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NORTH-WEST ESTONIA OFFSHORE WIND PARK

SUMMARY OF ENVIRONMENTAL IMPACT ASSESSMENT REPORT

SKEPAST & PUHKIM

Enefit Green

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SUMMARY OF THE CONTENTS OF THE REPORT

Enefit Green (developer since December 2018, so far the developer was Nelja Energia AS wants to establish an offshore wind farm **in order to** produce electrical energy with the capacity of up to 1100 MW for electricity generation. The number of planned wind turbines (107-182 pcs) depends on the power of the wind turbine type used (4-12 MW). The distance between wind turbines is approximately 1 km. The developer has chosen shallows located at least 12 km from Hiiumaa coast as the location of the planned wind park.

The need for developing wind energy is derived primarily from tightening environmental and energy policy of the European Union. Upon development of energy networks creation of new external connections is expected for functioning of joint electricity and gas markets. According to the national spatial plan Estonia 2030+, one of the preferred locations for creation of wind parks is Estonian western coastal water.

On 23 March 2006, Nelja Energia AS submitted an application for a special permit for water use to the Ministry of the Environment, during which the Environmental Impact Assessment (EIA) was initiated by the Ministry of the Environment on 5 May 2006 by decision No. 11-17 / 3873-2. On April 15, 2010, Nelja Energia AS submitted a building permit application to the Government of the Republic of Estonia. The superficies permit gives the right to encumber the seabed with offshore windsurfers 50 years. The procedure for applying for a special permit for water use as well as for a superficies license has been suspended until the EIA report has been approved.

The purpose of EIA has been to find out, whether and on which conditions it is possible to realise activity planned by the developer and what are the possible measures minimising significant negative environmental impact.

During the EIA, the environmental impact of establishing a wind farm and installing sea cables was assessed. Impact was assessed on real alternatives to the proposed activity. The EIA report also looked at the 0-alternative, i.e whether and what changes would the construction of the wind farm bring with it compared to today's situation.

For sea cables, the impact was assessed from the wind farm till grounding the cable. According to the special permit for water use and EIA program, the proposed activity included, *inter alia*, the installation of a sea cable for the wind farm towards the direction of Finland and Sweden and the related environmental impact assessment. Sweden and Finland were not contacted in the EIA report because the developer has given up stripping the cable in the respective directions.

Profound survey, special literature and expert assessments of the areas have been the basis for EIA report.

Results of evaluation of wind turbine alternatives

For wind turbines, the environmental impact was assessed for two possible alternatives (alternative 1 and alternative 2). The difference between the alternatives lies in the capacity, number and size of the development area TP 1 and the location of the planned wind turbines.

For wind turbine alternative 1, there are three wind turbines with different capacities: 4 MW, 6 MW and 7 MW. Depending on the capacity of the wind turbines used, the total number of wind turbines is 157-182. For Alternative 2, the wind turbines used are 7 MW and 12 MW wind turbines, the total amount of wind turbines is 107 pcs (including 37 pcs 7 MW and 70 pcs 12 MW wind turbines). Total wind power, distance and distance from the coast are the same for both alternatives. For both alternatives, wind turbines are designed for four separate development areas (TP 1, TP 2, TP 3 and TP 4). Comparing the alternatives, in case of alternative 2, the area of TP 1 is smaller and the wind turbines are located further away from Apollo nature reserve, there are no differences in the size and location of other areas of development compared to alternatives.

Sectoral assessment results for wind turbine alternatives and necessary minimising measures have been summarised in Table 1 (for better overview negative and positive impacts have been shown respectively in red and green colours):

Table 1. Evaluation results of turbine alternatives and necessary mitigation measures

Type of impact	0 Alternative	Alternative 1		Alternative 2		Mitigation measures/ recommendation /specification (for details see Chapters 9 and 10 of the EIA report)
		Impact during construction	Impact during usage	Impact during construction	Impact during usage	
Impact on waves, currents, mixing	0	0	-1	0	-1	Wave measurements near the wind farm and near the coast before and after the construction of the wind farm.
Impact on water quality	0	-1	0	-1	0	Water quality monitoring during construction work.
Impact on spreading of suspended solids	0	-1	0	-1	0	Operational monitoring of wind direction and speed, temporary suspension of work if necessary; monitoring the spreading of suspended solids during the start-up period of construction (during the installation of first 20 wind mills), until the end of construction works, if necessary; monitoring of suspended solids around wind turbines, located within 4 km of the nearest point to the Apollo protected area.
Impact on sediment movement and coastal processes	0	0	0	0	0	-
Impact on oil spill spread	0	-1	-1	-1	-1	Not performing works in strong wind conditions; proper compliance with safety rules; readiness for rapid and appropriate

						eradication of potential pollution
Impact on navigation risks	0	-1	-1	-1	-1	Restricting marine traffic in works zone during construction; wind farm and waterway markings.
Impact on ice risks	0	0	0	0	0	Use of foundations of sufficient strength; not carrying out works under ice conditions.
Impact on abundance of fish species	0	-1	0	-1	0	Not carrying out construction work during flounder spawning (May and June).
Impact on fishing (trawling)	0	-1	-1/-2	-1	-1/-2	Avoidance of construction activities during the construction phase during the most intensive fishing season (first and fourth quarter). In the use phase, the impact will depend on how close to the important trawling areas the wind turbines are built and what are the restrictions on trawling. Non-installation of TP 2 wind turbines in the development area in a separate eastern row; ensuring trawling ships movement to trawl fishing areas and between trawling areas through wind farm and wind turbines.
Impact on fishing (coastal fishing)	0	0	0	0	0	-
Impact of noise on fish stocks	0	-1	-1	-1	-1	Using equipment and techniques that minimize noise

						during seabed construction works; starting construction activity with a lower noise level.
Impact on fish habitats (creation of artificial reef)	0	-1	+1	-1	+1	Use of foundations which are most similar to naturally occurring material (rocky, limestone, non-toxic, surface structure allows attachment of species); Avoiding damage to the surrounding seabed when constructing foundations.
Impact on bird life	0	-2	-1	-2	-1	Implementing the compromise solution proposed by the bird expert - Revised development area TP 1; placing wind turbines in development area TP 1 at least 2 km from the boundary of Apollo shoal nature reserve; placement of wind turbines in development areas parallel to the migration direction; use of wind turbine types with smallest possible noise and vibration level; if possible, use of foundations with rough cover to promote shell distribution; implementing measures to reduce the risk of collision with wind turbines; compliance with measures to prevent, detect and eradicate oil spills.
Impact on chiropterans	0	-1	-1	-1	-1	Monitoring of chiropterans during the wind turbine construction phase and at the

						beginning of use; implementing measures to reduce the risk of collision with wind turbines and possible deaths.
Impact on bottom vegetation on soft ground	0	0	0	0	0	-
Impact on bottom vegetation on hard ground	0	-1	+1	-1	+1	Use of material that is not suitable for vegetation in underwater parts of wind turbines; Use of foundations which are most similar to naturally occurring material (rocky, limestone, non-toxic, surface structure allows attachment of species); avoiding damage to the surrounding seabed when constructing foundations; monitoring of seabed benthic fauna before construction works, immediately after competition of construction and during the exploitation phase of the wind farm.
Influence on seabed benthic fauna on soft ground	0	-2	+1	-2	+1	Using so called preparation of bottom only if strictly needed; the use of natural terrestrial material to stop erosion; use of foundations which are most similar to naturally occurring material (rocky, limestone, non-toxic, surface structure allows attachment of species); avoiding damage to the surrounding seabed when constructing foundations;

						monitoring of seabed benthic fauna before construction works, immediately after competition of construction and during the exploitation phase of the wind farm.
Influence on seabed benthic fauna on hard ground	0	-1	+1	-1	+1	If possible, not installing the foundations of the wind turbines in the habitat type of the reefs; use of material that is not suitable for vegetation in underwater parts of wind turbines; Use of foundations which are most similar to naturally occurring material (rocky, limestone, non-toxic, surface structure allows attachment of species); avoiding damage to the surrounding seabed when constructing foundations; monitoring of seabed benthic fauna before construction works, immediately after competition of construction and during the exploitation phase of the wind farm.
Impact on benthos (reefs)	0	-1	0	-1	0	If possible, not installing the foundations of the wind turbines in the habitat type of the reefs; use of material that is not suitable for vegetation in underwater parts of wind turbines; Use of foundations which are most similar to naturally occurring material

						(rocky, limestone, non-toxic, surface structure allows attachment of species); avoiding damage to the surrounding seabed when constructing foundations; monitoring of seabed benthic fauna before construction works, immediately after competition of construction and during the exploitation phase of the wind farm.
Impact on benthos (cay)	0	0	0	0	0	-
Impact on wrecks	0	-1	0	-1	0	The effect during construction remains local and the transfer of sediment to the conservation values in significant amounts is unlikely.
Impact on grey seal, including the Selgrahu grey seal reserve	0	-1	0	-1	0	Avoid noisy construction works during the calving and hair replacement periods (February-March and May-June) in TP 1 area.
Impact on ringed seals	0	-1	0	-1	0	Avoid noisy construction works during the calving and hair replacement periods (February-April) in TP 1 area.
Impact on sea eagles	0	0	-1	0	-1	The areas of the wind farm do not affect the main living and feeding areas of the sea eagle, but it may still be possible for individuals to enter the area of the wind farm and die (cannot be excluded).

Impact on Natura 2000 network sites	0	0	0	0	0	-
Impact on the following nature reserves: Hiiu limited conservation area, Kõrgessaare-Mudaste conservation area, Paole nature reserve, Tahkuna nature reserve, Väinamere convervation area, Selgrahu gray seal permanent habitat, Kadakalaiu ringed seal permanent habitat, Nõva-Osmussaare conservation area	0	0	0	0	0	.
Impact on Apollo shoal nature reserve	0	-1	-1	-1	-1	Implementing the compromise solution proposed by the bird expert - revised development area TP 1; development of wind turbines in the TP 1 development area at least 2 km from the border of nature reserve; placing wind turbines in development areas parallel to the migration direction; use of wind turbine types with smallest possible noise and vibration levels; operative monitoring of wind direction and suspended solids during the construction phase, if necessary, temporary suspension of works; monitoring

						of suspended solids during construction of the foundations of wind turbines; implementing measures to reduce the risk of collision with wind turbines.
Impact on the planned Kõpu marine protection area	0	0	0	0	0	-
Impact on economic development and employment	0	+2	+2	+2	+2	New direct and indirect jobs (estimated around 150) are emerging regarding wind turbine construction and maintenance.
Impact on tourism in Hiiumaa	0	+1	+1	+1	+1	Building a wind farm will allow to find additional aspects of marketing tourism in Hiiumaa regarding addition of new opportunities.
Impact on Hiiumaa community	-1	+1	+1	+1	+1	According to cooperation agreement 31.07.2017: Improved power supply connection. Support to the community by establishment of new NGO. Investment opportunity with guaranteed return.
Effect of vibration	0	-1	-1	-1	-1	The impact is local.
Visual impact	0	-1	-1	-1	-1	Assessing the visual impact is rather subjective and depends on the observer. The distance of wind turbines from the coast of Hiiumaa is sufficient (12 km) to prevent wind turbines from

						dominating, but there may be differences of opinion regarding the disturbance.
Impact on human health, well-being and property	0	0	0	0	0	There are no significant impacts, as noise, vibration, low-frequency noise and infra-red do not reach the local population. In order to reduce the risk of marine accidents, a traffic management plan must be drawn up for the construction period.
Impact on Border Guard radar system	0	-1	-1	-1	-1	In order to minimize impacts, the Border Guard radar positions must be taken into account when installing wind turbines. Another option is to establish a zone of navigation bans on the wind farm and its immediate surroundings.
Impact on climate change	0	+1	+1	+1	+1	Wind energy production reduces CO2 emissions because it is a renewable energy source. Estimated savings are about 3.5 million tCO_{2eq}.
Cross-border impact	0	0	0	0	0	Potential negative transboundary impacts on migratory birds should be specified on the basis of monitoring results during the lifetime of the wind farm.

The construction and use of the wind farm will have no adverse effect on the conservation objectives and areas of Natura 2000 sites as whole.

The construction of a wind farm may have a significant negative impact on the birds and the benthic fauna on the soft surface during the **construction phase**.

Significant negative impacts on bird life during the construction phase are associated with the destruction and disturbance of the benthos (decreasing food base), the formation and spread of suspended solids (impact on nutritional conditions) and direct disturbance from construction activity (noise, vibration, vessel traffic). The impacts are predominantly local, short-term and reversible. There is no significant negative impact on the significant food base for the birds using Apollo shoal nature reserve nutrition, as the closest development area (TP 1) is at least 2 km away and the food base there is preserved. Similarly, the noise generated by the construction activity does not cause significant disturbance to the birds there.

The significant negative impact on the benthic fauna on the soft surface is primarily related to the change of the bottom substrate resulting from the installation of wind turbine foundations, which in turn affects the fauna (habitat changes or disappears). The marine environment expert has proposed the necessary mitigation measures to reduce the significant negative impact.

Minor negative impacts on water quality, suspended solids spread, abundance of fish species, trawling, fish habitats (temporary loss of habitat quality) and noise (for fish), benthic flora and benthic fauna on a solid basis, benthic reefs, chiropteran and marine mammals may be negatively affected during the construction phase. The impact on the Apollo shoal nature reserve, wrecks and Border Guard radar systems, navigation risks, oil spill spread and vibration and visual effects has also been assessed to have a negligible negative level. The negligible negative impact on the Apollo shoal nature reserve consists of indirect disturbances to the conservation target birds of the nature reserve (see above). There are no negative effects on the habitat types, the status of protected species and the nature area as a whole, which are the conservation objectives of the protected area.

In the areas listed below, experts found that the impact on the construction of the wind farm is either neutral or non-existent: waves, sediment movement and coastal processes, ice-related risks, impacts on fishing on the beach, soft ground vegetation, benthic sandbanks, impact on sea eagles, human health, welfare and property.

The exploitation phase of a wind farm may have little or no significant negative impact on trawling. The extent of the impact will depend on how the wind turbines will be built near important trawling areas and what restrictions will be imposed on trawling. Significant impacts may arise from a direct conflict with important trawl fisheries (reduced areas) and the movement of vessels with restrictions on the fishing area to the fishing area and back. In order to preserve the important trawling area on the edge of the Vinkovy plateau, the expert of the fishery has proposed a solution where the wind turbines in development area TP 2 will not be built on a separate eastern line which is acceptable to the developer. In order to mitigate the possible constraints on the movement of fishing vessels resulting from the wind farm, the developer ensures the trawling movement to trawl fishing areas and from one trawl area to another through the wind farm and wind turbines.

The impact on birdlife during the exploitation phase of the wind farm remains at a negligible negative level. This is due to a compromise solution proposed by a birdlife expert, where the wind turbines are not built on Apollo shoal nature reserve and mitigation measures are applied to reduce the wind resistance and collision risk with wind farms. The wind turbines closest to the Apollo shoal nature reserve are designed to be at least 2 km away, so the nature reserve´s seabed, benthos and the birds are not harmed. The acoustic and visual disturbance and vibration associated with the use of wind farms can, to some extent, degrade the feeding conditions of birds in Apollo shoal, but it is nonetheless insignificant as the essential food base is maintained.

The wind turbines can cause the death of specimens of birds going to and from the Apollo shoal nature reserve due to the risk of collision with wind turbine blades. However, as waterfowl (including long-tailed duck) avoid wind farms, their risk of collision with wind turbines is relatively low. This can happen in very bad weather conditions, but even under these conditions, this probability is low, as usually there is no migration during bad weather.

During the exploitation phase of the wind farm, a negligible negative impact on the Apollo shoal nature reserve, which means indirect disturbance to birds in the protected nature area (see above),

may occur. There are no negative impacts on the habitat types, the status of protected species and the nature area as a whole, which are the conservation objectives of the protected area.

Minor negative impacts during the exploitation phase may also occur in the form of waves, noise to fish, chiropterans, sea eagles, navigational risks, oil spill spreads, navigation risks, as well as the impact of vibration and visuals and the impact on the Border Guard radar system. Impacts on fish habitats are predominantly positive (the emergence of artificial reefs, increased biodiversity and production).

In the following areas, the experts found that the use of the wind farm had no effect on them or that the impact would remain neutral: water quality, suspended solids distribution, sediment movement and coastal processes, ice risks, abundance of fish species and coastal fishing, benthic vegetation on soft surfaces, benthic habitats of reefs and sandbanks, marine mammals, wrecks , human health and wellbeing.

The most powerful wind turbine Haliade-2 12 MW is currently used as the basis for modelling the noise generated by wind turbines, resulting in a noise level of 60 dB spreading to a distance of 110 m 45 dB spreading to a distance of 1195 m from the wind farm. As the wind farm will be built at least 12 km from the coast of Hiiumaa, noise will not spread to the residential areas of Hiiumaa.

Infrared (frequency <20Hz) caused by electric wind turbine remains below human perception and hearing threshold. The infrared emitted by wind turbines is in the same magnitude as the natural phenomena. Consequently, the infrasound generated by the proposed offshore wind park has no significant negative impact on human health and well-being.

Building a wind farm is expected to have a significant positive impact on Hiiumaa's economic development and employment, as well as a positive impact on Hiiumaa's tourism, community and climate change (both in the construction and in the exploitation phase). There is no presumption of cross-border effects on the establishment of a wind farm.

Wind farms alternatives 1 and 2 generally have similar environmental impacts. The impact of alternative 2 is somewhat smaller, as it reduces the number of wind turbines in the development area and thus has less impact on seabed communities and marine benthos (especially in the TP 1 development area). In addition, alternative 2 has a development area TP 1 further away from the Apollo shoal nature reserve than alternative 1, which is better for bird life.

Potential cumulative impacts have been assessed in the areas of sectoral impacts, such as impacts on human health and well-being (noise, vibration, fishing, etc.) and property (risks related to marine traffic), marine mammals (impact on nutrition and reproduction areas, etc.). No additional cumulative effects were found based on the evaluation results.

Results of evaluation of alternatives to sea cables

In terms of marine cables, the environmental impact was assessed for two alternatives (cable installation alternative 1 and alternative 2).

In both alternatives, joining the wind farm's electricity network is planned from Aulepa substation on the mainland. In the case of sea cable installation alternative 1, connection to the power grid takes place over Hiiumaa - three export cables land on the shore of Hiiumaa in Tahkuna and Lehtma, the transmission cable landing near Suuresadama, Hiiumaa and near Rigudi, on Noarootsi peninsula. According to alternative 2, the wind farm is directly connected to the mainland. The landing of the cable on the continent is the same as for alternative 1: near Riguldi in Noarootsi. For both alternatives, Hiiumaa's circular power is guaranteed.

The **sectoral evaluation results** of the sea cable alternatives and **the necessary mitigation measures** are summarized in Table 2 (for a better overview, the table shows negative and positive effects respectively in red and green).

Table 2. Evaluation results of cable alternatives and necessary mitigation measures

Type of impact	0 Alternative	Alternative 1		Alternative 2		Mitigation measures/ recommendation /specification (for details see Chapters 9 and 10 of the EIA report))
		Impact during construction	Impact during usage	Impact during construction	Impact during usage	
Impact on water quality	0	-1	0	-1	0	-
Impact on spread of suspended solids	0	-1	0	-1	0	Operational monitoring of wind direction and speed during works which create suspended solids, temporary suspension of work if necessary; monitoring spread of suspended solids
Impact on navigation risks	0	-1	0	-1	0	Restricting marine traffic during construction in the works zone; marking water traffic areas.
Impact on sediment movement and coastal processes	0	0	0	0	0	-
Impact on abundance of fish species	0	-1	0	-1	0	Not carrying out construction work during flounder spawning time (May and June) and spawning time of Baltic herring (April).
Impact on fishing (trawling)	0	-1	0	-1	0	Avoidance of construction activities during the most intensive fishing season (first and fourth quarter).
Impact on fishing (coastal fishing)	0	0	0	0	0	-
Impact of noise on fish stocks	0	-1	0	-1	0	Using equipment and techniques that minimize noise from seabed

						construction work; starting a construction activity with works that have lower noise level.
Impact of electromagnetic fields on fish stock	0	-1	-1	-1	-1	Use of cables that generate as little electromagnetic field as possible; ditching or burying the cables in the seabed.
Impact on marine benthos (including the emergence of artificial reefs, effects on benthos, benthic fauna and flora)	0	0	0	0	0	-
Impact on birdlife	0	-1	0	-1	0	-
Impact on wrecks	0	-1	0	-1	0	The effect during construction remains local and the transfer of sediment to the conservation values in significant amounts is unlikely.
Impact on gray seal, including Selgrahu gray seal permanent habitat	0	-1	0	-1	0	In the TP 1 development area, avoid the noisy construction works during the calving and hair replacement periods (February-March and May-June).
Effect on ringed seal	0	-1	0	-1	0	In the TP 1 area development area, avoid the noisy construction works during the calving and fur replacement periods (February-April).
Impact on Natura 2000 network sites	0	0	0	0	0	-

Impact on nature reserves	0	0	0	0	0	-
Cross-border impact	0	0	0	0	0	-

Both the installation and the use of the cable trail are not expected to have significant negative effects. Unfavourable impacts on conservation objectives and site integrity of Natura 2000 network sites will not occur.

The construction phase may be accompanied by negligible negative impacts, primarily related to potential disturbance of the seabed, the release of sediments into the water column, the spread of suspended solids and direct disturbance from construction activities (noise, vessel traffic). These are predominantly local (cable proximity), short-term and reversible impacts. There is no predictive cross-border spread of suspended solids.

Minor negative impacts on water quality, suspended solids spread, the number of fish species (temporary decrease in the area), noise and electromagnetic fields to fish and, trawling, bird and marine mammals (temporary deterioration of dietary conditions due to reduced viscosity, noise disturbance) and wrecks. The installation of sea cables may interfere with the benthos in the construction phase, but the impact is not high and of short duration. The disturbed soft seabed will quickly recover in open sea conditions. Impact on the hard seabed remains neutral/absent.

There are no negative impacts on conservation objectives and site integrity of nature reserves and permanent habitats for seals.

For the rest of the marine environment, the cable-laying effect remains neutral/absent.

During the exploitation stage of cables only a minor negative impact might be applied on fish regarding electromagnetic fields, but it can be mitigated by the use of as little electromagnetic field cables as possible and by dipping or burying the cables in the seabed.

In the comparison of cable route alternatives, the impact will generally remain at the same level. Alternative 1 has somewhat greater impact, as in this case, the route also crosses the Väinamere conservation area (including Väinamere nature and bird area included to Natura 2000 nature network). Since there are several routes in the low sea in the cable installation alternative 1, the water in the coastal areas is also more likely to be clouded.

Potential cumulative effects have been assessed in area impact chapters. No cumulative effects were found based on the evaluation results.

1. BACKGROUND INFORMATION

1.1. Purpose and need for the proposed activity

Enefit Green AS (hereinafter *developer*) is involved in the development of renewable energy and the production of electricity and heat from wind, water, biomass, sun and municipal waste. The developer wants to establish an offshore wind farm with a capacity of up to 1100 MW **with the aim of** producing electricity. The number of planned wind turbines depends on the power of wind turbine (4-12 MW). The distance between wind turbines is about 1 km. The developer has chosen shallows located at least 12 km from Hiiumaa coast as the location of the planned wind park.

The need for developing wind energy is derived primarily from tightening environmental and energy policy of the European Union. Upon development of energy networks creation of new external connections is expected for functioning of joint electricity and gas markets. According to the national spatial plan Estonia 2030+, one of the preferred locations for creation of wind parks is Estonian western coastal water.

1.2. Permissions required to carry out the proposed activity

On 23 March 2006, Nelja Energia AS, the developer before Enefit Green AS (until December 2018), submitted an application for a **special permit for water use** to the Ministry of the Environment. The Ministry of the Environment initiated the environmental impact assessment of the application for a special permit for water use by decision No 11-17/3873-2 of 05.05.2006. The procedure for applying for a special permit for water use has been suspended until the EIA report has been approved.

On April 15, 2010, Nelja Energia AS submitted a **building permit** application to the Government of the Republic of Estonia. The superficies permit gives the right to encumber the seabed with offshore windsurfers 50 years. The procedure for applying for a building permit has been suspended until the EIA report has been approved.

1.2.1. Purpose and need for environmental impact assessment

The environmental impact assessment (EIA) is initiated on the basis of clause 6 (1) 5 of the Environmental Impact Assessment and Environmental Management System Act, according to which erection of a wind power plant into a water is an activity with significant environmental impact.

The purpose of EIA was to clarify whether and under what conditions the activities planned by the developer can be carried out and what measures are possible to mitigate the significant negative environmental impact.

1.3. EIA participants

1.3.1. Developer

During period 2006-2018, the developer of the offshore wind park of Northwest Estonia Nelja Energia AS.

Contact data: Regati pst 1, Tallinn 11911

Contact person: Siim Paist, phone 639 6610, siim.paist@neljaenergia.ee

Since December 2018, Nelja Energia AS shares are owned by Enefit Green AS, a renewable energy company of Eesti Energia, and Enefit Green is the developer in the further process.

Contact data: Lelle 22, Tallinn 11318

Contact person: Viktor Joasaare, phone 520 2230, viktor.joasaare@enefitgreen.ee

1.3.2. Decision maker

Marine Environment Department, Ministry of the Environment

Narva mnt 7a, Tallinn 15172

Contact person: Kaspar Anderson, phone 626 2990, kaspar.anderson@envir.ee

1.3.3. EIA Supervisor

Department of Environmental Management, Ministry of the Environment

Narva mnt 7a, Tallinn 15172

EIA expert group Skepast&Puhkim OÜ (*former name Ramboll Eesti AS*),

Laki põik 2, 12915 Tallinn

Tel 664 5808

E-post: info@skpk.ee

Contact person: Hendrik Puhkim, phone +372 698 8352, hendrik.puhkim@skpk.ee.

Expert group also comprised: Ecology Institute of Tallinn University, OÜ Eesti Geoloogiakeskus, Marine Systems Institute of Tallinn Technical University, Estonian Marine Institute of Tartu University and Agricultural and Environmental Institute of Estonian University of Life Sciences.

The expert group has been composed on the principle that all relevant areas covered by EIA are covered.

1.3.4. Stakeholders

Stakeholders will be informed of the publication of the EIA report.

1.4. Overview of the EIA procedure

1.4.1. EIA procedure 2006-2013

The Ministry of Environment has initiated the environmental impact assessment (EIA) on the basis of developer's application for **special use of water** submitted on 05.05.2006. Public presentation of EIA programme took place on **08-26.02** and public discussion took place on **26.02.2007** in the hall of Hiiu County Government. 23 persons participated in public discussion. EIA programme has been supplemented according to publications results. The Ministry of Environment has approved of the EIA programme on **22.05.2010**.

The bases for performing EIA have been wind park areas Apollo, Vinkovi, shallow 1 and shallow 2 and Neupokojev shallows initially proposed by the developer (Figure 1).

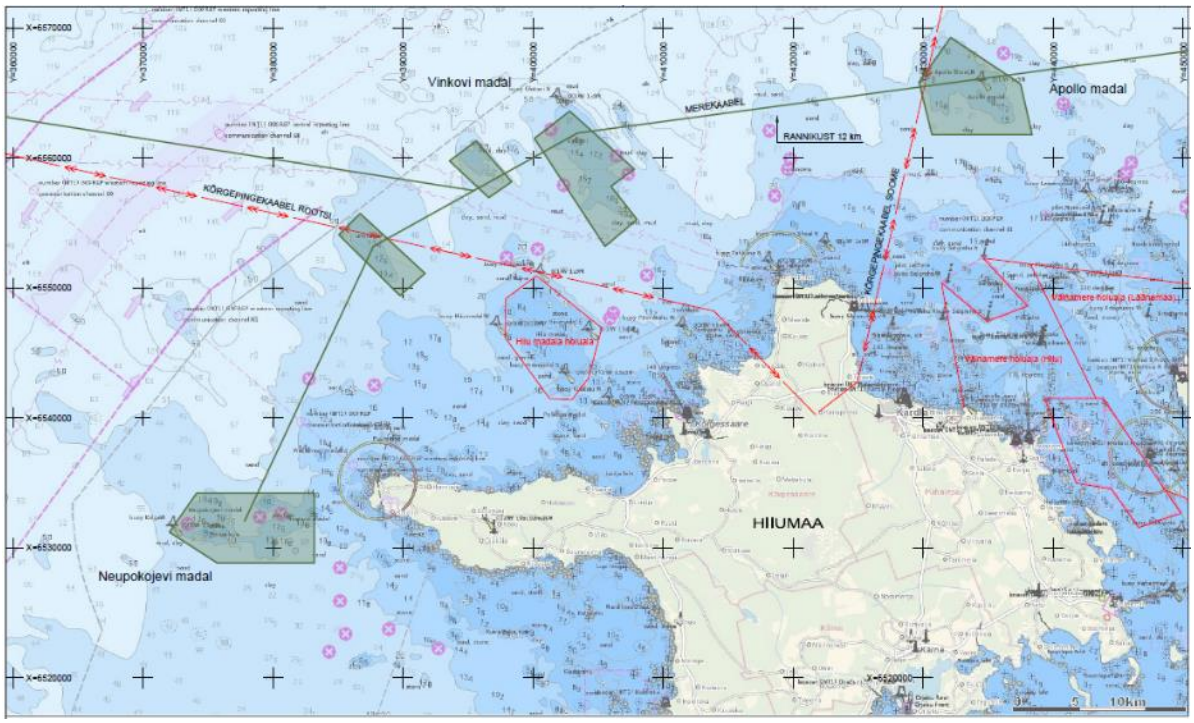

Figure 1. Areas proposed by the developer for the construction of a wind farm in 2006

In the period between 2007 and 2010 basic surveys have been performed in the framework of EIA, in order to receive data about the environmental condition of the project area and its surroundings. Surveys have been ordered from the area experts, and they included also expert assessment regarding possible impacts of creation of wind park. Survey/ expert assessment reports are included in the EIA report. On the basis of surveys and expert assessments **EIA report** has been complied, public presentation of which took place on **28.04-25.05** and public discussion took place on **26.05.2011** in Kärdla Cultural Centre. Over 30 letters have arrived from interested persons during the publication period, in which the basic of reviewed problems were related to location of wind parks, especially Neupokojev shallow, noise impacts, impacts on local tourism and fishing and visual impacts. In the period following the publication of EIA report (2011-2013) locations of wind parks have been discussed with interested groups, several meetings have taken place. As a result of the discussions, **location of wind park development areas has been corrected, and the developer has refused from proposed wind park area in Kuivalõuka shallow (old name Neupokojev)**. Location of corrected areas compared to initial locations is shown on the following figure (Figure 2).

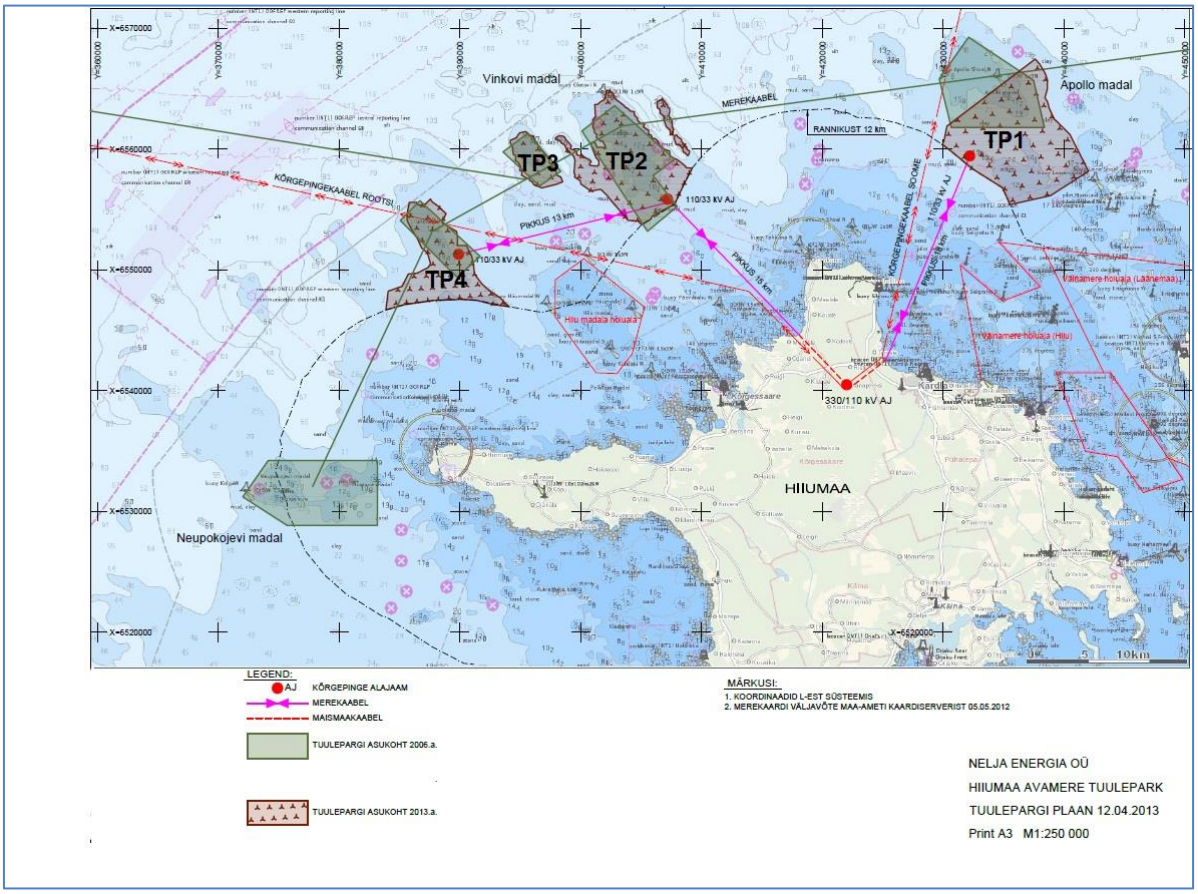

Figure 2. Location of corrected wind park areas as of 2015 compared to initial (Figure 1) locations

1.4.2. EIA procedure 2013-2016

Based on the corrected locations **additional basic surveys** have been performed and **expert assessment** complied regarding the areas previously not included.

EIA report was updated on the basis of corrected locations and on the basis of baseline studies and expert opinions. The basis for the compilation of the updated report was the areas of the wind farm as of 2015 (TP 1, TP 2, TP 3 and TP 4, Figure 3), which did not take into account the compromise solution, i.e the mitigation measure at TP1.

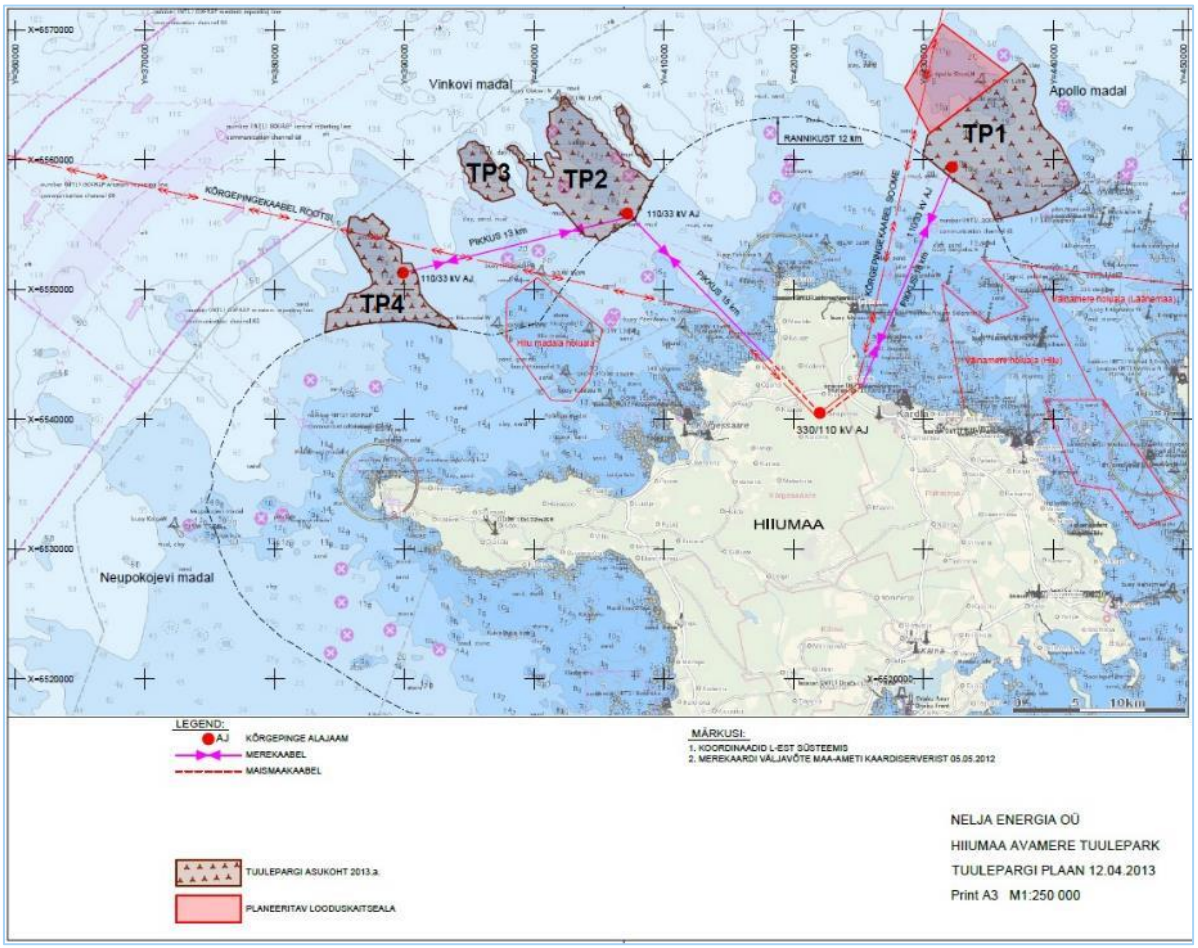

Figure 3. Areas of wind farm in 2015 based on EIA report

Based on the birds survey results the birds expert has made compromise proposal, pursuant to which wind park will be created in four areas (4) – TP 1 (area to the south from Apollo shallow), TP 2 (Vinkov shallow), TP 3 (Shallow 2) and TP 4 (Shallow 1). As the result, wind park will not be created in Apollo shallow. **Upon refusing from development of wind park in Apollo shallow, it has been a compromise solution and minimising measure**.

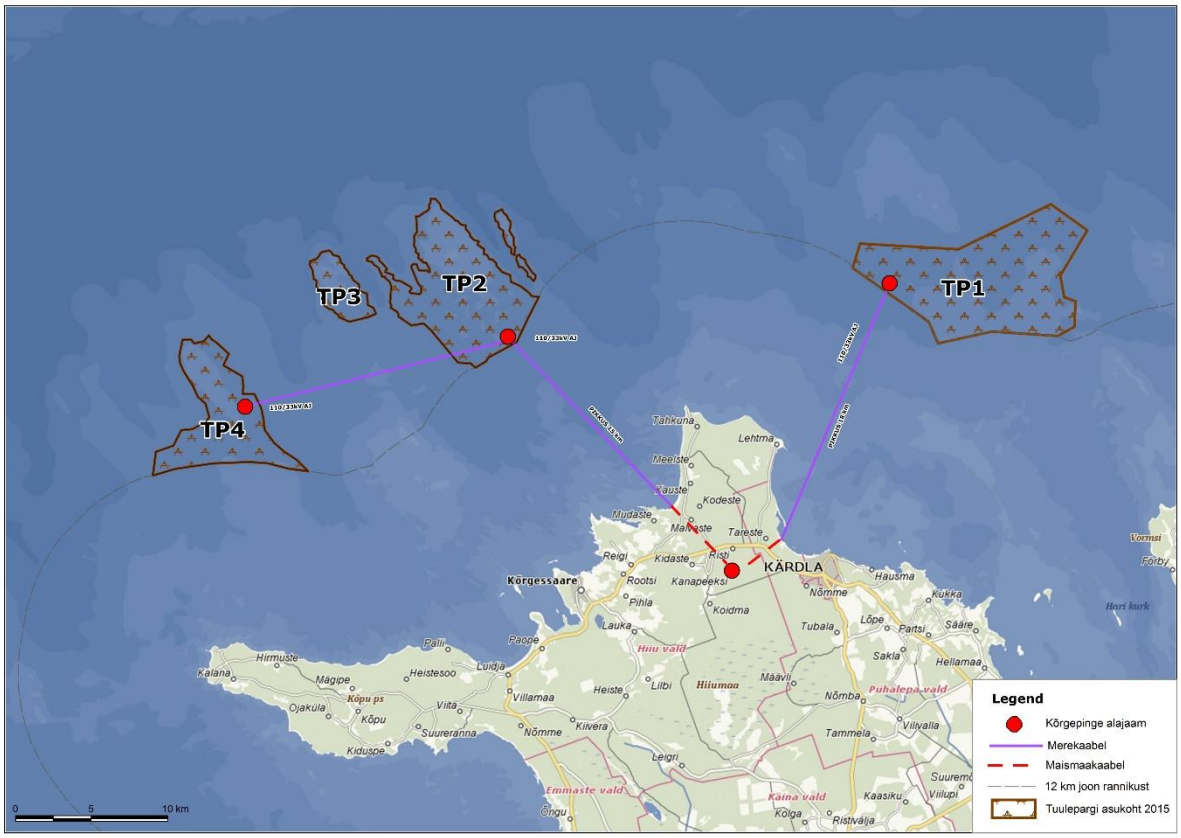

Figure 4. Compromise proposal of birds expert (minimising measure) 2016

The public display of the updated EIA report took place during the period **10.02.2017-17.03.2017** and the public discussion of the report was held on **08.03.2017** at Kärdla Cultural Centre and on **09.03.2017** at the Ministry of the Environment.

1.4.3. Letters received during the publication of the EIA Report, their contents and proposals

In the course of publishing the EIA report of the North-western Estonian offshore wind farm development project, a total of 27 opinions and letters were received from various institutions and individuals.

The following are the most topical topics raised: the timeliness of EIA regarding the long processing process, the location of terrestrial and marine cables, the presence of underwater archaeological objects in the area, the demolition of wind turbines, the impact of infra-red, the impact on chiropterans.

To sum up, both the substantive and the formal proposals for an environmental impact assessment report were received during the publication. The EIA report has been supplemented with more substantive issues, and inconsistencies have been corrected on the formal side.

1.4.4. Changes in the development of the offshore wind park in 2018-2019

04.05.2018 The Ministry of the Environment provided the developer with an opinion on the EIA report submitted for approval. The position included a non-approval of EIA report, a proposal to supplement the report (in substance and form) and to conduct a new disclosure.

The EIA expert group got acquainted with the comments and analysed and assessed the environmental impacts of the construction of the offshore wind park. In parallel, the developer

worked on finding alternatives to the wind farm area solution, which would mitigate the potential impact on environment, but would at the same time ensure the sense of development.

In addition to the wind turbine solution proposed in 2016 (hereafter referred to as alternative 1), in 2018 the developer developed an additional wind turbine alternative (hereinafter alternative 2, Figure 5). The difference between alternative 2 and alternative 1 lies in the use of partially powerful wind turbines (12 MW), smaller wind turbines and a smaller area of development TP 1.

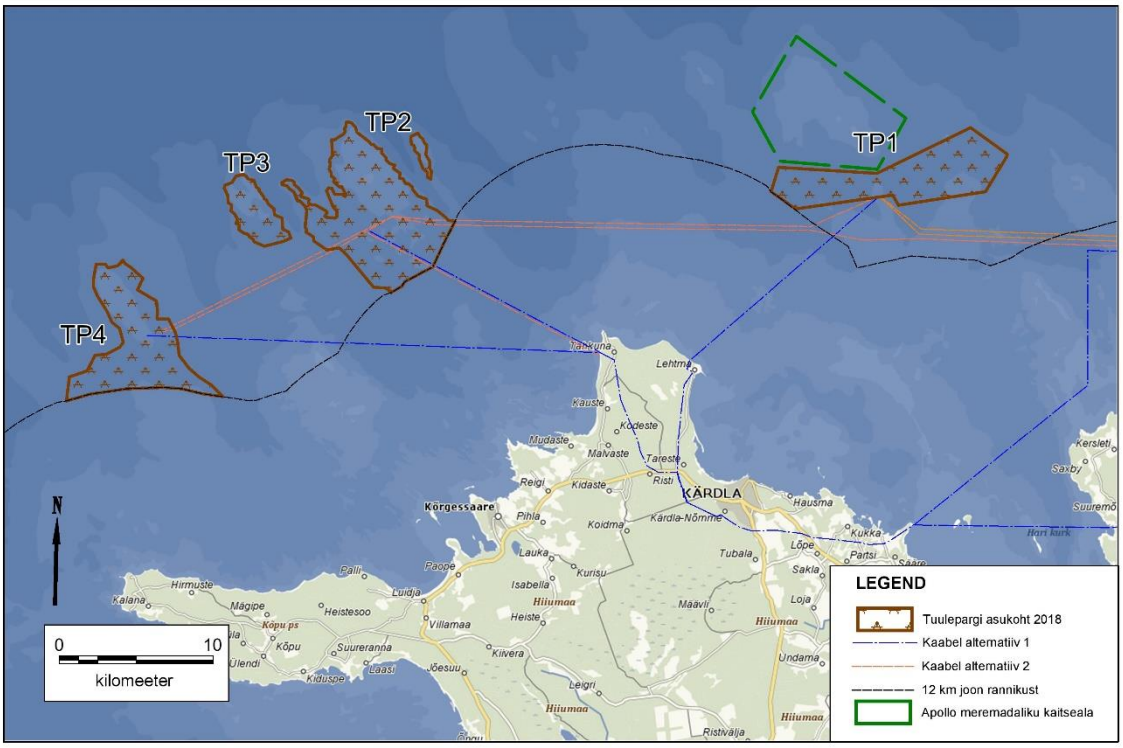

Figure 5. Alternative 2 to the wind farm developed by the developer in 2018

Due to comments from the Ministry of the Environment and an alternative 2 of the wind farm, the EIA expert group reviewed possible environmental impacts over key aspects of the marine environment. All the substantive topics were reviewed based on both wind farm alternatives and the possible runways for sea cables. In addition, the developer commissioned waveform and suspended solids modelling, where waves, suspended solids spreading and sedimentation were assessed for both wind farm alternatives and marine cable alternatives.

As a result of further assessments by the EIA expert group and the results of the modelling of suspended solids spreading and sedimentation, **the developer further adjusted the wind farm development areas and possible location of wind turbines**. Based primarily on the mitigation of negative impacts on Apollo shoal and bird feeding and trawling, **the developer abandoned the design of wind turbines in the northern part of TP 1 area** (in the case of both wind turbine alternatives) **and in the development area TP 2 in a separate eastern line**. As a result, as of 2019, all windmills in the TP 1 development area are planned to be at least 2 km from the Apollo shoal nature reserve and to one area instead of two separate development areas at Vinkov shoal. The location of the corrected wind farm areas is shown in Figure 6 (wind farm alternative 1) and Figure 7 (wind farm alternative 2).

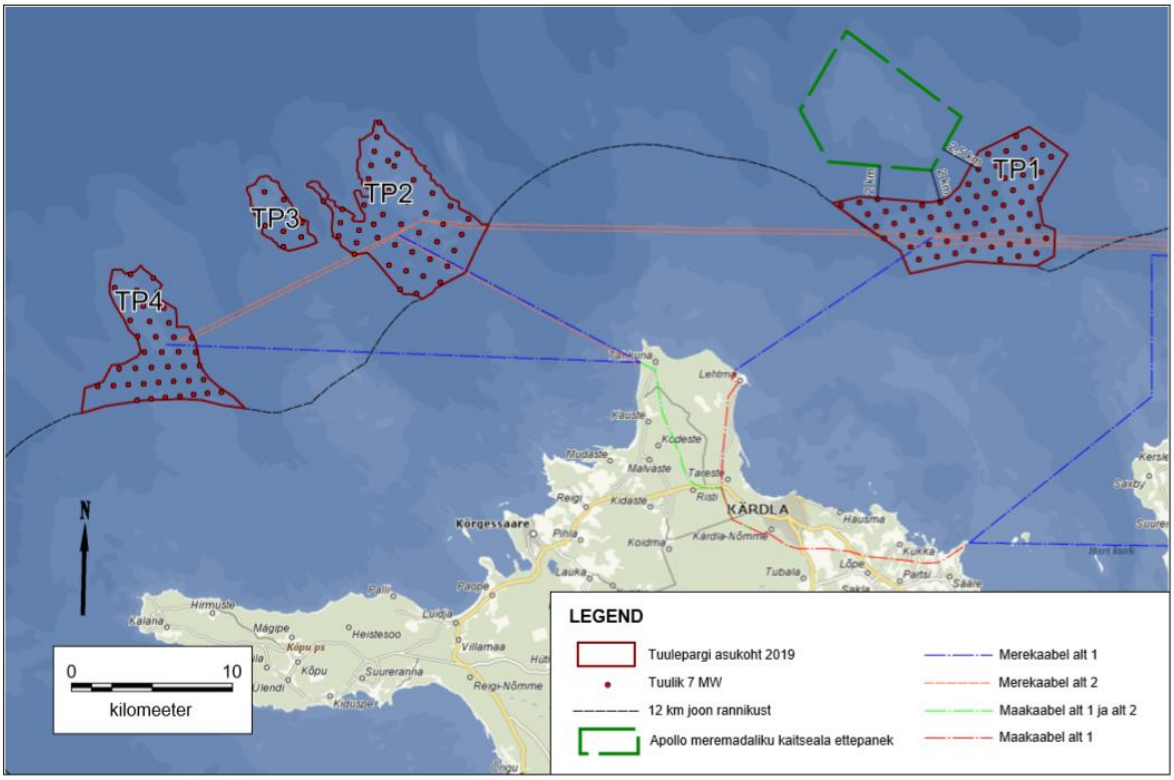

Figure 6. The location of wind farm areas in case of alternative 1 in 2019

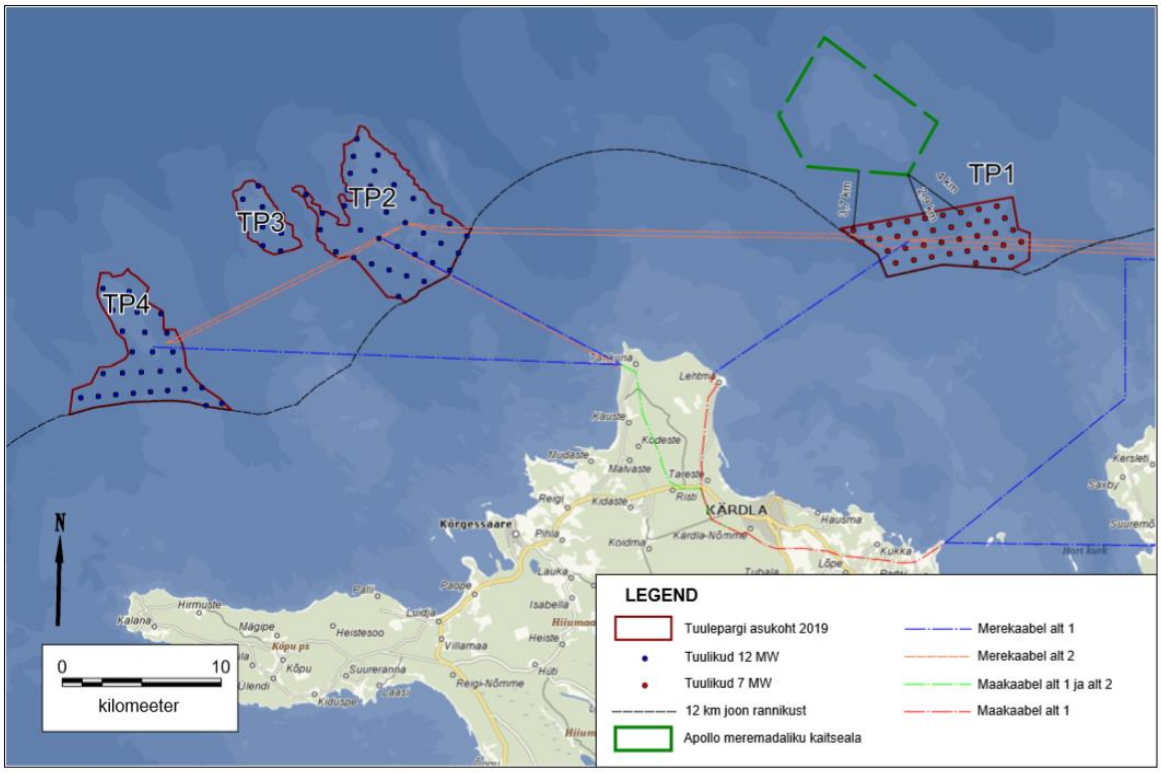

Figure 7. The location of wind farm areas in case of alternative 2 in 2019

The current EIA report was supplemented by wind farms areas as of 2019. In addition to EIA report, the location alternatives for wind farms were specified, the possible locations of the sea cable

runway were described, and the environmental impacts associated with these key aspects of the marine environment were assessed.

In essence, the report was updated on the installation of wind turbines and sea cables for alternatives to key aspects of the marine environment, including impacts on hydrodynamics, sediment movement, marine benthos, fish, birds and marine mammals, Natura 2000 network sites and nature reserves. In addition, the developer commissioned new visualizations for wind turbines for more powerful wind turbines (12 MW), new noise modelling and noise propagation maps. All previous studies were used as baseline studies, as the development areas of the wind farm remained after the adjustment to the same previously studied marine areas.

1.4.5. Bases and principles of impact assessment

EIA has been performed according to *Environmental Impact Assessment and Environmental Management System Act*. EIA report has been complied according to approved EIA programme, requirement provided for in § 20 of the Act and impact assessment guiding materials. While performing EIA, the existing data and the results of the surveys performed within the framework of EIA have been the guidance.

Both subjective experience (opinions of EIA expert group members) as well as objective assessment (results of surveys, modelling etc) have been used in the EIA procedure. Previous surveys, analyses and assessments have been taken as the basis when performing EIA.

Direct impact appears in direct consequences of the activity at the same time and place. Impacts at the time of construction, impacts accompanying the functioning of wind park, as well as impacts related to emergencies have been considered, and both negative and positive impacts have been examined.

Indirect impact represents cause-and-effect chain between environmental elements, and it may appear away from the actual place of activity and the impact may become apparent within a longer period of time.

Environmental impact is a presumed direct or indirect impact on human health and welfare, environment, cultural heritage or properties, arising with the activity;

Negative environmental impact is *significant*, if:

- it presumably exceeds environmental tolerance at the place of activity,
- causes either in the natural or social-economic environment irreversible changes, or
- represents risk to human health or welfare, cultural heritage or properties.

In order to assess *significance of the impact*, the following scale has been used:

- significant positive (+2);
- insignificant positive (+1);
- neutral / no impact (0);
- insignificant negative (-1);
- significant negative (-2).

1.4.6. Methods for forecasting the impacts and brief description of the survey methods

Methods for forecasting the impacts are as follows:

Noise, infrasound and vibration

At the time of construction, underwater, noise – special literature and expert assessment. Noise from operation of wind turbines – modelling software Soundplan 7.4, decree of the Minister of

Social Affairs No 42 as of 04.03.2002 and expert assessment. Infrasound and vibration – expert assessment based on special literature.

Seabed sediments and coastal processes

In order to find out whether the seabed has polluted sediments, a survey of seabed sediments has been performed. Sediment samples has been taken from seabed sediments in order to define granulometric composition, heavy metals and general petroleum products. Sample results have been compared to established limit values of dangerous substances in the soil (decree No 38 as of 11.08.2010 of the Minister of the Environment). Samples have been taken by a grabber from 12 different stations. Granulometric composition of the samples has been defined in the laboratory of the Estonian Geological Centre, which has accreditation of the Estonian Accreditation Centre (registration number of accreditation L093). Sieve analysis has been used in order to define.

Seabed fauna and dwelling places

Inventory has been performed in order to characterise seabed fauna and dwelling places composition and dispersion by species and quantitative seabed composition of the area. The value of seabed fauna and dwelling places remaining in the area of wind park planned in Hiiu shallows and the impact of the planned wind park on them have been assessed. Cards reflecting the dispersion of seabed fauna have been prepared in the course of work (seabed flora and fauna). Multi-radial sonar has also been used during the inventory. Sonar usage in comparison to usual mapping based only on pointed examination of seabed allows much more precision: compared to interpolation, data collected by sonar allow to more precisely foresee the dispersion of fauna and dwelling places in the area between actual points of seabed examination.

Initial data necessary for giving an assessment have been collected in the course of field operations. Methodological part of field operations is partially based on (surveys of seabed flora and fauna) methods of field operations used in the monitoring of Estonian National coastal waters.

In case of changes in area TP 1 in order to assess dispersion of seabed substratum, seabed fauna and dwelling places, forecasting mathematical modelling has been applied.

The work has been carried out by marine biology department of the Estonian Marine Institute of the University of Tartu.

Water quality, hydrodynamics, ice-related risks, navigation risks, possible dispersion of oil spot

Water quality has been assessed on the basis of indicators and established assessment criteria elaborated for application of Water Framework Directive (WFD) (decree of the MoE No 59 as of 12.11.2010 and its Annex 6).

With respect to hydrodynamics impact modelling experiment has been performed. With respect to dispersion of suspension and ice-related risks expert assessments have been given based on previous basic data.

In order to access probability of possible oil pollution in the location of wind parks, the model elaborated in Marine Institute of Tallinn Technical University has been applied.

Fish

Main survey method has been fishing by ichthyological monitoring nets with special standards. Such nets are also used for performing regular fish monitoring in permanent monitoring areas located in many different regions of Estonia. The method has also been used when performing surveys of the Estonian Sea Institute of the University of Tartu of other open sea waters (e.g. in the area of wind park planned in Neugrund shallow, in the survey of Gretagrund shallow fish etc). Thus, the data collected in Hiiumaa shallows can be compared to results obtained from other areas, which is an unavoidable prerequisite in comparative assessment of importance of this area in the context of Estonian coastal water as a whole. Collecting of ichthyological samples has been performed on the basis of previously defined network of stations, which was created on the basis of sea maps (shallows' size, depth etc have been assessed). Networks of stations covered all typical

dwelling places in the area covered by the project and depth areas from the top of shallows (depth of 6-10 m) down to depth of 20-22 m.

The purpose of fishing was to get information about fish with style of life close to seabed (non-pelagic). Collected ichthyological basic material (definitions of age, feeding analyses) has been processed in the laboratory. Basic data is stored in Marine Institute of the University of Tartu.

Birds

The task of the birds survey has been collecting of data about birds in the area, and as a result model cards of numerous water birds gathering in the survey area have been prepared. Survey area has covered all sea shallows located to the north from Hiiumaa. The size of inventory area has been 1900 km^2. Transects have been previously designed to the extent of the entire survey area. In order to avoid the impact of possible sun reflection transects were oriented towards north-south. The distance between transects was 3 km (minimal distance in case of chosen method). Flying transect total distance was 603 km. In the course of the survey the dispersion mosaic of migration (October-November, April-May), moulting (August) and wintering gatherings (January-February) of water birds and density of their number have been found out. In order to do that, four censuses of gatherings at non-nesting time have been performed. Census method has been transect census of open sea (*distance sampling*). Distance sampling is a widely used data collection method, by which data about the size of species population are gathered. Data collected by distance sampling allow to assess the density of population and forecast the assessment of population size. Sampling has been performed in three observation rows and from both sides. The airplane Partenavia 68 Observer of the Danish air-company Bioflight AS has been, which met conditions necessary for transect sampling in the open sea. The speed of observation flight was 185±10 km/h and the altitude 76±5 m. As a result of data processing, point and model maps of gathering sea birds have been prepared. Density of populations of birds species per km^2 has been presented on model maps, maps resolution has been 1x1 km^2.

The survey has been performed by Agricultural and Environmental Institute of Estonian University of Life Sciences in 2014-2016.

Sea mammals, species under protection and conservation areas

The basis for assessment have been the database of environmental register EELIS and data of inventories and surveys and programmes for protection of species. When analysing the extent, strength and significance of the impacts, the analysis of the map layers and expert assessment have been the basis. Peculiarities of protected objects of nature and tolerance with respect to different impact factors have been considered.

Natura 2000 areas

Natura assessment instruction, database of environmental register EELIS and special literature have been the basis for assessment. Relevant assessment is one part of EIA report.

Heritage protection values

The basis has been the state register of cultural heritage. Expert assessment.

Visual impact

Visualisations have been performed by EMD International A/S, who has used internationally recognised software WindPRO 3.0. WindPRO software uses real snapshots, the view points of which had been agreed with the representative of the local society. When doing the photos, very strict rules have been followed, so that software could calculate on their basis right positions and dimensions of the turbines.

Social-economic environment, including human health, welfare and properties; Hiiumaa tourism, society; economics and employment

When performing the assessment, special literature, analogous projects abroad, opinions presented in the course of EIA procedure, marine areas thematic plans, expert assessment have been the bases.

Climate changes

When performing the assessment, special literature and expert assessment have been the bases.

2. DESCRIPTION OF PLANNED ACTIVITY

2.1. General characteristics of wind park and parameters of wind turbines

The planned activity is creation of wind park in sea areas TP 1, TP 2, TP 3 and TP 4 located in north-western and northern direction from Hiiumaa (Figure 8 and 9). In materials and surveys that are the bases for EIA report, development area names Apollo (TP 1), Vinkov (TP 2), Shallow 2 (TP 3), Shallow 1 (TP 4) and Neupokojev/Kuivalõuka have been used.

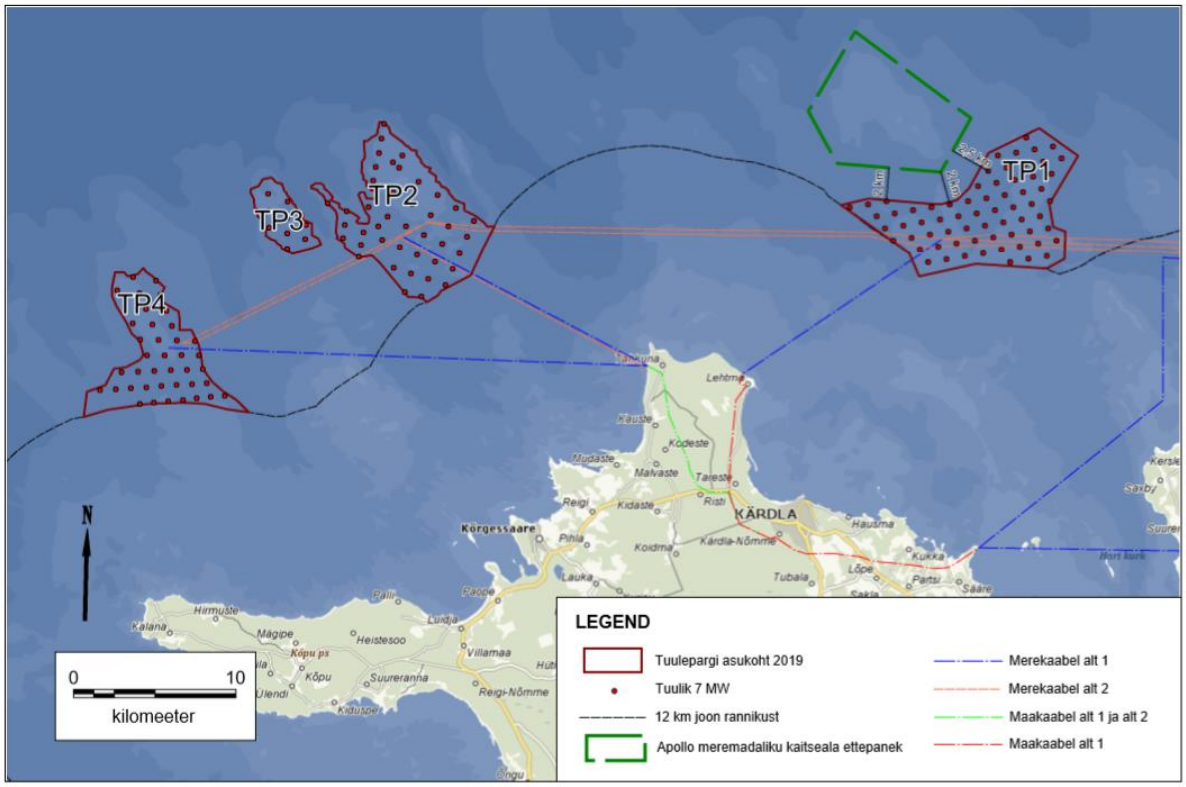

Figure 8. The location of planned wind farm areas in case of alternative 1 in 2019

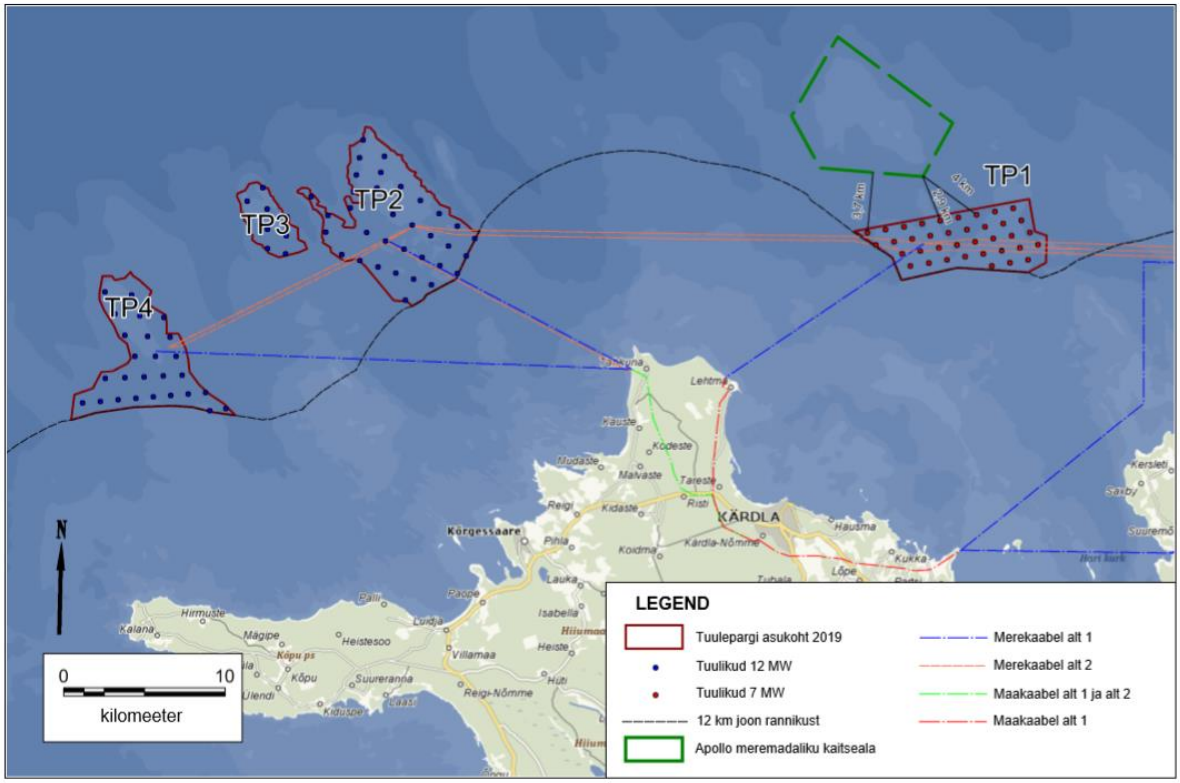

Figure 9. The location of planned wind farm areas in case of alternative 2 in 2019

Table 3. Parameters of the proposed wind farm

Parameter	Indicator
Total power	700-1100 MW
Nominal power of wind turbines	4 to 12 MW
Number of wind turbines	ca 107 to 182 (depends on the nominal power of the wind turbine)
Annual productivity	2,4-3,8 TWh/per year
Full power hours per year	Over 4000
Locations	TP 1, TP 2, TP 3 ja TP 4 (Figure 8 and Figure 9)
Distance from the coast of Hiiumaa	at least 12 km
Sea depth	no more than 30 m
Network connection	through Aulepa substation
Estimated construction time	2 years

Today, wind turbines suitable for installation into the seabed are for example Siemens SWT and Vestas V or Haliade-2 type. The nominal power of wind turbines is 4-12 MW, mast height 100-105 or 138 m and rotor diameter 130-164 m or 220 m. Due to the seabed conditions, the developer estimates the realistic capacity of the wind farm to be around 700-1100 MW. When selecting a lower power wind turbine, more wind turbines will be installed than with a larger wind turbine type.

If it is possible that more powerful windmills can technically be used in the construction of the wind farm, it is important that the use of more powerful wind turbines does not have a higher environmental impact than the most powerful electric wind turbine (Haliade-2 12 MW).

The general data for the different types of wind turbines are given in the table below (Table 4).

Table 4. General details of wind turbines that are fit for the sea

Type of wind turbine	Nominal power (MW)	Height of turbine hub from the water (m)	Diameter of the rotor (m)	Length of the propeller blade (m)
Siemens SWT-4.0-130	4	< 100	130	63
Siemens SWT-6.0-154-6	6	< 102	154	75
Vestas V164-7.0 MW	7	< 105	164	80
Haliade-2 12 MW	12	< 138	220	107

2.2. Types of foundations for electrical wind turbines installed in the sea

Today four different basic types of foundations may be used for installation of electrical wind turbine in the sea. These are (Figure 10):

1. *Monopile*
2. *Tripod*
3. *Jacket*
4. *Gravity based structure*

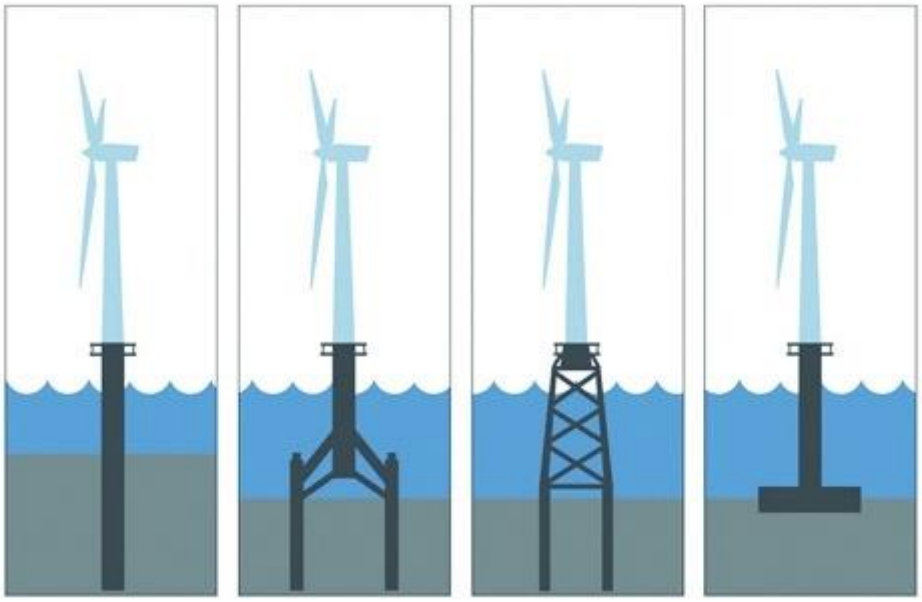

Figure 10. Types of foundations for electrical wind turbines (from the left: monopile, tripod, jacket and gravity based structure)[1]

[1] http://www.theengineer.co.uk/in-depth/the-big-story/wind-energy-gets-serial/1012449.article

When choosing between suitable types of foundations for Estonian waters it has been assessed[2], whether types of foundations, which would usually be suitable for similar depth of water and seabed conditions, are also tolerant to regular Estonian icy conditions. Wind turbines of north-western Estonian coast are planned for the depth of till 30 m. The total weight of foundations reach from 700 tons (jacket) till 3300 tons (gravity based structure).

Final choice and realisability of foundation construction depends on the chosen type of electrical wind turbine and the location of wind turbines in the wind park, which will be finally specified during the work project.

2.3. Phases of construction of offshore wind park

2.3.1. Construction of wind park

Construction of offshore wind park is essentially divided into two main activities:

- preparation works (including pouring the foundation) ashore;
- installation works in the open sea (including foundation, wind turbine hub).

For storing the foundations and wind turbines and for preparation of constructions activities presumably the Harbour of Paldiski will be used. It means that during construction period construction vessels will move directly to the location of wind park being under construction without mooring to Hiiumaa.

Equipment for installation of offshore wind parks is mainly based on specially constructed marine transport (*jack-up* type ships, lift cranes, barks etc). The choice of conception with solution suitable for each concrete wind park project depends primarily on environmental conditions dominating in the location of the wind park and on that fact, what the installed equipment is like (dimensions/ weight) and the way of installing (wind turbine in one piece or blades are separate etc), what is the general logistics of supply chain, the type of chosen foundation etc.

Construction of wind park is planned in phases, starting from development area TP 2 and finishing with development area TP 1 (Figure 8). More detailed construction plan will be drawn up in cooperation with chosen constructor in the course of compiling construction project. Presumed duration of construction period is up to two years. Depending on ice-related conditions it is possible to build all year, other possible temporal limitations arising from environment will also be taken into account during construction period.

2.3.2. Installation of cables

Installation of sea cables is a part of work process for construction of wind park. A brief overview of possible environmental aspects and practice until now with respect to installation of cable is provided as follows. This EIA will assess the impact on the installation and operation of undersea cables across major aspects of the marine environment. Terrestrial connections and their potential environmental impacts are not addressed.

Environmental aspects related to sea cables may be divided into pre-construction and after-construction aspects.

The main source of impact at the time of construction may be deemed deepening of the seabed, which creates possible disturbance to seabed fauna, suspension or limitation of professional fishing is also possible for the period of cable installation.[3] The desired depth for installation of cables into

[2] Potential of Offshore Wind Energy Industry for Estonian Companies, 2011. Garrad Hassan and Partners Ltd
[3] Rødsand 2 Offshore Wind Farm Environmental Impact Assessment Summary of the EIA-Report, 2007

the seabed is deemed 1-2 m.[4] It may be necessary at the time of construction to perform additional seabed surveys, in order, for example, for sea cable installed too deeply not to break and not to create significant economic damage due to decrease in wind park productivity as well as due to fixing the cable. Cable installation depends also on characteristics of seabed. In many places in Northern Europe the seabed is sandy, which due to its mobility can easily bare the cable and thus be more susceptible to external impacts (e.g. hummocked ice, fishing, anchoring).[5] In addition to that, environmental impacts at the time of construction may be deemed underwater noise and vibration arising during installation of cables, possible visual disturbance to sea fauna and some polluting substances released when re-locating sediments.[6]

Possible cable landfalls should be analysed separately and high-voltage cables constructed on the shore.

Cable after-construction environmental aspects may be deemed possible arising of local electromagnetic field when transporting the electricity through the cables and warming of the cables, which may have an impact on sea fauna.[7] Still the present practice confirms that the voltage of cables installed at the depth of at least 1 m into the seabed does not exceed 36 kV. Arising electromagnetic field does not create major disturbances to fish or sea mammals.[8] Using of cables with alternating current and three cores will decrease possible emission of magnetic fields, since core conductors' distance is small. In case of use of three separate cables for connection to the shore instead of one three-core cable, then from the point of view of minimising environmental impacts they should be located as close to each other as possible in order to decrease magnetic fields arising from them. For connecting wind turbines among themselves usually one three-core cable is used.[9]

Increasing temperature of sediments due to warming of cables may not be deemed significant negative environmental aspect, since until now performed measurements in case of already functioning wind parks have revealed the real increase in sediments temperature just by 2 °C, which does not create significant negative impact to seabed composition.[10]

2.3.3. Connection to electricity network

In order to find out possibilities for connecting of planned wind park to electricity network Tallinn Technical University has compiled work "Hiiumaa offshore wind park and its connection to electric system", OÜ Põhivõrk has also issued connection proposal and Elering OÜ preliminary conditions for connection to electricity network. Also, the survey from AS Empower has been ordered, which has surveyed different possibilities for connection of wind park: 1) over Hiiumaa, 2) along Hiiumaa directly to mainland etc. In case of all variants the developer guarantees additional network connection for Hiiumaa.[11]

Works specified in connection proposal and preliminary conditions for connection to electricity network will be performed by a network enterprise at the developer's expense. Taking into account

[4] Review of cabling technique and environmental effects applicable to the offshore wind farm industry. Technical Report, 2008
http://webarchive.nationalarchives.gov.uk/+/http:/www.berr.gov.uk/files/file43527.pdf
[5] Järvik, A. Assessment of environmental impacts arising from construction of offshore wind parks in north-western Estonian coastal sea. Tallinn, 2011
[6] Assessment of the environmental impacts of cables. Ospar Commission, 2009
http://qsr2010.ospar.org/media/assessments/p00437_Cables.pdf
[7] Rødsand 2 Offshore Wind Farm Environmental Impact Assessment Summary of the EIA-Report, 2007.
http://www.ens.dk/sites/ens.dk/files/undergrund-forsyning/vedvarende-energi/vindkraft-vindmoeller/havvindmoeller/miljoepaavirkninger/Roedsand/6250_de_ikke_teknisk_resume_uk_roddsand_031.pdf
[8] Horns REV 2 Offshore wind farm. Environmental impact assessment summary of the EIA-report. October 2006. http://www.eib.org/attachments/pipeline/20070322_nts_en.pdf
[9] Survey of fish fauna of Hiiumaa shallows region. Estonian Marine Institute, University of Tartu Tartu 2014
[10] Bojars, E. 2007. EIA for offshore wind parks – potentials for conflicts with NATURA 2000 designation. Riga
[11] Connecting of north-west Estonian offshore wind park to main network. Empower AS. Jaanuar 2015

capacities to be transferred, connection will be performed at the voltage of 330 kV. Transformation to 330 kV voltage will take place at Hiiumaa substation by means of two 110/330 kV automatic transformers (capacity à 500 MVA). Substation will in turn be connected by two 330 kV cable lines to Aulepa substation. From Aulepa substation connection goes on by 330 kV air-lines to Harku and Sindi substation. This solution will significantly improve electricity supply on Hiiumaa, since round connection with mainland will appear.

Alternatively, the developer considers the possibility to create connection to electricity network directly in Aulepa substation. Here the developer will consider two possible alternatives:

Cable installation alternative 1

In alternative 1, three export cables land on the coast of Hiiumaa in Tahkuna and Lehtma. The transmission cable will land near Suuresadama, Hiiumaa and near Rigudi, on Noarootsi peninsula. Initially, the transfer cable was also considered as an alternative to Hari Kurg, Vormsi and Voosi Kurgu (see Figure 11), but today the developer has abandoned it.

An overview of the power connection option for cable installation alternative 1 is given in Figure 11.

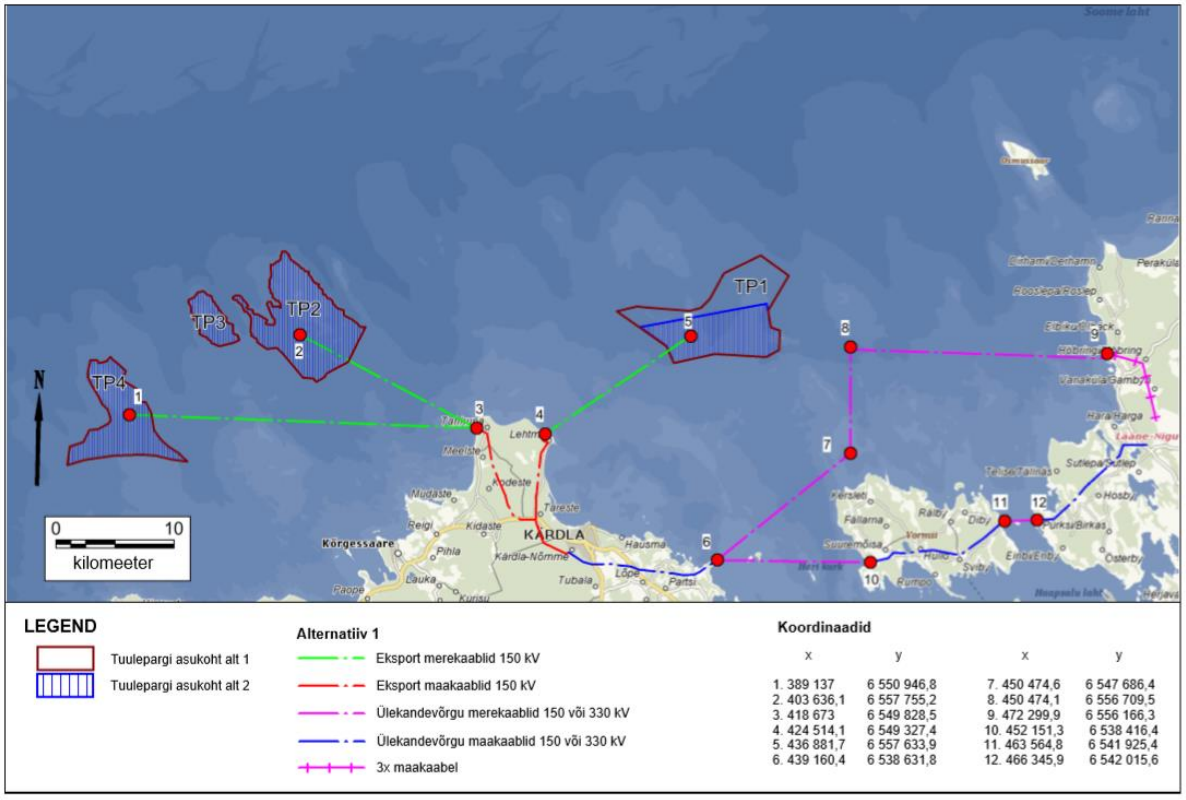

Figure 11. Wind farm connection option for cable installation alternative 1

Cable installation alternative 2

Alternative 2 connects the wind farm directly to the mainland. Cables are installed from wind farms along the most direct possible trajectory to the mainland. The landing of the cable on the continent is the same as for alternative 1: near Riguldi in Noarootsi. In order to provide Hiiumaa circular power, the cable will be built from the wind farm substation to Hiiumaa (capacity not more than 20 MW).

An overview of the power connection option for cable installation alternative 2 is given in Figure 12.

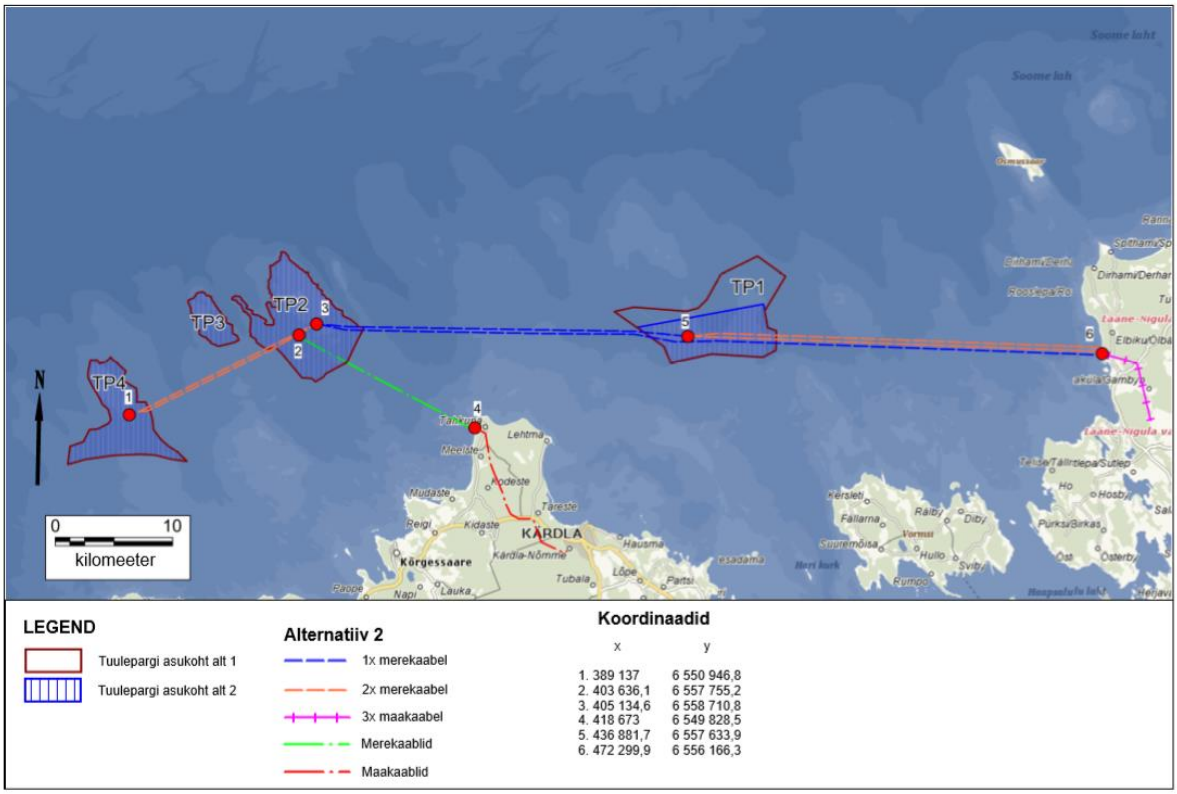

Figure 12. Wind farm connection option for cable installation alternative 2

With both cable installation alternatives, the planned sea cables are 1 m in diameter and the cables can fit into a corridor up to 10 m wide.

In the case of undersea cable construction, both alternatives are assumed to be recessed into sediments and covered with separated sediments. Table 5 shows the planned depth of the recess, the depth of the recess and the volume of sediment to be separated per running meter.

Table 5. Depths and volumes associated with cable recess

Cable installation	Cable depth (m)	Depth of recess (m)	Soil separation (m3 m-1)
At sea depth ≥ 20 m	1	2	4
At sea depth < 20 m	1,5	2,5	5

2.3.4. Operation on wind park

After construction of wind park, at the time of operation of wind turbines, wind turbines regular maintenance is foreseen (e.g. control of equipment and replacement of spare parts, if necessary). For this, in northern harbours of Hiiumaa (Lehtma, Kärdla, Suuresadama etc) maintenance ship(s) will be located, which will be at any moment ready to perform control and maintenance works, and the base for maintenance works will be founded on Hiiumaa.

2.3.5. Wind park demolition

Projected lifetime of wind turbines is according to the present experience at least 20 years. The duration of superficies licence is up to 50 years. If necessary, wind turbines can be entirely removed from the seabed together with foundations. Precise activity at the time of demolition depends on the conditions prescribed by the superficies licence. From environmental point of view, demolition

impacts are similar to construction stage – environmental disturbance is short-term and more intensive due to tighter ship traffic than in the period of wind park operation. If necessary, environmental requirements will be taken into account at the time of demolition regarding temporal limitations of performing the works.

2.4. Considering the alternatives

In case of this development two basic alternatives have been assessed: alternative 1 (creation of offshore wind park) and 0-alternative (wind park will not be created). In case of alternative 1 different technical variants have been considered (e.g. nominal power of wind turbine types), so-called lower alternatives.

In selecting alternatives to the locations of offshore wind farm sites, the developer has proceeded from the planning of the adjacent maritime area to Hiiu county and the results of the strategic environmental impact assessment. As a result, the developer has not yet seen the possibility of designing offshore wind farms outside the areas allowed in planning.

By the judgment of the Supreme Court of 08.08.2018 in court case No. 3-16-1472, the county plan of the maritime area bordering Hiiu county has been cancelled as regards the location of wind energy production areas (see chapter 2.5.2.5).

Based on this, the developer has the opportunity to consider building the wind farm in areas other than those permitted in the plan (outside the lowlands). The developer has been studying the lowlands since 2006 and has carried out extensive research in the areas and the areas do not exclude wind farms. As a consequence, these areas will continue to be considered as location alternatives to the wind farm, and other areas outside the lowlands will not be considered.

Taking into account characteristics of this project, different technological solutions of the wind park could be discussed as alternatives (wind turbine type and construction technology) and different number of wind turbines in proposed areas.

For alternative 1, there are three different wind turbine types available: Siemens SWT 4 MW, Siemens SWT 6 MW and Vestas V 7 MW. The wind turbines differ mainly in terms of power (4, 6 or 7 MW), rotor diameter (130, 154 164 or 220 m) and rotor blade length (63, 75 80 or 107 m). The height of the windmill mast would be 100-105 m or 138 m (see Chapter 2.1 of the EIA Report for more details). The distance between the wind turbines must be at least 1 km. In case the capacity wind turbine is smaller, more wind turbines can be installed - an estimated 182 pcs (4 MW), which would make the wind farm a total of 728 MW. With the most powerful wind turbines available, an estimated 157 wind turbines with an overall capacity of approximately 1100 MW could be installed.

For alternative 2, the wind turbines used are two different types of windmills, Vestas 7 MW and GE 12 MW (rotor diameter 164 and 220 m respectively, rotor blade length 80 and 107 m, and wind turbine height 105 and 138 m respectively). Similarly to alternative 1, the distance between wind turbines is also at least 1 km. The smaller capacity windmills (7 MW) are planned to be installed in the development area TP 1, in the amount of 37 pieces, and the larger wind turbines (12 MW) in the TP 2, TP 3 and TP 4, totalling 70 pieces. A total of 107 windmills are planned to be installed, the total capacity of the wind farm is also 1100 MW.

For Alternative 1, the total area of planned development areas is 168.89 km^2, which is as follows in development areas: TP 1 64.95 km^2, TP 2 55.75 km^2, TP 3 10.56 km^2 and TP 4 37.63 km^2. In alternative 2, the total area of development areas is 140.48 km^2. Compared to alternative 1, the difference is the smaller development area TP 1 (36.54 km^2 versus 64.95 km^2 in alternative 1) there is no difference regarding other development areas when it comes to alternatives.

When assessing the impacts so-called 0-alternative has also been considered, i.e. it has been assessed, whether and what changes creation of wind park would bring compared to the present situation – whether the situation will change for worse, i.e. negative impact, or for better, i.e.

positive impact. Respective comparative analyses are presented in chapters on assessment by areas.

In terms of alternatives of installing marine cables, there are two different alternatives to the location of the cable route - cable installation alternative 1 and alternative 2.

3. PRESUMABLY AFFECTED ENVIRONMENT DESCRIPTION AND ASSESSMENT OF ENVIRONMENT CONDITION

3.1. Hydrogeological conditions

3.1.1. Geology

Areas of creating offshore wind parks in north-western Estonian coastal waters remain within West-Estonian shelf, which is an underwater part of Baltic Klint surrounding from the side of mainland and continuation towards west of North-Estonian flag stone coast. Baltic Klint becomes apparent again in western coast of Öland island. The entire underwater part of Baltic Klint is geomorphologically strongly divided, and seabed depths vary there to a high extent.

Wind parks creation development areas TP 2 at Vinkov shallow and at shallows remaining to west from it (TP 3 and TP 4) are located within Ordovician underwater klint line, north-western tips of peninsulas directed towards north-west of this underwater klint or in immediate proximity. Under relatively thin sediment surface in those areas there can be found carbonate geological material of Ordovician period with mainly massive structure, which may be bare in some places (especially in areas close to klint edge) also on the seabed.

The most eastern development area, i.e. south-eastern part of TP 1 shallow, where the offshore wind park is planned, remains more to the south from underwater klint area and is located within western shelf within sediment rock plain of old group with thin surface. The differences in latitude/ depth of surface shape of this perspective wind turbines development area and open sea areas in close proximity are essentially smaller, than, for example, in the neighbourhood of area TP 2 considered above.

In southern part of shallow TP 1, in low waters, there are surface forms with hilly moraine shape, as well as there may be single piled edge formations apparently from ice period on mainland. In this area, the surface of earlier friable deposits have been washed through as a result of long-term stormy waves acting in a diffusing-piling way, of which there are mainly rough fragmental residual sediments on the seabed (sand, gravel, pebbles and lumps). Surface of carbonate rocks remains deep in comparison to wind park development area TP 2.

All areas chosen for creation of offshore wind parks are located in region, where the depth of water is up to 20 m. In all these areas the surface of friable deposits has been subject to intensive treatment by waves as the result of stormy waves, resulting in mainly roughly shaped residual seabed sediments within these shallows: sand-gravel, rubbles and lumps. Such characteristics of surface sediments are also confirmed by analyses of granulometric composition of samples taken from the surface of observed areas, in which the composition of sand-gravel fraction (in some places rubble-shaped) reaches 98-99% (Kask & Kask, 2007).

3.1.2. Seabed sediments

In 2007, seabed sediments survey has been performed in the planned wind park location[12]. In 2014, additional samples has been taken from seabed sediments in order to define granulometric composition, heavy metals and general petroleum products. In total, in 2014 additional samples have been taken from 12 points. Analysis results have been compared in the course of work to limit values established with respect to dangerous substances in the soil.

The observed areas are located in the open sea, where there are often strong winds and waves. Seabed sediments of the area mainly consist of particles belonging to several granulometric

[12] Surveys of seabed sediments at shallows located in the west, north-west and north from Hiiumaa. A. Kask, J. Kask. 2007, 20 lk

composition fractions. Water movement caused by waves has sorted sediments out and allocated them based on the relief in such a way that more tiny particles are present mainly in deeper areas and rough-shaped sediments in lower areas.

Based on analysis results it is apparent that more suspension will arise at construction works from development area TP 2 in the west and development area TP 1 in the south and south-east, than in other surveyed areas.

The content of five heavy metals (Cd, Cu, Pb, Zn, Hg) and general petroleum products has been defined in the laboratory of Estonian Geological Centre, which has been compared to norms. The results have shown that sediments are mainly in good condition in the area of taking the samples from the point of view of the content of defined heavy metals and general petroleum products. Only in development area TP 2 in the east sediments are in satisfactory condition, but not polluted.

3.1.3. Coastal processes

From the point of view of sea coast construction and development, Hiiumaa northern coast belongs to diffusing-piling flat coast. Piled sandy coasts are dominant here. In single areas such as small islands of Kõrgessaare surroundings (Külalaid etc) there are also small-size flag pebble coast ridges, which develop exceptionally in case of strong storms, when sea level is higher than average. Especially clear changes in coasts development have occurred and are occurring in the conditions of so-called extraordinary storms in different areas of the Baltic Sea, prerequisites of which are ice-free sea, relatively high sea water level and strong stormy winds blowing from suitable direction. Last time such extraordinary condition occurred at the time of Gudrun storm on 09.01.2005 (Tõnisson *et al.* 2009*).*

With strong stormy waves intensive waves activity appears in sandy coasts of the region in several areas of Kõpu peninsula (Ristna hoe, Luidja surroundings etc), as well as Tahkuna peninsula (Tuletorni and Lehtma harbour surroundings and other places). Coast destructions caused by storm activity, sand drifting, migration of sediments and coastal sand accumulation are mainly a natural phenomenon. Intensifying of coastal processes during the last decades is apparently related to global climate changes.

All areas of creation of wind parks remain more than 10 km away from coast line.

3.2. Hydrodynamic and climatic conditions

3.2.1. Wind

According to data of Vilsandi coast station the average wind speed in years 1981-2012 has been 6,1 m/s. Wind average speed has comparatively varied by years, changing in the interval between 5,3 and 7,0 m/s. The most windless period is from April till August, when the average wind speed is below 5,5 m/s. The period of stronger winds is from October till January, when the average wind speed is above 6,8 m/s (maximum in January 7,3 m/s). Strong winds are seasonal: e.g. recurrence of winds ≥10 m/s and ≥15 m/s in November is respectively 4 and 15 times higher than in May.

Dominating are south-western and western winds. More frequent appearance of those directions arises more, if only strong (10-15 m/s) or stormy winds (>15 m/s) are considered. Secondary stormy wind maximum is from northern directions. These two strong winds directions dominate especially in autumn and winter.

Stormy winds from NE, E and SE directions occur very rarely. At the same time, winds from those directions may be a little bit underestimated due to peculiarities of station location. For example, eastern winds are present in the Gulf of Finland significantly more frequently (Soomere & Keevallik, 2003), than it is apparent on the basis of Vilsandi data. Apparently, differences in morphology of open part of the Gulf of Finland and the Baltic Sea come into play: the first on is stretched in the direction of east-west, the second in the directions of north-south.

3.2.2. Ice conditions

Ice conditions may be very different in the Baltic Sea from year to year. Ice large amount is usually defined by winter frost, which in turn depends on atmosphere circulation. If the air flow from west, which brings warmer and more humid air from North-Atlantic to the Baltic Sea regions, is stronger, then winter is also softer. In addition to winter frost, local ice conditions also depend on other factors, such as wind regime or the amount of precipitation. Thus, even during relatively frosty winter Hiiumaa coast remaining in the open part of the Baltic Sea may be ice-free, if suitable winds push drifting ice away.

On the basis of observation made in Ristna in 1949-2004, the average period with ice cover has been approximately two months, whereas there have also been ice-free years (Jaagus, 2005). Although Ristna station is planned relatively closely to wind park areas, it still does not necessarily describe ice conditions of open sea very precisely, which may be different from what is happening at the coast. When characterising ice conditions of the regions, the Baltic Sea database has been used for year 1982-2009 compiled by Meteorological Institute of Denmark on the basis of satellite monitoring. The average period covered with ice in the area of planned activity is approximately up to twenty days. It is important to point out, that in this time interval there have been significantly more soft winters than the long-term average. During very frosty winters the entire wind park region may be covered with immovable ice. On the contrary, during soft winters there is no ice cover in the region. As a rule, ice thickness reaches its maximum in March, and in 1990-2009, on the basis of model data, the maximum monthly average ice thickness in the wind park region has been about 20 cm. It is still important to emphasize, that there have been no very frosty winters in the modelled time interval. During very frosty winter in 1986/1987 ice thickness in the region close to planned activity reached up to 30 cm (Haapala & Leppäranta, 1996). Thus, there still may be somewhat thicker ice in the region, than the model data show.

3.2.3. Water quality

Water quality in Estonian coastal waters has been assessed on the basis of indicators and established assessment criteria elaborated for application of Water Framework Directive (WFD) (decree of the MoE No 59 as of 12.11.2010 and its Annex 6).

Since environmental condition related to seabed fauna is reflected in other chapters of EIA report, therefore in this chapter assessments are provided, that have been made on the basis of measurements of phytoplankton, nutrients and water transparency. According to the data of initial assessment compiled for application of Marine Strategy Framework Directive (MSFD) (Estonian Marine Institute of the University of Tartu, 2012), coastal waters remaining to the north from Hiiumaa are of poor water quality according to phytoplankton (chlorophyll *a* and biomass), general nitrogen, general phosphor, as well as water transparency.

Although the planned wind park areas remain outside the boundaries of coastal waters, the provided assessments may be deemed well-grounded also for planned wind park areas. At the same time, in order to assess the quality of water of the sea area remaining outside coastal waters, official criteria in Estonia are absent. In the last HELCOM assessment of eutrophication of the Baltic Sea it has been found, that the condition of northern part of the Baltic Sea (taking into account winter content of nutrients, water transparency, chlorophyll content and oxygen concentrations) is also not good (HELCOM, 2014). Main reasons, why the assessment of ecological condition and assessments of the level of eutrophication do not conform good quality of water, is related to general enrichment of the Baltic Sea with nutrients. It is also related to higher level of chlorophyll and partial worsening of water transparency and lack of oxygen in deeper sea areas. Most of the nutrients sources are located ashore and are brought to the sea by rivers or directly through drainages. In open sea areas water quality depends a lot on the water quality in the entire Baltic Sea, and in order to improve condition it is necessary to take measures within the entire sea basin.

The important environmental problem in the Baltic Sea is (partially caused by excessive nutrients) a massive growth of cyanobacteriae. During last twenty years massive growth has been intensive during several summers also in the open sea area remaining to the north from Hiiumaa. Distant

monitoring as well as direct measurements have shown big intensity of cyanobacteriae massive growth in this region also in summer of 2014. In the end of July of 2014 growth of cyanobacteriae in the open sea has been significantly more intensive than in Estonian coastal waters.

Since one of the main factors affecting water quality is getting of suspension into the water in case of seabed disturbances, water turbidity measurement data have also been analysed from the region. The values of turbidity measured in different trips (along the entire route of the ship) by the flowing system installed on the survey ship Salme have mostly remained below the value of 2 NTU (on the basis of anchor calibration corresponds to the content of sailing substance approximately 2 mg/l). Higher turbidity values in the region have been measured at the time of phytoplankton spring flowering, where values exceeded 4 NTU. Survey results, that have been measured in the end of April 2014, have shown that turbidity measured in shallows area has been a bit higher at that period (2-2,5 NTU, single values exceeded 3 NTU), than in a deeper sea area remaining to north-east from development area TP 1 (values have mainly been in the interval of 1-1,5 NTU). All these values remain significantly lower, than the values of turbidity measured in regions close to work areas at the time of deepening and overturning works and in low sea with soft seabed.

3.3. Seabed fauna

Seabed inventory areas have been greatly affected by environmental conditions of the Baltic Sea open part. The main factor making up the fauna is depth, mechanical impact of waves and somewhat higher saltiness (6-7 psu) compared to sea parts remaining to east. in the described shallows, there have become apparent seabed flora and fauna species mainly characteristic to deep and open sea areas (HELCOM 2012). Small variety of species in these inventory areas may also be caused by lack of different dwelling places, openness to waves and big depths. Development area TP 1 (Apollo) shallow turned out to be the richest in species out of the surveyed areas (there are 15 different seabed fauna species).

3.3.1. Seabed flora

Out of seabed flora mostly red and brown algae species have been defined in the course of inventory of development areas TP 1 and TP 2 and TP 4, that are also more characteristic to deeper areas and open part of the Baltic Sea. The has also been found a species of green algae – *Cladophora glomerata*, which has been found in development areas TP 1 and TP 2. In development area TP 1 there has been found brown algae species with two strong thallomes – *Halosiphon tomentosus* and *Fucus vesiculosus*.

The biggest average biomass of seabed flora (29,67 g/m^2) is present at the depth of 17 m and it mostly comprised of thread-like red algae *Polysiphonia fucoides* (18,23 g/m^2) and red algae with strong thallome *Furcellaria lumbricalis* (10,8 g/m^2).

The most domination of seabed flora (20%) is present at the depth of 13 m and it is mostly comprised of the group of thread-like red algae (9,2%). Dispersion of domination of seabed flora diminishes as the depth increases, which is caused by diminishing availability of light to algae.

3.3.2. Seabed fauna

Dominating species in development areas TP 1, TP 2 and TP 4 seabed fauna is a *Mytilus trossulus* (edible mussel) with a sitting lifestyle, whose biomass in the surveyed sea areas is in the interval 0,002-571,62 g/m^2 (average biomass is 88,85 g/m^2) at the depth interval 13–37,3 m. Among species with higher biomass there also *Macoma baltica* (Baltic tellin) – average biomass 10,28 g/m^2. Variety of species is greater at smaller depths, where dwelling place can be found for species fixing to solid substratum, as well as for species that are commonly related to seabed flora. In deeper areas there are mostly species of seabed fauna with sitting lifestyle. Average drained weight of seabed fauna in the surveyed areas has been 78,84 g/m^2. There are many species in

development areas TP 1, TP 2 and TP 4 seabed fauna, whose average biomass is below 0,1 g/m^2. Maximum average biomass (552 g/m^2) of the surveyed areas has been reached at the depth of 14 m, which is mostly comprised of edible mussel (549,6 g/m^2).

The most domination of seabed fauna (69%) is present at the depth of 15 m and it is mostly comprised of edible mussel (55%). Domination of seabed fauna diminishes as the depth increases.

3.3.3. Seabed dwelling places

Dispersion of dwelling places pursuant to classification of dwelling places elaborated in the course of EU Life project "Marine conservation areas in the eastern part of the Baltic Sea" has turned out to be extremely homogeneous in areas TP 1, TP 2 and TP 4. Out of 18 seabed dwelling places of EU Life project "Marine conservation areas in the eastern part of the Baltic Sea" present in Estonian coastal waters only three have been present in all surveyed sea areas:

- 10 – moderately open solid seabeds with composition of shells;
- 17 – moderately open soft seabeds with composition of shells;
- 18 – moderately open soft seabeds without domination of any certain species;

When defining these dwelling places, geographical and biological data have mainly been the guidance. In the following table (Table 6) sizes of dwelling places elaborated in the EU Life project "Marine conservation areas in the eastern part of the Baltic Sea" are presented for given surveyed areas.

Table 6. Sizes of dwelling places elaborated in the EU Life project "Marine conservation areas in the eastern part of the Baltic Sea" for surveyed areas

Surveyed area	No. of dwelling place	Size, km²	Share, %
Apollo shallow (TP 1)	10	9.0	15
	17	13.4	22
	18	38.1	63
Vinkov shallow (TP 2)	10	11.1	47
	17	5.6	24
	18	6.9	29
Shallow 1 (TP 4)	10	3.9	16
	17	7.8	31
	18	13.2	53

Dwelling place No. 18 dominates at Apollo shallow, the share of which makes up 63% out of the entire area size. Dwelling place No. 10 dominates at Vinkov shallow (TP 2), the share of which makes up 47% out of the entire area size. Dwelling place No. 18 dominates at Shallow 1 (TP 4) surveyed area, the share of which makes up 53% out of the entire area size. The named dwelling places are mainly present over the entire concrete surveyed area.

The area of planned cable lines is occupied by habitat type 1170 (reefs), classified by nature directive Annex 1, the spread of other habitat in this area is limited.

The area of the proposed cable lines is predominantly a habitat type 1170 (reefs) qualifying as Annex I to the Habitats Directive.

3.4. Fish

The purpose of fish survey has been to characterise shallow fish remaining to west, north-west, north and north-east from Hiiumaa by quantitative net fishing. Work has been performed in May-June during two survey years: 2008 and 2014.

In total, in 2008 within five surveyed areas 4568 fish have been caught with cohesive networks, belonging to 13 different species, 5 orders and 10 families. Systematic list of fish is presented in Annex 1 to the fish survey report. As a result of survey performed in 2014, 400 fish were added at Shallow 3, the overall number of species remained the same.

Survey results are presented below in two subchapters: number of units (number of units per standard catching unit, CPUE) and proportion of different species and a biomass (proportion of total weight of different species to standard catching unit).

Number of different species

In total, 13 fish species have been caught in the course of field works. At the same time, two species were represented by just one unit (plaice and fourhorn sculpin) and a total of 4 perches has been caught. Flounder was very clearly a dominant species, making up in general 76% of the total number of units. The second species by number (viviparous eelpout) was already ten times smaller amount. Flounder amount at different depths and within shallows varied to a high extent. The main reason for this is still apparently not different suitability of areas for species to a high extent. The latter has also not been referenced by mapping of seabed dwelling places performed by Estonian Marine Institute (Martin and others, 2014). For example, in development area TP 1 (Apollo) the amount of flounder was approximately ten times smaller than at shallow 1 or Neupokojev shallow. St the same time, development area TP 1 (Apollo) offers richer foods base for fish with seabed lifestyle than other shallows (Martin and others, 2014). Thus, the reason for different amount of flounder has rather been the circumstance that some catches coincided with flounder's spawning period. Uneven increase in the amount of fish during spawning time and on migration ways is usual.

Biomass of different species

Since average weights of different species are quite different, than the species dominating by number are not necessarily at the same significant position in biomass. For example, quite numerous sprats and viviparous eelpout are on average significantly smaller than cods, flounders or Myoxocephalus scorpius. Also by weight the most important species is definitely flounder (confidently dominated at five shallows out of six), followed by cod and Myoxocephalus scorpius. Flounder, cod and Myoxocephalus scorpius comprised at least three quarters of the total amount of fish caught at all shallows. The named three most important species were followed by turbot and viviparous eelpout, that were by weight already significantly less important. As an exception, development area TP 2 could be pointed out here, where turbot was by weight in the third place after flounder and cod.

3.5. Sea mammals

Three species of mammals are dwelling in the Baltic Sea: grey seal (*Halichoerus grypus*), ringed seals (*Phoca hispida*) and harbour porpoise (*Phocoena phocoena*).

Grey seal

Grey seal is the largest mammals of the Baltic Sea. Dwelling place of a grey seal are surroundings of open sea islands and small island, animals have a settled lifestyle. Food is mainly fish – cod, flounder, salmon fish, herring fish. In addition to fish they eat in significant amounts marine invertebrates and plants.

Grey seals are mostly endangered by Baltic Sea pollution, hunting and ship traffic. Baby animals are endangered by soft winters. In addition to the above-said, significant anthropogenic risk factors are yet fish by-catch, disturbance, air traffic and military activity. Grey seal belongs to III protection

category in Estonia and is protected on the basis of nature directive as well (annex II and V). Several grey seal permanent dwelling places have been taken under protection in Harju, Saare and Hiiu county by the decree of MoE No. 78 as of 20.12.2005.

Grey seal is a seal species freely moving in the area of the entire Baltic Sea, whose central areas of dispersion are located in the middle part of the Baltic Sea. This species inhabits mainly in areas bordering upon open sea of archipelagos, using sea shallows as rookeries as well as islands above the water level, as a rule without flora cover. In Estonia grey seals are relatively rare in Väinameri to the south from ship line between Heltermaa and Rohuküla and to the north from Muhu. In other places of the Baltic Sea their number is small in internal archipelagos and sea narrowness, and more plentiful in open sea areas (Programme for protection of grey seal, 2014).

Estonian coastal waters are located in south-eastern part of grey seal permanent dispersion area. In Estonia grey seal is mostly dispersed towards west, bigger rookeries and whelping areas remain into waters of East-Estonian archipelago. In the Gulf of Finland the amount of grey seals is approximately 800, big part of seals is dwelling in waters of Finland. As known, grey seals inhabit regularly two areas in the Gulf of Finland, Uhtju islands to north from Kunda and in Vahekari in Malusi island groups in the Gulf of Kolga. The third area, where grey seals are often met, is locate in the west from Pakri islands. In the Gulf of Finland grey seals whelp on ice, since ice is formed in the eastern part of the Gulf of Finland also during warm winters (Programme for protection of grey seal, 2014).

In West-Estonian archipelago grey seal inhabits mainly areas in open sea in mouth of the Gulf of Finland, on western coast of archipelago and northern part of the Gulf of Riga. There is a lot of grey seals in Väinameri only in the period of spring shedding hair in Hari Strait, but single seals or smaller groups can be met during the entire ice-free period (Programme for protection of grey seal, 2014).

Dispersion of grey seals at the reproduction period is related to availability of ice at the reproduction period (February–March). In case of frozen sea they always prefer to reproduce on ice and they search for suitable types of ice for this (drifting ice or edge areas of immovable ice). Dispersion of suitable types of ice in Estonian coastal waters is directly related to winter character. Main reproduction areas are located in case of average winters and warmer than average winters at western and southern coast of Saaremaa, in the eastern and central part of the Gulf of Finland, more rarely also in the waters of Hiiumaa northern coast. If ice is absent, grey seals reproduce on islands, that are located mostly in the same region, where the ice suitable for reproduction is formed in cold winters. No islands are known as used for reproduction in the Gulf of Finland (Programme for protection of grey seal, 2014).

Grey seal rookery and census area, that are closest to the planned offshore wind park, is Selgrahu, which is located 3,5 km away toward south from wind park area of the development area TP 1 (Apollo). Selgrahu is one of West-Estonian large seal rookeries, the region of which has been made a permanent Selgrahu grey seals dwelling place. The area also belongs to nature conservation area of Väinameri. Areas of the planned wind park, primarily development area TP 1 (Apollo), are located in the north from Hiiumaa in the area of open sea, which is significant ice-based whelping area for grey seals. In Hiiumaa surroundings, the area for grey seal whelping are mainly drifting icy fields located in the northern part from Hiiumaa. The planned wind park areas, primarily development area TP 1 (Apollo), are significant as grey seal whelping areas during average or colder winters. In the region of wind park area no small islands or reefs can be found, that would be suitable for seals rookeries and for reproduction on the shore. Appearing of grey seals in the wind park areas outside whelping period is also probable, since the species is widely dispersed in the areas of the Baltic Sea.

Ringed seal

Ringed seal is an Arctic species, which is represented in the Baltic Sea by subspecies *P.h.botnica*. Today, they are represented in Estonia in Väinameri, the Gulf of Riga and eastern part of the Gulf of Finland. In the Baltic Sea the amount of species is at historical low level, in total the amount of species is assessed approximately 5000 animals, of which one fifth is inhabiting the coast in

Estonia.[13] Rookeries of Baltic Sea ringed seal subpopulation, that reach Estonian waters, are shown on the following figure. Mainly, West-Estonian population of ringed seal is located in Estonian waters, and south-western edge of ringed seal dispersion area of the Gulf of Finland reaches to the Gulf of Narva and Uhtju island (Jüssi et al, 2004). Ringed seal is mainly feeding on fish, less crustaceans and molluscs. Ringed seal reproduces after 9-10 months of gestation in the end of February or in March in a snow cave on ice or in another hidden place, where it remains for a month's time. Baby animals are fed about two months. Ringed seal belongs to the II category of protected species and is also protected on the basis of nature directive (Annex II).

On the contrary to grey seal, ringed seal has used dwelling places close to the coast during ice-free time. Due to this it is very climate-sensible, and the impact of warm winters on population is not suitable due to disturbance of reproduction. Today, the main dwelling areas of seals have remained in the regions, where the sea get frozen with ice in winters and at shallows, where these animals can lay at ice-free time without disturbance. The number of ani9mals is small, small and relatively timid with respect to human activity as well as other disturbances, due to which they can be seen very rarely and also their observance of complicated, for example, for the purposes of census. Seal is not a species conflicting with fishing, not very many of them die in traps and their menu does not coincide a lot with people. At the same time, it is a sensible species with respect to condition of sea environment, which is endangered with accumulation of organic poisons in feed circuit and whose success of whelping directly depends on climate. Now the parts of the Baltic Sea yet inhabited by seals are just a part of historical dispersion region, and upon decreasing of the amount there have remained less permanent rookeries during the last twenty years. Ringed seals of the Gulf of Finland may be deemed to be under the risk of disappearing, since geographical location enhances in this sea region both human-caused as well as natural stress (Programme for protection of ringed seal, 2015).

There are no permanent dwelling places of ringed seals or areas and recreation areas suitable for reproduction in the region of planned wind park. West-Estonian subpopulation with approximate number of 1000 animals (Programme for protection of ringed seal, 2015) has concentrated in Väinameri and the Gulf of Riga and the Gulf of Pärnu, where there are more suitable ice conditions for reproduction (ice cover is more stable and durable). Appearing of ringed seals in wind park areas is possible, but rather accidental, and it is not significant dwelling place for the species.

Harbour porpoise

In Estonian sea harbour porpoise was met quite often until 1950-s. The last certified find of harbour porpoise was in the end of 1980-s. It does not mean, that they could not swim around in Estonian sea. Several years ago in Latvia a dead harbour porpoise was found close to the city of Riga. In waters of Finland harbour porpoises have been seen every year. Harbour porpoise may appear in the region of the planned wind park, but this would be very rare visit by mistake.

3.6. Birds

The following is the overview of the results of ornithological surveys performed in autumn 2014, winter, spring and summer 2015, in winter 2015-2016 and in spring 2017.

3.6.1. Ornithological surveys 2014-2015

In the survey, main attention has been paid to migrating water birds and water birds gathering in winter. According to the purpose of work open sea birds have been observed. All water birds have been observed, that can be met in the open sea. Migrating birds (brantas, common cranes) and species related to the coast (swans, ansers, swimming ducks and merguses) have been excluded from analysis.

[13] Programme for protection of ringed seal (*Phoca hispida*) (confirmed in 2015) www.envir.ee/sites/default/files/viigerhyljes_ktk_kodukale.pdf

In total, during four censuses 21 birds species have been met, of which almost half, i.e. nine species were represented in all census periods (Table 7). The most numerous species, as expected, has turned out to be long-tailed duck, followed by common eider, scoter and larus. Depending on weather and light conditions defining of some species from the plane is complicated. Therefore, scoter (common and velvet), loon (red-throated and black-throated) and sterna (arctic and common) have been analysed together.

Table 7. Census of the number of birds that stopped in northern Hiiumaa coastal sea (autumn 2014, winter 2015, spring 2015, summer 2015)

No.	Species (English)	Species (Latin)	Spring 2015	Summer 2015	Autumn 2014	Winter 2015
1	Razorbill	*Alca torda*	3	22	0	9
2	Tufted duck	*Aythya fuligula*	8	0	80	0
3	Greater scaup	*Aythya marila*	282	0	0	0
4	Common goldeneye	*Bucephala clangula*	44	31	35	601
5	Long-tailed duck	*Clangula hyemalis*	6894	258	18354	13857
6	Loon	*Gavia species*	15	17	4	59
7	Great black-backed gull	*Larus marinus*	2	9	2	7
8	European herring gull	*Larus argentatus*	6	198	88	890
9	Common gull	*Larus canus*	23	291	978	5540
10	Black-headed gull	*Larus ridibundus*	29	37	9	6
11	Little gull	*Hydrocoloeus minutus*	0	23	7	0
12	Jaeger	*Stercorarius species*	0	6	0	0
13	Scoter	*Melanitta species*	243	7071	100	300
14	Great cormorant	*Phlacrocorax carbo*	30	12	1	0
15	Common eider	*Somateria mollissima*	2215	8286	0	0
16	Steller's eider	*Polysticta stelleri*	0	0	0	400
17	Caspian tern	*Sterna caspia*	4	0	0	0
18	Sterna	*Sterna species*	122	126	0	0
	Total		**9920**	**16387**	**19658**	**21669**

Density model has been made for more numerous species, by means of which the assessment of number has been made for the entire area and for separate shallows (Table 8). For less numerous species density model has not been made, since it may be not correct. Table 9 census data and assessment of number are provided for birds that stopped separately at Apollo shallow.

Table 8. Assessment of the number of birds that stopped in North-Hiiumaa coastal sea and at shallows (autumn 2014, winter 2015, spring 2015, summer 2015)

	Species	Spring 2015						Summer 2015					
		entire area	Shallow1/2	Vinkov	Tahkuna	Hiiu-shallow	Apollo	entire area	Shallow1/2	Vinkov	Tahkuna	Hiiu-shallow	Apollo
1	Long-tailed duck	23000	100	170	3560	6550	5400	1030	0	0	0	0	0

2	European herring gull							1800					10
3	Common gull		590	620				1800					10
4	Aythya	6200				250							
5	Scoter	1400		50		40	220	12900			60	1590	3900
6	Common eider	5400			90	770	60	23000	190	90	2650	7840	130
7	Steller's eider												
8	Loon												
9	Sterna	540	70	150	30			600	80	50	30	80	
	Species	**Autumn 2014**						**Winter 2015**					
		entire area	Shallow1/2	Vinkov	Tahkuna	Hiiu-shallow	Apollo	entire area	Shallow1/2	Vinkov	Tahkuna	Hiiu-shallow	Apollo
1	Long-tailed duck	82400	2230	1000	3290	680	46100	38300	4300	2200	1020	4740	14500
2	European herring gull	310		10	10	10	110	2300	110	230			10
3	Common gull	4000	20	60	30	10	1800	15800	520	3560	260	270	50
4	Aythya												
5	Scoter	100						1600					
6	Common eider												
7	Steller's eider							400					
8	Loon							360	10		60	40	
9	Sterna												

Table 9. Assessment of the number of birds that stopped in North-Hiiumaa coastal sea and in development area TP 1 (Apollo) (autumn 2014, winter 2015, spring 2015, summer 2015)

No.	Species	Spring 2015		Summer 2015		Autumn 2014		Winter 2015	
		entire area	TP 1	entire area	TP 1	entire area	TP 1	entire area	TP 1
1	Long-tailed duck	23000	5400	1030		82400	46100	38300	14500
2	European herring gull			1800	10	310	110	2300	10
3	Common gull			1800	10	4000	1800	15800	50
4	Aythya	6200							
5	Scoter	1400	220	12900	3900	100		1600	
6	Common eider	5400	60	23000	130				
7	Steller's eider							400	
8	Loon							360	
9	Sterna	540		600					

3.6.1.1. Spring migration

Spring migration of water birds starts in the end of February and usually ends in the second half of May, but in case of single birds, such as brent goose and sterna, it may last also till the beginning of June. Mass migration, which directly depends on weather, occur in cycles from the middle of April till the second half of May. Mainly migration occurs at the altitude 1-100 m above the sea. Main migration direction is NE, varying in the interval in the direction of N-NE-E. Important is the effect of coast as an ecological barrier (migration barrier) and a general line. Birds approaching Hiiumaa western coast from open sea from the direction of SW turn to the direction of NW-N before the coast and fly along the tip of Kõpu peninsula, continuing migration in the sea mainly in the directions of NE-NEE. Hiiumaa north-western coast affects mainly as general line and migration flow heads towards the surroundings of the tip of Tahkuna peninsula and continues from there in the open sea in the directions of NE-E. The main migration direction in the project area is NEE.

Migration is the most intensive in the morning, evening follows and it is the weakest at midday. Very big share of birds migrating through makes migration break, which usually lasts for 2-3 weeks. During this time they accumulate energy for continuation for so-called "migration jump". The best time for mapping the spring migration gatherings is the beginning of May. Unfortunately, it was not possible to do that due to very unsuitable weather in spring 2015, taking into account primarily flight safety and census errors arising from high waves. The flight was performed with a small delay, but still remained within migration period. Based on that the number of birds was a bit smaller than expected, but the overview of flock location still provided comprehensive results (Figure 13).

In spring, 16 birds species related to open sea were met in census area. In the middle of May density of diving fuck population was the greatest in development area TP 1 (Apollo), at the tip of Tahkuna peninsula, at Hiiu shallow and at the tip of Kõpu peninsula. General assessment for the entire area was 36 540 units, of which 5680 used development area TP 1 (Apollo) as a feeding area. Out of the shallows the most important feeding areas were development area TP 1 (Apollo) and Hiiu shallow.

The most numerous species were in spring long-tailed duck and common eider, who were followed by greater scaup and common scoter. Since defining of scoters from the airplane is complicated in some conditions, they were considered together. The biggest gathering of long-tailed duck were

located at Hiiu shallow, at the tip of Tahkuna peninsula and at Apollo shallow. In the entire area the total number of long-tailed ducks has been calculated 23 000 units, of which 5400 were feeding at Apollo shallow. The total estimated number of common eiders in the entire area turned out to be 5400 (Table 7), whose feeding gatherings were located close to the coast. Out of shallows common eiders used only partially Hiiu shallow. Scoters' (common and velvet) feeding gatherings were located relatively widely within the entire project area. Out of shallows development areas TP 1 and TP 2 were partially used. Approximately 1400 scoters stopped in the entire area (Table 9), of whom about 90% were common scoters. In the development area TP 1 approximately 220 birds stopped. The small number of scoters might be caused due to late census time. Aythyas, of whom 80% were greater scaups, stopped at Hiiumaa coastal sea in the amount of approximately 6200 birds. Feeding areas were located one in the north from Kärdla and the other south-eastern edge of Hiiu shallow. Since it was almost impossible to distinguish common terns and arctic terns from the airplane, these two species were considered together. As it is common to pelagic birds, terns were met almost everywhere within the project area. The largest concentration of terns was noticed in the west from the development area TP 2. Gulls were almost absent from the spring census. Single common gulls, European herring gulls and black-headed gulls have been met. From other species of terns, caspian tern and sandwich tern have been seen.

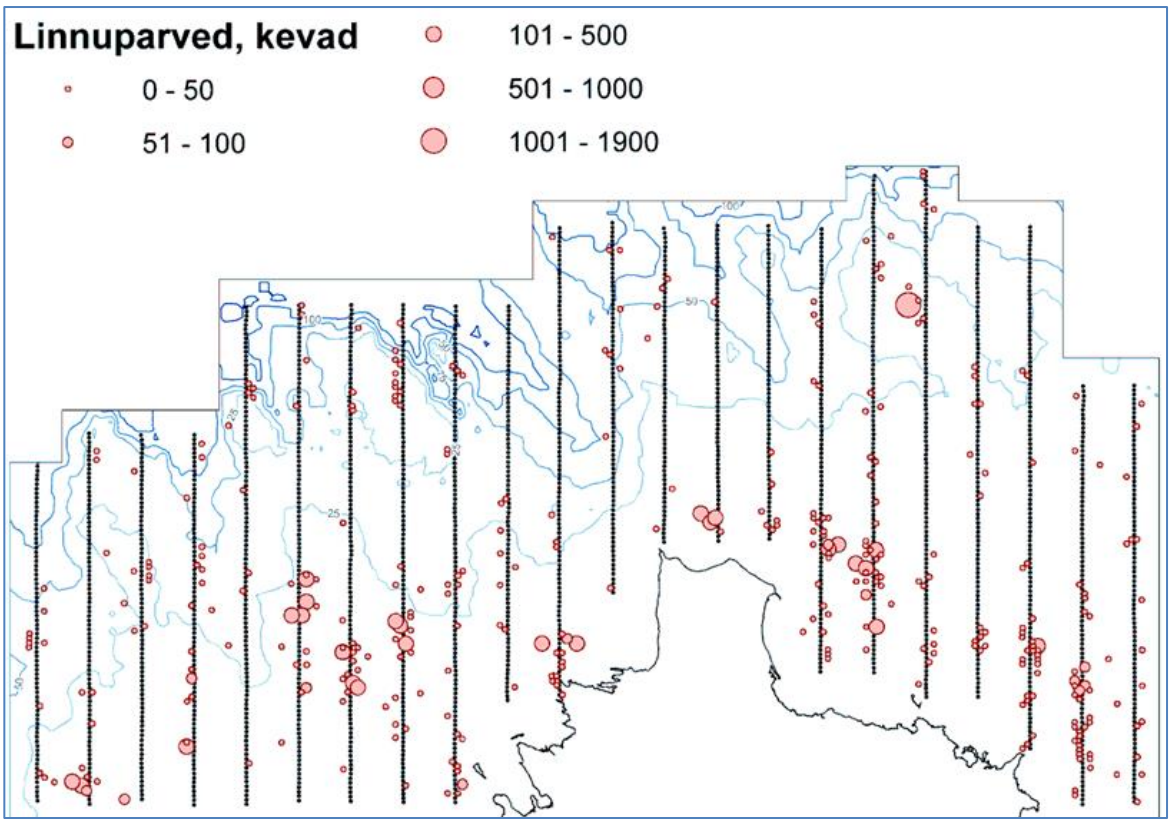

Figure 13. In spring, water birds stop in the census area (census data), 16.05.2015

3.6.1.2. Moulting

Moulting migration of arctic water birds occurs in July and August. Dominating species are scoters (common scoters with great majority) and charadriiforms. Daily migration occurs at the shallow above the water, usually copying the coast line. More intensive migration occurs in the morning, which is followed by evening and day, when migration intensity is the lowest. Some scoters use shallows, remaining to the north from Hiiumaa for migration stops. Approximately 41 130 water birds have stopped in the survey area in this period, of which 16 710 have used shallows as a feeding place (Figure 14, Figure 15).

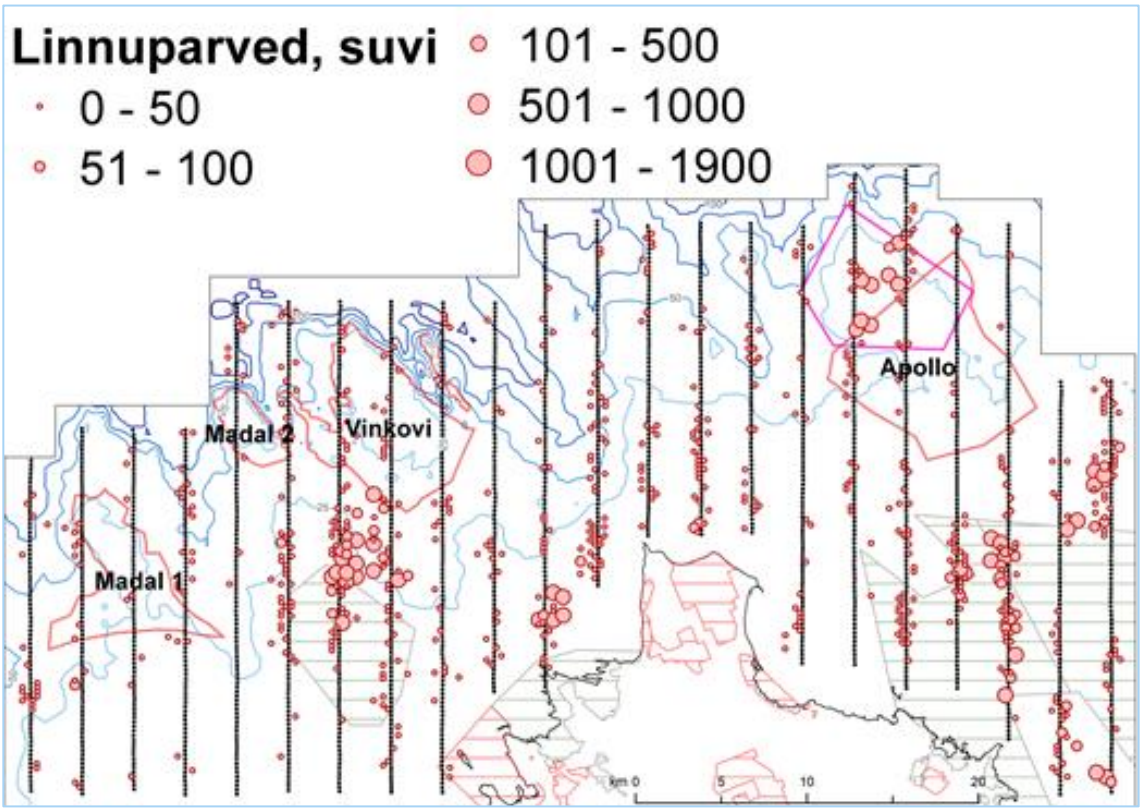

Figure 14. Location of water birds in the census area, that stop in the summer (census data), 04.08.2015 (shaded areas – conservation areas, red contour line areas in the sea – development areas, purple contour line area – planned Apollo conservation area)

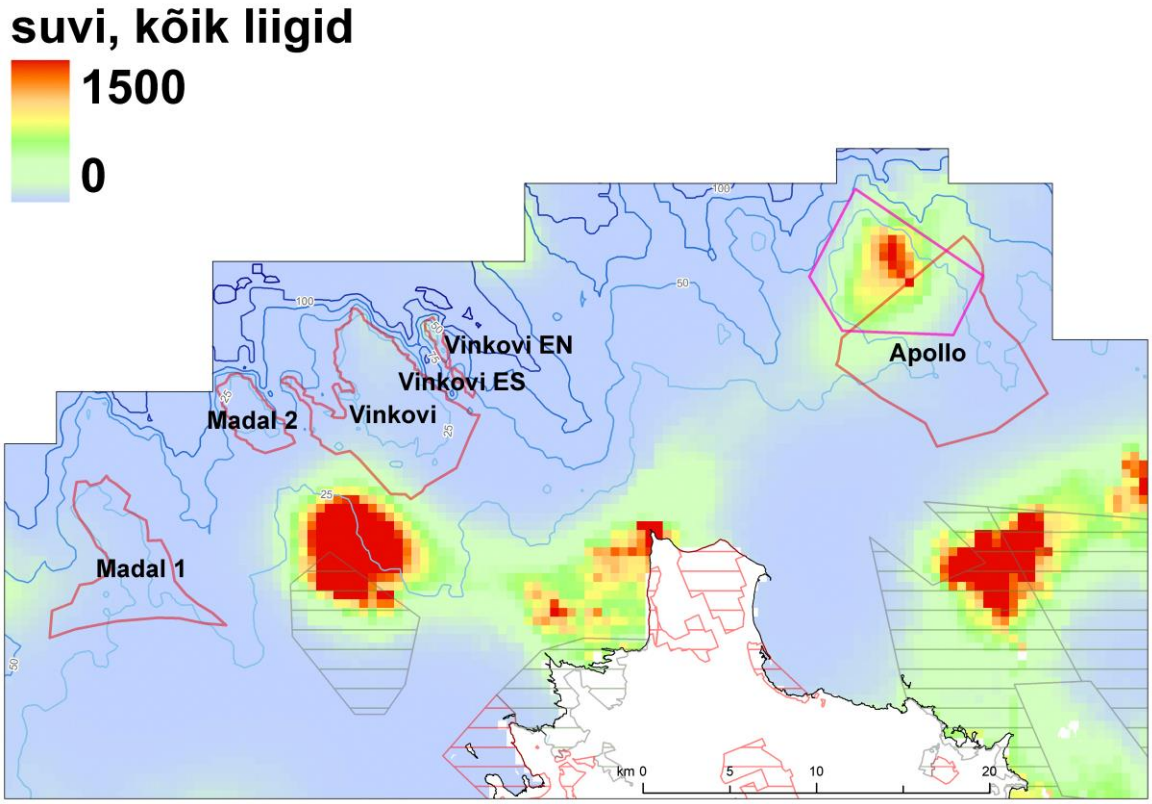

Figure 15. Summer dispersion of water birds and assessment of density amount in coastal sea of North-Hiiumaa, 2015

The most numerous stoppers have been scoters and common eiders. Scoters were located in four greater groups – in development area TP 1 (Apollo), north-east from Hiiumaa, west from Tahkuna peninsula and Hiiu shallows. In the entire area approximately 12 900 scoters have stopped, of which 3900 birds have used the development area TP 1 (Apollo). Hari Strait and North-Hiiumaa sea area are, as it is known, our region's greatest moulting area of common eider, which has been proven by this survey as well. In total, approximately 23 000 common eiders moulted in the area. Greatest moulting gatherings were located in the north-east from Hiiumaa, in Tahkuna coastal sea and south of the development area TP 2 (Vinkov). Gulls were dispersed in the survey area in a relatively scattered way, but still comprised 2 greater gatherings, which followed two fishing ships. These birds are not very related to sea shallows. Terns as pelagic birds were also dispersed relatively evenly, comprising the greatest density amount in the western edge of surveyed area. Other water birds species appeared in the area in small numbers, and no models have been made with respect to them.

3.6.1.3. Autumn migration

Autumn migration of water birds begins in the middle of August and lasts till December, which partially switches to wintering. Migration maximum of swimming ducks and aythyas is from the middle of August, which lasts till the beginning of October. The maximum number of long-tailed ducks and loons is from the end of October till the end of November. Since the last group is more related to open sea, i.e. arctic water birds, the flight has been planned in November.

During the day migration occurs above the sea mainly at the shallow, at the altitude up to 100 m. Main migration direction is SW, varying based on the coast line in the directions of W-SW-SSW. Important is the effect of coast as an ecological barrier (migration barrier) and a general line. Birds approaching Hiiumaa western coast from open sea from the direction of NE and E turn to the direction of NW before the coast and fly along Tahkuna hoe, continuing migration in the sea mainly in the directions of SW-SWW. The main migration direction in the project area is SWW-SW. Migration is the most intensive in the morning, evening follows and it is the weakest at midday, just like in spring. Hiiumaa shallows apparently remain in the edge areas of migration flow, since migration gathers to a greater extent at the tips of Tahkuna and Kõpu peninsulas in so-called "Bottleneck areas". However, water birds migrating through do use shallows as feeding areas.

In the end of November the density of population of diving ducks has been the biggest in the development area TP 1 (Apollo) (Figure 16). Approximately a total of 86 810 water birds have stopped in the project area. 82 400 long-tailed ducks stopped in the area, of whom more than a half (46 100 birds) have fed in the development area TP 1 (Apollo). The second species by the number has been common gull, with a total of approximately 4000 birds. There has been significantly less European herring gulls (310 birds). Both gull species have also partially used the development area TP 1 (Apollo) as a feeding area, but not a very big number.

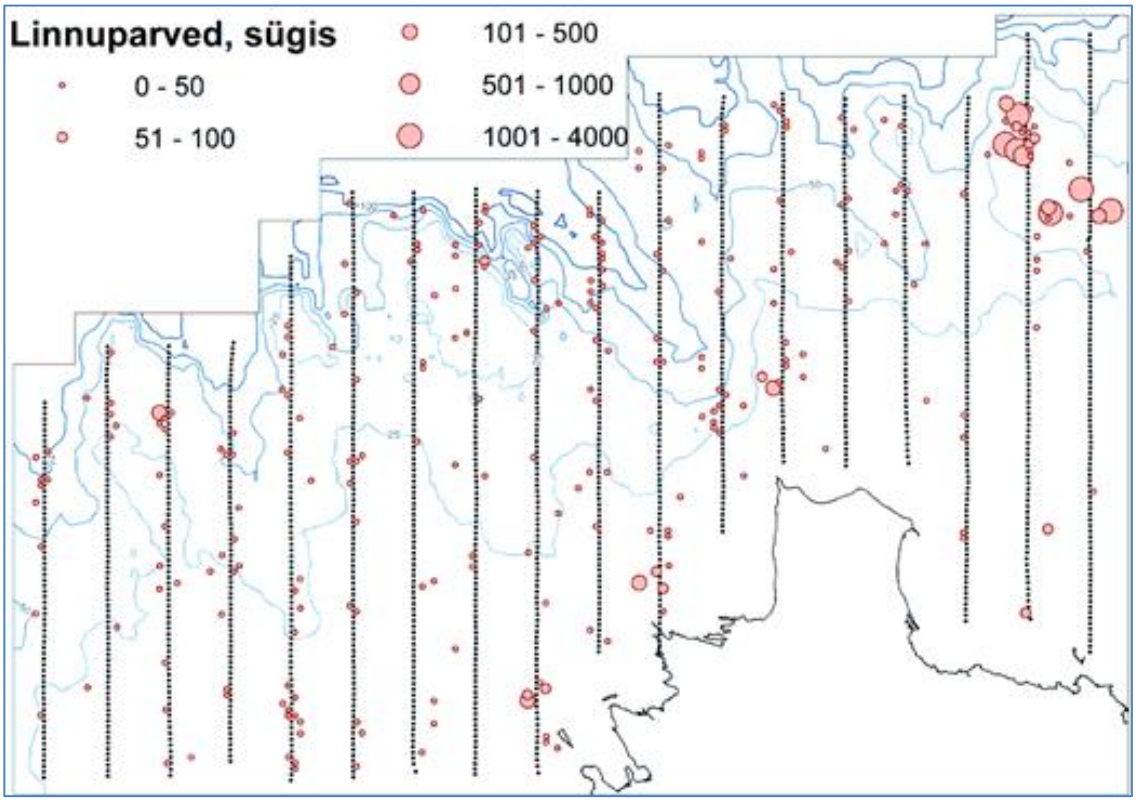

Figure 16. Water birds flocks stopping in the census area (census data), 30.11.2014

3.6.1.4. Wintering

Many arctic water birds remain to winter in our areas as well. There is a continuous tendency that it occurs more and more to a larger extent, since most of the winters have been warm during the last time, due to which the sea is also ice-free.

North-Hiiumaa coastal sea is important wintering area to many arctic water birds. In winter, 11 birds species related to open sea have been registered in the project area. Compared to spring and autumn, dispersion of flocks in the surveyed area was more even and more scattered (Figure 17). General winter estimate for water birds was 58 760 birds. Water birds number and density of population in winter was the highest in the development area TP 1 (Apollo) and in the area remaining to south from it, north-western Hiiumaa coast and Hiiu shallow (Figure 18).

There have wintered approximately 38 300 long-tailed ducks in North-Hiiumaa coastal sea, of whom about a half (14 500 birds) have used the development are TP 1 (Apollo). Large concentration of long-tailed ducks was also to the south from the development area TP 1 and north-western coast of Hiiumaa. Common gull was the most numerous of gulls, with approximately 15 800 birds. European herring gull was the second by number – 2300 birds. Gulls "migrations" in the Baltic Sea differ from migration movements of other sea birds in a way that they are more chaotic, due to which it is rather roaming movement. In non-nesting periods they gather in places, where there is a lot of food. Thus, they are attracted by fishing ships, due to which as a result dispersion mosaic of big gulls (European herring gull and common gull) is often caused by the location of fishing ships. Since it is very difficult to distinguish common and arctic sterna from the airplane, they have been traditionally examined together. Approximately 360 birds of sterna have stopped. As the birds feeding on fish they are not related to shallows, since they get food also from a deep water.

The biggest discovery has been made with respect to steller's eider. Since during water birds census in the middle of winter several observations have gathered from Hiiumaa north-western coast, there was a doubt that somewhere farther in the open sea there may be located wintering place of this species, which had been unknown until then (Figure 19). In the course of winter flight new

wintering area has been discovered at Hiiu shallow, where three flocks have been examined with a total of 400 birds (Figure 20).

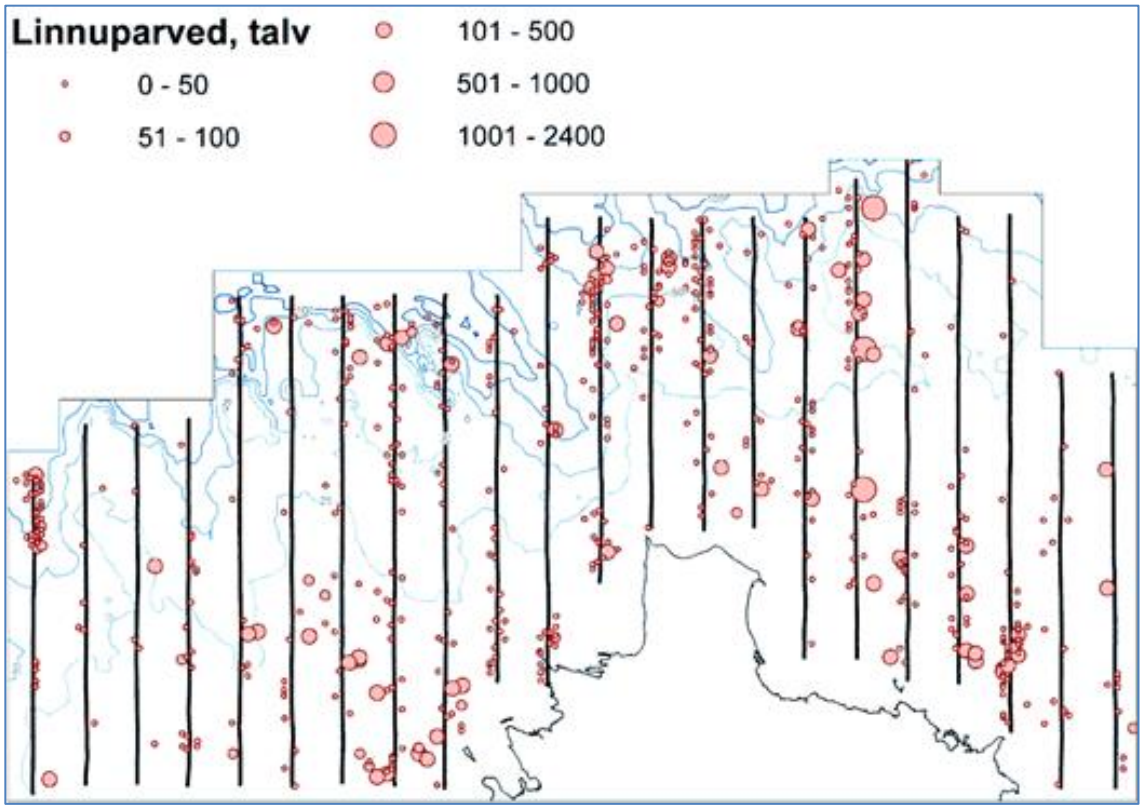

Figure 17. Location of wintering water birds in the census area (census data), 02.02.2015

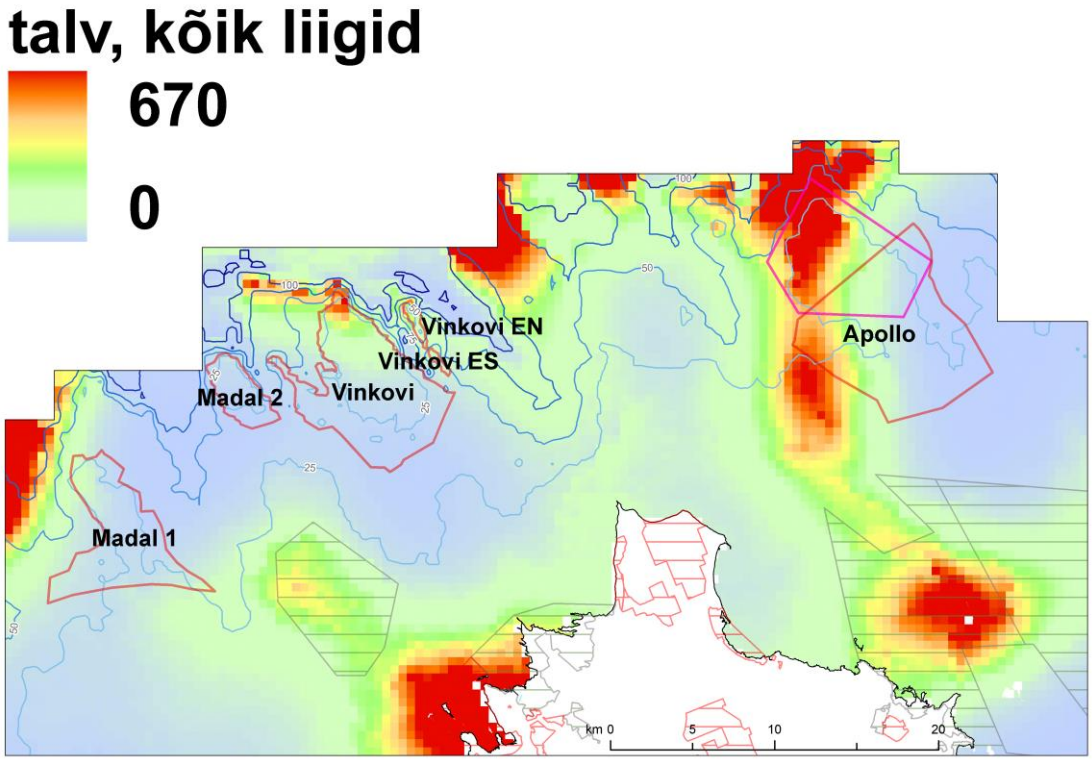

Figure 18. Winter dispersion of water birds and assessment of population density in coastal sea of North-Hiiumaa, 2015

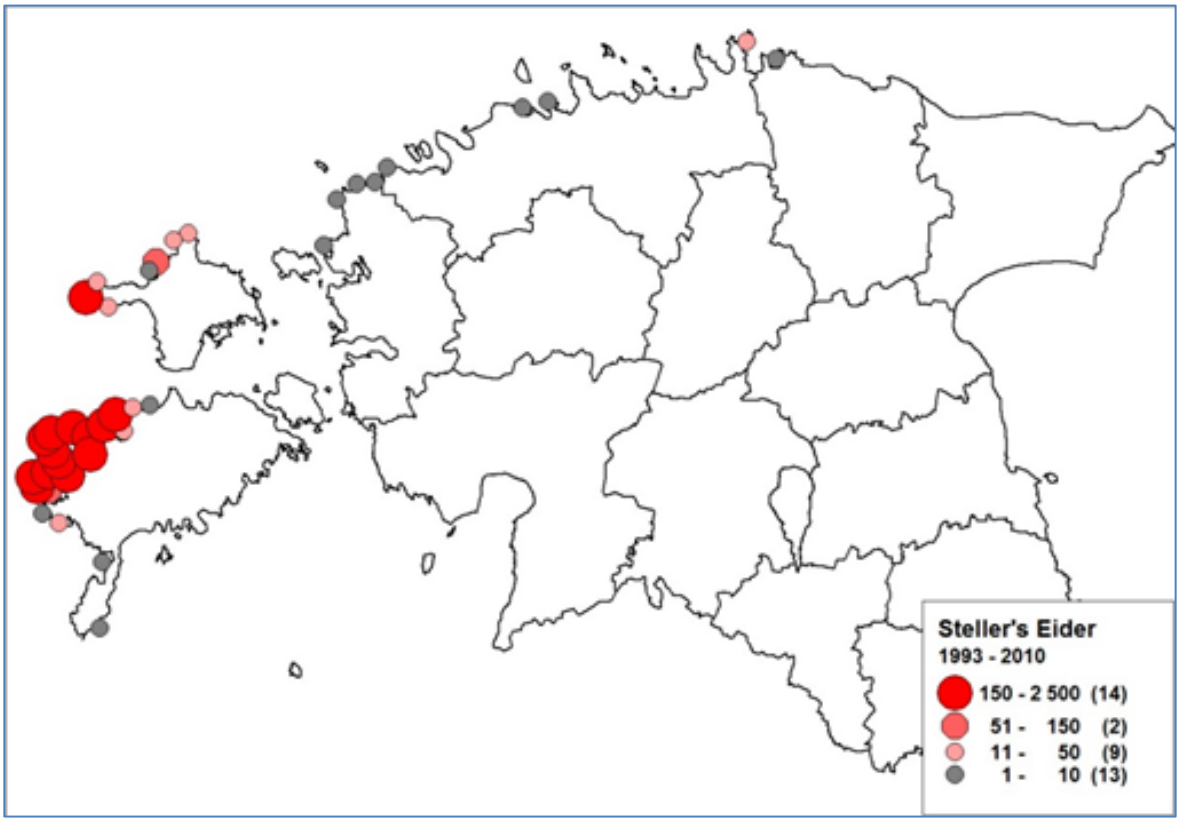

Figure 19. Steller's eider's winter dispersion according to water birds census in the middle of winter 1993-2010

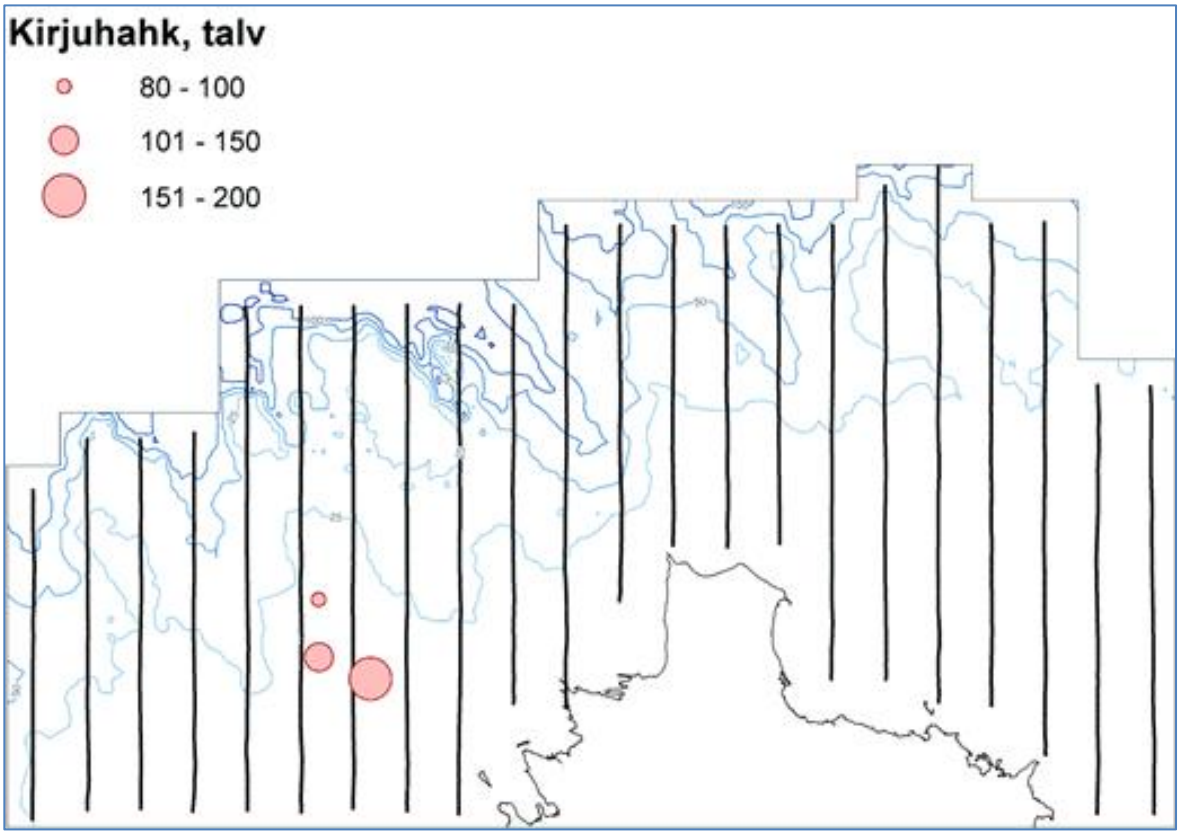

Figure 20. Steller's eider's wintering area at Hiiu shallow, winter 2015

3.6.2. International flight census of wintering birds[14]

In the period from December 2015 till October 2016 the Estonian University of Life Sciences has performed by the order of the Environmental Agency project "International flight census of wintering birds". International birds census was coordinated by HELCOM. In the course of the works, wide inventory of water birds has been performed in Estonian coastal sea, which was the part of the census over the Baltic Sea. The size of census area was 22 000 km^2, which makes up approximately 60% of the Estonian sea area. According to the project report the most numerous water bird species wintering in Estonia is long-tailed duck, whose official estimate is 100 000-500 000 birds (Elts et al., 2003). Within this project long-tailed duck has been estimated more than all other species, i.e. approximately 90 000 birds. Based on that, the assessment is about 90 000-460 000 birds. Long-tailed duck is widely dispersed in the entire territorial sea of Estonia. The best wintering areas for this species are located in Irbe Strait, Gretagrund, Väinameri and southern coast of the Gulf of Finland. New wintering area of long-tailed duck has been discovered at the coast of Ida-Virumaa.

3.6.3. Water birds census during the 2017 autumn migration[15]

In the survey, main attention has been paid to migrating water birds in the coastal sea of western Hiiumaa. The aim of the survey was to find out the main stopover sites for migrating water birds during autumn migration and the number of birds stopping in these sites. Also, to gather more specific data about the water birds stopping in the coastal sea of western Hiiumaa. All water birds that can be met in the area have been observed. The study focused on four areas in the coastal sea- Mardihansu bay, the planned Kõpu sea protection area, Vinkov sea shallow and the conservation area of Hiiu shallow.

During the census, 17 birds species have been met (25 645 birds in total, see Table 10). Of species encountered, long-tailed ducks (*Clangula hyemalis*) and scoters (*Melanitta species)* were directly related to the shallows. Long-tailed duck also turned out to be the most numerous water bird in the study area (21 314 birds). From fish-eaters, common gull *(Larus canus)* and the European herring gull (*Larus argentatus)* were the most numerous species. From species related to the coast, common goldeneye (*Bucephala clangula)* was the most numerous. Though, the common goldeneye usually stops near the shore and avoids the open sea. As all the shallows in the study area are located sufficiently far from the coast, common goldeneye was not encountered there.

Table 10. Census of the number of water birds and assessment of the number of birds that stopped in the coastal sea of western Hiiumaa (autumn 2017)

Species (English)	Species (Latin)	Census of the number of the birds	Assessment of the number of birds in coastal sea of western Hiiumaa		
			95% confidence interval		
			Overall assessment	Minimum	Maximum
Long-tailed duck	*Clangula hyemalis*	21314	40665	30482	54250
Velvet scoter	*Melanitta fusca*	11	108	28	412
Common scoter	*Melanitta nigra*	462	2079	1092	3957
Common goldeneye	*Bucephala clangula*	1602	11887	6725	21015

[14] International flight census of wintering birds, Leho Luigujõe & Ainārs Auniņš, 2016, www.keskkonnaamet.ee/public/LuigujoeAunins_2016_talvituvate_veelindude-rahvusvaheline_lennuloendus_lopparuanne.pdf

[15] Estonian University of Life Sciences, Institute of Agricultural and Environmental Sciences. Luigujõe, L, 2018. "Census of water birds stopping on the coast sea of western Hiiumaa". Report. Client: The Environmental Board of Estonia

Common merganser	*Mergus merganser*	120	1066	431	2639
Mute swan	*Cygnus olor*	106	508	118	2189
Loon	*Gavia species*	60	390	251	609
Little gull	*Hydrocoloeus minutus*	53	242	142	412
Common gull	*Larus canus*	318	1432	481	4263
European herring gull	*Larus argentatus*	202	675	363	1257
Razorbill	*Alca torda*	16			
Mallard	*Anas platyrhynchos*	150			
Tufted duck	*Aythya fuligula*	160			
Smew	*Mergus albellus*	25			
Black-headed gull	*Larus ridibundus*	30			
Great black-backed gull	*Larus marinus*	1			

The highest number of long-tailed ducks was encountered in the Hiiu shallow (8600 birds), followed by Mardihansu (6500 birds) and the Vinkov shallow (3500 birds). Only 500 birds stopped in planned Kõpu sea protection area. Altogether, 5000 long-tailed ducks stopped at shallow 1 (*madal 1* in EE in Figure 21) and Vinkov shallow.

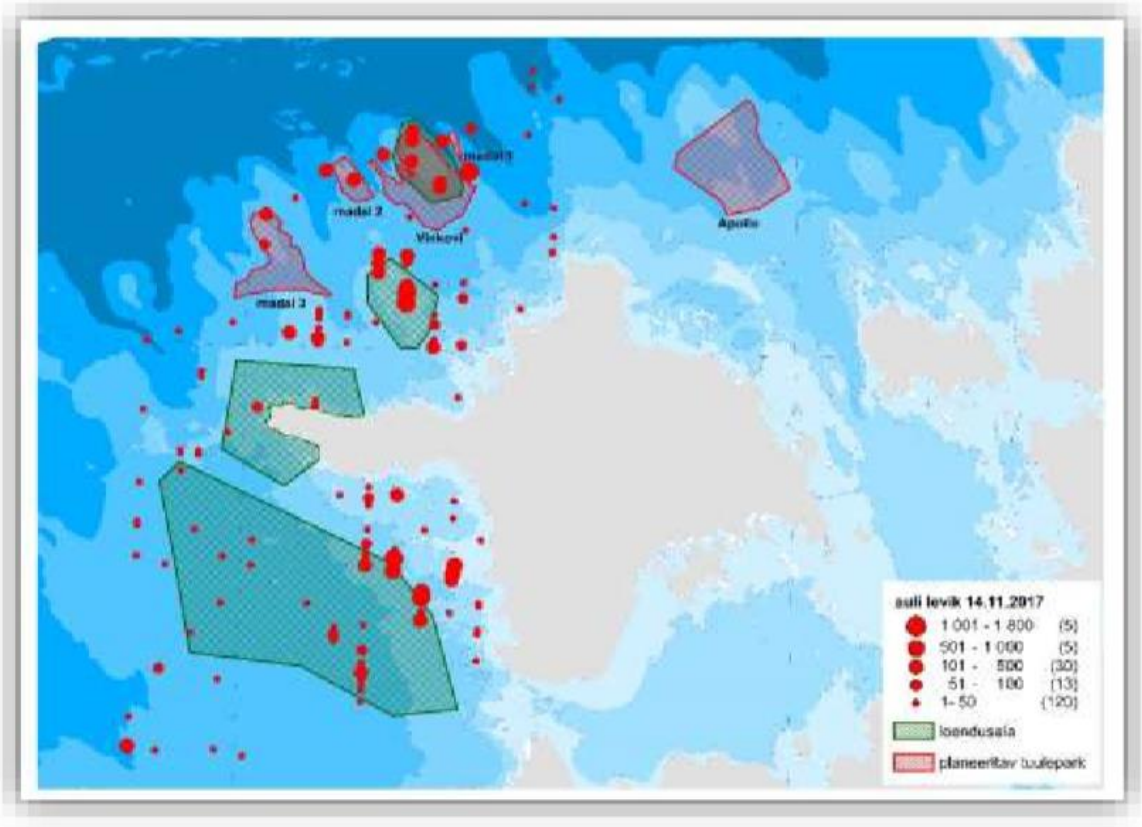

Figure 21. Long-tailed duck`s dispersion during 2017 autumn migration according to water birds census

3.7. Areas and objects under protection in the region

3.7.1. Conservation area of Hiiu shallow

Conservation area of Hiiu shallow is located 3,8 km away in the east from the development area TP 4 of the planned wind park in case of both alternatives and 4,7 km away to south-west from the development area TP 2. When installing a sea cable, the cable installation in case of alternative 1 would pass the northern tip of the conservation area at a distance of 1 km, in case of alternative 2, the nearest track would be 4.5 km away. The purpose for protection of conservation area is protection of flocks with a habitat type (1170) named in Annex I to EU Council directive 92/43/EMÜ regarding the protection of natural dwelling places and natural fauna and flora. The size of conservation area is 4484,1 hectares. The area intersects with nature conservation area of Hiiu shallow of Natura 2000 network.

3.7.2. Conservation area of Kõrgessaare-Mudaste

As for both alternatives, the conservation area of Kõrgessaare-Mudaste is located 11,4 km away to south-east from the development area TP 2 of the wind park and 16,1 km from development area 4, also to south-east. As for alternative 1, the nearest sea cable is located 4.7 km from the conservation area. The purpose for protection of conservation area is protection of habitat types named in Annex I to EU Council directive 92/43/EMÜ – coastal lagoons (1150*), large shallow inlets and bays (1160), Boreal Baltic islets and small islands (1620), Boreal Baltic coastal meadows (1630*), *Juniperus communis* formations (5130), alvars (6280*), Hydrophilous tall herb fringe communities (6430), Petrifying springs with tufa formation (7220*) and Alkaline fens (7230), and protection of birds species named in Annex I to EU council directive 79/409/EMÜ regarding protection of natural birds fauna and protection of migrating birds species habitats that need protection and are not named in Annex I.

3.7.3. Paope nature conservation area

As for both alternatives, Paope nature conservation area is located 12,3 km to south away from the development area TP 2 and 14 km to south-east away from the development area TP 4 of the wind park. As for alternative 1, the nearest sea cable is located 7,9 km from the conservation area. Conservation area intersects to a major extent with Paope nature conservation area of Natura 2000 network and with birds area of Kõrgessaare-Mudaste. Nature conservation area has been formed for the following purposes:

1) protection of diversity of coastal and sea ecosystems, meadow, forest and freshwater biocoenosis fauna;

2) protection of birds species, named in Annex I to the council directive 79/409/EMÜ regarding protection of natural birds fauna, and migrating birds species absent from Annex I, of which two belong to II protection category, and protection of habitats of Barnacle goose (*Branta leucopsis*), Common ringed plover (*Charadrius hiaticula*), Common tern (*Sterna hirundo*) and Common redshank (*Tringa totanus*), who belong to III protection category;

3) protection of habitats named in Annex I to the Council Directive 92/43/EMÜ regarding protection of natural habitats and natural fauna and flora – Sandbanks which are slightly covered by sea water all the time (1110), Mudflats and sandflats not covered by seawater at low tide (1140), Coastal lagoons (1150*), Large shallow inlets and bays (1160), Boreal Baltic islets and small islands (1620), Boreal Baltic coastal meadows (1630*), rivers and water courses (3260), *Juniperus communis* formations (5130), Semi-natural dry grasslands and scrubland facies on calcareous substrates (6210), alvars (6280*), Hydrophilous tall herb fringe communities (6430), Petrifying springs with tufa formation (7220*), Alkaline fens (7230), Western Taïga (9010*) and Alluvial forests (91E0*);

4) protection of habitat of the species named in Annex II to the Council Directive 92/43/EMÜ, which is at the same time the species of I protection category.

3.7.4. Tahkuna nature conservation area

As for both alternatives, Tahkuna nature conservation area is located on Tahkuna peninsula 12 km to south-west from the development area TP 1 and 12,6 km to south-east from the development area TP 2 of the wind park. Possible landing locations for the sea cable in Hiiumaa will be within 0.5 km of the protected area in case of both cable installation alternative. The conservation area intersects with Tahkuna nature conservation area of Natura 2000 network. The purpose of protection of Tahkuna nature conservation area is the following:

1) without human influence or with little human influence, protection of primeval forests, swamps and overgrown lakes, preservation of dunes and dune forests, and protection of species being under protection and of their habitats;

2) protection of species named in Annex I to the Council Directive 79/409/EMÜ regarding protection of natural birds fauna, which is also the species protected under I category;

3) protection of habitats named in Annex I to the Council Directive 92/43/EMÜ regarding protection of natural habitats and natural fauna and flora - grey dunes (2130*), wooded dunes (2180), Transition mires and quaking bogs (7140), Western Taïga (9010*), Fennoscandian deciduous swamp woods (9080*) and bog woodland (91D0*);

4) protection habitats of species named in Annex II to the Council Directive 92/43/EMÜ II, which is also species under protection of I category, and species named in Annex II, which is also species under protection of II category.

3.7.5. Väinameri conservation area

As for both alternatives, Väinameri conservation area's northern tip is located 3,1 km to south from the development area TP 1 of the wind park. To connect wind farm areas to the power grid, the installation of a cable through the conservation area in case of cable installation alternative 1 is to install a sea cable. The size of conservation area in the part of Hiiumaa (KLO2000340) is 60600 hectares, in the part of Läänemaa (KLO2000241) 67170 hectares and in the part of Saaremaa (KLO2000339) 42400 hectares. The major part of Väinameri conservation area remains outside of the possible area of impact of wind parks, impact may affect only north-western part of conservation area, which is located in the north-west from Vormsi island and Kadakalaiu. Väinameri conservation area intersects with Väinameri nature conservation area and Väinameri birds area of Natura 2000 network.

The purpose of protection of Väinameri conservation area in the part of Hiiumaa is protection of birds species named in Annex I to the Council Directive 79/409/EMÜ and protection of migrating birds species and habitats absent from Annex I.

The purpose of protection of Väinameri conservation area in the part of Läänemaa is protection of habitat types named in Annex I to the Council Directive 92/43/EMÜ.

3.7.6. Apollo shallow nature reserve

Apollo shallow nature reserve (KLO1000674) is located at offshore area, ca 14 km northeast of Hiiumaa and 21 km northwest of Vormsi. In case of alternative one, the nature reserve will be 2km from the development area TP1, and in case of alternative 2, 2.6 km. The export cable connecting the wind farm areas is 1.7 km away from the protected area in case of both cable installation alternatives. The area of the protected area is 5216.8 ha, the average depth of the sea area is 10-20 meters.

The protected area is formed by Regulation No.6 of 31.01.2019 "Establishment and Protection Rules of the Apollo Shallow Nature Reserve"[15] of Government of Republic of Estonia. The purpose of the nature reserve is:

1) to protect the Apollo shallow and its biota;
2) to protect the habitat types listed in Annex I to Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (ELT L 206, 22.7.1992, p. 7-50). These are submerged sandbanks (1110) and reefs (1170);
3) to protect protected species designated by Annex I to Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (ELT L 20, 26.01.2010, p. 7-25) and migratory species and habitats of migratory birds not listed in Annex I; These species are long-tailed duck (*Clangula hyemalis*), little gull (*Larus minutus*), common scoter (*Melanitta nigra*) and common eider (*Somateria mollissima*).

3.7.7. Nõva-Osmussaare conservation area (Läänemaa)

Nõva-Osmussaare conservation area in Läänemaa (KLO2000166) includes the sea area in Nõva and Noarootsi parish and a bit og land on the coast of the villages of Riguldi, Kudani, Hara and Telise in Noarootsi. The wind farm development area TP1 is 19.7 km east of the conservation area in case of both alternatives. In order to connect the wind farm area to the power grid, the installation of both cable assemblies is planned through the installation of a sea cable (see Chapter 2.3.2. The Läänemaa part of conservation area is 22081.6 ha (including 342.1 ha of land and 21739.5 ha of water).

The purpose of conservation area:

1) protection of habitat types listed in Annex I to Council Directive 92/43/EMÜ – underwater sand shallows (1110) and muddy foreshores (1140), wide low bays (1160), small islands and islets (1620), coastal meadows (1630*), sandy beach with herbaceous vegetation (1640), *Juniperus communis* formations (5130), alvars (6280*) and the protection of habitats of the species listed in Annex II and of the species listed in Annex I to Council Directive 79/409/ EMÜ and protection of protection of migratory bird habitats not listed in Annex I. The species whose habitat is protected are: greater scaup (*Aythya marila*), long-tailed duck (*Clangula hyemalis*), common scoter (*Melanitta nigra*), common goldeneye (*Bucephala clangula*, Eurasian eagle-owl (*Bubo bubo*), European nightjar (*Caprimulgus europaeus*), wood lark (*Lullula arborea*), common eider (*Somateria mollissima*), goosander (*Mergus merganser),* red-breasted merganser (*Mergus serrator*), brent goose (*Branta bernicla*), velvet scoter (*Melanitta fusca*), white-tailed eagle (*Haliaeetus albicilla*), Montagu's harrier (*Circus pygargus*), tawny pipit (*Anthus campestris*), hazel grouse (*Bonasa bonasia*), black stork (*Ciconia nigra*), grey seal (*Halichoerus grypus*), *Agrimonia Pilosa* (*Agrimonia pilosa*), *Dianthus arenarius (Dianthus arenarius ssp. arenarius).*

The Nõva-Osmussaare conservation area coincides with the Natura 2000 network Nõva-Osmussaare nature area and Nõva-Osmussaare bird area. The area is also part of wetlands of international importance (Ramsar area) [16].

3.7.8. Permanent habitat of Selgrahu grey seal

Selgrahu grey seal's permanent habitat is located 4,3 km to south from the development area TP 1 in both cases of wind park alternatives and at the same time intersects with Väinameri nature and birds area inn. In case of cable installation alternative 1, the sea cable runs 3km northwest from the permanent habitat, while in case of alternative 2, the cable distance is 5km. Selgrahu is one of

[16] eRT: https://www.riigiteataja.ee/akt/105022019011

[16] Vabariigi Valitsuse 28.03.2006 määrus nr 59 „Hoiualade kaitse alla võtmine Lääne maakonnas"; eRT: https://www.riigiteataja.ee/akt/106042018006?leiaKehtiv

the most important rookeries of grey seals in western Estonia. Area of permanent habitat intersects with Väinameri nature conservation area and Väinameri birds area of Natura 2000 network.

3.7.9. Kadalalaiu permanent habitat of ringed seal

Kadalalaiu permanent habitat of ringed seal (KLO3000099) has been protected under Regulation No. 78 of the Minister for the Environment of 20 December 2005 "Protection of Habitats of seals and ringed seals and protection rules". The permanent habitat is located 14.7 km south of the TP 1 wind farm alternative. To connect wind farm areas to the electricity grid, it is planned to install a sea cable in case of cable installation alternative 1 (see chapter 2.3.2). The area of permanent habitat is 2356.2 ha, including 2317.7 ha of water and 38.5 ha of land. The permanent habitat area coincides with the Väinameri nature area of the Natura 2000 network and the Väinameri bird area.

3.7.10.Planned protection areas

According to the data from Environmental Register, one planned new protection area is located in the region of wind park areas: Kõpu sea protection area. Border changes have also been panned with respect to Väinameri conservation area, Kõrgessaare-Mudaste conservation area and Kõpu nature protection area, but they will neither add protected areas to impact area of wind park areas nor make them closer to wind park areas compared to protected areas within present borders.

Kõpu sea protection area has been planned in the sea area with the size of 11 020 hectares surrounding western part of Kõpu peninsula. Planned protection area is in both wind park alternatives located 7,5 km to south from the development area TP 4 of the planned wind park. It is recommended to include the area into the network of protection areas of the Baltic Sea. The purpose of taking the planned sea area under protection is to preserve unique ecosystem of Kõpu coastal sea, which is an important bottleneck for birds' East-Atlantic migration route. It can be concluded from the birds fauna survey, that the region is representative as an area for appearance of migrating Arctic Anatidae.[17] It is especially during spring migration, but the area is quite important also for birds migrating in autumn. Two-three million water birds per year go through the area (Anatidae and Charadriiformes). At least 50% of globally endangered steller's eider gathering that winters in the Baltic Sea go through the area, about 50% of common scoter birds from north-western European migration route, about 40% brent goose European winter population, about 20% of long-tailed duck birds from north-western European migration route, about 5% of red-breasted merganser from north-western European population, from 1% to 5% of total number of little gull species, at least 2% of the total number of lesser black-backed gull nominal subspecies. It is also an important migration stop area for common scoter and long-tailed duck.[18] Kõpu peninsula and sea area bordering with it is essential to bat as well according to initial data. Five species of bats have been found in the area, they have also been discovered above the sea feeding and migrating. Gathering of Nathusius's pipistrelle takes place on Kõpu peninsula at the tima of migration before overcoming the sea. Kõpu peninsula sea area is also characterised by species-rich fish fauna, but the area has no special significance from the point of view of endangered species.[46] Habitats named in Annex I to the nature directive are present in the areas - reefs (1170) and sand shallows covered by sea water (1120).[46, 47] Out of water birds, one of the most important migrants in Kõpu sea area and potential stoppers in water area and coast are also loons (red-throated and black-throated), whooper swan and wood sandpiper. As known, common goldeneye and long-tailed duck flocks stop in the sea area in winters. Moulting migration if performed in the end of May and the first half of June by numerous male common eiders, the main flow of migration of whom is heading from north-western Saaremaa over the open sea to Ristna hoe. Also, moulting

[17] http://ilmajaam.postimees.ee/807232/eestimaa-looduse-fond-soovib-kopu-merekaitseala-loomist
[18] http://ilmajaam.postimees.ee/807232/eestimaa-looduse-fond-soovib-kopu-merekaitseala-loomist (14.04.2012)

migration of velvet and common scoters over the sea area in July-August and summer migration of gulls and sternas occurs.[19]

3.7.11. Objects of heritage conservation

In immediate proximity to the areas of planned wind park there will be several ship remains, the closest of which (in the area remaining to south from development area TP 1) will be "West" (about 350 m) and nameless ship remains (about 600 m), the remaining closest ship remains will be about 2 km away or farther.

The closest wreck to the planned sea cable route is about 1.2 km ("West"), the rest is further.

3.8. Social-economic environment

3.8.1. Hiiu county

Hiiu county, which includes surrounding small islands as well as Kassari island, is the smallest of the counties of Estonia, with a total size of 1023 km^2. The area of Hiiu county makes up 2,2% of the total area of Estonia. The biggest length of the island is 60 km and width 45 km, approximate length of coastline is 326 km. The highest point of the island is located in Kõpu (Tornimägi) and reaches 68 m above the sea level. The distance from Estonian mainland and Hiiumaa is 22 km, from Saaremaa only 6 km. Administratively the county is divided into four parishes: Hiiu parish with the town of Kärdla within the parish and parishes Emmaste, Käina and Pühalepa.[20]

3.8.2. Population of Hiiu county

8582 persons live in Hiiumaa county as of 01.01.2015. Within 10 last years population amount change has been negative and due to migration the number of people has become smaller by 700 persons.[21] Dispersion of population on the island is uneven, the greatest density is in south-east, south an east, and western and central parts are inhabited less. According to forecasts, Hiiumaa population will decrease each following decade by 800-1000 persons, being in 2040 only 5883.[22]

Almost half of economically active enterprises are registered in the town of Kärdla. Processing industry (15% of enterprises) and professional and technical activities (12,9% of enterprises) are on essential position in Hiiu county. Significant part is comprised of enterprises dealing with accommodation and catering, also transportation and warehouse (respectively, 11,2% and 6,7% of enterprises).

Almost half of the county population is working in town of residence. When heading to work, 47,9% of Hiiu county population go over the boundary of the town, 1 239 people. Yet not all people travelling between different towns are potential users of public transportation, since in many cases they work in neighbouring town and everyday distance is short enough to go on foot or by bicycle.

The biggest number of workplaces is in the town of Kärdla. Essential centre is also town of Käina, where 254 persons have place of work. Greatest movement occurs in the direction of these centres.

Production areas of Hiiumaa are concentrated in proximity to harbours or centres. The greatest concentration of production areas is in proximity to Kärdla and Käina. When choosing the location for production areas those areas are preferred that previously used to be production or entrepreneurship areas.

[19] EISA draft report of county plan of the sea area bordering with Hiiu county, 2012-2014. OÜ Alkranel, marine Systems Institute of Tallinn Technical University, OÜ Artes Terrae

[20] Hiiumaa website www.hiiumaa.ee/hiiumaa-info/

[21] Statistics Estonia www.stat.ee/ visited on 08.07.2015

[22] Statistics Estonia database http://pub.stat.ee data renewed on 21.03.2014

Upon guaranteeing sustainable development capacity of western Estonia (including Hiiumaa) there is comparatively quick decrease in permanent population primarily among young people and on islands, seasonableness of tourism and recreational sector, challenges in employment caused by contraction of earlier activities (fishing and agriculture) and small local market limiting competition conditions for islands' production enterprises and complicated access to other markets.

3.8.3. Electricity connections

Energy affects all aspects of Hiiumaa economic and social life, having significant impact on the balance of import-export, competitive capacity, employment and quality of life. Isolation and small size of the island causes greater electricity supply expenses, which arise from transportation, market size and infrastructure. Additional expenses create greater economic interest with respect to development of renewable energy and valuing of renewable energy carriers. Environmental and social benefits are added to economic benefits of developing renewable energy sector.

Supply of electricity to Hiiumaa is now provided by cable connection with Saaremaa. Electricity is not produced on Hiiumaa on industrial scale. Electricity consumption has increased by 21% during eight years (2005-2013). According to forecast of electrical network load by the year of 2030 a 6-7% increase of load is expected in Käinas and Kärdla, in other substations of the region significant increase of the load is not foreseeable at the moment.

According to the survey, the greatest electricity consumers are plastic industry enterprises and commerce. Increase of loads in the county depends on the development of economics and adding of new bug consumers.

In order to enhance development of entrepreneurship and economics, a perspective electricity line of 35 (110) kV has been defined in Hiiu county plan, which will guarantee availability of 110 kV in regions with the highest density of population, energy losses will decrease and voltage quality of the region will improve. It will allow new enterprises to also connect to electricity network. At the same time, today it is not possible to make connection over 3 MW, since there is no free capacity on the island.

3.8.4. Harbours

As a county close to the sea, harbours are an essential part of infrastructure of Hiiumaa. According to the data of Harbour Register[23], there are in total 20 harbours on Hiiumaa, 17 of them allow mooring of watercrafts. The harbours closest to the areas of planned wind park are located on northern coast of Hiiumaa – Kõrgessaare and Lehtma. Harbour of Kõrgessaare is a small harbour, offering harbour services only to watercrafts with a total length of 24 m, thus it is not possible to use this harbour, for example, for transportation of details necessary for construction of wind park.

3.8.5. Hiiumaa economics and tourism

On the basis of Hiiumaa economics review data[24] the county sectors of economics with the greatest turnover in 2013 have been commerce, plastic industry and construction. Tourism was on the third place behind food industry and agriculture. It shows that there is still significant tourism potential on Hiiumaa not realised until now. Development of tourism supports local development primarily via creation of workplaces and taxes. In case of tourism it is important to be able to market the target place, creation of offshore wind park and "island of green energy" may be one opportunity for this. Hiiumaa tourism is seasonal. Active summer months (June, July, August) are clearly different, than fillability of bed places in accommodation institutions exceed the indicators for January-December 8 times.

[23] Harbour Register www.sadamaregister.ee 08.07.2015

[24] Economic review of Hiiumaa, 2013
www.hiiumaa.ee/cfiles/documents/majandus/Hiiumaa+majandus2013.pdf

Thanks to well-divided and long coast line of Hiiumaa there are a lot of sand beaches suitable for sunbathing and bathing, best of them are located in the northern part of the island. The most well-known beaches are Kärdla, Tõrvanina, Lehtma, Tahkuna, Mangu, Luidja, Pallinina, Ristna and Kaleste. In addition to them, at the western tip of Kõpu peninsula, there is allegedly a number of best surfing beaches of the entire Baltic Sea, that are visited by a number of interested people during the entire season.[25]

[25] Beaches www.hiiumaa.ee/turism-majutus/83&g=20&gr=6 visited on 08.07.2015

4. NATURA 2000 RELEVANT ASSESSMENT

According to Environmental Impact Assessment and Environmental Management System Act § 29 activity permit may be issued for planned activity, if it is allowed by the procedure for protection of Natura network area and the decision-maker has made sure that the planned activity will not negatively impact the integrity of this Natura network area or negatively impact the purpose for protection of this area. Thus, the planned activity is possible only in the case, if it does not negatively impact Natura 2000 network areas.

In the course of this EIA a relevant Natura assessment has been performed. Relevant Natura assessment is a procedure, which helps to decide, whether realisation of the planned activity may impact preservation of integrity of Natura 2000 area and the species and/or habitat types being the purpose of protection. Probable impact of the planned activity on Natura 2000 species located in the examined areas has been forecasted upon relevant Natura assessment, and it has been assessed, whether and what impacts may affect species and habitats being the purpose of protection of Natura areas.

4.1. Information about planned activity and other projects or programmes that may significantly impact Natura area

Information about planned activity is provided in chapter 2 of this EIA report.

According to EIA programme of this project potentially impacted Nature 2000 areas are Hiiu shallow nature conservation area (international code EE0040129), Kõrgessaare-Mudaste birds area (EE0040130), Väinameri birds area (EE0040001) and Väinameri nature conservation area (EE004002). in the course of compiling EIA report, Kõrgessaare-Mudaste nature conservation area (EE0040122) and Paope nature conservation area (EE0040112) have been added to potentially impacted areas, which intersect with Kõrgessaare-Mudaste birds area. Tahkuna nature conservation area (EE0040133) located at Hiiumaa northern coast has also been added to potentially impacted areas.

Closest distances of Natura areas from the areas of the planned offshore wind park in both alternatives are the following:

- Hiiu shallow nature conservation area – 3.84 km;
- Kõrgessaare-Mudaste birds area – 11.4 km;
- Väinamere birds area – 3.1 km;
- Väinamere nature conservation area – 3.1 km;
- Kõrgessaare-Mudaste nature conservation area 11.4 km;
- Paope nature conservation area – 12.3 km;
- Tahkuna nature conservation area – 12 km;
- Nõva-Osmussaare bird area – 19.7 km;
- Nõva-Osmussaare nature area – 19.7 km;

The sea cable route is planned to pass through Nõva-Osmussaare bird protection area and nature area in case of both cable installation alternatives, in alternative 1, the route is planned to cross Väinameri bird area and the northern tip of the shallow nature area of Hiiu. From other areas of the Natura 2000 network, the closest cable routes will be within following distances:

- Kõrgessaare-Mudaste bird area – 4.7 km in case of alternative 1
- Kõrgessaare-Mudaste nature area – 4.7 km in case of alternative 1
- Paope nature area – 7.9 km in case of alternative 1
- Tahkuna nature area – 0.5 km in case of both alternatives

4.2 The planned activity is not related to organisation of protection of Nature 2000 areas located at examined area and is not necessary for this.

The assessor is not aware of other ongoing, submitted or approved projects or programmes in the examined region, which in a spatial or essential joint effect with the planned activity could have a negative interactive or accumulating impact on Natura areas. Characteristics of Natura areas remaining in the examined area of the planned activity

Natura 2000 areas, located in the examined area, are Hiiu shallow nature conservation area, Kõrgessaare-Mudaste nature conservation area and birds area, Paope nature conservation area, Tahkuna nature conservation area, Väinamere nature conservation area and birds area and Nõva-Osmussaare nature conservation area and birds area (Figure 22).

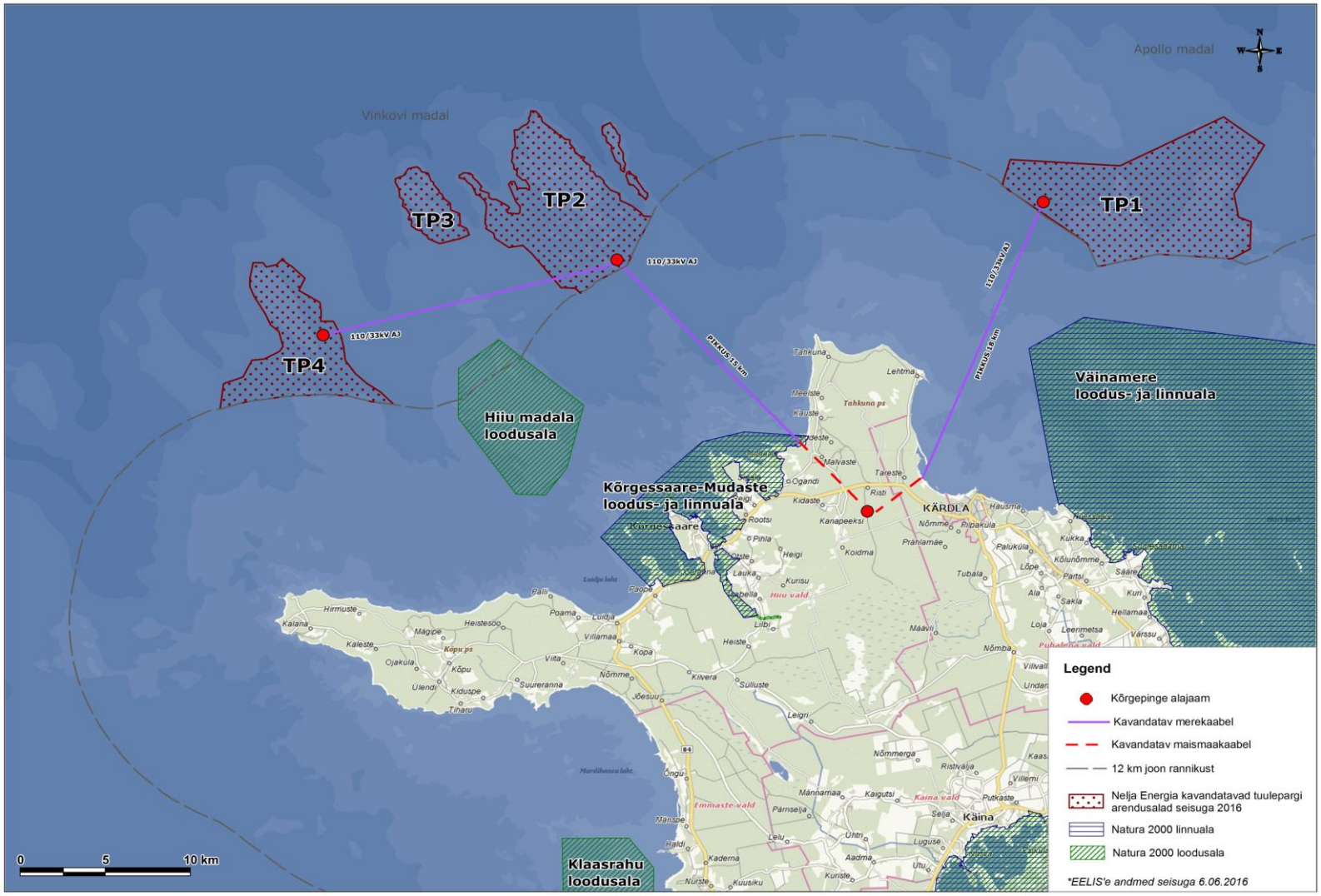

Figure 22. Natura areas closest to the project area (EELIS, May 2019)

4.2. Forecasting the impacts of the proposed activity on Natura sites

Due to the sufficient distance to **Hiiu lowland nature conservation area** and protected habitat type for which it is intended, the establishment, use and maintenance of wind farms has no direct human impact on it.

Indirect impacts on the habitat type could be due to impacts in the marine environment. According to the results of the wave modelling, the reduction in wave heights is less than 5 cm and the effects of the wind farm on waves and currents are relatively insignificant at this distance. Thus, impacts on the site will not occur through marine processes. According to the results of the movement of the suspended solids of wind turbine construction and the modelling of sediment deposition, some spread of suspended solids in the low nature area of Hiiu can occur, but the precipitation of the suspended solids in the area is small for both wind turbine alternatives, remaining within the natural state. By choosing a favourable wind direction for the works, it is possible to avoid the transfer of suspended solids from the areas of the wind farm to the nature area.

The installation of sea cables on the seabed results in a higher amount of suspended solids compared to installation of wind turbines. In case of alternative 1 cable installation, there may be some settlement of the suspended solids in the nature area, but most of the suspended solids or dominant sandy sediment settles close to the cable, and the bulk of the suspended solids will remain within the natural amount.

The habitat-type reefs (1170) which under protection in the nature area, will not be on the cableway, the closest habitat will be approximately 0.6 km from the cable route (alternative 1). Even if the area can be exposed to more suspended solids than natural amount in case of unfavourable wind, it would not have significant adverse effects on the habitat. By choosing a favourable wind direction for installation, it is possible to avoid sedimentation in the area of the reefs and minimize the sediment of suspended solids in whole area.

The cable installation alternative 2 does not have any effects on the nature area due to the installation of cables, as the nearest route is about 4.5 km away.

The risk of water pollution (including oil spill) is low.

All in all, the establishment of a wind farm (including the installation of sea cables) has no adverse effects on the status of the habitat type *reefs* condition that is a conservation objective of Hiiu lowland nature area or to the nature conservation area as whole.

General conclusion

Wind park alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

Cable installation alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

0 alternative: 0 – no adverse effects

All in all, the establishment of a wind farm (including the installation of sea cables) has no adverse effects on the status of the habitat type condition that is a conservation objective of **Kõrgessaare-Mudaste nature area**.

Indirect impacts on habitat types could occur through impacts on the marine environment. Habitats are coastal or directly linked to the sea costal lagoons (* 1150), wide low bays (1160), small island and islets (1620) and beach meadows (*1630).

According to the results of modelling waves, wind speed suspended solids spreading and sedimentation, the effects of wind turbines on wind speeds and waves are insignificant at this distance, and the noise from the installation of wind turbines and sea cables does not reach the nature area. There are also no effects on waves and coastal processes.

The risk of water pollution (including oil pollution) is low and preventable by preventive measures. Thus, it can be concluded that the establishment of a wind farm does not have any adverse effects on the habitat types targeted by the protection of the natural area of Kõrgessaare-Mudaste.

There is no direct or indirect impact on the establishment of the protected (*Cypripedium calceolus*), which is a conservation objective for the protected area of Kõrgessaare-Mudaste.

In conclusion, the establishment of a wind farm (including the installation of sea cables) does not have any adverse effects on the status protected species (*Cypripedium calceolus*) that is the conservation objective of the natural area of Kõrgessaare-Mudaste.

Thus, it can be concluded that the establishment of a wind farm does not have any adverse effects on the habitat types and species targeted by the protection of the natural area of Kõrgessaare-Mudaste and nature area as whole.

General conclusion

Wind park alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

Cable installation alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

0 alternative: 0 – no adverse effects

The establishment of a wind farm (including the installation of sea cables) has no adverse negative effects on the status of the habitat type condition that is a conservation objective **Paope nature area.**

According to the results of modelling waves, wind speed suspended solids spreading and sedimentation, the effects of wind turbines on wind speeds and waves are insignificant at this distance, and the noise from the installation of wind turbines and sea cables does not reach the nature area. There are also no effects on waves and coastal processes. The risk of water pollution (including oil pollution) is low and preventable by preventive measures.

In conclusion, the establishment of a wind farm (including the installation of sea cables) does not have any adverse effects on the habitat of protected species mink (*Mustela lutreola*) that is the conservation objective of the natural area of Paope.

Thus, it can be concluded that the establishment of a wind farm does not have any adverse effects on the habitat types and species targeted by the protection of the natural area of Paople and nature area as whole.

General conclusion

Wind park alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

Cable installation alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

0 alternative: 0 – no adverse effects

The establishment of a wind farm (including the installation of sea cables) has no adverse negative effects on the status of the habitat type condition that is a conservation objective **Tahkuna nature area.** There are no direct or significant indirect impacts on the nature area during installing sea cables, as there are no impacts on the coastal process when installing the cable, and the landing areas of the cables are within 0.5 km of the nature area and the closest habitat types. From this distance, no impact on land-based habitats will occur.

According to the results of wind speed and wave modelling, the wind farm's effects on wind speed and waves and on coastal processes are insignificant at this distance. There are no effects on habitat types. There is no effect on the spread of suspended solids as the nature area is located on

land and there are no marine areas and habitat types. The risk of oil spills that may endanger the coastline can be prevented by preventive measures. Therefore, it can be concluded that the establishment of a wind farm does not have any adverse effects on the habitat types targeted at the conservation of the Tahkuna nature area.

The establishment of a wind farm does not have any direct or indirect effects on the habitat of protected species fen orchid (*Liparis loeselii*) that is the conservation objective of the natural area of Tahkuna.

Thus, it can be concluded that the establishment of a wind farm does not have any adverse effects on the habitat types and species targeted by the protection of the natural area of Tahkuna and nature area as whole.

General conclusion

Wind park alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

Cable installation alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

0 alternative: 0 – no adverse effects

The closest protected habitat types *reefs* (1170) located in the **Väinameri nature area** is 4.7 km from the TP1 development area of the wind farm (in case of both alternatives of wind farm).

At this distance, the wind farm can have very little impact on the waves (a few cm decrease in wave height) that does not affect the marine environment and natural processes in the habitat areas. According to the results of modelling, the spreading and settling of the suspended solids accompanying the installation of wind turbines is insignificant. There are no adverse impacts on marine habitat types due to the construction and use of wind farm sites.

In the case of cable installation alternative 1, some disturbance of the seabed biota occurs. There is no habitat loss when installing the cable, as the seabed will remain similar when filling the cable dredging cavity. Dredging the seabed for the cable will emit suspended solids in the water column, most of which will settle close to the cable trail, but the finer fraction will also be transported further. Thus, it can be assumed that no sediment layer covering the biota will be formed on the seabed. The deposition of suspended solids does not significantly affect the physical structure of the habitat but may temporarily affect the benthos in the neighbourhood of the cable trail. This is a temporary, reversible and relatively minor impact. Hence, unfavourable impacts on habitat types are not involved.

Establishment of a offshore wind park, especially the establishment of development area TP 1, approximately 4.5 km away from Selgrahu does not directly affect the grey seal habitats. The noise generated by the wind farm is predominantly of a phonetic nature and, given the distance from the development area, the noise and visual disturbance to the seals associated with the operation of wind turbines is probably irrelevant. Thus, it can be assumed that the suitability of the Selgrahu seal habitat for the species and the number of animals using it does not decrease to an unfavourable extent to the species.

The grey seals populating in the area of wind farms can use the sea areas for feeding and calving on ice. Establishing the development areas can have some effect on the species during the building phase of the wind park due to noise, busier marine traffic and suspended solids. The spread of suspended solids can affect the fauna directly or indirectly due to reduced visibility in water, which, for example, prevents catches. The concentration of suspended solids affecting the biota is mostly within a few hundred meters, as the suspended solids settles and diffuses in the water. The suspended solids has no significant effect on the seals, as the animals keep away from the construction area and can move away from the suspended solids cloud. Possible disturbances are temporary and do not cause irreversible effects on the species.

Cable installation involves local and temporary disturbances and ringed seals keep away from direct work area away, but the effects are short-term and fully reversible. If construction work is avoided during the calving and fur sheading, there are no adverse effects of suspended solids on grey seals.

The closest important ringed seal habitat Kadakalaid will be 16 km outside the development area TP 1, outside any disturbance zone. Also, the nature area marine areas are far enough from wind farm areas to avoid significant disturbances.

Disturbances occur during cable installation and temporary interference of sea areas will occur in the form of spreading suspended solids into water. Therefore, marine mammals keep away from the work area, but the impacts are short-term and reversible. No significant negative effects will occur.

The proposed offshore cable will pass the ringed seal habitats Kadakalaid and Uuemererahu in case of alternative 1 from a distance about 1.5 km. The habitats are of particular importance during the period of shedding hair. If the cable installation is done during the hair shedding period, the animals may experience some disturbance. If construction work is avoided during this period, there are no significant impacts on seals. In the case of alternative 2, the cable is not installed into the area and given effects are completely not present.

The risk of oil spillage associated with the construction and operation of the wind farm is assessed to be low and preventable by preventive measures.

All in all, during the construction phase of building the wind farm can have minor negative effects, which are short-term and fully reversible. There are no unfavourable effects on the status of habitat types and species for conservation purposes of the nature area.

General conclusion

Wind park alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

Cable installation alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

0 alternative: 0 – no adverse effects

The installation, use and maintenance of wind turbines in **Nõva-Osmussaare nature area** has no direct or indirect effects, as all areas of the wind farm are far enough away from the nature area.

The installation of the sea cable through the natural area will have immediate effects on the nature area, as the dredging of the seabed will affect the seabed and its biota and some suspended solids will be thrown into the water column. The seabed type won´t change with dredging the cable, but the benthos will be temporarily affected. The effect to benthos is temporary and reversible.

Habitat types that serve as a conservation area will not be in the area of the cable trail, but near the coast, the habitat underwater sand dunes (1110) will be near the route (nearest areas 0.1 and 0.5 km away). According to the results of the modelling of suspended solids and sedimentation, suspended solids is settled in the nature area due to cable installation. Concentrations are low and sedimentation in the nature area is slow. Most suspended solids (fine sand) settles around the cable trail (closer than 250 m). Impacts can only occur in the nearest habitat area where sedimentation may affect benthos. Impacts are insignificant and reversible, and no habitat loss or deterioration occurs.

The noise and suspended solids cloud associated with cable installation may cause some relatively short-term disturbance to the target species of the nature area (European bullhead, European river lamprey). The extent of the interference is not great, and its impact is short-term and is limited to the fact that fish keep away from the working area. No adverse effects on species are anticipated.

The lifetime impacts of sea cables are limited to maintenance work on sea cables, which may result in minor noise interference and low noise levels. These lifetime impacts on the nature area and its conservation objectives are insignificant.

All in all, the construction of a wind farm (including the installation of sea cables) at the construction stage may result in minor negative impacts, which are short-term and reversible. There are no unfavourable effects on the status of habitat types and species for conservation purposes.

General conclusion

Wind park alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

Cable installation alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

0 alternative: 0 – no adverse effects

The conservation objective of the **Väinameri bird area** is several protected bird species. The habitats of most of the bird species that are protected are not located in the affected area of the wind farm.

The noise from development area (TP 1) may be carried to the bird area during the construction phase, but for the most part it is of a background nature and does not cause adverse effects on bird species that are protected by the bird protection area. Noise caused by wind turbine installation does not cause significant interference due to sufficient distance and the impact of possible disturbances is negligible. Suspended solids thrown into the water column due to construction of wind turbines can be transmitted in very small quantities to the bird area, but it remains within the natural amount and does not cause adverse effects on the site or to the birds there.

The habitat of bird species that are protected by the bird area may have short-term and fully reversible effects due to disturbances during the installation of the sea cable crossing the area and the spread of suspended solids. Noise and visual disturbances caused by the cable installing vessel and other equipment can deter birds from moving away from the working area, but not far away. The suspended solids cloud caused by works reduces the transparency of seawater, worsening visibility conditions for birds feeding in water.

These effects are manifested by the cable installation alternative 1, in case of alternative 2, the sea cable does not pass through the bird area and the effects are not present. However, the disturbance and the spread of suspended solids due to the installation of the sea cable are temporary and short-term and fully reversible impacts that do not have any significant negative impacts on any bird species under protection.

The protection of birds in the protection area of Väinameri bird area may be affected by an increase in vessel traffic through Hari kurk in connection with the construction and maintenance of the wind farm, but it remains at a negligible level.

Noise and visual effects from the wind farm's operating phase will not cause significant disturbance to bird species living in the bird area, as the areas of the wind farm are at a sufficient distance.

The risk of oil spills related to the construction and operation of a wind farm is assessed to be low, oil spills can be prevented by preventive measures.

All in all, the construction of a wind farm (including the installation of sea cables) at the construction stage may result in minor negative impacts, which are short-term and reversible. There are no unfavourable effects on the status of bird species and the bird area as a whole as a bird protection area.

General conclusion

Wind park alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

Cable installation alternative 1 and alternative 2: no adverse effects (construction and use phase)

0 alternative: 0 – no adverse effects

The target bird species of **Kõrgessaare-Mudaste bird area** are associated with sea areas, coastal waters and coastal habitats. Due to the sufficient spatial separation, there are no negative effects on habitats of the protected bird areas, nor do the activities cause significant disturbance to the birds. Also, the suspended solids cloud associated with the installation of the sea cable does not reach the bird area according to the modelling data. Although the risk of oil spill associated with the construction and operation of the wind farm has been assessed to be low, it is possible to have a negative impact in case of oil spill.

There is no direct or indirect impact on the bird area from the establishment, use and maintenance of the wind farm.

All in all, there are no adverse effects on the status of bird species that are protected by the bird area and no negative impacts on the bird area as a whole.

General conclusion

Wind park alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

Cable installation alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

0 alternative: 0 – no adverse effects

The installation, operation and maintenance of wind turbines has no no direct or indirect effects on **Nõva-Osmussaare bird area**, as all areas of the wind farm are far enough away from the bird area.

The installation of sea cables through the bird area will have immediate effects on the area, since the dredging of the seabed will affect the seabed and benthos and during the activity, suspended solids will be thrown into the water column. The seabed type will not change during the dredging of the seabed, although benthos may be temporarily affected. Impact on benthos is short-term and reversible. According to the results of modelling suspended solids spreading and settling, suspended solids will settled in the nature area due to cable installation. Most suspended solids (fine sand) settles around the cable route (closer than 250 m). The suspended solids reduce the transparency of seawater, thereby worsening bird nutrition. However, this effect is local and spatially limited to the working area.

Negative effects may be caused by sedimentation of suspended solids on fish roe in possible spawning areas, which may affect the fish and thus the bird's food base. Impact can be avoided if the work is not carried out during the fish spawning season and during the roe development period.

All in all, the construction of a wind farm (including the installation of sea cables) at the construction stage may result in minor negative impacts, which are short-term and reversible. There are no unfavourable effects on the status of bird species and the bird area as a whole as a bird protection area.

General conclusion

Wind park alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

Cable installation alternative 1 and alternative 2: 0 - no adverse effects (construction and use phase)

0 alternative: 0 – no adverse effects

5. ASSESSMENT OF ENVIRONMENTAL IMPACT ALLEGEDLY ARISING FROM THE PLANNED ACTIVITY

5.1. The size of the alleged impact area

The alleged impact area forms a development area of wind parks and sea cables, i.e. the direct area of the planned activity and its close surroundings. The size of the impact area depends on the concrete impact factors (e.g. noise, disturbances, air pollution, visual impact etc). Impact area also differs depending on component of the impacted environment (water environment, flora cover, fauna). The exact extent of impact is provided in respective chapters on areas of environmental impact assessment (noise, air and water pollution).

Comparing the wind farm alternatives, the extent of the expected impact depends on the size of the wind farm development areas (168.89 km^2 in case of alternative 1 vs. 140.48 km^2 in case of alternative 2) and location, the number of wind turbines planned for development areas (up to 182 wind turbines in case of alternative 1 and 107 wind turbines in case of alternative 2), capacity (corresponding to 4-7 MW and 7 MW and 12 MW) and location in development areas.

In case of most impacts and impacted environmental elements significant impact is limited to 4 kilometre, except for dispersion of suspension, which, in case of silt may reach up to maximum 6-8 km (in case of strong winds).

5.2. Impact on hydrodynamics

5.2.1. Impact to waves

Open sea wind turbines as obstacles installed in water directly impact waves, currents and mixing immediately around them. Depending on location of wind turbines and the size of wind park, these impacts may also reach definite distances away from the wind park. Wind turbines also impact wind conditions in immediate proximity to wind turbines and behind definite distance downwind, which in turn causes changes in waves, currents and mixing conditions downwind from wind turbines.

Under this EIA, wave simulations were performed for 0 alternatives and both wind farm alternatives. The impact of wind turbines on the waves in coastal waters near Hiiumaa was assessed. Wind directions and velocities that most likely impact on the coast of Hiiumaa were identified.

The results showed that the reduction in the significant height of the wave due to the foundations of the wind turbines is limited to 1-2 centimetres, and the impact is even smaller near the coast. The reduction in wave height due to wind shrinkage is significantly higher at certain wind speeds compared to the effect of foundations. The shadow effect produced by wind turbines is lower at strong wind speeds, so the effect on winds of 15 m/s, given the wave height in such conditions, is negligible. At 6 m/s and 12 m/s, the effect is relatively modest. The greatest impact on the wave occurs with 9 m/s wind. The significant height of the wave decreases when the wind blows 9 m/s with most directions near wind farms by at least 3-5 cm, but not more than 10 cm. Impact on the waves is greater (5-10 cm wavelength near wind farms) when the winds blow from ENE, WSW, W, WNW directions. The impact on the average wave height is significantly smaller (3-5 cm), as the significant impact occurs only when the observed sea area is below the wind of wind turbines and the wind speed is about 8-10 m/s. This means that most of the time there is no effect or it is very small.

In the coastal zone, alternative 1 has the greatest impact with 8-10 m/s ENE winds from Lehtma on the coastal strip in northwest-west; when both alternatives are applied, 8-9 m/s NNE wind in the Kõpu peninsula and 8-9 m/s in the case of WNW wind in Tahkuna nina region (both alternatives)

and Vormsi northwest coast (in case of alternative 1). The reduction in wave height in these areas with the corresponding winds is in the magnitude of 3-5 cm or 3-5% of the wave height. 8-9 m/s WNW (sector 280-320°); 8-9 m/s NNE (sector 10-40°) and 8-10 m/s ENE (sector 40-80°) share of winds in the region is 1.8%, respectively; 1.1% and 0.7%.

Thus, the relatively small impact of this in the coastal regions concerned is rare. The reduction in the average wave height in these coastal regions is significantly lower due the prevailing southwestern-western winds.

There is no cross-border impact to the waves.

Comparing the alternatives, there is a clear tendency that Apollo lowland´s wavelength shrink is stronger in case of wind farm alternative 1. The western wind farm area may have a somewhat stronger impact in case of alternative 2. Comparing the alternatives, the wave effect is somewhat greater in case of alternative 1. In the background of the natural variability, the wave height of the two wind turbine alternatives is modest.

Impact on seabed topography remains local. The influence of wind turbines on currents and vertical mixing is local and indistinguishable against the background of natural variability.

General conclusion

Wind park alternative 1 and alternative 2: 0 – neutral in construction phase; in use phase – 1 - negligible negative impact.

Cable installation alternative 1 and alternative 2: 0 – neutral/ negligible negative impact (construction and use phase)

0 alternative: 0 – neutral/no adverse effects

5.2.2. Impact on water quality

The impact on water quality is negative in the wind farm and cableway construction phase, but insignificant, as the impact is short-term and local and small compared to natural variability and other human impacts.

General conclusion

Wind park alternative 1 and alternative 2: 0 – negligible negative during construction phase; in use phase – 0 – neutral; in both cases direct and indirect.

Cable installation alternative 1 and alternative 2: 0 –negligible negative impact during construction phase; in use phase – 0 – neutral; in both cases direct and indirect.

0 alternative: 0 – neutral/no adverse effects

5.2.3. Impact to dispersion of suspension

Upon assessment of dispersion of suspension and its impact at construction of wind parks there is usually a presumption, that et the extent of soil-related works upon their construction is relatively limited. Since ice cover may be present in the regions of Hiiumaa offshore wind park (first of all drifting ice), whose static and dynamic impact on wind turbines should be taken into account, the most preferred type of wind turbines is gravity-based structure. Upon their installation sailing substance gets into water in the course of levelling the seabed, stabilising the foundation basis, filling the foundation cone with sand and installation of cables. According to very estimated assessment when wind turbines are installed on the ground in case of alternative 1 with a diameter of 30 m from a depth of 1 m and an for alternative 2 for an area of 50 m in diameter from 1 m (bottom levelling and base stabilization). When installing sea cables, assuming that the depth of the recess is twice the cable diameter, the expected volume of soil to be separated per running meter is 4 or 5 m^3 (sea depth ≥ 20 m and <20 m respectively).

Considering the duration of the wind park construction works period up to 2 years and that wind turbines will be installed in sections (up to 6 windmills at a time) and the sea cable step-by-step, the amount of sailing substance getting into water at once is relatively limited.

Within the framework of this EIA, the formation and spreading of suspended solids in the surrounding sea area, including areas of conservation importance, were modelled on the construction of the wind farm and the installation of sea cables. The simulations were performed on both wind farms and for both alternatives of installing connecting cables.

The results showed that most of the work-related suspended solids settles in the immediate vicinity of wind turbines/cables. The silt sedimentation area is somewhat wider, with a maximum spread of about 6-8 km. If the strong winds dominate from one direction, the suspended solids may be moved further from the original source, at a distance of about 10-12 km. At the same time, the sedimentation load which is of a few kilometres from the original source is very low (less than 1 mg/l, i.e within the limits of natural variability). This is due to the low proportion of fine material in sediments and it is also a hydrodynamically active offshore area with no sustained currents. The effect of varying currents differs.

The suspended solids created by the installation of wind turbines will not reach the protected areas of Kõrgessaare-Mudaste, Väinameri and Nõva-Osmussaare. To some extent, suspended solids can spread to the edge of Hiiu low conservation area (with strong SW and W winds). At the same time, there are high waves with winds from SW and W in the area and cable installation is difficult. The suspended solids arrive more often to Hiiu low area during the autumn-winter period. For both alternatives, less than 0.003% of the material entering the floating state reaches the conservation area.

Considering the extremely pessimistic (unrealistic) scenario that the sedimentation of the material is concentrated on only on 1 hectare, the sedimentation layer is only 0.3 mm. In the wild, scattering is much higher. Hiiu low area is far enough from the development area, and there are deeper sea areas between the wind farms and the lowlands of Hiiu, where the material sinks deeper/settles and does not reach a low area of the conservation area.

The installation of wind turbines may have little impact on Apollo shallow sea conservation area. In an unrealistic pessimistic scenario, assuming that the material is concentrated on only one hectare, the sedimentation layer is 2.3 mm in case of alternative 1. For Alternative 2, the amount is smaller as the smaller number of wind turbines occupy less seabed. The impact on the Apollo protected area is modest in case of both alternatives. The material can spread to the area and settle with higher currents in the prevalence of southern, eastern and south-eastern winds, which can be reduced by avoiding work in these cases.

Since both alternatives of cable installations pass through Nõva-Osmussaare conservation area, sedimentation of the suspended solids cannot be avoided. The alternative 1 of cable installation also has an impact on Väinameri conservation area and, to some extent, on Hiiu conservation area. Both alternatives have little effect on Apollo nature reserve. The silt sedimentation area is much wider than that of fine sand. However, the higher settling load occurs only in the vicinity of cables. With mitigation measures, Hiiu lowland´s suspended solid is likely to be completely prevented and the spread to the Apollo shallow sea area is significantly reduced. Since there are several routes in the shallow sea in case of cable installation alternative 1, the water in the coastal areas is also more likely to be clouded.

There is no predictive cross-border spread of suspended solids.

General conclusion

Wind park alternative 1 and alternative 2: 1 – negligible negative during construction phase; in use phase – 0 – neutral; in both cases direct and indirect.

Cable installation alternative 1 and alternative 2: 1 – negligible negative during construction phase; in use phase – 0 – neutral; in both cases direct and indirect.

0 alternative: 0 – neutral/no adverse effects

Mitigation measures

With the purpose to hold the impact of suspension dispersion within limited area, it is recommended not to perform deepening and other soil-related works in conditions of strong winds – wind speed more than 10 m/s on a long-term basis, especially if the wind direction is from west or NW-N;

Not to perform wind turbine foundation works in the area of development TP 1 in case of strong (over 10 m/s) southern, eastern and southeast winds and if southern, eastern and southeast winds prevailed the previous day with an average daily speed of over 6 m/s in order to prevent/reduce the spread of suspended solids to Apollo shallow sea conservation area.

In order to avoid the spread of suspended solids to Hiiu shallow sea, not to carry out installation of cables in the TP 4 area and in the north-western and western section of the conservation area (up to 4 km away from the conservation area) in case of cable installation alternative 2 if the southwest and/or western winds prevail the previous day at an average speed of more than 10 m/s.

In order to prevent/reduce the spread of suspended solids to Hiiu shallow sea, not to install the cables in cases of alternative 1 in north-west, north and west section of Hiiu lowland, if the previous day has been dominated by western, northwest and/or north wind and its daily average speed has exceeded 6 m/s.

When installing cables in Nõva-Osmussaare conservation area and Väinameri conservation area, if the suspended solids spreads more than 3 km from the source, stop the work until the current situation changes.

In order to reduce the spread of suspended solids from sandy cones, clean sand must be used and the recommendations given in this chapter (considering currents and winds) must be taken into account when performing the work.

Monitoring measures

Monitoring should be carried out when foundation wells are established during the start-up phase of the works, determining the direction and impact area of suspended solids during the installation of the first 20 wind turbines. If monitoring shows that the coverage area is significantly bigger (than described in the modelling work) and the suspended solids reach a significant extent (the concentrations are clearly different from the natural background) to at least one of the protected areas, the works must be temporarily suspended during the respective weather conditions (wind conditions) and continue monitoring until the work is completed. If such a scenario occurs, the distribution of suspended solids in the cable installation should also be monitored in full.

Regardless of the foregoing, monitoring of the spread of suspended solids must be made in those sections of the cable installation that occur in nature reserves or which impact may reach them.

5.3. Impact on movement of sediments and coastal processes

Impact arising from performance of works in the region of creation of wind parks and subsequent use is absent or neutral (0) with respect to stormy waves regime in the areas close to the coast, which remain far enough from the region of wind parks. Also there is no impact or it is neutral (0) upon the seabed structure and dynamics of sediments upon construction, use and possibly demolition of the wind parks.

Construction of wind parks in the coastal sea will not impact (impact is absent or neutral) characteristics of coastal processes (diffusing-piling processes), their intensification or weakening.

There is no activity foreseen to remove sediment from the coast. The surface will not be released back into the sea in development areas. Existing and official dump sites with special water use permits are used.

General conclusion

Wind park alternative 1 and alternative 2: 0 – neutral or no negative impact

Cable installation alternative 1 and alternative 2: 1 – neutral or no negative impact

0 alternative: 0 – no impact

5.4. Impact on seabed fauna

On the basis of surveys until now it is known that offshore wind parks impact seabed fauna and flora, fish, sea mammals and birds. If a possible impact of construction of offshore wind parks on sea environment were analysed, three different complexes of impacts could be distinguished – impacts at the time of construction, putting into use and arising from disposal. At the time of construction phase significant factor is mechanical disturbance, which affects several ecology factors (Pärnoja 2007) (Figure 23).

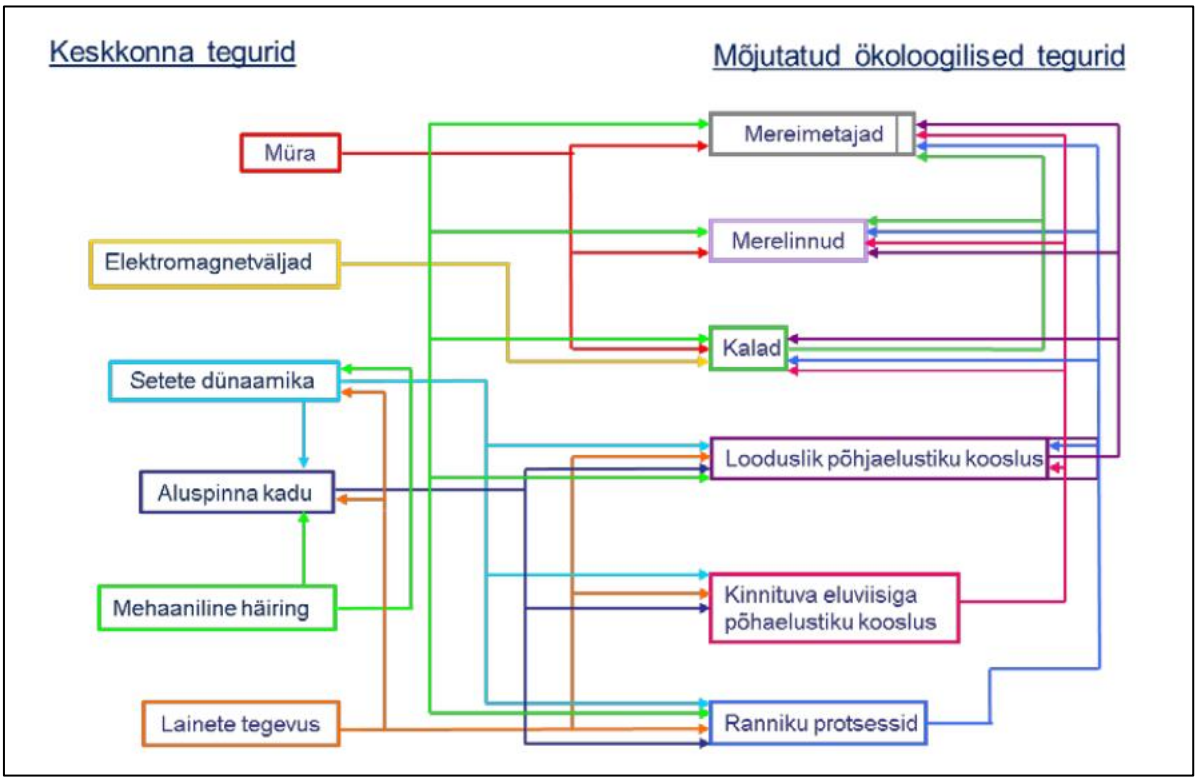

Figure 23. Impacts of environmental factors on ecology factors of sea environment at the phase of construction of offshore wind park (Hiscock et al. 2002)

On the basis of assessments until now, the main impact factor of construction of wind parks is mechanical disturbance. In case of deepening and overturning works arising from construction of offshore wind parks there is a strong, intensive mechanical disturbance (Hussina et. al. 2012). As a result of disturbance, some organisms may disappear from composition and vacant substratum will appear for new colonisers (Sousa 1984). Moderate mechanical disturbance may also provide for higher diversity of species after some period of time (Pärnoja 2004). Relatively small level of disturbance may affect as a stimulator for some species, and some changes in the structure of composition will appear, where dominating species are as a rule substituted at the same time when especially strong disturbance will lead to disappearance of the most species (Sousa 1984, Pärnoja 2004, Gill 2005, Herkül et. al. 2011).

By previous surveys it has been defined that noise and vibration do not have a very big impact on seabed fauna (Meißner & Sordyl 2006). These impacts are mostly caused by creation of surface corresponding to wind turbines by digging and explosion works, geological surveys, drilling,

installation of cables, divers' work tools, ships and equipment as well as work of turbines. At the same time, noise and vibration will apparently not create direct impact on seabed life in this interval.

The factor of artificial reef (substratum) has a large impact on sea environment and ecosystem in the phase of putting into use, i.e. so-called "reef effect", the impacts of which may be both positive (in a global level) and negative (on a local level) (Snyder & Kaiser 2009) (Figure 24).

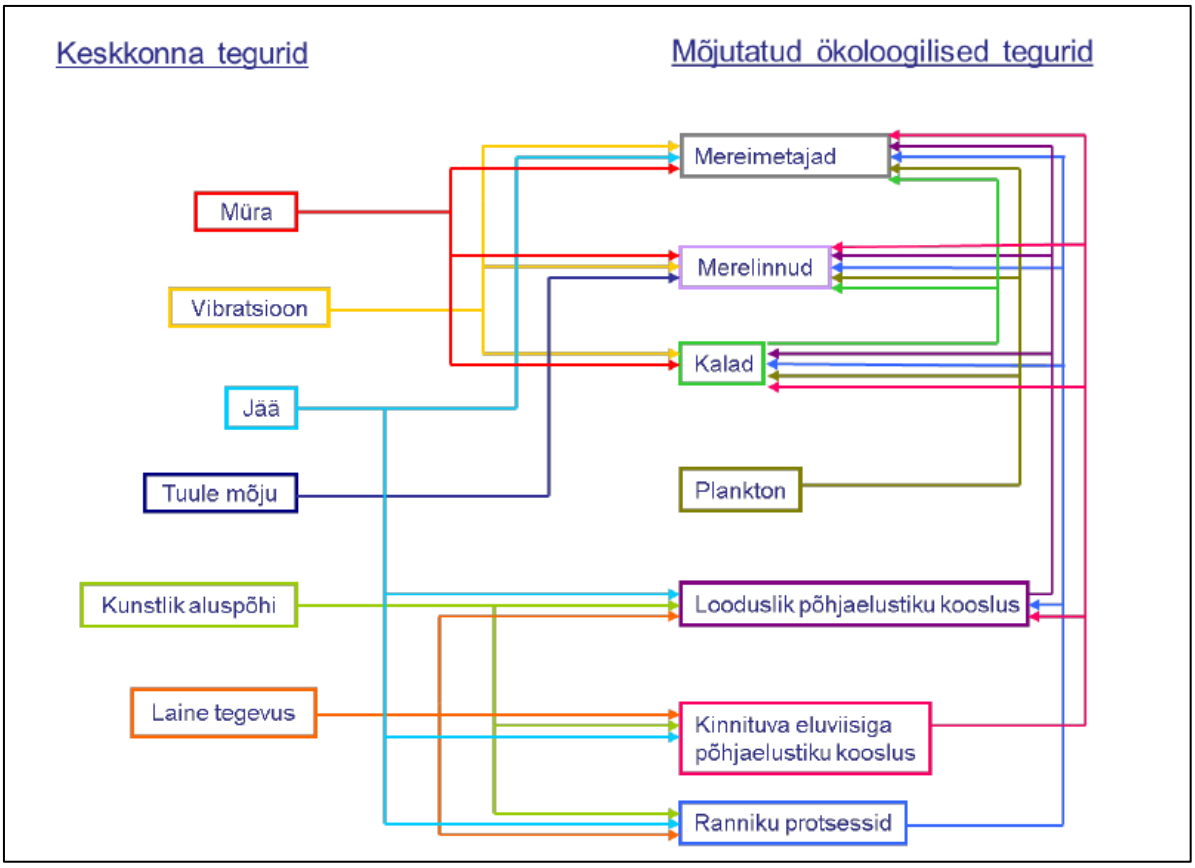

Figure 24. Impacts of environmental factors on ecology factors of sea environment at the phase of putting into use of offshore wind park (Hiscock et al. 2002)

The impact of artificial reef ("reef effect") on the surrounding environment and fauna depends much on the previous environment conditions and substratum dominating in the region. If there had previously been mainly soft, moving substratum in this region, then new solid substratum will have a greater impact (Kjær et. al. 2006). New substratum will be inhabited primarily by pioneer compositions consisting of different ephemeral (opportunistic) species of green, brown and red algae (Meißner et al. 2006, Nielsen 2006). Some species of this group of algae have adaptation to grow in poor light conditions and in water poor in nutrients (Leviton 2001). Deeper, below photic zone there are concrete surfaces used for construction for turbines' foundations in the conditions of the Baltic Sea, rich in seabed fauna species with sessile lifestyle (*Mytilus trossulus*, *Amphibalanus improvisus*) (Kautsky 1982, Westerbom et. al. 2002, Maar et. al. 2009), who can develop here due to low saltiness and the absence of predatory animals (Nielsen 2006).

Heat from electric cables may also impact seabed fauna. However, measurements in the surveys of already working wind parks have shown, that in reality the temperature of sediments increases only by 2 °C and it has not caused significant impact on surrounding seabed compositions (Meißner et al. 2006, Bojārs 2007).

Until now, the lifetime of one wind turbine has been accounted for a maximum of 20 years. Disassembly of wind parks from operations also causes negative impacts:

- visual and acoustic worries (disassembly of turbines, sea traffic);

- disappearance of habitats as the consequence of disassembly (recreation and feeding area for birds, upon removal of foundations the removal of seabed fauna and fish habitats);
- emission of polluting substances;
- turbidity of water and transportation of sediment upon removal of towers and cables and upon traffic and anchoring of water transportation means (Normative, 2007).

Gravity foundations are planned for both wind farm alternatives. If both alternatives use windmills with the biggest foundation (Haliade X), the installation of gravity foundations would result in a loss of habitat and disturbance for 1232450 m^2 in case of alternative 1 and 839950 m^2 for alternative 2.

In 2018, the loss of the seabed habitats for the post-Estonian Marine Strategy was assessed and it was found that the habitat types *reefs* (code 1170) destroyed due to anthropogenic physical loss of the seabed is total 6.5 km^2 in the Estonian marine area. The current habitat loss is estimated to be only 0.18% of the total habitat area in the Estonian marine area and the good environmental status threshold is set at 5%. In the event of the implementation of this project, if both alternatives would use GE Haliade X wind turbines with the highest capacity, the habitat area lost would increase to 7.7 km^2 (0.21% of the total habitat area) in case of alternative 1 and 7.3 km^2 in case of alternative 2 (0.20% of the total habitat area).

The material and surface structure of the gravitational foundation is apparently very similar in nature to the natural hard substrate (rocky, limestone seabed), so the change in habitat quality is minimal. An important difference with the natural situation will be the formation of a hard substrate in the low depth range ("reef effect").

All in all, both wind turbine installation alternatives will inevitably have an impact on the preservation, structure and function of the existing habitats on the seabed. In general, the alternative 1 affects the loss, structure and functions of the seabed habitats, as its realization occupies seabed to a greater extent and creates more new substrates.

General assessment and mitigation measures

Impact on seabed fauna	**Alternative 1**		**Alternative 2**		
	Impacts at the time of construction	**Impacts at the time of use**	Impacts at the time of construction	Impacts at the time of use	**Measures for avoidance or minimising of negative impact (if necessary)**
Impact on bottom vegetation on soft bottom	0	0	0	0	-
Impact on bottom vegetation on hard bottom	-1	1	-1	1	For undersea parts of wind turbines, use material that is not suitable for vegetation attachment; the material of the foundations must be as close to natural as possible (rocky, limestone, not toxic, the surface structure allows the species to attach); avoid damaging the surrounding seabed when installing foundations.

Impact on benthic fauna on soft bottom	-2	1	-2	1	If possible, do not use the so-called bottom preparation unless extremely necessary. As a result, the bottom substrate changes, which in turn affects the fauna (habitat changes or disappears). Use natural material from land to prevent erosion; the material of the foundations must be as close to natural as possible (rocky, limestone, not toxic, the surface structure allows the species to attach); avoid damaging the surrounding seabed when installing foundations.
Impact on benthic fauna on hard bottom	-1	1	-1	1	If possible, consider not placing windmills in the habitat type of the reefs; the material of the foundations must be as close to natural as possible (rocky, limestone, not toxic, the surface structure allows the species to attach); avoid damaging the surrounding seabed when installing foundations.
Effects on benthos (reefs)	-1	0	-1	0	If possible, consider not placing windmills in the habitat type of the reefs; the material of the foundations must be as close to natural as possible (rocky, limestone, not toxic, the surface structure allows the species to attach); avoid damaging the surrounding seabed when installing foundations.
Effects on benthos (cay)	0	0	0	0	

Monitoring measures

In order to monitor the environmental impact of the project and changes in the seabed biota and the quality of the habitat, a monitoring program should be launched during both the construction and the operation phase (for details see chapters 10.1.3 and 10.2.2).

Impact related to undersea cables

By its very nature, the construction of cableway does not destroy the habitat of the seabed under the cableway and has a very limited geographical impact. The construction and subsequent exploitation of the cable route will not significantly affect the distribution of habitats. In the case of a soft substrate, there may be some loss of habitat and habitat diversification by the addition of a hard substrate. Under certain conditions, it may happen that the added hard substrate (cable) falls under a soft sediment, and there is no difference in habitat distribution compared to the previous situation. All in all, the construction of a cable trail for habitat spread is extremely low during both construction and operation period.

Establishing a cableway can affect the quality of habitats through changes in the substrate and the distribution of species important for habitats. Since the cableway is primarily a hard substrate that is added to the seabed and the associated "reef effect", a greater change in the quality of the habitat is expected in particular on soft bases, where the additional hard substrate and "reef effect" increase the species diversity of this habitat through the formation of an additional substrate (Ambrose & Anderson, 1990, Langhamer 2012). Hard bottoms have minimal impact. In conclusion, it can be assumed that the installation and further exploitation of the cableway will have only a marginal impact on the quality of the seabed habitats.

Under hard substrate conditions, the hard substrate added to the cableway is not significantly different from the natural substrate and, if added, no effect on the species composition of the bottom vegetation is expected.

All in all, installing sea cables can disturb the benthos, but as a rule, this effect is not great and is short-term. The disturbed soft seabed will quickly recover in open sea conditions (Coates 2015). The electromagnetic effect of the cables on the attached species has not been described so far. Moving species may have some effect, but it is certainly limited to the vicinity of the cable. Also, the electromagnetic impact of cables on aquatic plants has not yet been identified.

The cables can have a positive impact in the immediate vicinity for both the flora and the sedentary biomas, and diversify seabed habitats, especially in soft seabed areas, attracting different species.

Overall, the impact of cable alternative 2 on benthos is lower compared to alternative 1.

General conclusion

Alternative 1 and alternative 2: 0 – neutral or no impact

0 alternative: 0 – neutral or no impact

Monitoring measures

When implementing the project, it is important to establish a detailed monitoring plan that would allow monitoring of possible impacts in the area occupied by the project, monitoring in as many different environmental conditions as possible (different depths, different substrates).

5.5. Impact on fish

The most important conclusions of fish survey performed within EIA are presented in this chapter. More profound overview of this topic can be found from fish survey report.

5.5.1. Impact on fishing

Coastal fishing

There is essentially no direct impact on coastal fishing, i.e. creation of wind park will not create any additional limitations in fishermen's traditional fishing areas. At the same time, creation of wind park may impact flounder spawning grounds and thereby impact negatively flounder population. This impact depends on the details of construction of wind park, i.e. used technical solutions. In case of the most environmentally friendly solutions are taken into use, e.g. cables generating very weak electromagnetic field, then the impact will be quite moderate.

Trawling

Hiiumaa is one of the most important counties from the viewpoint of the Estonian open sea fishing (trawling). The importance of fishing industry as an employer is also high in this county. Trawling is performed according to legislation only in those areas, which are deeper than 20 meters. However, this depth corresponds according to today's viewpoint approximately to the maximum depth of installing the wind turbines. This, in a narrower meaning problem is not that big. In reality, there is still a problem. Wind turbines areas may start narrowing ship traffic to catch area and back

from there. In case if wind turbines are still installed into deeper waters, a direct conflict will arise. The second problem is electric cables connecting different parts of wind park (i.e. different shallows) and connecting wind park with coast. In case if cables installed onto the seabed (and not into the seabed) are used, then closure of trawling in some areas may turn out to be a required preparation measure. The third and apparently the biggest problem is potential risk that noise generated by wind parks may keep fish off some areas, where trawling has until now been very profitable due to geology of the seabed. One of these areas is, for example, a narrow hollow in the north-west from development area TP 2, the steep "side" of which is according to "Hiiu Kalur", for example, one of their best fishing places.

Although the impact of wind parks on fish has been analysed by today in the course of many experimental field works, surveys have mainly been limited by gadidae and flatfish. In case of these groups it is known that wind parks do not have now any impact on fish fauna. At the same time it is stated, that fish may hear the wind park noise already from the distance of several kilometres. Although it does not cause any damages for them, it is possible that the noise worsens communication between fish with a shoal lifestyle. At the same time, there is no more exact information regarding this topic. Thus, it is only to be ascertained that since, for example, in case of development area TP 2 fish-rich "side" of hollow may remain in case of construction of wind park at the distance of approximately a kilometre to the closest wind turbines, in the light of today's knowledge the park's negative impact on profitability of fishing cannot be excluded.

Wind park may impact fish fauna at the stage of construction as well as operation. Impacts at the stage of construction are in essence short-term, but at the same time as a rule greater than in the period of operation of wind turbines. In the course of the survey performed in England (Perrow et al. 2011) the impact of construction of wind turbines on little tern has been proven, the concrete reason of which has been considered the fact that in the course of construction of wind park the number of young herring fish (the important feeding object of little tern) has significantly decreased in the region. In case if gravity-based structure is used for installation of wind turbines (requirement of the plan of sea areas bordering with Hiiu county), then the risk of negative environmental impact (noise and suspension), which may arise in case of drilling solutions, will significantly decrease.

The fishing effort of the active traps (bottom trawls) in contact with the seabed at the location of the wind farm and possible sea cables is minimal. The pelagic species are mainly caught in the area – European sprat and Baltic herring. Intensive fishing takes place in the first and fourth quarters of the year (according to the Ministry of Rural Affairs).The largest fishing effort in the area falls mainly from the areas where wind turbines are located, but also on the slopes of Vinkov 1. The profitability of trawling in the sea area bordering the wind farm can be considered as average at Vinkov 2, but above average in the immediate vicinity of Vinkov 1, as well as in the east and west of Apollo lowland.

Wind turbines are predominantly designed for lowlands with a seabed depth of less than 20 m. In areas where the wind turbines are installed deeper, there may be a direct conflict with trawl fishing. The main conflict area is the Vinkov 1 region, especially its eastern side, which lies in the development area TP 2. One of the ways to mitigate the conflict in the Vinkov region is to leave the TP 2 windmills in the development area on the separate eastern line of Vinkov 1 lowland.

In particular, the efficiency of the trawling may be affected by the wind farm's construction period due to the increased noise level and vessel traffic. Considering that the most intensive trawl fishing takes place in the first and fourth quarters of the year, conflict can be mitigated by avoiding or minimizing construction activity at that time. It is advisable to prefer the second half of the summer for the construction activity, when the spawning time of the flounder is over.

In the wind farm exploitation phase, wind turbine areas may begin to narrow the movement of vessels to important trawling areas. The mitigation measure is to allow trawling vessels to move to trawl fishing areas and from one trawl area to another through the wind farm and between wind turbines.

There is no conflict with potential sea cables, as pelagic species are mainly caught in the area and pelagic trawl is a trap that moves through the water column rather than the seabed.

5.5.2. Impact on spawning areas

From the point of view of fishing, the most important species are Baltic herring and flounder whose catchment areas are in the area affected by the wind farm. An alternative to sea cable installation 1 is on the herring spawning grounds north of Vormsi Island. North of Hiiumaa is the most important spawning ground near Hiiu lowland. The spawning areas of the eastern part of the Baltic sea are located in the eastern part of the Gotland Deep. There are no more detailed studies of the location of flounder spawning in the north of Hiiumaa sea area. It is known that the spawning grounds of the southern population of the coastal flounder of the Gulf of Finland are located near the areas open to the currents and free from sediments, near the islands and peninsulas and at a depth of 4-27 m, and the main spawning is at a depth of about 10 m (Ojaveer, 2014). This depth range falls within the wind farm area.

Preparing the seabed for gravitational foundation of the wind turbines and installing cables is accompanied by the re-deflation of sediment solids, which primarily affects early stages of fish development - roe, larvae and juvenile fish. In order to protect flounder spawning, the construction work on wind farm areas should be avoided in May and June, and during the spring, during the Baltic herring spawning period from April to May. Dredging and dumping works must be avoided at Hiiu lowland, where is the most important feeding area of Estonian coastal waters for flounders.

Considering that greater disturbance occurs during the construction phase and is therefore temporary and that the area under the gravitational foundation of the wind turbines does not constitute a significant part of the potential spawning area of flounder, the in-use spawning grounds can be considered to be minimal.

5.5.3. Impact on fish in summary

Wind park impacts fish fauna mainly through the following aspects:

- construction noise, for example, noise from drilling and/or ramming the piles at construction stage (if gravity-based structure is used, then the arising noise will be significantly smaller and more short-time);
- sailing sediment arising due to soil works at construction stage;
- ships noise related to construction at construction stage;
- wind turbines' operation noise at the operating stage;
- electromagnetic fields of the cables between the wind turbines at the operating stage;
- electromagnetic fields of the cables connecting the wind park with the coast at the operating stage;
- noise from ship traffic related to maintenance of wind turbines at the operating stage;
- Impact on fish behaviour of physical structures constructed into water (e.g. so-called cumulative impact) at the operating stage.

In addition to the above-said construction of wind park will bring about indirect impacts over the feed circuit. The respective survey has reached conclusion that due to arising of noise, vibration and new free substratum some changes may occur in the seabed fauna. Since at the present time the is still no very exact prognosis of changes occurring in the feed circuit, then it is not possible to forecast the impact of such changes on fish fauna. It is clear that in case if feeding base becomes poorer (smaller biomass, less invertebrate species), it will negatively affect fish inhabiting the region. Becoming poorer, at the same time, is not apparent, however, – at least not in the long-

time perspective. Rather new substrata have been created with construction of wind parks, which may increase the number of some fish groups in the regions (e.g. gadidae).

Taking into account the fish species and the number, defined on shallows close to Hiiumaa, it may be said that creation of wind park will not cause direct and indisputable risk to fish fauna.

The following argumentation is the basis for such opinion:

- No fish species has been caught at the surveyed shallows, that are included into Annex II of the Nature Directive.
- No species of Annex V of the Nature Directive have been caught at shallows close to Hiiumaa.
- 5 fish species included into Estonian Red Book have been caught at shallows close to Hiiumaa: lumpfish, great sand eel, shorthorn sculpin, fourhorn sculpin and longspined bullhead. All 5 caught species are included into category 5 (undefined). Naming in category 5 does not automatically bring any obstacles for activities in these regions, where the named species live.
- One species named in Annex III of Bern Convention has been caught at shallows close to Hiiumaa: shorthorn sculpin. Naming in this annex does not automatically bring any obstacles for activities in the regions, where the named species live.
- In conclusion, some species have been caught in the course of works, that deserve attention from nature protection point of view. Some species live at shallows close to Hiiumaa apparently year round; however, these species are as numerous or even much more numerous as in other places of coastal sea of Estonia.
- At the shallows close to Hiiumaa the following fish have been caught from the most important for fishing industry of Estonia: sprats, turbot, flounder, European perch, cod. At the same time, these are fish, that are quite numerous almost everywhere in the coastal sea of western Estonia. For European perch open sea is definitely not a typical habitat, and lower and more hidden areas close to the coast are still important for this species. The surveyed shallows close to Hiiumaa may apparently be deemed quite important for flounder and turbot. However, quantitative comparative data for the entire Estonian coastal sea are, unfortunately, absent, which would allow at least approximately to assess how big percentage of the essential habitats for species the surveyed shallows make up. At the same time, wind parks have no significant negative impact on flatfish in the light of today's knowledge. The area is used extremely little by professional coastal fishermen due to distance and openness to storms.
- One sea flounder has been caught at shallows close to Hiiumaa, which is the first definitely documented case of catching this species over 60 years (the last one was caught in 1948, as known). Although the species in very rare in Estonia, at the same time it is very typical industrial fish in the southern part of the Baltic Sea. The species gets into Estonia rarely, because it prefers higher saltiness.
- Today's knowledge about the impacts of wind park on fish fauna are stating the following: the most significant negative impacts on fish fauna are the noise and electromagnetic fields appearing due to the cables. At the same time, it has not been discovered until now in the case of wind parks working in the surveyed sea, that these factors would impact significantly the number of fish species caught in the course of this survey or disturb the normal lifecycle of the species.
- Cable has to be installed in order to connect the wind park with land. Although concrete data are absent, it is possible that between the shallows and Hiiumaa there lies an important migration way of at least part of mature migrating European eels heading towards Sargasso sea. Experiments performed in other places (e.g. Sweden) show, that electric fields arising from cables impact European eel migrating in the Baltic Sea in a disturbing way, as a result of which migration speed decreases and some fish may move aside from the initial migration direction. Thus, it may be concluded that the cable to be installed may be an additional disturbing factor on the European eel migration way. At the same time, this negative impact can be minimised by using cables with the lowest environmental impact and by digging the cable into the seabed.

Although the number of gravity foundations in Aalternative 2 is numerically less and they are installed in smaller areas, they are larger in size, so it can be assumed that the impact of the alternatives compared to the gravitational foundation during construction is not significantly different.

In comparison of the alternatives to installing sea cables, alternative 1 has somewhat greater impact, as with this, the cableway will be on the herring spawning ground, north of Vormsi island.

Overall assessment of wind turbine alternatives and mitigation measures

Impact on fish	**Alternative 1**		**Alternative 2**		**Measures to prevent or mitigate negative effects (if applicable)**
	Impacts during construction	**Impacts during use**	**Impacts during construction**	**Impacts during use**	
Impact on abundance of fish species	-1	0	-1	0	Installation of gravity foundations and similar construction work must be carried out outside the flounder spawning time, i.e. construction work must be avoided in May and June. If no mitigation measures are applied, the impact at the construction stage is -2.
Impact on fishing (trawling)	-1	-1 or -2	-1	-1 or -2	Construction activities in the first and fourth quarters should be avoided when the most intense fishing time has arrived. If no mitigation measures are applied during the construction phase, the effect is -2. In-use effects depend on the restrictions imposed on trawling.
Impact on fishing (coastal fishing)	0	0	0	0	
Impact of noise on fish stocks	-1	-1	-1	-1	Equipment and techniques that minimize noise should be used for seabed construction work. Noise-producing activities must be started so-called softly (more quietly) so that fish can escape from the area when louder sound is produced. If no mitigation measures are applied, the effect during construction is -2.
Impact on fish habitats	-1	+1	-1	+1	

Impact on fish	Alternative 1		Alternative 2		Measures to prevent or mitigate negative effects (if applicable)
	Impacts during construction	Impacts during use	Impacts during construction	Impacts during use	
(creation of artificial reef)					

Overall assessment of cable installing alternatives and mitigation measures

Impact on fish	Alternative 1		Alternative 2		Measures to prevent or mitigate negative effects (if applicable)
	Impacts during construction	Impacts during use	Impacts during construction	Impacts during use	
Impact on abundance of fish species	-1	0	-1	0	Installation of gravity foundations and similar construction work must be carried out outside the flounder spawning time, i.e. construction work must be avoided in May and June. If no mitigation measures are applied, the impact at the construction stage is -2.
Impact on fishing (trawling)	-1	0	-1	0	Construction activities in the first and fourth quarters should be avoided when the most intense fishing time has arrived. If no mitigation measures are applied during the construction phase, the effect is -2. In-use effects depend on the restrictions imposed on trawling.
Impact on fishing (coastal fishing)	0	0	0	0	
Impact of noise on fish stocks	-1	-1	-1	-1	Equipment and techniques that minimize noise should be used for seabed construction work. Noise-producing activities must be started so-called softly (more quietly) so that fish can escape from the area when louder sound is produced. If no mitigation measures are applied, the effect during construction is -2.

Impact on fish	Alternative 1		Alternative 2		Measures to prevent or mitigate negative effects (if applicable)
	Impacts during construction	Impacts during use	Impacts during construction	Impacts during use	
Impact of electromagnetic fields on fish stock	-1	-1	-1	-1	Use as low as possible electromagnetic field underwater cables, recess or bury the cables into seabed. If no mitigation measures are applied, the effect is -2.

Overall assessment for 0 alternatives: 0- No impact

Monitoring measures

For monitoring the fish, a program must be developed for both the construction and operation phases (see chapters 10.1.5 and 10.2.4 for details).

5.6. Impact on birds fauna

5.6.1. Principles of sea birds protection

What is related to protection of sea birds may be divided into four topics:

1) places of gathering and wintering of water birds stopping during migration

Estonia is located on the East-Atlantic migration route and due to its central location has a high value as a place for migration stop as well as wintering place. Benthophage water birds, i.e. feeding from the seabed, use shallows for this, where the depth is suitable for diving. There are five such shallows in coastal sea of northern Hiiumaa: Apollo (TP 1), Hiiu and Vinkov shallows (TP 2) and two nameless shallows (Shallow 1/ TP 4 and Shallow 2/ TP 3);

2) areas important for pelagic species

Such areas are often related to special hydrological conditions (increase flows, fronts between water masses), which cause high biologic productivity. Internationally, representatives of storm petrels of the order of *Procellariiformes* belong to pelagic species with high protection value . In Estonia storm petrels are presented only as mistaken visitors, gulls, sternas and jaegers are represented as pelagic species in our regions. The higher protection value is primarily owned little gull *Hydrocoloeus minuta*, that has not been noticed in the project area in large amount;

3) "bottleneck areas" of migration route

The populations of many bird species nesting in the western Siberian tundra and taiga zone pass through the Gulf of Finland during their migration from breeding areas to wintering areas and vice versa. It is estimated that this number can reach 4-5 million individuals. Waterfowl migration often follows a coastal line that causes mass concentration on cape peaks and narrow straits. In the vicinity of the project areas, such places are the tip of Tahkuna and Kõpu peninsula and Põõsaspea, which is slightly east. For example, it has been assessed that in 2004 the strait between Põõsaspea peninsula and Osmussaare has been crossed by 15-20% of Brent goose *Branta bernicla*, 40-50% of Barnacle goose *Branta leucopsis*, 11% Eurasian wigeon *Anas penelope*, 30% Northern pintail *Anas acuta*, 13-32% of Greater scaup *Aythya marila*, 11% Red-breasted merganser *Mergus serrator*, 50-95% of Common scoter *Melanitta nigra* and 30-65% of Red-throated loon *Gavia stellata* of out north-western European populations (Ellermaa & Pettay, 2006). A big part of this migration flow crosses also coastal sea of northern Hiiumaa, and part of birds remains at Hiiu

shallows for stoppage and wintering. The topic of bottleneck areas of migration route has become extremely vital with respect to programmes for creation of wind parks in "bottleneck" areas (Väinameri, Sõrve peninsula). The survey of migration in these areas requires radar surveys.

4) nesting colonies

Birds nesting on islands and small islands use sea surrounding the islands for feeding. In earlier materials published by *BirdLife International* the species have been divided into three groups on the basis of feeding radius: 5 km (little tern, black guillemot), 15 km (arctic tern, common tern and sandwich tern, common gull, great cormorant) and 40 km (lesser black-backed gull, razorbill) (*BirdLife International*, 2004). Although there are no small islands in the project area, a big part of birds from colonies located in the neighbouring areas uses surrounding sea for feeding.

5.6.2. Direct risk factors arising from offshore wind parks

1. Food resource and feeding conditions (significant effect)

The most vulnerable via food resource and feeding conditions are water birds species feeding at sea shallows. In such a case these are usually water birds from north looking for food, whose diving depth is up to 30 m. They are long-tailed ducks, common eiders and greater scaups feeding with northern fauna. The biggest risk upon destruction of seabed habitats are changes in the seabed related to construction of wind turbines, which in turn causes changes in the fauna of the seabed.

During seabed preparation and construction work, the benthic will most likely be destroyed on "construction sites" and its immediate surroundings, which means loss of food base for the birds. Another biggest threat is disruption. Due to the visual and acoustic disturbance of wind turbines, waterfowl will avoid areas of the wind farm, although it has been their traditional eating area. Reducing the number of wind turbines can reduce avoidance but mitigating the disturbing effect in this way is not significant. There is a small chance that some birds will become accustomed to windmills. For fish-eaters (loons, mergansers) and pelagic species (gulls, terns), the impact of wind farms is smaller because these species can also cope in deep water and are not directly related to the lowlands. They may be concentrated on the lowlands where there may be more abundant fish stocks. Lowland might be important areas of spawns for many species of fish, which in turn will increase the value of the lowlands as feeding places for fish-eating waterfowl species.

In the course of performed surveys it has been found that **the biggest concentration of migrating stopping and wintering water birds was at Apollo and Hiiu shallow**.

The importance of the development area TP 2 (Vinkov) has not become notable in the survey of 2014, but the reason for this may be a bit late censuses in spring as well as in autumn. The importance of Vinkov and Glotov shallows for sea birds is shown by the census in the of October 2007, when approximately 40 000 birds have stopped in total in two areas. At the same time, it should be noted that all of the northern Hiiumaa basins have to be seen as a single feeding area on the migration route. Depending on the number of birds, the season and the weather, waterfowl are likely to use the whole area.

Subsequent separate examination is needed by globally endangered Steller's eider, whose main food in wintering areas are shells. Although it is known, that Steller's eiders are active here mainly at coastal shallows and feeding areas do not reach deep open sea shallows of the wind park, contact with the wind park at the time of migration is still possible, and the risk factor is still high due to the species' global endangering.

According to the compromise proposal, the developer adjusted the location of the wind farm development areas, the development area TP 1 was shifted away from the Apollo shallow nature reserve, and no wind turbines are planned for Apollo shallow. The closest windmills would be located at least 2 km away from the Apollo nature reserve, as for both alternatives of the wind turbines, so that there is no damage to the seabed, the benthic habitat, and food base for the birds. However, acoustic and visual disturbances and vibrations associated with the construction and use of wind farms may have an impact, which may result in some degradation of dietary

conditions at Apollo shallow. However, this may have a negligible impact as the essential food base of birds using Apollo shallow is maintained.

When comparing the alternatives of the wind farm, then alternative 2, where the windmills are located up to 6 km from the Apollo shallow, is the most suitable, because in this case the wind farm is further away from the Apollo shallow. Disturbance caused by the wind farm is several times lower, which in turn improves the nutritional conditions of the Apollo shallow conservation area.

2. Wind turbines as obstacles to migrating water birds (significant impact)

Working wind parks are a significant obstacle to migrating water birds. In several places in Western Europe profound radar surveys have been performed in order to find out the impact of offshore wind parks to water birds being in transit migration. All surveys show that migrating birds avoid offshore wind parks, do not enter into their areas and do not fly through them (Desholm, 2006). Since radar observations have never been performed in the project area, so the route of the main migration flow in the northern Hiiumaa coastal sea can only be presumed.

Visual observations from the coast show that spring as well as autumn migration gathers mainly at the tips of Kõpu and Tahkuna peninsulas. Taking this into account, only Kuivalõuka (with the former name Neupokojev shallow) and Apollo shallow remains on the migration way, and **with very big probability northern Hiiumaa shallows will remain to the north from main migration corridor of water birds and will not represent big obstacle for birds being in transit migration. Offshore wind park has not been planned at Kuivalõuka shallow**.

Observations made in Põõsaspea show that some part of autumn migration also flows from the other side of Osmussaar, which in turn creates an opportunity that the migration might cross the TP2, TP3 and TP4 wind farm areas. Since there are no radar observations, it can only be assumed. On the other hand, TP 2, TP 3 and TP 4 are historically important waterfowl feeding areas that attract waterfowl and, as a result, the migration route may be much wider than expected, covering all of these lowlands.

Reducing the number of wind turbines to increase wind power capacity is not mitigating. The only mitigating factor is to change the shape of the development area TP1, placing wind turbines in the same direction as the migration. In the comparison of alternatives, the planned wind park in the TP1 area in case of alternative 2 is narrower and has less wind turbines, which is why its impact as a migration resistance is somewhat smaller. In the case of TP2, TP3 and TP4 there is no difference from the bird's point of view when comparing alternatives 1 and 2, because the arrangement of the wind turbines remains the same for both alternatives and therefore the influence on the migration resistance does not change.

3. The risk of collision with wind turbine blades (significant impact)

The birds species with higher level of collision risk are species, who use rising airflows in migration (birds of prey, storks, common cranes, great cormorants and gulls). Since the rising airflows are created above the land, then the risk of collision is greater at the coast and in wind parks located on the shore. Taking into account that airflows rising in the open sea are practically absent, then offshore wind parks do not represent significant risks to these groups of species, especially if to consider that so-called "planning" species avoid big bodies of water and apply low wing flapping motion when overcoming them.

Above water bodies, bird migration occurs mostly at low altitudes, ranging from 1 to 300 m. It is different for different taxonomic groups. Wind farms represent the greatest threat to loons, genus, long-tailed ducks, common scoeters and gulls as their migration height coincides with the work area of the rotors.

As waterfowl are known to avoid wind farms, the risk of collision with windmills is shrinking. The biggest collision risk is at night and in very bad weather conditions such as fog, strong wind, rainfall. In aforementioned cases, migration does not usually occur. Wind farms pose the greatest threat to long-lived and low-productivity species, all waterfowl and many woodcocks (Exo et al. 2003).

Wind turbines used in offshore wind farms typically have longer-blade rotors than terrestrial ones. As a result, there is also a risk of collision, since at the same angular velocity, the end velocity of the blade and the turbulence are greater for the longer blade.

The night lights of the wind turbines can be a major threat to migratory terrestrial birds as they attract migratory birds to wind farm areas. Radar studies at Helgoland, Fehmarn and Rügen show that 20-30% of the migrating terrestrial birds below 2000 m sea fly in the height of between 0-200m, which remains within the rotor´s working range (Hüppop and Wendeln unpubl.). Based on visual observations from the coast, the most important land-based migratory corridors in the project area are Spitham and Tahkuna to Hanko and vice versa. Wind farms TP1, TP2, TP3 and TP4 won´t be directly on this road, but there is a high risk that wind turbines may tilt night-time migration towards wind turbines. The importance of the colour of the lights on the birds is still being studied.

In summary, there is no big difference between alternative 1 and 2. For alternative 1, the windmills are smaller, but their number is larger. For alternative 2, there are less wind turbines, but they are higher, which in turn are more dangerous for migratory birds.

Mitigation measures

As the development area TP1 remains a well-known migratory route for birds, the mitigating factor is to place them along the migration direction. There are several mitigation measures to reduce the risk of collision in regards the lights of wind turbines (see chapter 9 for details).

Sea cables

The harmfulness of the sea cable connecting the wind farms to birds has not been studied precisely, but it is likely to be small compared to the risk posed by the wind farms. The use of sea cables can have a minor impact on the food base and nutritional conditions during their installation, there are no significant impacts during the use phase. Alternative 2 is certainly a better alternative, as the cable runs along a more direct path, damaging less the different biotopes.

5.6.3. Impact on birds fauna based on the stages of planned activity

Creation of wind park

In the course of preparation and construction of the seabed seabed fauna on "construction platforms" and in its closest proximity will apparently be destructed, which means disappearance of birds' food basis. Definitely, dispersion of suspension arising from construction will have a significant impact on area between wind turbines, which will worsen feeding conditions of water birds (transparency of sea water will become worse).

In addition to the destruction and depletion of the seabed biota, direct disturbance during construction (noise, vibration, vessel traffic) has also a significant impact. The wind farm is being built in practice gradually and up to 6 wind turbines are being built at the same time, so the effect during the construction is simultaneously in a rather small area and the impact on the bird life is local. In a situation where wind turbines are located at least 2 km from the Apollo nature reserve, the noise generated by wind turbines does not have a significant negative impact on the birds staying there. Noise is likely to remain at a negligible level.

Considering that the volume of construction works is very large, it is not possible to determine a suitable construction period.

When comparing alternatives of wind farms, alternative 2 is more appropriate, as wind turbines are located further away from the lowland, and the farther the windmills are, the less disturbance, including noise, there is.

Installation of sea cables

The impacts of establishing a sea cable connecting the wind farms is primarily related to changes in the seabed and the spread of associated suspended solids (see Chapter 5.2.3), which worsens

the feeding conditions of the birds. In both cases, this is a short-term disturbance. The benthos is likely to recover over time. In the comparison of cable installation alternatives, the impact of alternative 2 is less significant from the point of view of bird life, as it is less damaging to different biotopes, both on the seabed and on land.

Operation on wind park

Since wind parks do not have a positive impact on sea birds, one should be very careful when planning them and be ready for compromises and, if necessary, find other alternatives.

When implementing the compromise proposal, TP 1 will be shifted away from the Apollo shallow nature reserve and no wind turbines will be built on the Apollo shallow. As the closest wind turbines are located at least 2 km from the Apollo nature reserve, the seabed, the benthos and the important food base for the birds will not be damaged.

However, acoustic and visual disturbances and vibrations associated with the construction and use of wind farms can have an impact, which may result in some degradation of dietary conditions at Apollo shallow. However, this may have a negligible effect as the essential food base of Apollo shallow is maintained.

Alternative 2, where the windmills are located up to 6 km from the Apollo shallow, is the most suitable alternative because the wind farm is farther away from the Apollo shallow and interference from the wind farm is several times smaller, which in turn improves the nutritional conditions in the neighbouring Apollo conservation area.

In a situation where wind turbines are located at least 2 km from the Apollo nature reserve, the direct noise of wind turbines does not have a significant negative impact on the birds staying there. Noise is likely to remain at a negligible level. In the comparison of alternatives, alternative 2 is more appropriate, since windmills are located further away from the shallow, which also results in lower noise background and visual disturbance compared to alternative 1.

Working wind farms are an important obstacle to migratory waterfowl. The impact of wind turbines as a migration resistance has been assessed in Chapter 5.6.2. One aspect of wind farms working is the lights used to make wind turbines visible in the dark. Wind turbines hazard lights represent a major threat to night-time terrestrial birds, attracting birds to the wind farm, and significantly increasing the frequency of bird collisions with wind farms. The risk of collision due to wind turbines is assessed in Chapter 5.6.2.

There is also a need for continuous maintenance of wind farms, which increases the number of service vessels operating in the area, which in turn increases the disturbance of birds in the maritime area. The maintenance of the wind farm is planned to take place on a regular basis, rather rarely, and using small, environmentally friendly bases. There is no significant daily increase in marine traffic in the area.

The impacts of a sea cable connecting the wind farms are primarily related to the construction phase and the resulting changes in the seabed and the spread of suspended solids. No significant impacts in the use phase apply.

Demolition of wind turbines

Upon demolition of wind turbines removal of foundations should be avoided, since it would damage biotops of the whole seabed area already for the second time.

5.6.4. Other most important risk factors for water birds being in migration and on migration stops

Other most important risk factors, which may cause the increase of cumulative impact on birds, is oil pollution, by-catch, ship traffic, digging, deepening, overturning, construction and eutrophication.

Oil pollution is one of the most significant potential risk factors for water birds stopping and feeding in the sea, causing their death due to undercooling and toxic substances that got into digestive apparatus. Greater migrating gatherings, that feed at shallows. are mostly endangered. During twenty years, long-tailed duck population has decreased up to two times, and the primary reason for this is deemed oil pollution (Larsson & Tyden 2005) and by-catch. In order to avoid risk, important are primarily the state measures for prevention, discovering and elimination of oil pollution. However, the risk of oil pollution related to construction of wind park and keeping it in use is presumably not big.

By-catch is one of the most significant risk factors in case of all diving birds species (Žydelis et al. 2009). With respect to fishing, other possible factors are also noted, e.g. change of food basis. Since in the offshore wind parks fishing is as a rule prohibited, then by-catch is not very important in this case as a risk factor.

Ship traffic may disturb stopping water birds and increases the possible risk of oil and other pollution. Use of powerful watercrafts with low draught, for example, scooters, in low sea areas may in principle endanger seabed compositions as birds' food basis. Still it should be pointed out that use of scooters at low open sea shallows is not probable, however, the most important ship route in the Baltic Sea lies not very far from the development area TP 1. Part of ships, which are heading to Hiiumaa Lehtma and Suuresadama harbours, are also crossing project area, but due to their small number they apparently do not represent a big risk to birds fauna. In addition, ships avoid sea shallows. A slight increase in the impact of vessel traffic to wind farms due to the maintenance vessels.

Digging, deepening, overturning and construction activities cause destruction of seabed compositions, which in turn directly impacts food basis of water birds, but which will recover with great probability over time. At the same time, water transparency will also temporarily decrease in digging and overturning areas, which in turn will impact seabed and fish fauna. Definitely, digging of sand should be avoided at Hiiu shallow, especially taking into account that this is a wintering place of globally endangered steller's eider. Activities related to wind park construction directly impact seabed compositions, but with great probability they will recover over time. At the same time, minimising measures can be used, for example, creation of suitable substrata for molluscs.

5.6.5. Birds protection value of Northern Hiiumaa coastal sea

Mosaic of dispersion of birds migrating through and feeding from Northern Hiiumaa coastal sea, also temporal division of gatherings is an important component, which should be taken into account when planning activities in these areas.

Sea basin of Northern Hiiumaa as a whole is an important migration and migration stoppage place for many arctic water birds. If spring and autumn migration were compared, then migration is more intensive in autumn, since many water birds do not enter Väinameri and follow coastal line of Northern Hiiumaa and Western Saaremaa. On the contrary, big part of spring migration goes through Väinameri and smaller part follows Saaremaa and Hiiumaa coastline (Figure 25). That's why the amount of birds stopping in migration is significantly higher in autumn.

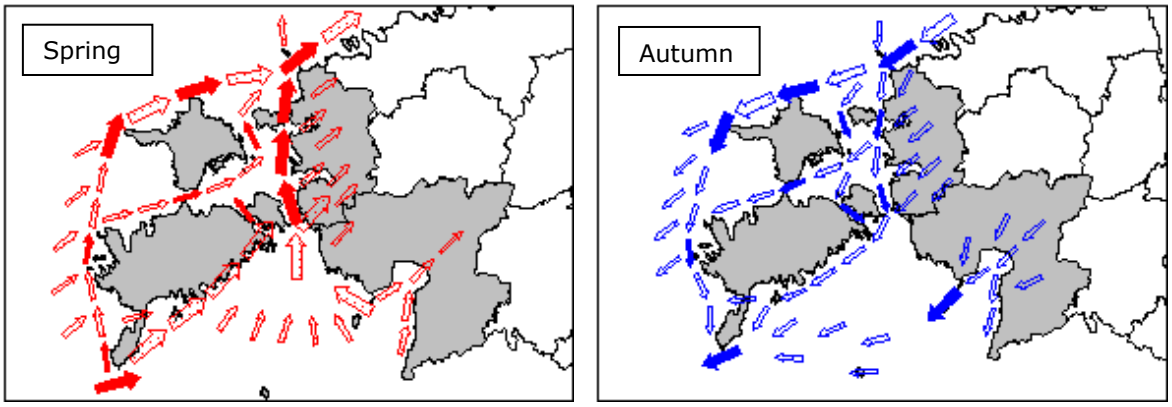

Figure 25. Transit migration of arctic water birds in coastal area of Western Estonia

Birds species with the highest nature protection value in this area are steller's eider, red-throated and black-throated loon (species from Annex I of European Council Birds Directive). Yet little gull, caspian tern, sandwich tern, arctic tern, common tern and little tern may appear in this area from the species of Annex I. The most important of the species of Annex II are long-tailed duck, greater scaup, common eider and velvet and common scoter.

Especially great attention should be paid to long-tailed duck deserving greater protection, whose amount has significantly decreased during last decades. International programme for organisation of protection of long-tailed duck is being prepared, where the necessity to protect long-tailed duck's migration stoppage and wintering places has been pointed out. In January 2019, the Apollo shallow nature reserve was established, one of the conservation objectives of which is to protect the protected species covered by Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (ELT L 20, 26.01.2010, p. 7-25), lists in Annex I and the migratory birds species and their habitat not listed in Annex I. Those species are long-tailed duck (*Clangula hyemalis*), little gull (*Larus minutus*), common scoter (*Melanitta nigra*) and common eider hahk (*Somateria mollissima).* Apart from the Apollo protected area, there are no more marine protected areas north of Hiiumaa based on the available data.

In case of birds species stopping in the sea the purpose of protection is usually protection of habitats of numerous species, whose amount in the area makes up an important part of population amount. Internationally, one of the most accepted criterion upon choice of important areas is so-called Ramsar criteria (Heath and Evans, 2000). Criterion number 6 of Ramsar Convention asserts that internationally important area is deemed area, where regularly stops 1% of some species or subspecies of the population. The second criterion, number 5, asserts that those areas should also be protected, where regularly 20 000 or more water birds stop. As a result of this survey, according to the birds fauna expert's assessment Apollo and Hiiu shallow would qualify to be such areas, which are some of the most important place for stopping of water birds during autumn migration and at the time of wintering in coastal sea of Northern Hiiumaa and where regularity criterion is also fulfilled. Earlier surveys also show Vinkov shallow's big birds protection value and this especially in autumn (Leito 2008), but in the course of this survey significantly great density of population of water birds has not been noticed there. According to European Commission guidelines according to Ramsar criterion in order to create birds are with international importance the area should be regularly used by more than 20 000 long-tailed ducks each season (*"any season"*) during at least three subsequent years.[26]

5.6.6. Compromise proposal and a summary of the birdlife

Based on the results of birds fauna survey the birds fauna expert has made the following compromise proposal: situation, where wind park is created in the development area, which

[26] http://ec.europa.eu/environment/nature/natura2000/marine/docs/marine_guidelines.pdf

consists of four shallows – area remaining to the south from Apollo shallow (TP 1), Shallow 1 (TP 4), Shallow 2 (TP 3) and Vinkov shallow (TP 2). In this case Apollo shallow will not be included, which is the most important stopping place of water birds in the coastal sea of Northern Hiiumaa. In case if Apollo shallow is abandoned, it will clearly be a compromise and a minimising measure.

When implementing the compromise proposal, TP 1 will be shifted away from the Apollo shallow nature reserve and no wind turbines will be built on the Apollo shallow. As the closest wind turbines are located at least 2 km from the Apollo nature reserve, the seabed, the benthos and the important food base for the birds will not be damaged. However, acoustic and visual interference and vibration associated with the construction and use of wind farms may be affected, which may result in some degradation of dietary conditions at Apollo shallow. However, this may have a negligible impact, as the essential food base of birds using the Apollo shallow is still preserved. Alternative 2, where the wind turbines are located up to 6 km from the Apollo shallow, is the most suitable alternative because the wind farm is farther away from the Apollo shallow and the disturbance from the wind farm is lower, which in turn improves the nutritional conditions in the neighbouring Apollo nature reserve.

In a situation where wind turbines are located at least 2 km from the Apollo nature reserve, the direct noise of wind turbines does not have a significant negative impact on the birds staying there. Noise is likely to remain at a negligible level. In the comparison of alternatives, alternative 2 is more appropriate, since windmills are located further away from the ground, which also results in lower noise background and visual disturbance compared to alternative 1.

In conclusion, any occupation of sea areas by a human being leads to a decrease in the abundance of Arctic waterfowl in these areas. To which extent or how much it shrinks is very difficult to predict, as there are many factors that causes it (direct obstruction, destruction of benthic fauna associated with construction, vibration, area size, number of wind turbines, etc.). However, the answer to this question can only be given after the follow-up. The planned activities are located outside the important areas of long-tailed ducks (the most important areas are Hiiumaa and Apollo shallow).

In the implementation of the compromise proposal, the impact of the wind farm is expected to be low for waterfowl at Apollo shallow in the exploitation phase of the wind farm, but the actual impact is likely to become apparent only in the follow-up. As the long-tailed ducks and other bird species will continue to be able to use the Apollo shallow to its full potential, they are expected to be negligible during the exploitation phase of the wind farm (including effects on food base, nutritional conditions, visual and acoustic disturbance). The impact of wind turbines as a migratory impediment is significantly negative, resulting in a significant negative risk of collision with wind turbine rotors. When applying mitigation measures, the collision risk can be mitigated.

During the construction phase, the impact on bird life levels will be significantly negative.

The installation of sea cables has a minor impact on the construction phase, with no significant impacts during the operational phase.

General assessment:

Alternative 1 and alternative 2 of wind farm: Construction phase -2 - significant negative impact; use phase -1 - negligible negative impact (when implementing compromise and mitigation measures)

Cable installation alternative 1 and alternative 2: during construction phase -1- negligible negative impact; use phase 0 - no neutral/no impact

0 alternative: 0 - No impact

Mitigation measures

See Chapter 9.

Monitoring measures

Generally, radar studies are used for large wind farm constrcutions, which generally gives the best overview of the location of migratory waterfowl in a specific area. The radar survey provides an overview of bird movement patterns, 'bottlenecks' of migration, and migration altitudes. See chapters 10.1.4 and 10.2.3 for details.

5.6.7. Impact on chiropterans

When flying over the sea, bats usually have a flight altitude of up to 10 m, but when feeding at lighthouses, wind turbines and other vertical objects at sea, for example, flying around wind turbine blades, they fly on much higher altitudes. Such observations indicate that wind turbines built into the sea can increase bats' mortality. Bats at sea are more often feeding in places where the abundance of insects flying in the air or crustaceans on the surface of water is high. (Lutsar 2011, Ahlén, Baagøe & Bach, 2009). The areas of the proposed offshore wind farm are so far off the coast that we cannot talk about the local insect fauna in these areas.

If birds die in wind farms due to the rotors swinging, then bats who have developed echo locating, which make them observe moving objects better than stationary objects, can see swirling rotors and can avoid colliding with them (Kilki 2013).

However, dead bats are often found in terrestrial wind farms. According to the hypothesis of the drop-in pressure, the high mortality of the bats is caused by the rapid decrease of the air pressure at the moving blade. This results in barotrauma, which is a tissue damage to air-containing structures caused by rapid or excessive pressure change. Bronchial barotrauma is a lung injury caused by rapid air swelling in the lungs. However, the air swells so quickly that the bat cannot breathe it out instantly and that causes deadly damage. (Kilki 2013)

It has been found (Baerwald et al. 2008) that in wind farms, 90% of bats die from barotrauma-induced internal bleeding, and only half of the deaths were associated with direct contact with the rotors.

Bats' behaviour and risk factor (migration resistance and probability of collision and frequency) in wind farms is similar to birds and they can be compared. It is also similar to the fact that the main risk period is spring and autumn migration (Leito 2008). However, an important difference compared to birds is that bats are attracted to the wind farms from the surrounding ambient air and the turbines are gathering insects (food) that concentrate their frequency and density. In offshore wind farms, this effect is smaller, but still exists (Ahlén et al. 2008). The negative impact on bats is the locomotion and navigation difficulties and errors caused by rotor movement, which affect bats that live primarily in the vicinity of the mainland wind farms.

Due to the location of the proposed wind farm sites, they may have some impact on the bats migration corridor between Estonia and Finland. For these corridors, their exact location (preferred migration trajectories) and their overlap with wind farm areas are not known.

Observation data (Lutsar, 2011) show that bats (especially the Nathusius' pipistrelle) starting from Kõpu Peninsula are likely to cross the Baltic Sea from east to west during autumn migration. As the areas of the wind farm are located north of the given line, the wind farms in this potential migration corridor are not affected.

Due to the above, it follows that the areas of the north-west Estonian offshore wind park may cause death to some of the bats passing during spring and autumn migration on the Estonian-Finnish migration route. If migrating bats fly low above the sea and do not rise near the rotors (for nutritional purposes), there will be no significant death or injury of the animals.

The average wind speed in the wind farm area is over 9 m/s and the wind turbines start working at wind speeds of about 5 m/s. Considering the migration rate of bats, migration usually takes place in relatively quiet weather when the windmills are not working or running at low speeds, where the risk for bats is low. In the case of stronger winds, when the wind turbines are running

at full speed, migration can only take place in case of favourable wind (downwind). This fact obviously significantly reduces the likelihood of bats being killed.

However, the proposed areas of the offshore wind park may have some negative impact on Finnish bat populations of common pipistrelle, nathusius' pipistrelle and northern bat, this in case of relatively concentrated migration through wind farm sites and when migration occurs in windy weather when rotors rotate at higher speeds. The prerequisite for collisions and death of animals is that bats fly so high (above the normal migration height) that they reach the rotor impact zone. If migration occurs in a wider area and is scattered, and the bats fly low, the impact on bat populations is negligible. The project does not have significant impact of Estonian chiropteran populations, as the migration of Estonian populations takes place predominantly in the south and does not pass through areas of the wind farm.

General assessment

Alternative 1 and alternative 2 of wind farm: -1 - negligible negative impact (construction and use phase)

Cable installation alternative 1 and alternative 2: during construction phase -1- negligible negative impact; use phase 0 - neutral/no impact

0 alternative: 0 – no impact

Mitigation methods

Appropriate solutions must be applied to mitigate the risk of collision of chiropterans with wind turbines and to minimize possible death (see Chapter 9 for details).

Monitoring metods

As it is not known to have any monitoring study of chiropterans in the development area of the wind farm, there are assumptions that they are found in the area, so it is necessary to carry out manual monitoring during the wind farm construction phase.

5.7. Impact on sea mammals

5.7.1. Grey seal

The proposed wind farm areas, in particular the TP1 development area, are located in the north of Hiiumaa in the offshore area, which is a grey seal breeding area if ice is present. In the area around Hiiumaa, the grey seals breeding area area is mainly the ice fields located north of Hiiumaa. Due to the climate warming, the freezing of the open sea around the wind farm area has become relatively less frequent and short-term and therefore the seals are not able to breed in the areas of TP2, TP3 and TP4 areas. Therefore, the Gulf of Riga is of greater importance for seals in the West-Estonian region as a breeding area, where a more suitable drift is formed. During the ice-free period and outside the period of reproduction and hair replacement, the area of wind farm areas is a dispersed area of life and nutrition, as evidenced by GPS surveys of seal movement (Silts, 2014).
The closest grey seal area and counting area to the proposed offshore wind park is the Selgrahu, which is located at 4.3 km south of TP 1 for both alternatives of the wind farm. Selgrahu is also used by grey seals in case of poor ice conditions, when it is not possible to give birth on ice. At the same time, the habitat and sea in the surroundings is on Väinameri nature area. There are no other small islands, reefs or habitat suitable for breeding for seals in the vicinity of wind farm development areas.

Impacts during construction

The construction of a marine wind park in development area TP 1 does not directly affect the grey seal habitat, but during the wind farm construction phase, the species may be disturbed by noise and, to a lesser extent, by visual disturbances (due to the spread of suspended solids).

The sound and undersea noise heard by seals, which causes disturbances, reaches several kilometres. The biggest noise is caused by blasting, which apparently can be heard by the seals for several dozen kilometres (Dietz 2015) and which can cause behavioural effects on animals. Although the need for blasting, the number and severity of blasting is not known at the time of drafting this EIA, it is one-off instantaneous noise events. Since gravitational foundations are used in wind turbine construction, not mortars, which would be accompanied by noisy piling of piles, then constructing the wind turbines does not cause activities with very high noise level. Thus, it can be assumed that no significant noise disturbance in the construction work will occur. Direct physical effects - temporary or permanent hearing damage can only be caused by underwater noise if the animals are in the immediate vicinity of the work area. For seals who encounter a noise exceeding 130 decibels, there is a risk of permanent or temporary hearing damage. Studies have shown that seals that remain in the 90-130 dB noise level during wind farm construction are leaving. However, since seals keep away from the work zone, hearing damage is unlikely to occur.

Seals use both underwater and above-water acoustic communication that can be disturbed and shielded by noise. In the lowlands, the water has a wider bandwidth than the air. Such disturbances, which lead to animal behavioural reactions, can occur over several kilometres (Dietz 2015). Major disturbances are caused by the establishment of pile foundations, and in the case of gravity foundations (as in the present case), the effects of construction work are smaller (McConnell, Lonergan & Dietz 2012). The experience of the southern part of the Baltic Sea regarding building wind farms in Denmark shows that grey seals are also relatively tolerant to wind farm construction. Most of the noise seems to have a background effect.

Construction work is accompanied by an increase in vessel traffic in the area, which in turn causes noise disturbance. Some noise is also associated with the installation of sea cables due to the movement of the cable tray. However, the volume and range of noise caused by vessel traffic is lower than in the case of noisy construction work.

The noise during construction can also affect the fish that feed the seals by scaring them away from the work area. The sensitivity of fish to noise is lower than that of seals and the impact on fish is rather small. Thus, the noise associated with the work does not cause the seals to lose their food base.

The construction of wind turbines and the installation of sea cables (mainly due to the movement of the cable laying platform and the dredging of the cable on the seabed) will also cause the suspended solids to float and spread. A suspended solids cloud reduces water transparency and prevents seals from catching. According to the modelling of sediment spreading and sedimentation within the framework of this EIA report, most of the suspended solids in the course of the works settle in the vicinity of wind turbines and cables. The spread of the silt is somewhat larger, at a maximum of 6-8 km, but at a distance of a few kilometres from the source, the suspended solids level is very low. In the water column, the suspended solid remains relatively short-term. The potential impacts of suspended solids on seals are therefore local and short-term in the construction of wind turbines as well as during the installation of a sea cable. In addition, seals also keep away from the suspended solids rich zone and there is no significant effect on seals by the distribution of suspended solids.

Sedimentation of suspended solids may endanger fish spawning, lead to negative impacts on fish stocks and thus changes in seals food base, as well as changes in benthic habitats may lead to changes in the food chain and seals food base. Since this report estimates the impacts on the fish, including the number of fish, rather small, the potential impacts through the food chain to grey seal are also relatively small. In addition, grey seals are located in the deepest sea areas with deeper water, which means that animals are not excluded from very high value feeding areas.

Comparing the alternatives of wind farm development areas, alternative 2 has a somewhat lower impact, as the area of the wind farm area and the total number of wind turbines are smaller (140.48 km^2 and 107 wind turbines in case of alternative 2 vs 168.89 km^2 and 157 wind turbines for alternative 1). The smaller area of the wind farm area and the much smaller total number of wind turbines will have somewhat lower impacts. The impact on the Selgrahu seal habitat area is significantly smaller in case of alternative 2 because the development area TP 1 is located further away from the habitat.

In the comparison of cable installation alternatives, impacts on sea cables do not differ by alternatives, as the number, length and approximate arrangement of the cables are the same in both cases. In the case of interconnection cables inside wind farms, the effect of alternative 2 is somewhat smaller, since the smaller number of wind turbines means that the number of connection cables, the total length and the number of connections is smaller.

All in all, possible disturbances during construction are temporary, do not cause severe disturbances or irreversible effects on seals, a significant deterioration of habitat quality, and a sustained reduction in the use of Selgrahu.

Effects during use

During the use phase of the wind farm, the work of wind turbines is accompanied by visual disturbance and the noise of wind turbines, which also spreads through the wind turbines to the water environment. The disturbance is also caused by vessel traffic in connection with maintenance work. However, disturbances during work are much less intensive and more stable in nature compared to those in construction, allowing the biota to adapt to them better. Also, the spatial extent and impact of disturbances during the operation of the wind farm are smaller than in the wind farm establishing phase (Bergström et al. 2012). There are examples of the southern part of the Baltic Sea (Nielsen 2006), where seals have adapted relatively well to wind turbines after the construction of the wind farm and continued to use wind farm areas as habitats.

It is likely that the quality of wind farm areas as potential habitats will be lower than in other sea areas, but grey seals are unlikely to directly avoid areas of the wind farm. Certainly, wind farms are not an impenetrable barrier for seals. Therefore, there is no reason to believe that wind farms would become an obstacle to grey seal migration.

The lifetime impacts of wind farms on benthic habitats and fish stocks have been assessed as low (see Chapters 5.4 and 5.5). Thus, there is no reason to expect significant adverse effects on the grey seal food chain and food base.

As the areas of the offshore wind farm cover a relatively small part of the offshore areas and are located in relatively low ice areas, the opportunities for breeding on ice for the species in the wider area will not be significantly impaired even if the animals should avoid breeding on ice in the areas of the wind farm. Offshore wind farms can have some impact on the ice conditions in the area, as relatively large and many masts of wind turbines prevent the movement of ice fields and contribute to the formation and retention of ice in the wind farms, between them and the coast. Thus, in the northwest coast of Hiiumaa, the duration of the ice cover can be prolonged and hence the conditions for seals breeding on ice can improve.

The distance of the closest habitat Selgrahu in case of both alternatives of the wind farm from TP1 is 4.9 km, sufficient to prevent the noise and significant visual disturbance of wind turbines to the animals in the habitat. Thus, it can be assumed that the quality of the Selgrahu habitat and the abundance of seals using it do not decrease significantly.

In the comparison of wind turbine alternatives, alternative 2 has a slightly smaller impact, as the area of the development areas is smaller, there are fewer wind turbines in the areas and their placement is sparser. Another factor that mitigates the effects is that the development area TP 1 is located at a distance from the Selgrahu habitat.

General assessment:

Alternative 1 and alternative 2 of wind farm: Construction phase -1 - negligible negative impact; use phase 0 – neutral impact/no impact

Cable installation alternative 1 and alternative 2: during construction phase -1- negligible negative impact; use phase 0 - neutral/no impact

0 alternative: 0 - No impact

Mitigation measures

In order to minimize interference, noisy construction work, especially in the TP1 area during breeding or fur replacement period of seals should be considered to be avoided.

5.7.2. Ringed seal

The sub-population of ringed seal in Western Estonia is concentrated in Väinameri, in the Gulf of Riga and in the Gulf of Pärnu, where ice conditions are more suitable for breeding. During average or rougher winters, the ringed seals prefer the Gulf of Riga for breeding since there is suitable ridged ice; during warmer winters when there is not enough ice, the seals breed in Väinameri. During the ice-free period, the ringed seals are using the Gulf of Riga as feeding area and Väinameri as resting area since there are suitable rocks and reefs reaching out of the sea. In the sea areas of the proposed wind farm area, there are probably no significant habitats in the form of feeding or calving areas for ringed seals. Also, there are no resting areas used by the ringed seals around there. The presence of ringed seals in wind farm areas occurs primarily in the course of food migration, as well as in migration between seal populations. The areas of the wind farm are likely to remain on the migration route between the populations of West Estonia and the Gulf of Bothnia.

Impacts during construction

During the wind farm construction phase, noise is associated with various activities, causing disturbance to possible ringed seals in the vicinity of wind farm areas. The effects of possible blasting are the most far-reaching, which can cause interference within a radius of a few dozen kilometres. The area of disturbances associated with the construction of gravity foundations and other construction works is several times smaller. The construction of wind turbines and the installation of sea cables (mainly due to the movement of the cable laying platform and the dredging of the cable on the seabed) will also cause the suspended solids to float and spread. Suspended solids reduce water transparency and prevents seals from catching. Potential suspended solids effects are local (limited to wind turbines and cables) and short-term.

Since it is not a ringed seal permanent habitat, a relatively small number of animals (single specimens) may appear in the impact zone. Impacts of construction work are relatively short-term and do not cause significant negative impacts on the population of Western Estonia. However, during the construction period, seals will avoid the wind farm due to interference.

Since wind farms are not very large, animals can move around with relatively little energy consumption. In addition, it is likely that seals will also keep away from the suspended solids rich zone and suspended solids area will not cause significant impacts on them.

Comparing the alternatives of the wind farm development areas, alternative 2 has a somewhat lower impact, as the area of the wind farm area and the total number of wind turbines are smaller (140.48 km2 and 107 wind turbines alternatively 2 times vs 168.89 km2km2 and 157 wind turbines for alternative 1). The smaller area of the wind farm areas and the much smaller total number of wind turbines cause somewhat less impact. In comparison to the alternatives to cable installation, the impacts on the land cables connecting to the land are not different, as the number, length and approximate arrangement of the cables are the same in both cases. In the case of interconnection cables inside wind farms, the effect of alternative 2 is somewhat smaller, as fewer cables and fewer connections are needed to connect a smaller number of wind turbines.

Comparing the alternatives of wind farm development areas, alternative 2 has a somewhat lower impact, as the area of the wind farm area and the total number of wind turbines are smaller (140.48

km^2 and 107 wind turbines in case of alternative 2 vs 168.89 km^2 and 157 wind turbines for alternative 1). The smaller area of the wind farm area and the much smaller total number of wind turbines will have somewhat lower impacts. The impact on the Selgrahu seal habitat area is significantly smaller in case of alternative 2 because the development area TP 1 is located further away from the habitat. In the comparison of cable installation alternatives, impacts on sea cables do not differ by alternatives, as the number, length and approximate arrangement of the cables are the same in both cases. In the case of interconnection cables inside wind farms, the effect of alternative 2 is somewhat smaller, since the smaller number of wind turbines means that the number of connection cables, the total length and the number of connections is smaller.

Effects during use

As past experience of wind farms shows some (often relatively good) adaptation of seals to wind farms, there is no reason to assume that wind farms would become an important barrier to ring seals migration. As the wind farms are not very large, the animals on the migration can also pass through with relatively low energy consumption (is they fear passing through the wind farm areas due to disturbances). In the exploitation phase of the wind farm, the ringed seals are unlikely to avoid areas of the wind farm but may prefer these areas less because their quality as a habitat is lower due to underwater noise caused by wind turbines.

In the comparison of wind turbine alternatives, alternative 2 has a lesser impact, as the area of the development areas is smaller, there are fewer wind turbines in the areas, and their placement is sparser.

General assessment:

Alternative 1 and alternative 2 of wind farm: Construction phase -1 - negligible negative impact; use phase 0 – neutral impact/no impact

Cable installation alternative 1 and alternative 2: during construction phase -1- negligible negative impact; use phase 0 - neutral/no impact

0 alternative: 0 - No impact

Mitigation methods

In order to minimize the potential impact to ringed seals, noisy construction work on wind turbines and sea cables should be avoided in February and March, in conditions where the sea area is frozen or there is drifting ice.

5.8. Impact on nature reserves

Due to the sufficient distance, **Hiiu shallow conservation area** or its protected habitat type has no direct human impact due to the construction, use and maintenance of wind turbines.

There is a disturbance of the seabed biota when installing the cable, but it has a reversible effect. The type and shape of the seabed will not change significantly after cable installation. There are no habitat types that are protected at the cable trail. Thus, there are no significant negative impacts on the conservation area in connection with the installation of the sea cable. In case of alternative 2, the cables have no effect as the nearest cable route is 4.5 km away.

Indirect impacts on the storage area could be due to impacts in the marine environment. The effects of the wind farm on waves and currents are relatively insignificant at this distance, the reduction of wave heights is less than 5 cm based on the modelling results. According to the modelling of the suspended solids of the wind turbine construction and the sedimentation of the suspended solids, some movement and precipitation of the suspended solids may take place in the storage area, but the precipitation of the suspended solids in the area is small for both wind turbine alternatives, remaining within the natural background. The effect of construction is applied to a a rather small area, and the amount and spread of the resulting suspended solids and the likelihood of sedimentation in the low nature area of Hiiu is in practice very marginal and the impact is

negligible. By choosing a favourable wind direction for work, it is possible to completely prevent the transfer of suspended solids from the wind farm areas to the conservation area.

The installation of cables results in a higher amount of suspended solids compared to wind turbines. However, most of the suspended solids, or the dominant fine sand fraction settles close to the cable, and most of the potential range of suspended solids remains within the natural background. Sedimentation is slow. The protected habitat type *reefs* (1170) are approximately 0.6 km from the cable route. In this area, in case of unfavourable wind, the suspended solids can reach a higher level than the natural background, but this effect would not have a significant negative impact on the habitat. By choosing a favourable wind direction when installing the cable in case of alternative 1, it is possible to avoid sedimentation in the area of the reefs and minimize the sedimentation at the conservation area as whole.

In conclusion, the establishment of a wind farm (including the installation of sea cables) does not have any adverse effects on the habitat type targeted by Hiiu shallow conservation area, nor on the area as a whole.

General assessment:

Alternative 1 and alternative 2 of wind farm: no adverse effects (construction and operational phase)

Cable installation alternative 1 and alternative 2: no adverse effects (construction and operational phase)

0 alternative: 0 - No impact

Due to sufficient distance, there are no immediate impacts on the **Kõrgessaare-Mudaste conservation area**. The effects of wind turbines on wind speed and waves are negligible at this distance. There won´t be any impacts to the coastal processes. The suspended solids of wind turbines or sea cables does not reach the conservation area. Thus, there are no significant negative impacts on water quality and suspended solids, which could affect the marine and coastal habitats and the bird species to be protected. The risk of water pollution (including oil spill) that may affect the coast and bird life is low and preventable by preventive measures.

In conclusion, the establishment of a wind farm does not have any adverse effects on the habitat type targeted by Kõrgessaare-Mudaste conservation area, nor on the area as a whole.

General assessment:

Alternative 1 and alternative 2: no adverse effects (construction and operational phase)

Cable installation alternative 1 and alternative 2: no adverse effects (construction and operational phase)

0 alternative: 0 - No impact

Due to sufficient distance, there are no immediate impacts on the **Paope conservation area**. The effects of wind turbines on wind speed, waves and bottom sediments and coastal processes are negligible at this distance. The suspended solids appearing due to construction work does not reach the conservation area. The risk of water pollution (including oil spill) that may affect the coast and bird life is low and preventable by preventive measures. Thus, it can be concluded that the establishment of a wind farm does not have any adverse effects on the communities, species and habitat types that the Paope nature reserve protects.

General assessment:

Alternative 1 and alternative 2 of wind farm: no adverse effects (construction and operational phase)

Cable installation alternative 1 and alternative 2: no adverse effects (construction and operational phase)

0 alternative: 0 - No impact

There is no direct impact on **Tahkuna nature reserve** due to insufficient distance from the areas of the wind farm. The impacts of the wind farm on the water quality and marine life of the coastal area around the protected area are negligible. The impact of sea cable installation on coastal waters and white-tailed eagle feeding areas is small, short-term and reversible. White-tailed eagle nesting areas are at a sufficient distance from the sea cable landing sites to prevent any disturbance to them. There is also a low risk of oil spills that may endanger the coastal areas and the white-tailed eagle. Thus, it can be concluded that the establishment of a wind farm does not have any negative effects on the communities, species and habitat types that are protected by Tahkuna nature reserve.

General assessment:

Alternative 1 and alternative 2 of wind farm: no adverse effects (construction and operational phase)

Cable installation alternative 1 and alternative 2: no adverse effects (construction and operational phase)

0 alternative: 0 - No impact

The marine habitats *reefs* (1170) of the **Väinameri conservation area** will be affected by cable installation alternative 1 in case of cable dredging up to 10 m wide (cableway corridor width. There is no habitat loss when installing the cable, as the character of the seabed remains characteristic of the habitat when filling the cable trunk and the benthos will also recover in time. It is therefore a temporary and reversible effect.

The suspended solid of wind turbines will not reach the conservation area. The suspended solids are manifested in the cable installation alternative 1, where the cable passes through the conservation area; in case of alternative 2, the sea cable will not pass through the area, thus there is no impact. Deepening the bottom of the cable in the section of the cable trail that passes through the conservation area will throw some suspended solids into the water column, most of it will settle in the vicinity of the cable trail, but the finer fraction will also move further. Concentrations are low and sedimentation is slow. Protected habitat types *reefs* (1170) spreads in the affected area in small area in. Ca 1.9 km from the cable route, there is a habitat *water-flooded sandbanks* (1110). Deposition of suspended solids does not affect the physical structure of the habitat, and impacts on biota are also insignificant due to sufficient distance.

Cable installation can cause temporary and insignificant impacts on bird species living in marine areas of the conservation area and disturb marine mammals. The spread of suspended solids can affect the fauna directly or indirectly due to reduced visibility in water, which, for example, prevents catches. The concentration of suspended solids affecting the biota is mostly within a few hundred meters, as the suspended solids settles and diffuses in the water. The suspended solids have no significant effect on the seals, as the animals keep away from the work area and can move away from the suspended solids cloud. In the case of cable installation during the fur replacement period, there may be some disturbance to the animals in the habitats near the cable way area. If construction work is avoided during the given period, both the disturbance and the adverse effects due to suspended solids are absent. Possible disturbances are temporary and do not cause irreversible adverse effects on the species. In the case of alternative 2, the cable is not installed into the area and the effects are not present.

Possible, but less likely, is also the presence of target species, European river lamprey and European bullhead in the area. Fish are affected by both the noise of the cable installation and the release of suspended solids into the water column, which temporarily reduces visibility. Negative

effects could be caused by sedimentation on the fish roe on possible spawning grounds, but there are no spawning grounds of these species in the area.

Increased vessel traffic through the Hari kurk, due to construction and maintenance work, may have a relatively insignificant impact on protected birds in the Väinameri conservation area. The proposed offshore wind park (development area TP 1) is located far enough from the conservation area (at least 3.2 km) and does not affect the habitats of bird species living in the area and does not impair their quality. During the construction phase, disturbances from wind farm areas will not have a significant impact on birdlife, as well as the amount and effect of suspended solids in the wind farm areas will be negligible. In case of alternative I, the sea cable passing through storage area causes interference in the work area and the spread of suspended solids. However, these are temporary and insignificant impacts that do not have any significant negative effects on any bird species that are protected.

The risk of oil spills related to the construction and operation of a wind farm is assessed to be low, oil spills can be prevented by preventive measures. Noise caused by wind farm construction does not cause significant disturbance and the impact of potential disturbances is negligible. Noise and visual effects from the wind farm's operating phase will not cause significant disturbance to bird species in the conservation area.

All in all, the construction of a wind farm (including the installation of sea cables) at the construction stage may result in negligible negative impacts, which are short-term and reversible. There are no significant negative impacts on habitat types, the status of protected species and the nature area as a conservation objective of the conservation area.

General assessment:

Alternative 1 and alternative 2 of wind farm: no adverse effects (construction and operational phase)

Cable installation alternative 1 and alternative 2: no adverse effects (construction and operational phase)

0 alternative: 0 - No impact

The construction of offshore wind farm, especially development area TP1 and the installation of sea cable has no direct impact on **Selgrahu grey seal permanent habitat**, but during the wind farm construction stage, some disturbances may occur due to noise. Possible disturbances are temporary and are unlikely to cause irreversible effects or a significant deterioration of habitat quality or permanent loss of use of the site. In the case of noisy construction works in TP 1, consideration should be given to avoiding them during the breeding and fur replacement period of seals. In the construction phase, a small amount of suspended solids may be carried to the site, especially in the case of cable installation alternative 1. However, suspended solids levels are within the natural background and no significant negative effects on seals occur.

During the use phase of the wind farm, the noise and visual disturbance associated with the operation of wind turbines is relatively insignificant. Thus, it can be assumed that the quality of Selgrahu grey seal habitat and the abundance of animals using it do not decrease significantly.

In conclusion, establishing a wind farm does not have any significant negative effects on a permanent habitat.

General assessment:

Alternative 1 and alternative 2 of wind farm: no adverse effects (construction and operational phase)

Cable installation alternative 1 and alternative 2: no adverse effects (construction and operational phase)

0 alternative: 0 - No impact

Kadakalaiu ringed seal permanent habitat is located outside the potential impacts of wind farm sites.

In case of cable installation alternative 1, the sea cable crosses a permanent habitat on a 3.4 km section. The cable passes through the habitats of Kadakalaid and Uuemererahu about 1.5 km away. If cable installation is performed during the fur replacement period, the animals may experience some disturbance in the form of the cable laying vessel and the noise associated with the work. If construction work is avoided during this period, there are no significant impacts on seals.

Cable installation involves the spread of suspended solids cloud in the permanent habitat area. The suspended solids cloud has no significant effect on the seals, as the animals keep away from the work area during construction work and can also move away from the suspended solids cloud. The impact of the spread of suspended solids is short-term and reversible.

In case of alternative 2, the sea cable will not be installed into the area and the only factor may be the vessel traffic associated with the wind farm in the area of the permanent habitat. Vessel traffic has no significant negative impact on habitat and seals.

In conclusion, establishing a wind farm does not have any significant negative effects on a permanent habitat.

General assessment:

Alternative 1 and alternative 2 of wind farm: no adverse effects (construction and operational phase)

Cable installation alternative 1 and alternative 2: no adverse effects (construction and operational phase)

0 alternative: 0 - No impact

There will be some suspended matter carried to **Apollo shallow nature reserve** during construction of wind turbines and sea cable installation. Considering that the suspended solids settle on a large area and the coarser fraction has already settled at that distance, the amount of settling material per unit area is very small and the layer is very thin (less than 0.1 mm). Sedimentation is expected to occur in the southern part of the protected area, and suspended solids concentrations and sedimentation rates are likely to be within the natural background. It is important to note here that the modelling and the resulting quantities have been made on the assumption that the cable will be installed at the same time in the development areas along the route. In practice, the installation takes place in stages, so that the concentrations of suspended solids in the water column are actually smaller and sedimentation is slow. Thus, the impact of the suspended solids on the marine habitats targeted by the protected area is small and irrelevant. Sedimentation of wind turbine suspended solids versus natural variability plays a major role. Impact is short-term and fully reversible.

The suspended solids cloud will degrade the transparency of the water and the nutritional conditions of the bird species that are protected by the nature reserve. However, this effect is limited (because the suspended solid is already quite dispersed at a given distance) and short-term, limited by the construction period. The effect of the construction period on the spread of suspended solid in the Apollo shallow area can be significantly reduced by observing weather conditions and wind directions. Thus, significant impacts on the conservation values of the site are relatively small and can be largely avoided by time selection.

Noise from the construction period and disturbances caused by the movement of vessels and other equipment may have a minor impact on waterfowl stopping in the area. Impacts will be manifested primarily in the southern part of the protected area by about 1 km. Majority of disturbances during construction are not affected by bird disturbance during construction.

In-use effects mainly consist of effects on bird species that are protected. As the distance to the nearest wind turbines is more than 2 km, the development area of wind farm TP1 will not cause significant disturbance to birds in the protected area. The nature reserve seabed, benthos and e food base are not damaged. The acoustic and visual disturbance and vibration associated with the construction and use of wind farms may, to some extent, degrade the feeding conditions of birds at Apollo shallow, but are of minor significance as the essential food base for birds using shallow for feeding is maintained. Due to the lack of significant impacts on the protected marine benthos, there are no significant negative impacts on bird nutrition. The wind farm is somewhat an obstacle to migrating birds that go to or leave Apollo. As a rule, birds avoid wind farms, flying along them, but in case of poor visibility, they also fly through the wind farm. Thus, some negative effects on bird species that are protected by the site may occur during the exploitation phase of the wind farm. However, the impacts are not so strong as to make the protected area unsuitable for seabirds.

All in all, building a wind farm at the construction stage can have minor negative effects, which are short-term and reversible. There are no significant direct impacts during the use phase, but the areas of the wind farm may cause the death of specimens of birds entering and leaving the protected area. There are no significant negative impacts on the habitat types, the status of protected species and the nature area as a whole, which are the conservation objectives of the nature reserve.

General assessment:

Alternative 1 and alternative 2 of wind farm: negligible negative impact on the construction and use phase (indirect effect due to impact on birds)

Cable installation alternative 1 and alternative 2: no adverse effects (construction and operational phase)

0 alternative: 0 - No impact

The installation, use and maintenance of wind turbines has no direct or indirect effects on **Nõva-Osmussaare conservation area**, as all areas of the wind farm are far from the conservation area. The installation of sea cables through the conservation area has direct effects on the area. Dredging the seabed for the cable will affect the seabed and its biota, and a large amount of suspended solids will be emitted into the water column during this operation. The seabed type does not change during the dredging of the cable, the impact on the benthos is related to the construction phase and mostly reversible. There is a direct loss of biota in the area of cable trenching and the suspended solids in the neighbourhood of the route. Protected habitat types will not be in the area of the cable trail, but in the vicinity of the coast, underwater (0.1 and 0.5 km) habitat *underwater sandbanks* (1110). As a result of the cable installation, suspended solids is settled in the conservation area, most of which (fine sand) settles in the vicinity of the cable trunk. The transfer of suspended solids to the protected habitat types does not affect the physical structure of the habitat, but may temporarily affect benthos. Impacts on the habitat are fully reversible. Impacts on protected habitat types can be largely prevented by choosing periods with favourable wind direction when suspended solids carry away from the nearest habitat areas.

Disturbances (noise, vessel traffic) and suspended solids cloud caused by cable installation work can cause some relatively short-term effects on water birds and seals under protection. The suspended solids have no significant effect on the seals, as the animals keep away from the work area and can move away from the suspended solids cloud. The magnitude of the interference is not great, and their impact is short-lived.

The in-use effects are limited to maintenance work on wind turbines and sea cables, which may result in minor disturbances and low noise levels. These lifetime impacts on the habitat area and its conservation objectives are insignificant.

All in all, the building stage of a wind farm can have minor negative effects, which are short-term and reversible. There are no significant negative impacts on habitat types, the status of protected species and the nature area as a conservation objective of the conservation area.

General assessment:

Alternative 1 and alternative 2 of wind farm: no adverse effects (construction and operational phase)

Cable installation alternative 1 and alternative 2: no adverse effects (construction and operational phase)

0 alternative: 0 - No impact

The planned Kõpu Marine conservation area or the species living there, and the habitats located there won´t have significant disturbances or other significant negative effects during the construction and operation of the wind farm.

General assessment:

Alternative 1 and alternative 2 of wind farm: no adverse effects (construction and operational phase)

Cable installation alternative 1 and alternative 2: no adverse effects (construction and operational phase)

0 alternative: 0 - No impact

5.9. Impact on species under protection

According to Environment Registry (EELIS database) there are no habitats of protected birds species in the areas of the planned wind park. Impacts on water birds stopping in the area (including protected species) have been described in chapter 5.6 of EIA report.

White-tailed eagle (*Haliaeetus albicilla*) is protected species of I protection category, that is directly related to sea ecosystems through feeding. There are several nesting places of white-tailed eagle in the northern and western part of Hiiumaa, the closest of which are located approximately 13 km from wind parks. White-tailed eagles use mainly coastal areas and coastal sea as feeding area. Areas of offshore wind park are located at least 12 km from the coast in the open sea and eagles apparently do not use these areas as feeding places and therefore may themselves in the wind park areas primarily in the course of migrations. Although migrating birds mainly avoid wind parks, the possibility of death or damage of birds as e result of collision with wind turbine blades may be in place also in case of white-tailed eagle. Considerable direct impact on white-tailed eagle's habitats and feeding areas in the planned areas of wind park during construction as well as operation stage is absent. With respect to wind park, water quality and sea fauna in the coastal sea of the region of white-tailed eagles' habitats will not be significantly impacted. Also, the risk of oil pollution, that may endanger white-tailed eagles' feeding places, is small.

With regard to the installation of sea cables, in case of alternative 1 cable installation, there can be impacts on coastal sea areas. Impacts consist of interference during cable installation and the spread of suspended solids clouds. The impact of sea cable installation on coastal sea and white-tailed eagle feeding areas is small, short-term and fully reversible. White-tailed eagle nesting areas are located at a sufficient distance (over 2 km) from the sea cable landing sites to prevent any disturbance during nesting.

General assessment:

Alternative 1 and alternative 2 of wind farm: during the construction phase 0 - neutral / no effect; use phase -1 – insignificant negative impact. Wind park areas will not impact white-tailed eagle's

basic habitats, but the birds' appearance in those areas and death may still be possible (cannot be excluded).

Cable installation alternative 1 and alternative 2: 0 - neutral / no effect (in construction and use phase)

0 alternative: 0 - No impact

5.10. Impact on heritage protection values

Impact of planned activity on heritage protection values depends on the type of object being under heritage protection and on its distance from with wind park areas and sea cables to be constructed. Taking into account the wind turbines' impact on local hydrodynamics, the movement of sediments in case of planned wind park has a relatively local character. Assuming that the diameter of wind turbine pipe is 3-4 m, hydrodynamic impact would reach to a maximum of 15 m from wind turbine. But if a foundation is constructed for wind turbines, the diameter of which exceeds the diameter of pipe 2-3 times, hydrodynamic impact will be noticed on a respectively bigger area. Erosion and entire transfer is directly related to the soil characteristics around wind turbines. The results of the modelling of suspended solids carried out within the framework of this EIA show that most of the suspended solids settle in the immediate vicinity of wind turbines and cables.

In conclusion, the effect remains relatively local and the transfer of sediment to the conservation values in significant amounts is unlikely.

General assessment:

Alternative 1 and alternative 2 of wind farm: construction phase -1 - negligible negative impact; use phase 0 - no negative effects

Cable installation alternative 1 and alternative 2: construction phase -1 - negligible negative impact; in use phase 0 - neutral / no effect

0 alternative: 0 - No impact

5.11. Noise, infrasound and vibration

5.11.1. Noise of offshore wind parks

Noise created by wind generator primarily depends on the construction of equipment. Greater risk was represented by older wind turbines, in which there were technical problems[27]. According to the basic rule noise caused by the work of wind turbines merges the noise background of the environment at the distance of 300 m. On the coast the noise of wind generators disturbs people less than inland due to wind, waves and other natural background noises[28]. However, greater impact on water fauna may be caused by underwater noise created by working parts of the construction (generator, cooling systems etc). Such noise is transferred from the turbine into water in the form of vibration.[29]

Noise created by wind turbines is divided into two:

1) aerodynamic noise – noise created from the motion of propeller blade and wind;

[27] Õunpuu, J. 2005. The history of wind energy and people's attitude before and after construction of wind park. Available at www.tuuleenergia.ee/uploads/File/Seminaritoo.pdf

[28] Lahtvee, T. 2005. Environmental impact of producing electricity from renewable sources and its assessment. Tallinn University. Available at www.tuuleenergia.ee/about/teadustood

[29] Danish Offshore Wind – Key Environmental Issues. 2006. DONG Energy, Vattenfall, The Danish Energy Authority and The Danish Forest and Nature Agency

2) mechanical noise – electric wind turbine generator, gearbox.

The more powerful is the wind turbine motor, the bigger is the emission of noise.

In order to assess the impact of wind turbines noise, noise modelling has been performed. As a result of noise modelling, noise maps have been compiled characterising the dispersion of noise, which is presented in Annex 7 of EIA report.

When modelling the noise, special software *SoundPLAN 7.4* has been used, and internationally generally accepted calculation method *ISO 9613-2:1996 Acoustics -- Attenuation of sound during propagation outdoors -- Part 2* has been used as a model for calculation of industrial noise: *General method of calculation.* When modelling, the worst possible situation has been considered.

When assessing the noise, the levels of industrial noise applicable for II category in the existing residential areas have been used: 60 dB at day and 50 dB at night time.

Noise modelling results:

Wind park alternative 1

As a result of noise modelling, it was found that the noise level of 60 dB spreads in case of most powerful wind turbine type Vestas V164 7.0 up to 27 m from the wind farm. The 45 dB noise level spreads up to 684 m from the wind farm. For other types of windmills, the distances are smaller. The coast of Hiiumaa is about 12 km from the wind farm. It follows that noise levels higher than permitted levels do not spread to residential areas.

It is common knowledge that the wind profile affects the propagation of the sound outdoors. The noise levels are stronger for the listener when the wind blows from the noise source (the sound is downwind). For side winds, where the wind blows between the listener and the noise source, the expected noise levels are about 2dB lower than the downwind levels. In the case of sound propagation (from the listener to the source of noise), the noise levels may be up to 10 dB lower due to the sound refraction (the listener remains in the shadow of the sound waves)[32].

The noise modelling results take into account the downwind sound propagation and wind turbine technical data according to wind speed 8 m/s. At wind speeds of less than 8 m/s and other wind directions, the wind turbine noise levels are even lower for the listener than shown on the noise map.

Wind park alternative 2

As a result of noise modelling, the noise level of 60 dB was found to be spreading up to 110 m from the wind farm for the most powerful wind turbine type Haliade-2 12 MW. The 45 dB noise level spreads up to 1195 m from the wind farm. In Vest V164 7.0, the 60 dB noise level spreads up to 27 m away from the wind farm and the 45 dB noise level spreads up to 684 m away from the wind farm. The coast of Hiiumaa is about 12 km from the wind farm. It follows that noise levels higher than permitted levels do not spread to residential areas.

Alternative 1 and alternative 2 of wind farm: 0 - no adverse impacts (construction and operational phase)

0 alternative: 0 – no impact

5.11.2. Infrasound

Infrasound are called sound waves, the frequency of which is below 20 Hz[30]. Infrasound is created both by natural processes (atmosphere low-frequency fluctuations, wind), industries as well as equipment working at low speed. In case of electrical wind turbines infrasound mainly arises downwind when the blade of electrical wind turbines rotor passes the hub, and also upwind, when wind turbines with horizontal axes create uneven low-frequency sound while rotor blades are

[30] Leventhall, G. 2007. What is infrasound? Progress in Biophysics and Molecular Biology 93: 130-137

rotating.[31] Infrasound and low-frequency sounds are dispersed almost without getting weaker into building on the contrary to sounds with higher frequency.[32,33]

Surveys show that infrasound created directly by wind turbines, have so low frequency and strength, which human ear does not register.[34] According to the measurement performed in Australia[35] the level of infrasound 1,5 km away from the wind park was 50-70 dB(G). In the named survey, infrasound strength was measured in urban as well as countryside environment. In countryside environment measurement results were inside as well as outside similarly low, being just in some cases marginally a little bit higher in external conditions. In addition, infrasound strengths were not different in house located closely to wind parks from those, which were located significantly further from wind parks.

Infrasound levels also depend on local wind conditions. In the survey performed in Australia the levels of infrasound in the period of weaker winds remained below 40 dB(G) in immediate proximity to wind parks as well as further. In the period of stronger winds the level of infrasound was 50-70 dB(G) also close to the wind parks as well as away from them. Briefly, work results show that infrasound level in houses, which were located in proximity to wind turbines, is not greater than infrasound level, which exists in other urban and countryside environments. In addition, it may also be said that the measured levels of infrasound caused by wind turbines have insignificant size compared to other background infrasound present in the environment.[36]

On the basis of surveys and measurements performed earlier, it may be asserted that infrasound caused by electric wind turbines remains below human hearing and perception threshold. Infrasound emitted by wind turbines is within the same level as levels produced by natural phenomena. Based on that, infrasound created by the planned offshore wind park will not significant impact on human health and well-being.

General assessment:

Alternative 1 and alternative 2 of wind farm: 0 – no impact

Cable installation alternative 1 and alternative 2: 0 – no impact

0 alternative: 0 – no impact

5.11.3. Low-frequency noise

Low-frequency noise are deemed soundwaves, the frequency of which is within the interval of 10-200 Hz.[37] Low-frequency noise recommended levels at the night time inside rooms have been established by the decree of the Minister of Social Affairs No. 42 as of 04.03.2002. State regulation with respect to low-frequency noise impact levels in outside conditions is absent.

Modelling of low-frequency noise has shown that noise levels emitted by the planned wind park in different acceptance points are lower than the values of recommended noise levels presented by the decree of the Minister of Social Affairs No. 42 as of 04.03.2002. It is apparent from the

[31] Heikkinen, G. 2013. Negative environmental impacts of inland wind parks and their reflection in environmental impact (strategic) assessment reports in Estonia. Bachelor Thesis, Tallinn University

[32] Bolin, K., Bluhm, G., Eriksson, G. and Nilsson M.E. 2011. Infrasound and low frequency noise from wind turbines: exposure and health effects. Environmental Research Letters 6

[33] Hansen, K. L., Hansen, C. H., Zajamšek, B. 2015. Outdoor to indoor reduction of wind farm noise for rural residences. Building and Environment, 1-9 (in press)

[34] Leventhall, G. Infrasound from wind turbines – fact, fiction of deception

[35] EPA, 2013. Infrasound levels near windfarms and in other environments

[36] EPA, 2013. Infrasound levels near windfarms and in other environments

[37] The decree of the Minister of Social Affairs No. 42 as of 04.03.2002 "Noise normative levels in residential and recreation area, in residential houses and jointly used buildings and the methods of measuring noise level"

measurements performed in Finland that in two cases out of three real measurements provide lower results than the modelling of noise[38].

Modelling results are also confirmed by different measurements (Aslund *et al.* 2013) in immediate proximity to electric wind turbine (305 m), from which it becomes clear that the levels of infrasound and low-frequency noise remain significantly lower than it has been prescribed by legislation (Great Britain, Japan and USA). Due to this scientists have reached conclusion that infrasound and low-frequency noise have no impact on human health farther than 305 metres from wind turbine (Aslund *et al.* 2013). Bolin et al. (2011)[39] reach the summary in their survey that infrasound is not heard in proximity to wind turbines, this even more in case of households, which are located further from wind turbines, and that infrasound does not create disturbance to human and therefore has no damaging impact on human health.

General assessment:

Alternative 1 and alternative 2 of wind farm: 0 – no impact

Cable installation alternative 1 and alternative 2: 0 – no impact

0 alternative: 0 – no impact

5.11.4. Vibration

Vibration is created in the period of construction of wind park (digging and explosion works, drilling, geological surveys and installation of cables) as well as at the time of wind turbines operation and subsequent demolition of wind turbines.

At the time of wind turbines operation vibration is created due to vibrating of the turbine's constructions. Since the wind turbines are in contact with seabed, vibration waves are dispersed also there. Sea wind turbines are constructed in such a way that vibration to seabed created during operation were minimal. Construction of wind turbine should allow vibration to arise as little as possible, should suppress it and avoid its transfer. This is important in order to guarantee stability and strength of wind turbines.[40,41]

In case of contemporary wind turbines vibration has insignificant activity and it is not transferred further outside the wind turbine foundation[42,43]. Insignificance of vibration impact is also confirmed by experience of Denmark by the example of Horns Revi and Nystedi offshore wind parks.[44] According to EIA report of Rampion (Great Britain) offshore wind park (with a total power of 400 MW), vibration impact is also deemed insignificant at the stage of construction, demolition as well as operation of wind park.[45]

Vibration impact at the stage of construction, demolition and operation of wind park is insignificant. Vibration is suppressed in wind turbines foundations and is not transferred outside the foundations. Thus, dispersion of vibration to the mainland and negative impact on human well-being and properties caused by vibration are not forecasted.

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[38] Low frequency noise and infrasound survey. Ramboll Finland OY, 2016

[39] Bolin, K., Bluhm, G., Eriksson, G. and Nilsson M.E. 2011. Infrasound and low frequency noise from wind turbines: exposure and health effects. Environmental Research Letters 6

[40] Environmental impact strategic assessment draft report for county plan of sea area bordering with Hiiu county, 2012-2014, OÜ Alkranel, Marine Systems Institute of Tallinn Technical University, OÜ Artes Terrae

[41] Preliminary assessment of environmental impact of Seljametsa-Tammuru wind park in Paikuse parish. Hendrikson&Ko OÜ, 2008

[42] EISA report of detailed plan compiled for Triine land plot and parts of Ado land plot in Esivere village. Entec AS, 2006

[43] Preliminary assessment of environmental impact of Seljametsa-Tammuru wind park in Paikuse parish. Hendrikson&Ko OÜ, 2008

[44] Offshore wind farms and the environemnt. Danish experience from Horns Rev and Nysted. Danish Energy Authority

[45] Rampion Offshore Wind Farm. Section 27 – Noise. 2012. E.ON Climate & Renewables UK Rampion Offshore Wind Limited

General assessment:

Alternative 1 and alternative 2 of wind farm: 1 – insignificant negative impact (during construction and using phase)

0 alternative: 0 – no impact

5.12. Social-economic impact

5.12.1. Impact on economic development and employment [46] [47]

Planned economic impact of north-western Estonian offshore wind park is the following:

- payment for a superficies right in the amount of EUR 15,3 million per year;
- income from renewable energy in the amount of EUR 100 million per year earned through renewable energy co-operation mechanisms of the European Union;
- Productivity of renewable energy 3 TWh per year;
- Decrease of greenhouse gases 3 million tons per year;
- Workplaces with high additional value.

Development of entrepreneurship will be enhanced by creation of wind parks, since:

- Offshore wind parks are absent in Estonia, the development and use of wind energy industry will create research areas for students and scientists, which will allow Estonia in co-operation with foreign experts to receive information about impacts arising with creation of wind parks in the conditions of Estonia.
- Taxes arising from entrepreneurship are the main source of covering the state maintenance costs. Therefore, positive impact of entrepreneurship on the state will be evident through receiving of tax revenues and this is directly from taxation of entrepreneurship as well as labour force taxes. Workplaces in business creating new value will in turn provide preconditions for creation of new workplaces in service sector.

Workplaces will also be created in different stages of creating the wind park starting from planning of the wind park till regular maintenance of wind turbines and their utilisation in long-term perspective. Workplaces may be directly related to concrete wind parks or indirectly related e.g. through producers of wind turbines. In energy sector additional value of the enterprises is 5 times higher than the Estonian average additional value.

Wishing to specify the number of possible local workplaces to be created, workplaces to be created may also be grouped in the following way: at the time of construction (production of wind turbines, transportation of wind turbines, installation of wind turbines) and at the time of operation (maintenance of wind turbines, administration of wind park).

According to the developer's assessment, with creation of wind park only in Hiiu parish alone will be added approximately 30 new direct workplaces (maintenance technicians, logistics employees, production managers, operators, warehouse workers), to which approximately 20 indirect workplaces will be added on Hiiumaa - helpers, employees of accommodation institutions, harbour workers etc. In total it is possible to create up to 100-150 new workplaces.

Offshore wind park created close to German coast, Helgoland island, (883 MW, 200 wind turbines) provided 300-450 people with temporary work at the stage of construction. After completion of offshore wind park 150 permanent workplaces have been created on the island – approximately

[46] EIA of wind park planned in north-western Estonian coastal sea: social-economic impacts, 2008, interim report, Hendrikson&Ko OÜ

[47] Environmental impact strategic assessment draft report for county plan of sea area bordering with Hiiu county, 2012-2014, OÜ Alkranel, Marine Systems Institute of Tallinn Technical University, OÜ Artes Terrae

100 of them are directly related to wind park maintenance and approximately 50 with ships. In addition, the development of wind park has significantly revived activity of catering and accommodation institutions on the island. [48] [49]

Creation of offshore wind park may impact fishing possibilities and thus fishing sector of Hiiumaa. Fishing as a traditional field of activity is on important place on Hiiumaa, although sales revenue of the fishing sector makes up a small part of the entire economy of Hiiumaa, and 61 people have been working in fishing sector in 2013. The main part of Hiiumaa fishing volume is provided by fishing in the Baltic Sea[50]. Upon performance of EIA it has been found that the impact of the planned activity on coastal fishing is non-existent, i.e. creation of wind park will not cause any additional limitations. With respect to trawling planned activity may have an impact on allocation of fish resources and performance of fishing operations (movement of ships to catch area and back to home harbour). Trawling takes place only in those sea areas, that are deeper than 20 m. This depth approximately corresponds to the maximum depth of wind turbines installation. Therefore, the impact on trawling in a narrow meaning is insignificant.

Upon performance of EIA it has been found that the planned activity has no impact on the number of fish species defined in the course of the survey of fish fauna performed within the framework of EIA in the region of wind parks or on disturbance of species' normal life cycle. Upon forecasting negative impacts it should still be kept in mind that the sphere has until now yet been researched very little, due to which longer negative impacts (also cumulative impacts of different wind parks) may yet be undiscovered. Taking into account the fish species and the number, defined on shallows close to Hiiumaa in the course of EIA, it may be said that creation of wind park will not cause direct and indisputable risk to fish fauna. At the same time, conclusion has been reached in the course of EIA, that rather new substrata will be created with construction of wind parks, which may increase the number of some fish groups in the region (e.g. gadidae).

Based on the above-said, it may be assumed that the impact of the planned activity on economic development and employment is in general positive. Upon realisation of the planned activity local workplaces will be created, that may be related to transportation of wind turbines (both logistics as well as organisation and realisation), installation of wind turbines (construction works and materials on the coast and at the sea) and maintenance of wind turbines.

General assessment:

Alternative 1 and alternative 2 of wind farm: +2 significant positive impact (construction and using phase)

Cable installation alternative 1 and alternative 2: +2 significant positive impact (construction and using phase)

0 alternative: 0 – no impact

5.12.2. Impact on Hiiumaa tourism

Based on the importance of tourism of coastal regions local inhabitants have often a number of fears and prejudice with respect to offshore wind parks. Since tourism depends on attracting environment, local inhabitants are afraid that because of wind turbines the change of landscape visual picture may negatively impact recreation area, causing the decrease of recreational value and lower interest against visiting the regions.[51] Until now the world experience has not seen or perceived negative impact on tourism with creation of offshore wind parks resulting in the decrease

[48] http://www.offshore-stiftung.com/60005/Uploaded/Offshore_Stiftung%7C2013_04SBO_SOW_tourism_study_final_web.pdf
[49] http://www.tuuleenergia.ee/2016/08/pohjamere-saar-pani-tuuleenergia-enda-kasuks-toole/
[50] Hiiumaa ecenomic review 2013
[51] Environmental impact strategic assessment draft report for county plan of sea area bordering with Hiiu county, 2012-2014, OÜ Alkranel, Marine Systems Institute of Tallinn Technical University, OÜ Artes Terrae

of the number of tourists[52]. This is rather subjective fear, not objectively assessed reality, and the surveys show that it has either positive effect on local tourism or there is no effect.[53, 54]

Taking into account the circumstance that Hiiumaa tourist sector has rather moderate importance today, creation of wind park allows to find new aspects in marketing Hiiumaa tourism with respect to addition of different new opportunities. However, exhibiting of wind park and searching for opportunities to tie it to other tourist attractions presumes good marketing. Thus, the planned activity provides for opportunity for development of Hiiumaa tourism and thereby has positive impact on tourism sector.

In addition, creation of wind park (construction and maintenance) will have a year-round positive impact on Hiiumaa accommodation institutions with respect to the increase in number of visitors. The development of tourism will have a positive impact on other sectors as well, primarily trade and transportation.

General assessment:

Alternative 1 and alternative 2: +1 negligible positive impact (construction and using phase, for both wind farm and cable installation)

0 alternative: 0 – no impact

5.12.3. Impact on Hiiumaa society

The people's support for renewable energy often behaves in a so-called U-shape – first the support for renewable energy is great, the support decreases significantly when real projects are clarified and the support increases again after realisation of the project (after completion of construction). Thus, it may be said that people in general support renewable energy, although little involvement into planning and decision-making process decreases people's trust with respect to those projects.[55] Such controversy disrupts the functioning and co-operation of society, which in the context of Hiiumaa is a significantly negative impact. Confrontation with respect to offshore wind parks has been great at the time of publishing EIA report in 2011, therefore it is positive that through the public planning process different possibilities of use of sea area have been weighted, including locations suitable for wind park[56].

Developments of wind energy may bring significant benefits to society, which may be both monetary and non-monetary. Under non-monetary benefits is meant primarily the developer's contribution in the interests of development of local society, where the development activity significantly impacts living environment.[57]

Hiiu parish, Nelja Energia AS (since December 2018, the subsidiary of Eesti Energia, Enefit Green AS) and Hiiumaa Offshore Tuulepark OÜ have concluded three-sided protocol of joint intentions, which states that the parish and the developer would establish a non-profit organisation (MTÜ) for co-operation. According to the protocol, for example, the developer must give to the disposal of MTÜ at least 0,2% of the revenue received from the sales of each MWh of electric energy produced by the wind park belonging to or operated by the developer, but not less than EUR 0,32 per each

[52] Assessment of environmental impacts arising from construction of offshore wind parks in north-western Estonian coastal sea, 2011, Estonian Marine Institute of the University of Tartu
[53] Lilley, M. B.; Firestone, J.; Kempton, W. 2010 The Effect of Wind Power Insallations on Coastal Tourism. Energies 3, 1-22
[54] Kontogianni, A., Tourkolias, Ch., Skourtos M., Damigos, D. 2014. Planning globally, protesting locally: Patterns in community perceptions towards the installation of wind farms. Renewable Energy 66, 170-177
[55] Bonar, P. A. J., Byden, I. G., Borthwick, A. G. L. 2015. Social and ecological impacts of marine energy development. Renewable and Sustainable Energy Reviews 47, 486-495
[56] By the decree of the Governemt of the Republic No. 441 as of 11.10.2012 county plans have been initiated in the sea areas bordering with Hiiu and Pärnu counties
[57] Karjus, M. 2011. Compensation to local societies for tolerance regarding wind parks www.riigikogu.ee/v/failide_arhiiv/Tuulepargid.pdf

produced MWh of electricity.[58] If the power of the planned wind park is 700 MW and the assessed production is approximately 2 450 000 MWh per year, then EUR 0,32 per each produced MWh means the revenue of EUR 784 000 per year, which may be directed to education, culture or other spheres important to society[59]. Nelja Energia has created MTÜ-s in several Estonian and also Lithuanian municipalities, to whom EUR 0,32 is transferred for each MWh of electricity produced by the wind turbines. During 2015 wind parks of AS Nelja Energia have supported organisations in total with EUR 144 284 (in Estonia EUR 75 872 and in Lithuania EUR 68 412). Which local projects are specifically supported, is decided by MTÜ board, which consists of the representative of local municipality as well as Enefit Green AS.

In addition, in the same protocol it has been agreed that:

- as a result of electrical connection of wind park round electric energy supply will be created for Hiiumaa, which will increase reliability of electricity supply both to local inhabitants as well as enterprises;
- The base of wind park maintenance works can be located in Hiiu parish, which will give work to local people and will apparently increase the number of inhabitants on Hiiumaa;
- Training of wind park maintenance specialists is performed on Hiiumaa;
- Hiiu parish inhabitants and energy unions functioning in the parish have a right within six months as of the beginning of wind park production process to obtain preferred stocks and/or bonds in the nominal value of EUR 17 000 000 maximum with fixed yearly return of 15% from the nominal value of preferred stock.

In case if non-profit organisation (MTÜ) will be established and local society will thus get monetary benefits from producing electrical energy by means of offshore wind park, which will be possibly directed to spheres important for the society, it may be presumed that the planned activity has a positive impact on Hiiumaa society.

General assessment:

Alternative 1 and alternative 2: +1 negligible positive impact (construction and using phase, for both wind farm and cable installation)

0 alternative: -1 negligible negative impact (some jobs won´t appear and electricity security remains weak)

5.12.4. European experience of involvement society

Creation of MTÜ in the framework of development of north-western Estonian offshore wind park in order to offer benefits to society is not a new phenomenon. Similar examples can be widely found in other places in Europe. Community benefit is a monetary or non-monetary benefits, which the developer contributes in the interests of development of local community, where the development activity significantly impacts the living environment. The definition is taken from British sources, where community benefit is understood as the developer's voluntary contribution[60].

Internationally tradition of providing benefits to community has rooted itself stronger in countries, where the development of wind energy has occurred longer and it has a bigger share (e.g. in Spain, Germany and Denmark). In these states benefits meant for community are in majority of cases already in integral part of the project, existing either as a local tax, workplaces or local production.

On the basis of the experience of other states it may be said that there is no one definite working solution, how to create benefits to local community. Several of them (e.g. taxation) are not

[58] Environmental impact strategic assessment draft report for county plan of sea area bordering with Hiiu county, 2012-2014, OÜ Alkranel, Marine Systems Institute of Tallinn Technical University, OÜ Artes Terrae
[59] Potisepp, M. 2014. Impacts of the wind park to Hiiumaa inhabitants, Hiiu Leht www.tuuleenergia.ee/2014/04/meretuulepargi-mojud-hiidlastele/
[60] MTÜ Arhipelaag 2009. Local benefit upon creation of wind parks

applicable in Estonia due to taxation system in force. However, there are other possibilities that should be considered. In case of offshore wind park of north-western Estonia the most reasonable solution should be deemed finding of the result satisfying as most as possible all participating parties, how the local community could receive benefit from the planned activity, by negotiations. Creation of the respective MTÜ will provide suitable basis and format for this.

5.12.5. Visual impact

Visual impact when creating offshore wind parks is one of the most significant impacts, since it is the most observable and the most far-reaching. Thus, visual impact is well perceived. Although there is much subjectivity when assessing visual impact, the significance of the impact depends on the exact location of wind park, its size and allocation of wind turbines. When assessing the impact, it is important on the one hand to distinguish subjective assessment of new situation perceived by people compared to the previous one. From the other hand, it is important to distinguish objective change in the sea and landscape picture, which can be assessed, for example, on the basis of the distance between wind turbines and the coast or also on the basis of, for example, observation sectors opening from mostly visited places. People's subjective assessment is often related to fears associated to creation of wind park, which are, for example, possible dispersion of noise, impact on seabed of fish reserves etc. Such impacts can still be minimised. However, if behind subjective negative assessment there is an unfounded hostility, then it is not possible to minimise such impact.

In order to assess objective change in the sea and landscape picture, visualisations have been compiled by EMD International A/S. For this, software WindPRO 3.0 has been used, which in widely accepted in the world. Also, Land Board WMS services have been used when defining the locations. Upon compiling visualisation two types of turbines have been taken as the basis: a) 158 x V164 Vestas turbines with the core height of 105 m and propeller diameter of 164 m; b) 182 x SWT 4-130 turbines with the core height of 100 m and propeller diameter of 130 m. Official visual details of turbines are included in WindPRO software. Coordinates of wind turbines location have been given by the developer.

The results of visualisation are presented in Annex 9 of the EIA report, where views opening from the coast have been shown from eight points mentioned above in case of wind turbines with two different dimensions (158 x V164 Vestas turbines and 182 x SWT 4- 130 turbines). Due to the addition of an alternative wind turbine alternative (alternative 2), visualization was complemented and views of a solution using the most powerful and higher wind turbines (Haliade X 12 MW, 70 pcs) were added. New visualizations are included in Appendix 9 to this EIA. The new visualization for alternative 2 mainly shows the visibility of higher wind turbines off the coast of Hiiumaa. Although for alternative 2, 7 MW wind turbines are partly used (TP 1 in the development area), they have already been visualized, and since they are installed in the same development area and the same distance from the coast, the alternative visibility is already covered by the previous simulation and no new visualizations were performed.

With respect to significance of visual impact the distance of wind park from the coast plays a great role. International experience until now has shown that if a wind park is located approximately 10 km away from the coast, wind park is accepted by society.[61]

Observability of offshore wind park mainly depends on weather conditions and roundedness of the Earth. Roundedness of the Earth comes into play in case of observability only in case of big distances and open observation corridors. In order for the wind turbine to stay behind so-called shadow of roundedness of the Earth within its entire height, observer should be approximately 35 km away from it.[62]

Hiiumaa offshore wind park is planned 12 km away from Hiiumaa coast. In case of such distance wind park will not be visually dominating complex of objects even with a clear weather, not

[61] Hendrikson&Ko OÜ, 2010. Neugrund offshore wind park EIA report
[62] Hendrikson&Ko OÜ, 2008. EIA of wind park planned in north-western Estonian coastal sea: social-economic impacts. Interim report

speaking about observability in the conditions of rainy or foggy weather. It can be seen from visualisation figures that the difference in observability in case of two different types of wind turbines is not big.

General assessment:

Alternative 1 and alternative 2 of wind farm: -1 – insignificant negative impact

0 alternative:0 – no impact

5.12.6. Impact on human health and well-being

Noise modelling results show that in case of alternative 1, using Vestas V164 wind turbines of 7 MW power, the noise level is only 60 dB (target value) in the vicinity of the wind farm (27 m) and 45 dB noise level spreads up to 684 m from the wind farm. For other types of windmills, the distances are smaller. In alternative 2, the noise level of 60 dB in case of the most powerful wind turbine type Haliade-2 is up to 110 m from the wind farm, 45 dB to 1195 m from the wind farm. It may concluded from this, that the noise has no impact on human health and well-being. The results of modelling low-frequency noise have also shown that the noise levels are so small that there is no negative impact on human health and well-being. In case of infrasound the surveys have shown that in immediate proximity to wind turbines (305 m) the noise levels are significantly lower than the have been defined in legislation of the states (Great Britain, Japan and USA). Due to this scientists have reached conclusion that infrasound and low-frequency noise have no impact on human health farther than 305 metres from wind turbine.

The potential external air pollution associated with vessel traffic serving the offshore wind park is not significant. It is highly probable that maintaining vessels of approximately 18 m in length will be selected as maintenance vessels. Fuel consumption for such vessels is about 150 l/h when speed is less than 23 knm. 330,000 litres of diesel fuel is spent on three ships a year, which is 3.4 GWh.

There is no activity intended to remove sediment from the coast. Existing and official dumping areas are used for which a special permit for water use has been issued. Effects on the potential deterioration of ambient air quality in this regard are negligible.

General assessment: 0 – no significant impacts

Alternative 1 and alternative 2 of wind farm: 0 no significant impact (construction and using phase)

Alternative 1 and alternative 2 of cable installation: 0 no significant impact (construction and using phase)

0 alternative: 0 – no impact

5.12.7. Impact on properties

The impact of the planned activity on properties is indirectly related to disappearance of people's salaries or workplaces, if creation of wind park would cause decrease of fish reserves or change of fishing opportunities. From assessment of fish fauna it is concluded that creation of wind park will not cause significant negative environmental impact on fish fauna.

Impact on properties is direct when collision of ships with wind turbines happens and thereby ships are damaged. It is apparent from the assessment of navigation risks performed within the framework of EIA, that ships are crossing possible wind park area relatively often, and in the construction period the risk of ship accidents in the regions is also higher. Modelling of ship accidents has shown that collision of ship with wind turbine in case of relatively tight ship traffic in the Baltic Sea may happen (Kriegers Flak I project in the southern part of the Baltic Sea) once in 56-58 years (see SSPA Sweden AB, 2010). A much higher probability is a type of possible collision of drifting ship with wind turbine (probable once in 71 years) than in case of ship capable of moving (probable once in 305 years). Thus, probability of collision of ship and a wind turbine is quite low. In spite of this, in order to guarantee sea traffic safety, marine traffic area in the wind park region

should be marked according to the requirements. Based on the above-said, it may be stated that the impact of the planned activity on properties is neutral or absent.

General assessment:

Alternative 1 and alternative 2 of wind farm: 0 neutral/no impact (construction and using phase)

Alternative 1 and alternative 2 of cable installation: 0 neutral/no impact (construction and using phase)

0 alternative: 0 – no impact

5.13. Possible transboundary impact

In case of transboundary impact the following aspects may be pointed out:

1. In the conditions of open electricity market of the European Union all producers of electricity may sell produced electricity to European consumers. Estonia belongs to Nord Pool Spot sales region of electricity market. In addition to Estonia, Nord Pool Spot also includes Norway, Sweden, Finland, Denmark, Latvia and Lithuania.[63] Taking into account production volumes and consumption of electric energy produced by the planned offshore wind park in the future, creation of park will not have significant impact on functioning of the market until now and therefore will not have significant impact on international scale;
2. Planned wind park is located approximately 20 km away from the boundary of Estonian territorial sea, the sea cableway will be even further. The named distance is enough in order for the noise, dispersion of suspension and sediments (see chapters 5.2.3 and 5.3) and visual impact to remain within the boundaries of Estonian territorial sea, and transboundary environmental impact will not be created;
3. Possible negative transboundary impact is related to impacts of offshore wind park on birds fauna at the time of operation (primarily on migrating birds). The significance of the named impact needs subsequent clarification in the course of monitoring performed at the time of operation of wind park;
4. Theoretically transboundary impact may appear also on fish fauna and sea mammals. However, taking into account conclusions reached in given EIA that the named impact is insignificant, no significant transboundary effect is foreseen.

   If there is desire in future to connect the planned wind park with coast by a cable (Finland or Sweden), this activity may cause transboundary impact. Installation of marine cable in international waters is not the object of this EIA and the extent and significance of impact will be determined in the course of a separate EIA procedure.

General assessment:

Alternative 1 and alternative 2 of wind farm: 0 neutral/no impact (construction and using phase)

Alternative 1 and alternative 2 of cable installation: 0 neutral/no impact (construction and using phase)

0 alternative: 0 – no impact

5.14. Impact on border guard radar system

Taking into account parameters of the planned wind turbines, they will remain visible to all radars of marine surveillance system of the Border Guard Board, into whose field of observation the wind turbines will remain. Thus so-called shadow area will be created for radar behind wind turbines. If

[63] http://energiatalgud.ee/index.php?title=Elektriturg&menu-60#label-NPShind2

many wind turbines are located with unsuitable allocation with respect to radars, it is possible to create quite large blind zones for marine surveillance system of the Border Guard Board. Rotating wind turbines blades create impact to radar signal also through Doppler effect. Upon construction of Hiiumaa offshore wind park, blind zones will be created behind groups of wind turbines, which have been planned for shallows 2 and 3. It means that big blind zones will be created on international sea route and the external border of the European Unions close to Hiiumaa north-western coast. In addition to the above-said, impacts to marine surveillance system will be created upon construction of wind parks from wind turbines as disturbing objects not representing any interest for marine surveillance system. More complicated navigation observation will also be caused (yachts for entertaining trips, other service vessels etc) in the areas of the planned wind parks.

In order to minimise the named impacts, it is possible to create wind turbines for marine system of Border Guard in such a way that their allocation with respect to each other should be in the form of a network where wind turbines would be located in network junctions. In this case Border Guard radar positions should be located on prolongations of network cells sides in order to create so-called jalousie effect. In order to create the effect, the distance between wind turbines needs to be set at least 625 m, which would guarantee the relationship of at least 80:20 with respect to free and hidden zone.

The second possibility to minimise the impacts is the establish navigation exclusion zone in the wind park and the areas of its immediate surrounding, for entering into which the permit of Border Guard Board would be necessary[64].

Thus, it may be said that creation of wind park will considerably disturb the work of the marine surveillance system of the Border Guard Board, but taking into account proposals made for minimisation of impacts, undisturbed work of the marine surveillance system of the Border Guard Board is possible.

General assessment:

Alternative 1 and alternative 2 of wind farm: 1 insignificant negative impact

Alternative 1 and alternative 2 of cable installation: 0 no impact

0 alternative: 0 – no impact

5.15. Impact on climate changes

Development of renewable energy (including wind parks) is one important opportunity to decrease emissions of greenhouse gases. Production of wind energy will decrease CO_2 emissions, since it is a renewable source of energy. Presumed power of the north-western Estonian offshore wind park is up to 1100 MW. Average annual production is a commercial secret of the developer, but if a moderate annual production of 40% in case of the sea wind park is assumed (which is a rather moderate assumption in case of the sea wind turbines), approximate maximum production of electric energy will be 3,8 TWh (3800 GWh). Assessed economy of CO_2 is 3,5 million tons. Electric energy from renewable sources has been produced in Estonia in 2015 in the amount of 1507 GWh, which is 11,1 percent more than in 2014. Production of the Estonian renewable energy has made up 16,7 percent of the total consumption of electric energy, i.e. 1,9 percentage points more compared to 2014. Estonia has set up the goal to reach the share of renewable electric energy to 17,6 percent of the total consumption by 2020.[65] In 2015, wind parks have produced a total of 693 GWh of energy.[66] Thus, the total consumption of renewable energy would significantly increase in Estonia upon realisation of the planned offshore wind park. Increase in production of renewable

[64] Tõnu Sisask, 2008. Assessment of Hiiumaa wind park impacts on providing of internal security of the Republic of Estonia (on the work of marine surveillance system of the Border Guard Board)

[65] http://elering.ee/taastuvenergia-kattis-moodunud-aastal-167-protsenti-elektri-kogutarbimisest/

[66] http://elering.ee/taastuvenergia-kattis-moodunud-aastal-167-protsenti-elektri-kogutarbimisest/

electric energy should respectively minimise the amount of energy produced from fossil fuels, which would have positive impact in the local plan to restrain climate changes. Globally, the amount of fossil energy used in Estonia remains small, and realisation of the planned activity in the world scale will not have special impact. However, there are co-operation mechanisms established by the directive on renewable energy in the European Union, in order for the member states to be able to jointly develop renewable energy sources. Since Estonia has a significant wind energy potential, in addition to achieving of state goal Estonia can use this resource also for achievement of the goals of the European Union.[67] In this form Estonia would support with renewable energy other European countries as well and would enhance the decrease of fossil fuels and emissions of CO_2 into the air.

In strategic document "Hiiumaa 2020 renewable energy programme" the goal has been set as follows:

- to increase the share of local renewable energy sources in consumption up to 80%;
- to decrease emission of CO_2 compared to 2005 by 100%;
- to achieve neutral energy balance with respect to emissions of CO_2.

Fulfilment of these goals will decrease negative impact on climate. Fulfilment of goals will be enhanced by the planned offshore wind park.

General assessment:

Alternative 1 and alternative 2 of wind farm: +1 insignificant positive impact

Alternative 1 and alternative 2 of cable installation: 0 no impact

0 alternative: -2 significant negative impact, i.e if the wind farm is not built, significant use of fossil fuels will continue

[67] EISA draft report of county plan of the sea area bordering with Hiiu county, 2012-2014

6. POTENTIAL ENVIRONMENTAL RISKS UPON CONSTRUCTION AND OPERATION OF WIND PARK

6.1. Risks related to ice

The region's ice conditions, including the risk of major ice bank movement and overall drift should be taken into account upon projecting and creating the wind park. In up to 50% of years there are drifting ices in the regions of the wind park, in extraordinarily frosty winters permanent ice may occur. Taking into account the lifetime of the wind park of up to 50 years, occurrence of such frosty winter at least once is probable. It is important to choose such type of wind turbines foundation, which is foreseen and projects to resists static and dynamic pressure created by ice. Maximum average monthly thickness of ice in the regions of the wind park within 20 years has been 20 cm – whereas in the development areas TP 2, TP 3 and TP 4 probability of appearance of ice and its average maximum thickness is smaller than the respective parameters in the development area TP 1. In very frosty winter the thickness of ice in the region may reach up to 30 cm (Haapala & Leppäranta, 1996). In order to minimise risks, possibility should be taken into account, that the thickest blocks of ice are drifting into the region from the Gulf of Finland.

The developer has weighted as possible wind turbines foundation types monopile, tripod, jacket and gravity based structure (see chapter 2.2 of EIA report). Taking into account ice conditions of the region, the most preferred types of foundation in order to avoid risks is gravity-based structure, which is able (primarily due to its mass, since the cone of concrete foundation will be filled in with sand) to resist dynamic pressure of drifting ice.

In addition to dynamic pressure exercised in wind turbines by ice, it is important to consider ice conditions at the time of construction of wind park – it is recommended not to perform construction works in the periods of the presence of ice. It should also be taken into account that in winter there may be situations, where servicing of the wind turbines by ships not possessing ice class will not be possible during some time.

General assessment:

Alternative 1 and alternative 2 of wind farm: 0 neutral/no impact (if recommendations are taken into account)

Alternative 1 and alternative 2 of cable installation: 0 no impact

0 alternative: 0 – no impact

6.2. Navigation risks, including the impact on navigation

Navigation risks and risks of sea pollution arising from them exist both at the stage of construction as well as at the stage of operation of wind park. The area close to the wind park to be created is crossed by marine transport heading to harbours of the Gulf of Finland. The amount of ships entering and leaving the Gulf of Finland has been approximately 37 000 on the basis of data for 2006 (HELCOM, 2007) and approximately 41 000 ships per year on the basis of data for 2012 (HELCOM, 2014b). Although the main ship route is located from the north of the planned wind park, it is clearly seen from the AIS data that ships relatively often go also through possible wind park area (Figure 26). In addition to this, the deepest sea area remaining to the north from Hiiumaa is an important fishing regions, which presumes the movement of fishing ships from harbours to fishing areas and in immediate proximity to the wind park to be created between them. More and more intensive is also the traffic of small ships and sailing yachts in the sea area of Hiiumaa.

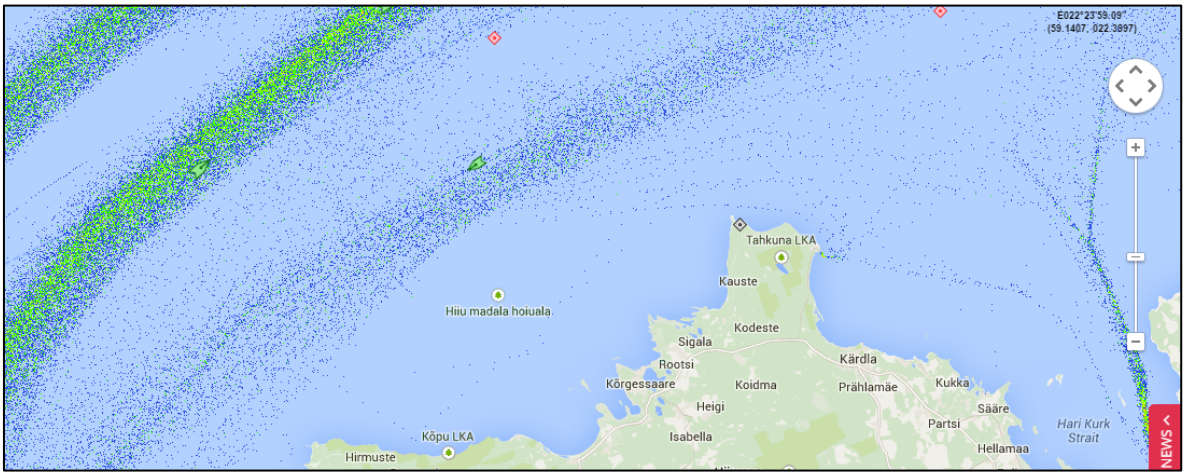

Figure 26. Intensity of ship traffic according to the data of AIS (*Automatic Identification System*) (source: Marinetraffic.com, 23.10.2014)

Environmental risks upon construction of wind park are mainly comprised of levelling of surface and stabilisation of foundation basis, and of possible accidents related to installation of wind turbines. The developer has to guarantee that ships participating in construction works should follow established safety rules. For example, since it is a hydrodynamically active (open to waves) region, in order to minimise the probability of accidents at the time of construction works should be performed only in respective wind conditions. It is also not safe to perform works in icy conditions.

In the period of construction time the risk of ship accidents in the region is also higher. Therefore, schedule for regulation of ship traffic should be drawn up for the period of construction of the wind park to be created in the region of performing the works and it should be coordinated with Maritime Board. Safety zones should be established around working ships, of which to inform by means of navigation message. Since in order to guarantee safety limitations to navigation should be established, creation of wind park will have some impact in navigation in the region. Since the area remaining in the direction of open sea from wind park has natural ship traffic, then creation of wind park will not cause stoppages in ship traffic – ships will correct their route and will go around the work region.

Environmental risks upon operation are mainly related to navigation risks and based on that also to risks of oil pollution. According to HELCOM data in total 149 ship accidents happened in the Baltic Sea in 2012. One of the often occurring type of accidents (22% of accidents) has been collision with another object (not ship; HELCOM, 2014b). The most often reason for accident has been (43%) human mistake. The same reasons may also be presumably the main reasons for possible collision of ship with wind turbine. Taking into account statistics of ship accidents, it has been shown by the way of modelling, that collision of ship with wind turbine in case of relatively tight ship traffic in the Baltic Sea may happen (Kriegers Flak I project in the southern part of the Baltic Sea) once in 56-58 years (see SSPA Sweden AB, 2010). A much higher probability is a type of possible collision of drifting ship with wind turbine (probable once in 71 years) than in case of ship capable of moving (probable once in 305 years).

When choosing the wind park areas and location of wind turbines, the increase of navigation risks in the region should definitely be avoided. When drawing up the concrete scheme of location of wind turbines, their allocation should be coordinated with Maritime Board.

The important precondition for guaranteeing safety of sea traffic in the wind park region is marking according to the requirements of wind park area and, if necessary, also of marine traffic area going through the region and of marine traffic area of small vessels. The developer has to draw up the respective project and to coordinate it with Maritime Board.

General assessment:

Alternative 1 and alternative 2 of wind farm: -1- insignificant negative impact, direct (construction and using phase)

Alternative 1 and alternative 2 of cable installation: -1- insignificant negative impact, direct (construction and using phase)

0 alternative: 0 – no impact

6.3. Possible prognosis of the dispersion of oil spot

The wind turbine contains 500 litres of oil per wind turbine. With a frequency of up to once a year, there is an oil replacement that takes place in a so-called closed system inside the wind turbine and during which the oil does not enter the marine environment. Oil spills from wind turbines are only possible in an emergency situation with a low probability of occurrence.

In given work, the probability of pollution spreading in the locations of wind farms has been assessed. The results of modelling the dispersion of oil pollution may be summarised as follows: possible oil pollution may reach the coast (however, with relatively low probability, depending on dominating meteorological conditions) within 24 hours after the occurrence of pollution. In case of possible pollution arising in the development area TP 2 the biggest risk of dispersion of oil spot to the coast is in case of strong (>10 m/s) NW-N winds; the endangered coastal area is Hiiumaa northern coast in the west from Tahkuna peninsula. In case of possible pollution arising in region 1 pollution will reach the coast faster in case of strong and moderate (>8 m/s) NW-W winds; endangered coastal area is Hiiumaa northern coast, the gulf of Luidja. Pollution arising in the development area TP 1 may most probably reach the cost in Dirhami region, on Vormsi or Hiiumaa northern coast, if strong western or north-western winds are dominant (>10 m/s).

General assessment:

Alternative 1 and alternative 2 of wind farm: -1- insignificant negative impact (unlikely, direct construction and using phase)

Alternative 1 and alternative 2 of cable installation: 0 - no impact, direct (construction and using phase)

0 alternative: 0 – no impact

Mitigation methods

Above all, it is necessary to follow the safety rules that preclude oil spills when performing the work. For more information on mitigation measures, see Chapter 9.

7. SUMMARY OF ASSESSMENT RESULTS, INCULDING CUMULATIVE IMPACT

The following is a summary of the impact assessment for wind turbine alternatives and marine cable alternatives for each field/topic. In the tables, the negative and positive effects are marked with red and green respectively for a better view.

Table 11. Assessment results of wind turbine alternatives

Type of impact	0 Alternative	Alternative 1		Alternative 2	
		Impact during construction	Impact during use	Impact during construction	Impact during use
Impact on waves, currents, mixing	0	0	-1	0	-1
Impact on water quality	0	-1	0	-1	0
Impact on the spread of suspended solids	0	-1	0	-1	0
Impact on sediment movement and coastal processes	0	0	0	0	0
Effect on oil spill spread	0	-1	-1	-1	-1
Impact on navigation risks	0	-1	-1	-1	-1
Impact on ice risks	0	0	0	0	0
Impact on abundance of fish species	0	-1	0	-1	0
Impact on fishing (trawling)	0	-1	-1/-2	-1	-1/-2
Impact on fishing (coastal fishing)	0	0	0	0	0
Impact of noise on fish stocks	0	-1	-1	-1	-1
Impact on fish habitats (creation of artificial reef)	0	-1	+1	-1	+1
Impact on birdlife	0	-2	-1	-2	-1
Impact on chirpoterans	0	-1	-1	-1	-1
Impact on bottom vegetation on soft ground	0	0	0	0	0

Impact on bottom vegetation on hard ground	0	-1	+1	-1	+1
Impact on benthic fauna on soft ground	0	-2	+1	-2	+1
Impact on benthic fauna on hard ground	0	-1	+1	-1	+1
Impact on benthos (reefs)	0	-1	0	-1	0
Impact on benthos (sand shallows)	0	0	0	0	0
Impact on wrecks	0	-1	0	-1	0
Impact on grey seal, including Selgrahu grey seal permanent habitat	0	-1	0	-1	0
Impact on ringed seal	0	-1	0	-1	0
Impact on white-taled eagel	0	0	-1	0	-1
Impact on Natura 2000 sites	0	0	0	0	0
Impact on following nature conservation areas: Hiiu shallow conservation area, Kõrgessaare-Mudaste conservation area, Paole nature reserve, Tahkuna nature reserve, Väinamere conservation area, Selgrahu grey seal permanent habitat, Kadakalaiu ringed seal permanent habitat, Nõva-Osmussaare conservation area	0	0	0	0	0
Impact on Apollo shallow nature reserve	0	-1	-1	-1	-1
Impact on the planned Kõpu marine protection area	0	0	0	0	0
Impact on economic development and employment	0	+2	+2	+2	+2
Impact on tourism in Hiiumaa	0	+1	+1	+1	+1

Impact on the Hiiumaa community	-1	+1	+1	+1	+1
Effect of vibration	0	-1	-1	-1	-1
Visual impact	0	-1	-1	-1	-1
Impact on human health, well-being and property	0	0	0	0	0
Impact on Border Guard Radar System	0	-1	-1	-1	-1
Impact on climate change	0	+1	+1	+1	+1
Cross-border impact	0	0	0	0	0

The construction and use of the wind farm will have no adverse effect on the conservation objectives and areas of Natura 2000 sites as a whole.

The construction of a wind farm may have a significant negative impact on the birds and the benthic fauna on the soft surface during the construction phase.

Significant negative impacts on birdlife during the construction phase are associated with the destruction and disturbance of the benthos (decreasing food base), the formation and spread of suspended solids (impact on nutritional conditions) and direct disturbance from construction activity (noise, vibration, vessel traffic). Impacts are predominantly local, short-term and reversible. There is no significant negative impact on the significant food base and habitat of Apollo shallow, as the closest development area (TP 1) is at least 2 km away and the food base there is preserved. Similarly, the noise generated by the construction activity does not cause significant disturbance to the birds there.

The significant negative impact on the benthic fauna on the soft surface is primarily related to the change of the bottom substrate resulting from the installation of wind turbine foundations, which in turn affects the fauna (changes or disappears). The marine environment expert has proposed the necessary mitigation measures to reduce the significant negative impact.

Minor negative impacts on water quality, suspended soldis spread, abundance of fish species, trawling, fish habitats (temporary loss of habitat quality) and noise (fish), benthic and benthic fauna on a solid basis, benthic reefs, chiropterans and marine mammals may be negatively affected during the construction phase. The impact on the Apollo shallow nature reserve, wrecks and Border Guard radar systems, navigation risks, oil spill spread, and vibration and visual effects has also been assessed to have a negligible negative level.

In the areas listed below, the experts found that the impact on the construction of the wind farm is either neutral or non-existent: waves, sediment movement and coastal processes, ice-related risks, impacts on fishing on the beach, soft ground vegetation, benthic sandbanks, impact on white-taled eagles, human health, welfare and property.

The **exploitation phase of a wind farm** may have little or no significant negative impact on trawling. The magnitude of the impact will depend on how close to the important trawling areas wind turbines will be built and what restrictions will be imposed on trawling. Particular impact may be due to a direct conflict with important trawl fishing grounds (loss of areas) and movement of vessels with restrictions on the fleet from the catchment area and back. In order to preserve the important trawling area on the edge of the Vinkovy plateau, the expert of the fishery has proposed a solution where the windmills in TP 2 will not be built on a separate eastern line which is acceptable to the developer. In order to mitigate the possible constraints on the movement of fishing vessels

resulting from the wind farm, the developer ensures the trawling movement to trawl fishing areas and from one trawl area to another through the wind farm and wind turbines.

The impact on bird life during the exploitation phase of the wind farm remains at a negligible negative level. This is due to a compromise solution proposed by an avian expert, where the wind turbines are not built on Apollo shallow, the buffer zone will be created between TP 1 area and the Apollo shallow nature conservation area and mitigation measures to reduce the wind resistance and collision risk from wind farms will be applied. The wind turbines closest to the Apollo nature reserve are designed to be at least 2 km away from the sea; the seabed, the benthic fauna and the important food base for birds are not affected. The acoustic and visual disturbance associated with the use of wind farms and vibration can, to some extent, degrade the feeding conditions of birds at Apollo shallow, but it is nonetheless insignificant as the essential food base is maintained. The windmills can cause the death of specimens of birds going to and from the Apollo shallow nature reserve due to the risk of collision with wind turbine blades. However, as waterfowl (including long-tailed ducks) avoid wind farms, their risk of collision with windmills is relatively low. This can happen in very bad weather conditions, but even under these conditions, this probability is low, there is usually no migration in bad weather.

During the exploitation phase of the wind farm, a negligible negative impact on the Apollo shallow nature reserve, which implies indirect disturbance of birds to protect the nature area (see above), may occur. There are no negative impacts on the habitat types, the status of protected species and the nature area as a whole, which are the conservation objectives of the protected area.

Minor negative impacts during the use phase may also occur in the form of waves, to fish as noise, chiropterans, white-taled eagles, navigational risks, oil spill spreads, navigation risks, as well as the impact of vibration and visuals and the impact on the Border Guard radar system. Impacts on fish habitats are predominantly positive (the emergence of artificial reefs, increased biodiversity and production).

In the following areas, the experts found that the use of the wind farm had no effect on them or that the impact would remain neutral: water quality, suspended soldis distribution, sediment movement and coastal processes, ice risks, abundance of fish species and coastal fishing, benthic vegetation on soft surfaces, benthic habitats for reefs and sandbanks, marine mammals, wrecks , human health and well being.

The most powerful wind turbine Haliade-2 12 MW is currently used as the basis for modelling the noise generated by wind turbines, resulting in a noise level of 60 dB to 110 m and a distance of 45 dB to 1195 m from the wind farm. As the wind farm will be built at least 12 km from the coast of Hiiumaa, noise will not spread to the residential areas of Hiiumaa.

Infrared (frequency <20Hz) caused by electric winds remains below the human perception and hearing threshold. The infrared emitted by wind turbines is in the same order of magnitude as the natural phenomena. Consequently, the infrasound generated by the proposed offshore wind park has no significant negative impact on human health and well-being.

Building a wind farm is expected to have a significant positive impact on Hiiumaa's economic development and employment, as well as a positive impact on Hiiumaa's tourism, community and climate change (both in the construction and in the exploitation phase). There is no presumption of cross-border effects on the establishment of a wind farm.

Alternatives 1 and 2 of wind farms have a similar environmental impact in general. In addition, alternative 2 has a development area TP 1 further away from the Apollo shallow nature reserve than alternative 1, which is better for bird life. Potential cumulative impacts have been assessed in the areas of sectoral impacts, such as impacts on human health and well-being (noise, vibration, fishing, etc.) and property (risks related to marine traffic), marine mammals (impact on nutrition and reproduction areas, etc.). No additional cumulative effects were found on the basis of the assessment results.

Table 12. Assessment results for cable alternatives

Type of impact	0 Alternative	Alternative 1		Alternative 2	
		Impact during construction	Impact during use	Impact during construction	Impact during use
Impact on water quality	0	-1	0	-1	0
Impact on the spread of suspended soldis	0	-1	0	-1	0
Impact on navigation risks	0	-1	0	-1	0
Impact on sediment movement and coastal processes	0	0	0	0	0
Impact on abundance of fish species	0	-1	0	-1	0
Impact on fishing (trawling)	0	-1	0	-1	0
Impact on fishing (coastal fishing)	0	0	0	0	0
Impact of noise on fish stocks	0	-1	0	-1	0
Impact of electromagnetic fields on fish stock	0	-1	-1	-1	-1
Impact on marine benthos (including the emergence of artificial reefs, effects on benthos, benthic fauna and benthic habitat)	0	0	0	0	0
Impact on bird life	0	-1	0	-1	0

Impact on wrecks	0	-1	0	-1	0
Impact on grey seal, including Selgrahu grey seal permanent habitat	0	-1	0	-1	0
Impact on ringed seal	0	-1	0	-1	0
Impact on Natura 2000 sites	0	0	0	0	0
Impact on nature conservation areas	0	0	0	0	0
Cross-border impact	0	0	0	0	0

Both the installation and the use of the cable trail are not expected to have significant negative effects. Unfavourable impacts on conservation objectives and site integrity of Natura 2000 sites will not occur.

The construction phase may be accompanied by negligible negative impacts, primarily related to potential disturbance of the seabed, the release of sediments into the water column, the spread of suspended solids and direct disturbance from construction activities (noise, ship traffic). These are predominantly local (cable proximity), short-term and reversible impacts. There is no predictive cross-border spread.

During the construction phase, negligible negative impacts on water quality, suspended matter spread, abundance of fish species (temporary decrease in the area), noise to fish and electromagnetic fields, trawling, bird and marine mammals (temporary deterioration of dietary conditions due to reduced viscosity, noise disturbance) and wrecks may occur. The installation of sea cables may interfere with the benthos in the construction phase, but the impact is not high and of short duration. The disturbed soft seabed will quickly recover in open sea conditions. Impact on the hard seabed remains neutral / absent.

There are no negative impacts on conservation objectives and site integrity of nature reserves and permanent habitats for seals.

For the rest of the marine environment, the cable-laying effect remains neutral/has no effect.

In the **use phase of cables**, only negligible negative effects on fish can occur with respect to electromagnetic fields, but this can be mitigated by the use of as few electromagnetic fields as possible by cables and by drilling or burial of cables.

In the comparison of cable route alternatives, the impact will generally remain at the same level. Alternative 1 has a somewhat greater impact, as in this case, the route also crosses the Väinameri conservation area (including the Väinameri nature area and bird area included in the Natura 2000 network). Since there are several routes in the low sea in the cable installation alternative 1, the water in the coastal areas is also more likely to be clouded.

Potential cumulative effects have been assessed in sectoral impact chapters. No cumulative effects were found on the basis of the assessment results.

8. ASSESSMENT ON FOLLOWING SUSTAINABLE DEVELOPLEMT PRICIPLE AND SUSTAINABLE USAGE OF NATURAL RESOURCES

The principles of sustainable development are respected throughout the design and construction of the wind farm, as well as the maintenance and decommissioning of wind turbines.

In addition to feasibility, the use of marine areas (fishing, marine traffic, birds and marine mammals) is also taken into account when selecting the location of wind farm areas and determining the number of wind turbines - areas have been repeatedly revised according to the results of the surveys and the information that has emerged from communication with stakeholders, to minimize and mitigate the impact of the wind farm; for this, several professional studies have been carried out. Several mitigation measures are taken into account in the construction of the wind farm and proposals have been made for the necessary monitoring.

9. MEASURES FOR MINIMISING SIGNIFICANT NEGATIVE ENVIRONMENTAL IMPACT

Seabed sediments

Suspended solids can be reduced during monitoring. If the monitoring reveals that the suspended solids spreads in the conservation areas beyond 3 km from the source, the work must be stopped until the currents change to minimize the area affected by the suspended solids in the conservation areas.

Work must be stopped until the current of the currents changes, if the monitoring indicates the spread of suspended solids (concentrations clearly distinct from the natural background) in the Apollo protected area.

The work must be stopped until the current of the currents changes, if the monitoring carried out in the alternative 1 of the cable installation shows the spread of suspended solid (the concentrations are clearly different from the natural background) to Hiiu shallow.

Propagation of suspended solids is likely to be completely avoided if the installation of wind turbines in the area TP4 is not carried out if southwestern and/or western winds dominate the previous day at an average speed of more than 10 m/s;

For cable installation alternative 2, do not conduct the cable recess in the northwest and western section of the conservation area (up to 4 km from the conservation area) to prevent the suspended solids reaching Hiiumaa, if the previous day has been dominated by the western wind and the average daily speed exceeded 10 m/s;

In case of cable installation alternative 1 to reduce the effect of Hiiu shallow conservation area, do not perform the cable recess in Hiiu from northwest, north and west if the previous day has been dominated by western, northwest and/or north wind and the average daily speed exceeded 6 m/s. If the above-mentioned operational monitoring is applied and the work stopped, if necessary, then this mitigating measure will have no significant additional effect.

In order to reduce the impact of suspended solids and sedimentation on Apollo shallow nature reserve, do not carry out works creating suspended solids in TP 1 area if the previous day has been dominated by south, east and/or southeast winds with an average daily speed of more than 6 m/s. If the above-mentioned operational monitoring is applied and the work stopped, if necessary, then this mitigating measure will have no significant additional effect.

Seabed fauna

Based on the survey results, the following minimising measures / limitations should be used in the period of construction of offshore wind park, in order to damage sea environment and seabed fauna as little as possible:

1) use preparation of seabed for gravity-based foundation in cases of extreme necessity – it is a strong anthropogenic disturbance, as a result of which substratum changes/disappears and the composition of seabed fauns changes/dies;
2) damage to the seabed shall be avoided when establishing a wind turbine foundation;
3) the material of the foundations must be similar to the natural seabed as much as possible (rocky, limestone, non-toxic, the surface structure allows the attachment of the species);
4) upon creation of offshore wind park to be guided by the maps of habitat types and, if possible, not to or, if possible, install wind turbines less to an area, where there are habitats with nature protection value, primarily EBHAB habitat number 10 – moderately open solid with compositions of seabed shells – and reefs habitat type of Annex 1 of the EU nature directive (1170), which have high nature protection value. This is caused due to a bigger biomass than usual (high production) and significance in food circuit. Habitat has an important structural role in the areas with high hydrodynamic activity. Shells and balanuses are biological filters, they decrease the amount of

phytoplankton found in water and improve transparency of water. Shells are an important food for several fish species and in lower areas shells also make up a big part of water birds' food;

5) in case of wind turbine foundations and wind turbines underwater parts it is recommended to use materials and paint, which is less suitable for fixing of seabed fauna species (by this "reef effect" is minimised);

6) when preparing erosion barriers use natural material originating from inland.

Birds

Wind park areas locations – as s minimising measure, creation of wind park at Apollo shallow has been abandoned on the basis of birds fauna expert's proposal. In order to protect birds staying and feeding at Apollo shallow, the wind turbines of in TP 1 must be located at least 2 km from the boundary of the Apollo shallow nature reserve.

Types of wind turbines – wind turbine type should be preferred, whose noise level and vibration are as small as possible.

Creation and demolition of wind turbines – when choosing between different foundation types, environmental impact on seabed fauna arising from their construction should be taken into account. Since seabed fauna will probably be destroyed entirely by construction of foundations, then as a minimising measure the underwater part of the foundation could be covered with rough cover in order to enhance the dispersion of shells on the foundations of wind turbines. This has also been done tentatively in case of open sea wind turbines in the Baltic Sea. With respect to creation and demolition of wind turbines oil pollution risk will theoretically also increase, but compared to the similar risk, which may find the project area from outside, this is insignificant. In order to avoid the risk, it is important to follow the measures to prevent, detect and eliminate oil spills.

Allocation of wind turbines in the wind park – upon creation of wind parks in birds' migration ways, birds' dominant migration direction should be definitely taken into account, whereas the rows of wind turbines in the wind park should be located in parallel to migration direction. In such a case rows of wind turbines of the wind parks planned at Hiiumaa shallows should be planned in the direction of migration – in the development area TP 1 in the direction of east-west and in other areas (TP 2, TP 3 and TP 4) in the direction of NE-SW.

Wind turbines safety lights – wind turbines safety lights represent very big risk to inland birds migrating at night, attracting the birds to wind park area and significantly increasing the frequency of birds' collision with wind turbine blades. Therefore, there is a rule – the less lights, the safer it is for birds.

Light types

For minimising the impact of lights several different ways are known at the moment:

a. intermittent lights are safer;

b. definite light types and colours are safer;

c. intermittence frequency of safety lights should be as long as possible and it should synchronised to the entire extent of the wind park;

d. more and more is spoken about so-called "intelligent lights". Such lights are switched on only in case if a ship or an airplane has entered the wind park risk zone. At other times the wind park is dark and does not endanger night migrants.

Lots of lights surveys have been performed in the world, in order to decrease the risk of birds' collision with high constructions. For example, it has been found that the light type "L-864 strobe" (24 flashing cycles per minute) does not attract birds so much as other light types. At the same time, it has been defined that constantly burning lights attract more birds. Many authors find that white lights are significantly safer than red ones. At the same time it should be pointed out, that many research works are contradictory to each other, and when choosing the lights, the location

of the wind park should always be taken into account, and each concrete development requires separate approach.

Chiropterans

Appropriate solutions must be applied to mitigate the risk of collision with chiropterans and to minimize possible death, such as:

limiting the wind turbine rotor speed until stop (during migration);

Installing ultrasonic repellents on windmills that leade potential bats away from the wind farm.

Fish

Temporary limitation – Avoid wind farm construction works and installing sea cables in May and June, when flounder is spawning and the installation of sea cables also during herring spawning from April to May.

Minimising of noise impacts – in order to minimise noise impacts it is possible to apply the wrapping of pile used for drilling into acoustically isolated material or surround the equipment with curtain consisting of air bubbles. Also drilling techniques may be varied in such a way in order for its impact to be minimal. Start noise-producing activities so-called in a soft way (quieter) so that fish can leave the area when the louder sound is generated.

Reducing the impact on trawling - Avoid construction and related noise in the first and fourth quarters when the most intense fishing time is.

minimising of electromagnetic fields – there are two possibilities in order to minimise the negative impact of electromagnetic fields of the cables: digging of cables into the seabed and use of such cable types, emission of magnetic fields of which is close to zero.

The first variant cannot be applied everywhere in Estonia, since the seabed is in several regions solid and additional drilling or deepening to be performed for digging the cable in is not reasonable from the point of view of environment and it would also cost too much.

Thus, the cables used in the offshore wind park could preferably be with alternating current and have three cores. This will decrease emission of magnetic fields, since the distance between conductors will be small. From the point of view of environment construction of such cable is definitely more preferable. In case if for connection with the mainland it is still decided to use three separate cables, these cables should definitely be located in immediate proximity to each other in order to minimise magnetic fields arising from them. For connecting wind turbines among themselves usually one three-core cable is used, which is accepted from the point of view of environment.

Sea mammals

In case of very noisy construction works in the regions of development area TP 1 it should be considered to avoid them in the periods of whelping and shedding hair of grey seals (February-June).

Risks related to navigation and ice

In order to minimise risk at the time of construction, the developer and the performer of works should have programme for prevention of risks.

Location of wind turbines in the wind park area and sea cable routing is needed to be coordinated with Marine Board in order to guarantee safe ship traffic and traffic of small vessels (if necessary, establishment of zones for marine traffic and zone for marine traffic of small ships) in the region.

The developer has to submit the time schedule of construction activity to the Marine Board, according to which limitations of ship traffic will be established for the time of performing the works around concrete regions.

Wind park area and marine traffic areas through the wind park or in proximity to the wind park should be marked according to the requirements, in order to guarantee safety of marine traffic in the region.

When choosing and projecting the type of foundation ice conditions of more frosty winter should be taken into account, which may occur during 50 years.

The developer (operator) should compile and realise the programme for servicing the wind turbines in icy conditions.

Border Guard Board radar system

In order to minimise impacts, border guard radar positions should be taken into account when installing the wind turbines. The other possibility is to establish navigation exclusion zone in wind park and its close proximity.

Avoidance of oil pollution and prevention of proliferation

First of all, upon performance of works it is necessary to follow safety rules, which would exclude the arising of oil pollution.

Since some risk of oil pollution is at the time of construction of wind park, it would be recommended not to perform works in the conditions of strong long-term winds (over 10 m/s) (directions primarily – from north, north-west, west, south-west; in order to exclude the impact on Apollo protection area also in case of southern and south-eastern winds).

Operator of wind park should have possibilities to liquidate pollution at least during 24 hours as of its occurrence, which would significantly reduce the probability of getting of pollution to the coast.

Use wind turbines remedies that exclude/minimize the possibility of oil spillage (eg double walls on an oil tank, a special collector for collecting oil in case of leakage). If necessary, install additional special tools for use in oil spills.

In case of possible oil spill response and rapid elimination of pollution, it is recommended to use wind farm maintenance vessels.

Ensure that personnel are trained to respond quickly to pollution and appropriately eliminate pollution.

10. PROPOSALS FOR MONITORING

10.1. Monitoring at the time of construction

10.1.1. Waves

As no offshore windfarms have even been established in Estonian offshore waters, the assessments given by this work and previous model simulations must be verified by measurements. This will allow model simulations to be specified and better interpreted in impact assessments for the construction of the following wind farms. Measurements must be made on at least two points:

- the wind direction dominating near the wind farm,

- near the coast.

Measurements must be made at both measurement stations for at least one year (depending on ice conditions, not continuously) before and after installation of the wind turbines.

10.1.2. Seabed sediments, spread of suspended solids

Carry out monitoring of the spread of suspended solids during foundation of works. On-site measurements should be used to determine the direction and range of application of the suspended solids during the installation of the 20 wind turbines. If monitoring indicates that the coverage area is significantly higher (as described in this work) and the suspended solids reaches a significant extent (the concentrations are clearly different from the natural background) to at least one of the conservation areas, the works must be temporarily suspended with the respective weather conditions (wind conditions) and monitoring continued until the work is completed. If such a scenario occurs, the distribution of suspended solids during the cable installation should also be monitored in full. Such a scenario is very unlikely in the light of the results of this work.

Regardless of the foregoing, monitoring of the spread of suspended solids in those sections of the cable installation that take place in the storage areas or which impact may extend to the storage areas must be made. In other words, monitoring of suspended solids should be done:

- Alternative 1 for the entire cable installation;

- in Nõva-Osmussaare conservation area and up to 4 km from the border, in the case of alternative 2;

- Up to 4 km from the nearest point of the Apollo shallow protected area when installing wind turbines and cables.

10.1.3. Seabed fauna

Monitoring of seabed habitats and sea environment should be organised at the time of construction of the wind farm as well as later in the course of operation in order to monitor possible changes and to allow to quickly react to unwanted changes in the condition of seabed habitats and environment.

In the course of monitoring at the time of construction, seabed fauna and environmental conditions of the close surroundings of wind parks should be monitored (turbidity of water, the amount of suspension in the water column, nutrients). Condition of seabed fauna should be monitored on soft and solid seabeds located in immediate proximity to construction. Parameters of water environment should be monitored with frequency of up to two times per month, the condition of seabed fauna once in the course of construction and once after the end of construction activity.

Prior to construction activity it is recommended to perform in the development area TP 1, which has not been covered by the previous inventory, the inventory of seabed habitats according to the

methods of inventories performed previously in other areas of location of wind park. This would give possibility to also perform quantitative assessment of dispersion of habitats.

The structure and characteristics of the seabed habitat (bottom sonar mapping, underwater video observations, where possible quantitative sampling, oxygen conditions, organic content of sediment, sludge organic content, etc.) shall be documented at construction sites for windmills and within 200 m radius of each foundation.

Immediately after laying the foundations, the seabed biota and habitat status and the extent of possible damage (video observations) should be documented in the immediate vicinity of the foundation (200 m radius).

When installing cables, set up a detailed monitoring plan for the project to allow monitoring of possible impacts on the entire project area and in as many different environmental conditions as possible (different depths, different substrates).

10.1.4. Birdlife

Upon creation of big wind parks in general case radar surveys are used, which gives in a general case better overview of location of migration flow of water birds in the concrete area. Radar survey gives overview about moving directions of birds, about "bottlenecks" of migration and migration altitude. The exact monitoring methods and time schedule should be agreed upon with the decision-maker prior to creation of wind park.

10.1.5. Fish

For monitoring of fish fauna a monitoring programme should be elaborated during construction phase. Monitoring should include the survey in the last year prior to construction of wind farm (fixing of exact initial situation), survey at the time of construction and survey at the work stage.

10.1.6. Chiropterans

As it is not known that there have been monitoring of chiropterans in the development area of the wind farm so far, while there are assumptions that they are found in the area, it is necessary to perform monitoring of chiropterans in the wind farm during the construction phase.

10.2. Montoring during use

10.2.1. Waves

As no wind farms have been previously built in Estonian offshore waters, the assessments given by this work and previous model simulations must be verified by measurements. This would allow modelling simulations to be specified and better interpreted in impact assessments for the construction of the following wind parks. Measurements must be made on at least two points to record the impact.

First, the wave parameters must be measured in the direction of the dominant wind direction near the wind farm. Secondly, surveys have to be done near the coast. Measurements must be made at both measuring stations for at least one year (depending on the ice conditions continuously) after the installation of the wind turbines.

10.2.2. Marine benthos

Organise monitoring of seabed habitats and sea environment in order to monitor possible changes and to allow to quickly react to unwanted changes in the condition of seabed habitats and environment:

- monitor the colonization of the foundations by the biota of the seabed (quantitative sampling/estimation, once a year, five years after foundation, the entire depth range from bottom to surface, three foundations per site);
- monitor the accumulation of organic matter in the vicinity of the foundation (sediment traps, five years, three foundations per site);
- monitor the status of seabed habitats in wind farm areas (3 station areas, underwater video observations, quantitative sampling, once a year).

With a frequency of once per year mapping of seabed fauna condition should be performed in immediate proximity to wind park and inside the wind park (20-30 stations per each complex of wind turbines). Condition of fauna of both solid and soft substrata should be assessed. In addition, after the end of construction stage a repeated sonar survey of seabed sediments should be performed within a couple of years in order to define the impact arising from with wind park on re-allocation of sediments.

10.2.3. Birdlife

Subsequent monitoring of birds stopping in the areas of created wind parks. The exact monitoring methods and time schedule should be agreed upon with the decision-maker after creation of wind park.

One of the important components of subsequent monitoring is registration of collision of birds and monitoring in operating wind park. For this, several methods have been elaborated.

10.2.4. Fish

In order to monitor the fish, a monitoring program must be developed during the operational phase. The monitoring must include a study every two years during the wind farm's operational phase. The exact study plan should be formulated in cooperation between the developer, the decision maker and the investigative body.

10.2.5. Chiropterans

Perform chiropterans monitoring at the beginning of the wind farm's lifetime.

11. COMPLICATIONS ARISEN AT ENVIRONMENTAL IMPACT ASSESSMENT AND COMPILING OF EIA REPORT

The main complication may be named the changing of the planned areas of the wind park on several occasions, which had caused repeated supplementing of assessments and report, including the necessity for additional surveys. The process of EIA performance has been going on for years, since at the time of initiation of EIA in Estonia there was absent both legal framework for constructing in the sea as well as agreed bases of using the sea areas.

Other significant complications when compiling the EIA report have not appeared.

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