide, nitrogen oxides, sulphur dioxide, hydrocarbons, and particulate matter, but impacts will remain insignificant. Noise from trenching and equipment may also increase locally for about three months; effects are short-term and not significant for public health.

For transformer substations, modelling shows noise levels near residences could reach 33–49 dBA, slightly exceeding night-time limits in some places. With planned noise barriers, levels will be reduced to 33–43 dBA, ensuring compliance with hygiene standards.

Electromagnetic field modelling, based on measurements at Klaipėda substation, indicates electric field strengths up to 0.058 kV/m and magnetic flux densities up to 0.399 μ T, far below permissible values (0.5–1.0 kV/m and 20–40 μ T). No EMF-related health impacts are expected.

Overall, potential health impacts are assessed as short-term, localised, and insignificant during construction, with compliance ensured during operation through technical measures.

Measures to prevent, reduce and compensate for public health impacts

If noise levels during construction exceed the limits set in HN 33:2011, mitigation will include barriers, restricted working hours, optimized equipment use, and prior notification of local residents.

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 5.7.1. 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

	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 5.7.2. 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

Survey methods and study area

The current condition was assessed using cartographic materials, nautical charts, land maps, feasibility studies, Lithuanian GP 2030, and sectoral strategies. Impacts were evaluated by analysing spatial and functional compatibility of the OWF with existing marine and land activities, considering conflicts, constraints, and potential synergies.

The survey area covers Lithuania's territorial waters, EEZ, and onshore zones in Palanga City and Kretinga District. At sea, activities include fishing, shipping, sand extraction, dredged material dumping, recreation, and existing infrastructure, alongside restricted-use zones and cultural heritage sites. Onshore, the area includes planned export cable corridors to the Darbėnai 330 kV switchyard, crossing land uses, forests, recreational zones, heritage sites, protected areas, and security zones. The area was defined to ensure OWF development aligns with other uses and legal requirements.

Current state: sectors of the economy potentially affected by OWF development

Marine activities in the Lithuanian EEZ and territorial waters include fishing, shipping, dumping of dredged material, sand extraction (including beach nourishment), recreation (diving), engineering infrastructure (pipelines, cables, installations), restricted-use areas (military training sites, wrecks, cultural heritage), and prospective resource extraction. Onshore, the main activities are agriculture and recreation. The OWF will contribute significantly to Lithuania's energy independence strategy, requiring harmonisation with other sea and land uses.

Fishing sector. The OWF area overlaps 1.66% of ICES rectangle 40H10 and 1.82% of 41H10. Fishing intensity is low due to unsuitable seabed and the EU ban on cod fishing (until at least 2030). The OWF export cables cross the 29th coastal fishing sector, where about 40 t of fish are caught annually, mainly round goby (>60%), Baltic herring, and smelt. Annual catch value between 2012–2022 varied from €3,000 to €22,000. Compensation mechanisms exist for restrictions.

Shipping. Lithuania's two main navigation routes serve Klaipėda Port (about 7,000 ships annually) and the Būtingė oil terminal (90–100 tankers). The OWF is outside international shipping lanes, with the nearest corridor 340 m away. Export cables will cross shipping lanes without significant conflicts. Relevant coastal anchorage points include the Būtingė terminal and Šventoji port roadstead.

Dumping of dredged material. Two marine dumping sites operate near Klaipėda Port: one 11 nautical miles southwest (13.9 km², used since 1987) and one 6 nautical miles northeast (sandy material). Since 2001, 400,000 m³ of sand has been used for coastal nourishment near Palanga. All sites are more than 38 km from the OWF.

Recreational resources. Palanga and Šventoji beaches are about 36.8 km from the OWF. Coastal tourism activities include cruise shipping, recreational boating, fishing, and diving (mainly at wrecks >20 km from OWF). Trenchless cable installation ensures recreational zones (beaches, dunes, bathing areas) are not impacted.

Engineering infrastructure. The area contains the Būtingė oil terminal buoy and 7.3 km pipeline with 1 km safety zone, two TeliaSonera submarine cables (Šventoji–Gotland, Šventoji–Liepāja), and the NordBalt HVDC interconnection. A new Lithuanian–Polish HVDC cable, "Harmony Link," is planned. Export cables bypass the buoy and major HVDC routes but intersect TeliaSonera cables.

Restricted and hazardous areas. Part of the OWF lies within a former minefield zone. Lithuania's EEZ also contains military training ranges and WWII wrecks. Thorough seabed surveys and decontamination will be required before construction.

Chemical weapons. After WWII, 40,000 t of chemical munitions were dumped in the Baltic, mainly in the Gotland Deep (~70 nautical miles from Lithuania's EEZ). No direct risk to the OWF is expected. Monitoring projects (CHEMSEA, MODUM, DAIMON) confirmed arsenic traces and depleted benthic fauna but no significant wider marine impact.

National security zones. The OWF area falls within a territory subject to construction restrictions due to national security requirements, meaning project approval must be coordinated with the Lithuanian Armed Forces. Measures may include investment sharing, technical mitigation (radars, monitoring systems), or compensation agreements. The area is outside designated radar protection zones.

Onshore use of PEA area. Export cables (13.5 km for CN OWF and 13.6 km for "Area D") will cross Palanga and Kretinga municipalities to the Darbėnai 330 kV switchyard.

Potential impact on material assets

Fisheries and fishing. In the OWF area, impacts include reduced fishing grounds and restrictions on active methods such as trawling, which will be prohibited to protect export cables. Passive gear may be allowed under agreements between the developer and fishermen. The area (119.5 km²) is a very small share of Baltic fishing grounds, and restrictions are not expected to cause major losses. Historically, trawling has not taken place in the area due to unsuitable seabed; fishing with set nets has been limited, with cod catches collapsing since 2017 and cod fishing banned since 2019. Cod recovery is unlikely before 2030. Construction noise, particularly pile driving, may affect pelagic species. It is recommended to schedule pile driving in May–August, outside peak fishing season. OWF structures may provide positive effects by functioning as artificial reefs, increasing biodiversity and spawning potential.

In nearshore cable corridors, restrictions will apply during construction and operation. Nets will be restricted above buried cables due to anchor damage risk. Compensation mechanisms also apply here under the Law on Fisheries.

Protection zones for transmission cables and substations. According to the Law on Special Land Use and Conditions (SLUC):

- Underground cable lines: 2 m protection zone on each side.
- Underwater cable lines: 100 m on each side, including water column.
- ONSs, switchyards, converter stations: protection zone equals built-up area and airspace above.
- Transformer units or switching points: 5 m zone around.

Prohibited activities in protection zones include construction of residential or public buildings, markets, transport stops, storage of hazardous materials, parking or storage of vehicles and machinery, public events, blocking access to grids, kite flying or drones (unless for maintenance), spraying chemicals, hot works, and material storage not related to grid.

Activities requiring prior approval from the grid operator include construction, reconstruction, mining, dredging, vegetation planting or removal, irrigation, hot works, installing parking, use of vibration machinery, changing land elevation, anchoring in cable zones, or driving overheight vehicles under overhead lines.

Preventive, mitigation and compensatory measures for the impact on material assets

- Support for local communities.
- Compensation for losses to fishermen.
- Former minefields and other hazardous zones require detailed seabed surveys before design works. If dangerous objects are found, decontamination must be carried out.
- Compensation for easements on land plots within export cable corridors must follow the procedure established by the Government of Lithuania.

6. RISK ANALYSIS AND ASSESSMENT

Risk analysis (RA) of the planned OWF evaluates potential emergency situations and their impact on the social and natural environment.

Offshore risks to people and the social environment include hazards from rotating turbine blades, possible tower collapse, and electrical voltage exposure to personnel. Collision risks exist for aircraft and ships operating near WTGs. Environmental risks include potential oil leaks from turbine rotors, ship fuel spills, and leaks from offshore substations.

Onshore risks involve accidents in export cable corridors and transformer oil leaks or fires in transformer substations.

Methodology

RA requirements are set in Annex 1, Section 9 of the EIA Procedure (Order No. D1-885, 2017). RA must identify hazardous objects, infrastructure, residential and recreational areas, and zones of natural or industrial risk near the PEA. It must also assess how external events may affect PEA continuity.

Offshore risks. Key factors: nearby OWFs, shipping lanes, Būtingė terminal pipelines and anchorage, coastal fishing sectors, Palanga/Kretinga residential and recreational areas, underwater pipelines and cables, minefields, WWII weapon zones, and radar protection areas near Palanga airport.

Onshore risks. Relevant elements: transport and utility networks, oil and gas pipelines, highways, Palanga airport, residential and recreational territories, industrial and chemical storage zones.

RA process and methodology consists of three stages: hazard identification (HAZID), risk assessment (magnitude/probability), and risk acceptability. Hazards include use of oils and waste, equipment failures, transport accidents, terrorism, extreme weather, and energy/communication interruptions. Risk matrices are applied at the EIA stage, with mitigation proposed for higher risks.

Data sources. Methodologies, maps, planning documents, accident statistics, and population data. Risks are grouped as: social, environmental, property, and business continuity.

Incidents in OWFs. G+ Offshore Wind HSE data show construction is the riskiest phase. In 2024: 1 fatality, 99 lost-time injuries, 57 restricted work day injuries, 74 medical treatment injuries, 442 first aid cases. Main causes: lifting operations, manual handling, maintenance, equipment failures, and operator errors.

Climate-related risks. Soil liquefaction risk exists in Lithuanian seabed (dusty sands, loams). IEC and DNV GL standards require reinforced turbine design.

Risk management strategies. According to PMBOK®: avoidance, escalation, transfer, mitigation, and acceptance. For Lithuanian OWFs, focus on the five riskiest processes: lifting, worker transfer, ship operations, work at height, and electrical works. RA results must be integrated into design and construction planning.

Current status: PEA adjacencies and activities within them

Offshore, risk objects include economic activities near the OWF, shipping channels and anchorages, cables and pipelines, security-related territories, and archaeological objects including WWII UXO. Onshore risks relate to infrastructure (oil and gas pipelines, roads, electric cables), natural features (rivers, marshes, sandbanks), security areas (testing grounds, airports), and hazardous facilities (chemical storage, factories). Some objects are both risk factors and vulnerable elements, such as ships in shipping corridors or sunken explosives.

Distances to shipping and port facilities. The OWF does not fall within international shipping lanes or anchorages. Distances: 340 m to Latvia lane, 16.9 km to Šventoji/Būtingė terminal anchorage, 20.3 km to Sweden lane, 24 km to planned transit corridor, 30.1 km to Būtingė terminal buoy, 40.1 km to Klaipėda LNG anchorage.

Engineering facilities. The Būtingė terminal has a 1,000 m radius water area and 300 m safety zone along its 7.3 km pipeline. Export cable corridors are 374 m from the buoy zone and 362 m from the pipeline zone. Two TeliaSonera submarine cables intersect the planned export cable corridors: the 218 km BCS East-West (Šventoji–Sweden) and the 97.8 km BCS East (Šventoji–Liepāja). Other cables (Kaliningrad–Russia, NordBalt, Harmony Link) are outside the PEA influence.

Commercial fishing areas. The OWF lies within ICES areas 40H10 and 41H10. Trawling starts 2 km south; intensive zones lie 20 km further. Export cables cross the 29th coastal fishing ground near Latvian waters.

Dredged material dumping sites. Designated dumping sites for Klaipėda port sediments are more than 40 km from the PEA, posing no risk.

Recreational areas. Tourism services include cruises, inland boating, fishing, and diving. The nearest diving zones are over 30 km from the PEA.

Restricted and hazardous areas. The PEA overlaps a zone of former minefields; Lithuanian waters also contain WWII munitions and military training ranges.

Territories important for national security. The OWF site falls in an area where construction must be coordinated with the Lithuanian Armed Forces, with possible cost-sharing agreements or technical mitigation.

Adjacent PEA areas onshore. Export cable corridors run from the coast to the Darbėnai 330 kV switchyard, crossing oil pipeline and road protection zones, the Šventoji River, and the 110 kV Palanga–Skuodas overhead line. A Pelėkiai substation is planned nearby. Tree felling will be required in forested areas. The nearest agricultural facility is ~180 m away; a medium-hazard warehouse recorded in 2008 has been demolished. Flood risk from rivers and drainage channels is negligible, with cables installed ≥ 1 m below watercourse beds. Crossings will be coordinated with Orlen Lietuva and Litgrid, and all works will follow construction and safety standards.

Natural and catastrophic meteorological phenomena offshore and onshore. Winds of 28–33 m/s are classified as storm-force, while winds above 33 m/s are hurricane-force. On average, 35 such events occur annually, each lasting 20–30 hours. The strongest recorded wind reached 40 m/s in Nida in 1999. LiDAR measurements near Palanga (2022–2024) registered maximum speeds up to 37.8 m/s at 280 m altitude. Other risks include dense fog with visibility below 100 m, icing over 35 mm, sea waves above 6 m, and floods affecting cable routes. Local earthquakes up to magnitude 4–5 and soil liquefaction in thixotropic sediments are possible.

Risk objects and hazardous factors

Key risk objects include WTGs, OSS, export and inter-array cables, onshore substations, and vessels. Internal hazards are structural failures, fires, oil spills, and electrical leakages. External hazards are shipping corridors, fishing grounds, existing cables and pipelines, the Būtingė terminal, military zones, UXO sites, aviation, and bird collisions. Natural factors are storms, hurricanes, icing, fog, and strong waves. Human errors and deliberate actions may also increase risk.

People at risk include construction workers, service staff, ship crews, passengers, and aircraft pilots, with possible injuries or fatalities. Environmental components at risk are marine and freshwater bodies, soil, and air due to spills, leaks, or fires. Birds may collide with turbine blades. Property risks include WTG collapse, cable damage, ship or aircraft accidents, and loss of equipment.

During construction and dismantling, possible events are accidents involving machinery and ships, spills of fuel or oil, failures of lifting mechanisms, collapse of towers under installation, electrical leakages, and worker falls. During operation, risks include tower collapse, rotor blade ejection, nacelle fires, oil spills, foundation settlement, and electrical failures. External threats are ship or aircraft collisions with WTGs, detonation of UXO, and sabotage. Natural hazards include strong winds, hurricanes, icing, fog, large waves, earthquakes, and soil liquefaction.

Preventive measures include restricting work under extreme conditions, training and safety instructions, prohibition of uncoordinated activities in protection zones, UXO surveys and clearance, reinforced foundation design, installation of fire detection and extinguishing systems, and coordination with defence and safety authorities.

Qualitative risk assessment of predicted hazardous events

Risk assessment follows the FRD recommendations (Order No. 1-189, 2011) and evaluates both probability and potential consequences. Probability is scored from 1 to 5: very low (<1 in 100 years), low (1 in 50–100 years), medium (1 in 10–50 years), high (1 in 1–10 years), very high (more than once per year). Impacts are scored separately for human health (P1), property and environment (P2), and business continuity (P3), from insignificant (1) to catastrophic (5).

For natural hazards in the Baltic Sea, strong winds of 28–33 m/s, dense fog, severe storms, hurricanes above 33 m/s, and waves over 6 m are assessed as high-probability (4–5 points). Earthquakes and soil liquefaction are rated low to very low (1–2 points). Onshore, very strong winds and hurricanes are also considered highly probable (4–5 points).

For technological hazards, 52 potential events were identified: 16 during construction/dismantling offshore, 31 during offshore operation, and 5 onshore (2 during construction, 3 during operation). Most construction-related hazards have low or very low probability (1–2 points), though fuel spills, collisions, lifting accidents, and electrical leakages are rated medium (3 points). During operation, bird strikes on turbines, oil or fuel spills, fires, structural collapses, cable damage, and collisions are identified, with a few rated medium to high probability.

Impacts on human health are mostly limited (2 points: 1–5 injuries), with significant impacts (3 points: up to 5 deaths or 10 injuries) possible in 23 of 52 events, including falls from height, vessel collisions, electrical failures, fires, and rotor damage. No events exceed this category, as workforce exposure is limited and permanent staffing is absent offshore.

Property impacts range from insignificant (losses up to EUR 0.1 million) to significant (EUR 0.2–1 million). Offshore construction hazards such as vessel collisions, cable damage, UXO detonation, and aircraft strikes may cause significant losses even with low probability. During operation, 14 offshore events with significant impacts were identified, including turbine collapse, OSS fires, ship collisions, and UXO migration. Onshore, impacts are mostly insignificant or limited.

Environmental impacts are generally insignificant or limited. A single event with very high impact was identified: tanker collision with OWF and oil spill, rated very low probability. High-impact events include potential collisions at the Būtingė terminal. Most other events involve small spills or localized pollution.

Business continuity impacts range from insignificant (<6 hours disruption) to very large (3–30 days). Offshore construction hazards caused 5 major disruptions (1–3 days). Offshore operation hazards include 3 very large events (OSS fire, OSS foundation tilt, export cable failure) and 1 major event (tanker collision and oil spill). Onshore, one major disruption was identified (export cable failure).

The FRD risk matrix ($R=T \cdot P$) was applied. Hazards rated as high risk offshore include electrical leakage during OSS construction, OSS fires in operation, export cable damage, and tanker collision with oil spill. Onshore, high risks are electrical leakages at ONSs (construction and operation) and export cable damage. Medium risks include vessel collisions, worker falls, lifting accidents, rotor ejection, and UXO detonation.

High and very high risks require preventive and mitigation measures in design and operation, including structural reinforcement, UXO clearance, fire protection, electrical safety systems, and emergency planning. Medium risks require ALARP measures (reasonable and cost-proportionate). Acceptable risks may be monitored and reassessed during RA reviews.

Risk and consequence assessment of ship collisions with wind turbines

Shipping risk assessment follows established methodologies, including those of MARIN, Germanischer Lloyd (GL), and DNV. Collision probability depends on traffic intensity, navigation direction relative to the OWF, and navigational error. Models calculate potential collisions adjusted by causality or navigational error factors.

In 2022, about 460 large vessels passed through nearby corridors. The nearest shipping corridor is 340 m from the OWF boundary, with the main navigation flow 3.8 km away. Based on traffic intensity and error rates, the probability of collision with the OWF is approximately $7.4E-05$ per year, or once every 13,500 years. The risk from drifting vessels is reduced by prevailing winds and distant anchorage locations. Collisions with fishing, service, or recreational vessels are unlikely to cause major damage; the probability of collision with small fishing vessels in a 500 m protection zone is about once every 5,000 years. Service vessel operations are considered safe due to low speed and controlled access.

Consequences vary by ship type. Collisions with dry cargo or passenger ships are expected to have limited to large impacts, while tanker collisions could cause significant oil spills with major environmental consequences. Oil contained in turbines or substations is minimal, but ship fuel and cargo present the greatest pollution risk. A major tanker accident could affect up to 10% of the Lithuanian coastline between Šventoji and Palanga.

Individual risk indicators (IRPA) for crew and passengers remain well below accepted thresholds. For example, the calculated annual individual fatality risk for passengers is $8.45E-09$, compared to the acceptable threshold of $1.00E-06$.

As low as reasonably practicable (ALARP) principle and risk reduction measures. Most OWF-related ship collision risks fall into the ALARP zone, requiring cost-effective mitigation. Recommended measures include establishing a 300–500 m safety zone marked with buoys near shipping corridors, continuous UXO seabed monitoring due to drifting mines, and an emergency management plan covering extreme weather and other hazardous events. Additional ALARP measures involve staff training, use of best available technologies, and application of industry good practice guidelines.

Preventive measures during construction, operation and dismantling

To reduce risks of ship collisions or cable damage, entry into the OWF water area will be restricted. During technical design, shipping authorities will be consulted to define safety zones, publication of navigational warnings, routing, areas to be avoided, surveillance systems, and marking of structures with AIS, lighting, and radio beacons. In military zones, design is coordinated with the Lithuanian Armed Forces; no special prohibitions are foreseen.

Navigation rules for service vessels will be established with the Water Transport Department. Construction areas will be announced through navigational messages and illuminated at night. Continuous monitoring by radar and vessels on duty will reduce collision risk. Construction dates near shipping lines, especially cable laying, will be coordinated. The same approach applies during dismantling.

During operation, the OWF control centre will operate 24/7 with GPS and turbine data, coordinated with the LNM RCC, which manages search, rescue, and pollution response. A pollution and rescue plan will define notifications, communication, shutdown/start-up, response forces, and equipment, tested regularly through exercises. The OWF may be included in the national list of facilities required to have local pollution response plans, coordinated with municipal and national institutions. Three levels of pollution incidents are foreseen, depending on scale and required response. Rescue and emergency plans will include evacuation routes, medical support, and procedures for accidents during construction, operation, and dismantling.

The OWF will comply with national fire safety regulations. Each WTG will have automatic control, braking, storm control, lightning protection, and lighting systems. Manual and automatic shutdown options will be provided. Fire extinguishers will be placed in WTG towers and nacelles. Fires are considered rare and typically contained to nacelles or substations; oil quantities are limited. Generator units are insured, and extinguishing burning nacelles is not planned, though automatic systems may be installed if specified in the technical design.

Export to the grid will use at least two main and two backup cables. Burial depth, safety zones, and distances between cables will follow technical standards. OSS devices will include concrete oil collection pits, and ONSs will connect 220–330 kV lines. Lightning protection, 3.5 m access roads, fencing with warning signs, and automatic safety equipment will be installed. Periodic inspection and maintenance of ONSs and connections will be conducted. Impacts are contained within substation boundaries, and final preventive measures will be specified in the technical design.

7. ANALYSIS AND EVALUATION OF ALTERNATIVES

Assessment method

The comparison of offshore wind farm (OWF) development alternatives is based on the concept of sustainable development. Alternatives are assessed across three equally weighted dimensions: economic growth, societal well-being, and environmental quality, ensuring that no single dimension is prioritized over the others.

The impact on each component is evaluated by significance and weighted importance (%). Significance is determined using both quantitative indicators and qualitative aspects.

Impact assessment values are as follows:

- Significant positive = +3, significant negative = -3
- Moderately significant positive = +2, moderately negative = -2
- Slightly significant positive = +1, slightly negative = -1
- Neutral impact = 0

From a sustainable development perspective, the aggregated indicator is calculated by summing the economic, social, and environmental scores, with each dimension assigned equal weight (one-third).

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 reflects the current environmental status without project implementation. In this case, changes in the Baltic Sea would not result from the OWF. However, EU and national energy and climate objectives, including NECP targets for GHG reduction, would not be achieved.

The development alternative foresees the installation and operation of an OWF with a capacity of up to 700 MW in the area approved by Government Resolution No. 171. A larger capacity may be installed if environmental restrictions and legal requirements are met.

The export cable corridor to the 330 kV Darbėnai Switchyard (Žyneliai village, Kretinga district) is analysed as per the Engineering Infrastructure Development Plan. No other routes are assessed. The export cable corridor for Area D is also analysed from the OWF boundary to the Darbėnai Switchyard. Other route options are not considered.

The EIA analysed advanced offshore WTGs up to 20 MW capacity or more, reflecting regional technology trends. Maximum parameters considered: tower height 170 m, rotor diameter 300 m, total tip height 350 m.

Two layout alternatives were assessed:

1st alternative – maximum development: up to 68 turbines across the entire OWF area, geometrically distributed.

2nd alternative – optimal development: up to 55 turbines, with setbacks 2 km from Natura 2000 boundaries and sensitive seabed habitats.

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 was made.

The evaluation of alternatives shows that in terms of water quality both options are equivalent, as impacts are limited to local and temporary turbidity during construction, without long-term effects. Ambient air and climate benefits are the same for both alternatives, with significant positive contributions to greenhouse gas reduction. Impacts on the seabed are similarly local and minor, arising from foundation installation and cable laying, and do not differ between alternatives.

The effect on the landscape is also comparable, since the OWF is located 36.8 km offshore; turbines may only be visible under exceptional visibility conditions, which does not exceed thresholds for significant impact. Differences become more evident when considering biodiversity. While both alternatives cause temporary disturbance to benthic habitats and fish during construction, the optimal alternative requires fewer turbines and shorter cable routes, thereby

reducing the disturbance of reef habitats and minimizing impacts on Natura 2000 areas. The same applies to bird species, where the optimal alternative lessens disturbance and habitat loss compared to the maximum alternative.

When comparing the aggregated results for the natural environment, the maximum alternative scores –1.10, while the optimal alternative reaches –0.35, indicating that environmental impacts are notably reduced under the second option.

From the perspective of marine use, both alternatives lead to the same restrictions: trawling becomes impossible in the OWF area, and some coordination with the Armed Forces is required, but no significant navigation impacts are expected. Cultural heritage and natural resource components show no differences, with protective buffers and additional investigations applied in both cases when needed. For the social environment, both alternatives achieve strong positive results of +0.90, reflecting significant contributions to energy security and no substantial negative impacts on cultural heritage or resources.

The economic dimension shows the highest positive scores. Both alternatives score strongly, with +3.00 for the maximum and +3.00 for the optimal development, driven by investment, job creation, local community support, and major contributions to energy independence. The maximum alternative is slightly stronger in direct economic viability, but the optimal alternative ensures the same long-term strategic benefits with lower environmental trade-offs.

In summary, the maximum alternative provides higher turbine numbers and potentially greater economic return, but with stronger environmental impacts. The optimal alternative balances economic and social benefits with significantly reduced environmental effects, achieving a higher sustainable development indicator (0.93 vs 1.18), and therefore aligns more closely with the principles of sustainable development.

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 (ideally 49).
- No construction and, where possible, no cable installation will occur in the most valuable benthic habitats.
- 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 valuable benthic habitats and applying additional impact mitigation measures for bird protection areas, 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.

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 and by applying the prescribed environmental impact mitigation measures.

Main Measures to Avoid, Reduce and Compensate for Environmental Impacts

The environmental mitigation framework for the CN OWF and export cable corridors covers offshore and onshore activities across all project phases – planning, construction, operation, and decommissioning.

Waste. During technical design, waste amounts will be forecasted and a management plan prepared. Construction and operation waste will be sorted, collected in containers, and delivered to ports for transfer to licensed handlers. At decommissioning, most OWF components will be reused or recycled; the remainder will be disposed of in approved facilities under Lithuanian law.

Water. Pollution control includes baseline and follow-up water quality monitoring around construction sites, environmentally safe corrosion protection, and oil-separating systems at substations. Runoff will be monitored and stopped if oil concentrations exceed 7 mg/l. Onshore, trenchless methods (HDD) will be used at sensitive river crossings, avoiding direct disturbance of water bodies. No work will occur within 25 m of protected water zones.

Air. Ships must comply with MARPOL standards. During construction and operation, low-emission machinery is required, and dust suppression rules apply for bulk material transport and storage.

Seabed, Subsurface, and Soil. Environmentally friendly excavation and backfilling methods will be used to reduce seabed disturbance. UXO surveys will be conducted, and sensitive topography avoided where possible. Onshore, fertile soil layers will be stored and reused, compacted soils restored, and only sound machinery allowed to prevent leaks.

Protected Areas and Natura 2000 Sites. Offshore, a 2 km buffer will be maintained from the Klaipėda-Ventspils Plateau site. Displaced boulders and gravel will be reused to restore reef habitats, and artificial reef plates installed where appropriate. 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). 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. Onshore, trenchless methods will be used at the Šventoji River SAC, and no cable works will occur during sensitive fish migration or spawning periods.

Habitats and Vegetation. Cable trenches will be backfilled with original sediments. In meadows and forests, restoration will use local soils and natural regeneration, avoiding non-native seed mixes. Compensation for forest loss and protected greenery removal will follow national legislation.

Birds. WTGs must be set back 2 km from Natura 2000 boundaries. Construction, dismantling, and cable works are restricted during bird migration and overwintering periods. Lighting will be adjusted to minimize attraction. Compensatory measures include seabird GPS/GSM tagging and support for safer fishing practices to reduce bycatch.

Bats. Migration monitoring will be carried out using detectors. Compensatory shelters will be installed in at least 10 coastal foraging sites.

Marine and Terrestrial Mammals. Pile driving will use soft-start and acoustic deterrence methods, with DBBC or HSD noise-reduction systems. Service routes will follow designated shipping lanes to limit disturbance. During decommissioning, monopile cutting technologies will minimize noise. Onshore, excavation must avoid harming young mammals by gradual soil movement.

Fish. Noise mitigation and soft-start piling will be used during construction and decommissioning. HDD methods are applied at river crossings, with seasonal restrictions during spawning and migration of salmonids and lampreys. Sediment control screens will reduce turbidity.

Landscape. WTGs will be painted in low-contrast tones to reduce visibility and glare. Construction sites will avoid sensitive areas, and disturbed landforms will be restored with local vegetation.

Cultural Heritage. Offshore wreck ID 231123 will be protected with a 50 m buffer. Onshore, export cable routes avoid cultural heritage sites. If finds are discovered during earthworks, authorities will be notified immediately.

Public Health. No direct mitigation is required, as OWF operations are far offshore and away from residential zones. Onshore substations will include noise-reducing barriers (approx. 35 m long, 6 m high).

Material Assets. Support for local communities is ensured through levies distributed to coastal municipalities. Fishermen are compensated for losses under national rules. Onshore, landowners affected by servitudes for export cable corridors will receive compensation according to legal procedures. After OWF decommissioning, dismantling must ensure safe restoration of fishing opportunities and prevent marine debris from abandoned structures.

8. MONITORING

The CN OWF in the Lithuanian EEZ, together with its onshore transmission grid connection and the “Area D” OWF export cable, will impact various environmental components. To manage these effects, a comprehensive monitoring programme is required. The purpose of monitoring is to observe, assess, and predict impacts on the natural environment and ensure reduction of pollution or other negative effects. The monitoring programme must be prepared and agreed with the EPA before construction and should cover construction, operation, and decommissioning phases, following HELCOM guidelines. The “Area D” OWF cable monitoring will be integrated into the broader monitoring programme of the “Area D” OWF.

Outline of monitoring for the CN OWF and its onshore transmission grid connection

Underwater noise monitoring. Noise monitoring is mandatory during foundation installation. The aim is to assess effects on marine organisms and the efficiency of noise reduction. Standards applied include ISO 18406 and DIN SPEC 45653, with monitoring distances of 750 m and 1500 m. The scheme must be detailed in the technical design.

Water monitoring. Baseline current and water quality measurements are required before construction. Pollutant concentrations (e.g., heavy metals, hydrocarbons) must be tested before, during, and 3–6 months after construction to ensure compliance with environmental standards.

Seabed monitoring. Detailed seabed investigations will be conducted before construction at foundation and cable sites. During operation, inspections will focus on structural safety. Sediment quality testing should be conducted after construction, regularly during operation (6–12 months), and after decommissioning.

Monitoring of seabed habitats in protected and Natura 2000 areas. Annual monitoring along export cable corridors will assess habitat recovery, using indicators such as substrate type and *Mytilus trossulus* colony condition. Results will be compared with EPA (2023) and PTPI (2024) surveys.

Zoobenthos monitoring. Sampling will be performed after construction at 5–7 sites in the project area and 3 reference sites. During operation, monitoring at 6–7 sites will include quantitative sampling and vertical gradient surveys using video or colonization plates.

Monitoring of seabirds and bats. Bird and bat monitoring will be conducted during construction and for three years after, then repeated every five years in two-year cycles. Significant impact is defined as a >20% decline from natural long-term bird population fluctuations. Migratory bird counts will use radar, acoustic recorders, and ship/aircraft transects. Bat monitoring will rely on detectors installed on structures and coastal comparison sites.

Marine mammal monitoring. Monitoring will cover seals and harbour porpoises across all project phases, including abundance, habitat use, noise levels, and diversity.

Baltic Sea fish monitoring. Fish monitoring will assess abundance, diversity, habitat condition, noise levels, pollutant concentrations, and invasive species across all lifecycle phases. Methods may include telemetry, acoustic monitoring, and eDNA analysis.

Monitoring of plankton will allow tracing changes in total and relative abundance and biomass of different phytoplankton species as well as zooplankton species composition, abundance, and size.

Monitoring of the “Area D” OWF’s connection to the onshore transmission grid

Annual monitoring will be conducted along the export cable corridor to assess habitat recovery, using EPA (2023) and PTPI (2024) baselines for comparison. The recovery will be evaluated by indicators of the physical environment (substrate composition, ratio of stable reef-specific to mobile substrates) and the biological environment (*Mytilus trossulus* colony size, abundance, and associated species diversity).

9. INFORMATION ON POTENTIAL SIGNIFICANT TRANSBOUNDARY IMPACTS

The Espoo Convention requires a transboundary EIA for large wind energy installations. In Lithuania, the Ministry of Environment (MoE) coordinates this process. In September 2024, the MoE notified Latvia, Estonia, Finland, Sweden, Denmark, Germany, and Poland about the planned CN OWF. Latvia, Denmark, Finland, Sweden, and Germany agreed to participate in the procedures and submitted comments, while Estonia declined formal participation but requested EIA documents. Transboundary consultations and proposals are summarised in Annex 9 of the EIA report.

The CN OWF area is located 0.9 km from the Latvian EEZ, 69 km from the Swedish EEZ, and 35.8 km from the Russian EEZ. Localised impacts are expected on water, air, seabed, cultural values, and public health. From a transboundary perspective, the most relevant aspects include biodiversity (especially bird migration), landscape visibility, shipping, fisheries, and potential oil exploration restrictions.

Impact on Natura 2000 sites. Latvia's "Natura 2000" sites Nida-Perkonė (23.5 km) and Papė (36.9 km) lie closest to the OWF. The northern onshore cable corridor runs within 120 m of Papė SAC/SPA. These areas are critical for bird and bat habitats, including species such as great bittern, Eurasian curlew, and pond bat, as well as several protected waterfowl species.

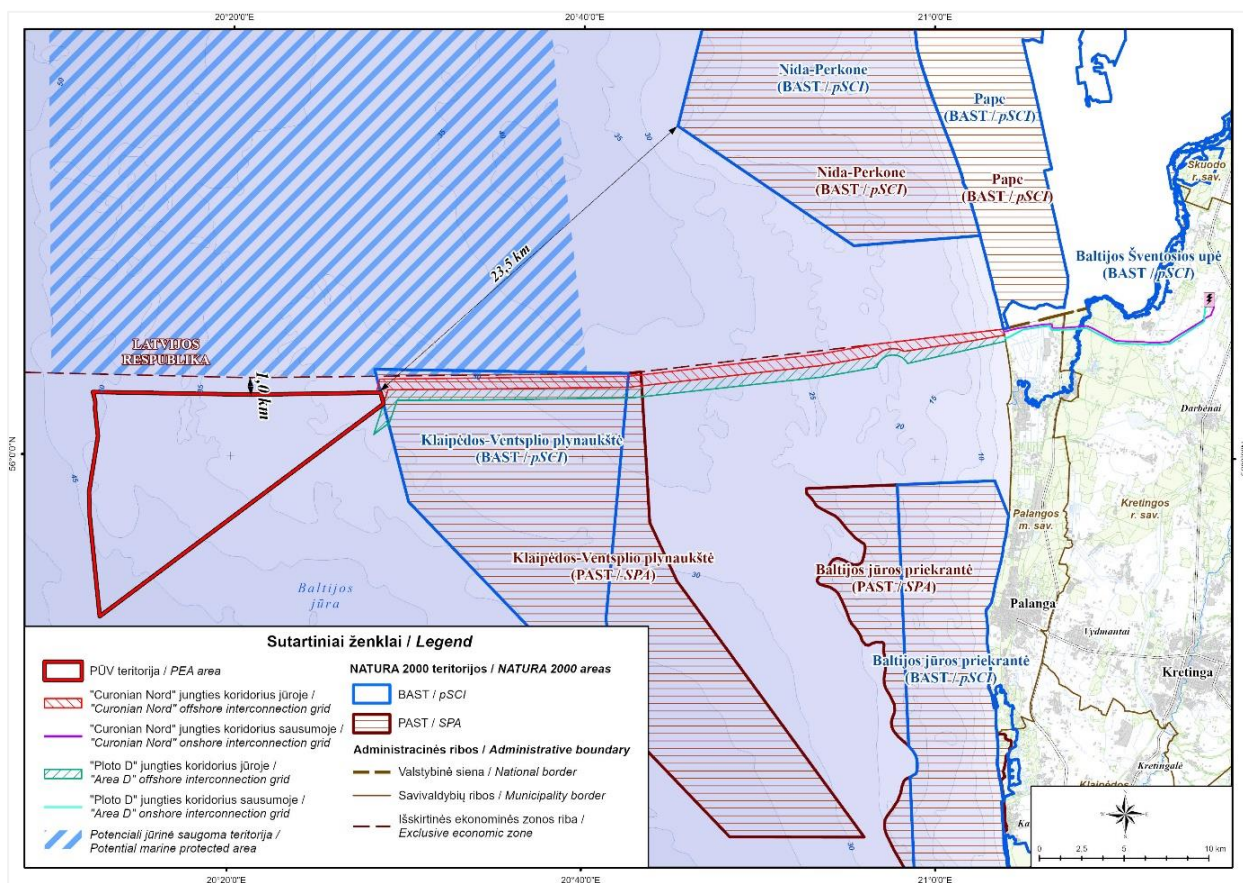


Fig. 9.1.1. Distances from the PEA territory to the boundaries of Natura 2000 areas designated in Latvia.

Impact on birds. The OWF could disturb migratory and wintering birds, particularly common scoter and long-tailed duck, which depend on benthic habitats. Displacement effects are possible, though migration intensity in the area is relatively low. Cumulative effects with planned Latvian OWFs may increase risks for benthic-dependent species. Mitigation measures, including operational phase protections, are selected.

Impact on bats. Bat migration intensity is significantly lower offshore (20–30 km) than nearshore. Studies indicate regular migration is unlikely at the PEA site, though occasional individuals may reach the area. Mitigation measures are selected.

Impact on fish. Impacts are expected mainly during construction and decommissioning due to turbidity and noise. Effects are local and temporary, with recovery expected post-installation. Long-term positive effects may occur through artificial reef formation around foundations. Cumulative effects are unlikely for key species (flounder, cod, herring).

Impact on marine mammals. Construction noise, especially pile driving, poses the greatest risk. Marine mammals are not permanently present but may visit the area. Operational noise is negligible. Cumulative impacts could occur if construction overlaps with Latvian OWF projects. Coordinated scheduling is recommended.

Impact on the Landscape. The OWF is located 37 km from the Latvian coast, making visibility from Latvian viewpoints negligible. Cumulative effects with planned Latvian OWFs may slightly increase horizontal visibility but are expected to be more relevant for Lithuanian resorts.

Impact on International Shipping. No international navigation routes cross the OWF site. Collision risk is low, estimated at 9.0×10^{-5} annually, below acceptable thresholds. Tanker collisions, although very rare, could result in significant oil spills requiring emergency preparedness.

Oil Field Exploration. The OWF does not overlap with Latvian oil exploration zones. With a 0.9 km distance to the Latvian border, no significant impacts are expected.

Impact on Fisheries. Fishing activity in the PEA is moderate, historically shared between Lithuanian and Latvian vessels. Temporary restrictions may occur during construction, especially due to pile driving noise affecting herring and sprat up to 33 km. Long-term, turbine foundations may act as artificial reefs, improving fish habitats and biodiversity.

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