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University of Tartu

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Nelja Energia AS

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NORTH-WEST ESTONIA OFFSHORE WIND PARK

SUMMARY OF ENVIRONMENTAL IMPACT ASSESSMENT REPORT

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Compiled by:	**Aune Aunapuu, Liis Kikas, Veronika Verš, Kristiina Ehapalu, Raimo Pajula, Esta Rahno, Merje Lesta, Vivika Väizene, Andres Kask, Kaarel Orviku, Georg Martin, Markus Vetemaa, Urmas Lips, Leho Luigujõe, Hendrik Puhkim**

Project number 2013_0056

Skepast&Puhkim OÜ
Laki 34
12915 Tallinn
+372 664 5808
info@skpk.ee

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SUMMARY OF THE CONTENTS OF THE REPORT

Nelja Energia AS (developer) wants to create offshore wind park **in order to** produce electrical energy with the capacity of 700-1100 MW. The developer has chosen shallows located at least 12 km from Hiiumaa coast as the location of the planned wind park. Nominal power of wind turbine is 4-7 MW, hub height 100-105 m and diameter of the rotor 130-164 m. Based on the seabed conditions the developer assesses the realistic capacity of the wind park around 700-1100 MW, i.e. installing approximately 166 wind turbines. If a type of wind turbine with a lower capacity is chosen, more wind turbines will be installed in comparison to choosing a type of wind turbine with a higher capacity. The distance between wind turbines is approximately 1 km.

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.

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. The basis for initiation of EIA is Environmental Impact Assessment and Environmental Management System Act § 6 section 1 (5), pursuant to which creation of wind power station in a body of water is an activity with significant environmental impact. The developer has submitted application for **superficies licence** to the Estonian Government on 15.04.2010. Both water special use permit and superficies licence application proceedings have been suspended until the approval of EIA report.

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.

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

The assessment results of the areas and necessary minimising measures have been summarised as follows (for better overview negative and positive impacts have been shown respectively in red and green colours):

Type of Impact	Impact at the Time of Construction	Impact at the Time of Use	Recommendation/ Proposal/ Minimising Measures for Monitoring
Impact to waves, currents, mixing	0	-1	Additional modelling of waves; measuring for one region before and after installation of wind turbines.
Impact to water quality	-1	0	Monitoring of water quality during construction works.
Impact to dispersion of suspension	-1	0	Define sediment structure in regions of connection cables and assess the dispersion of suspension; monitoring during the works time. Not to perform works in conditions of strong winds (10 m/s), especially in case of strong southern and south-eastern winds in the region TP 1 of developing zone.
Impact to dispersion of oil spot	-1	-1	Not to perform works in conditions of strong winds.
Impact to navigation risks	-1	-1	Limiting of ship traffic in the working zone at the time of construction; marking of wind park and water traffic zones.
Impact to ice-related risks	0	0	Use strong enough foundations; not to performs works in icy conditions.
Impact to number of	-1	0 or -1	Upon installation of foundations, creation of cable

Type of Impact	Impact at the Time of Construction	Impact at the Time of Use	Recommendation/ Proposal/ Minimising Measures for Monitoring
fish species			trenches and similar construction works flatfish spawning time should be avoided (May and June).
Impact to fishing (trawling)	-2 (in immediate proximity)	-1 or -2	The impact depends on how close to significant trawling areas wind turbines will be constructed and what limitations will be set to fishing.
Impact to fishing (coastal fishing)	0	0	-
Noise impact to fish fauna	-1	0 or -1	First of all, use equipment and work methods in construction works related to seabed, which create as little noise as possible.
Impact of electromagnetic fields to fish fauna	-1	-1	Use underwater cables, that create as little electromagnetic field as possible (including deepening them).
Impact on fish habitation areas (creation of artificial reef)	+1	+1	Artificial reefs provide habitation to different species of sea fauna and flora, providing among other things food and shelter to many fish species.
Impact on seabed flora on soft seabed	0	0	There is not much seabed flora in development areas, the average biomass of species is below 1 g/m^2.
Impact on seabed flora on solid seabed	-1	+1	In case of underwater parts of wind turbines use material, which does not fit for flora in order to attach.
Impact on seabed fauna on soft seabed	-2	+1	If possible, use so-called preparation of seabed in extreme necessity. As a result, seabed substratum will change, which will in turn affect fauna (habitation will change or disappear). Against erosion, use natural material from the coast.
Impact on seabed fauna on solid seabed	-1	+1	Consider not to install wind turbine foundations in areas, where fish dwell in shoals.
Impact on seabed dwelling places (shoals)	-2	0	If possible, consider not to install wind turbine foundations in areas, where fish dwell in shoals.
Impact on seabed dwelling places (sand shallows)	0	0	-
Impact on remains	-1	0	-
Impact on grey seal, including permanent dwelling place of Selgrahu grey seal	-1	-1	In case of very noisy construction works in development area TP 1 it should be considered to avoid them in the periods of whelping and shedding hair of grey seals.
Impact on ringed seal	0	0	-
Impact on white-tailed eagle	0	-1	-
Impact on special conservation areas	0	0	The closest special conservation area (Väinamere) is located at 3,5 km to wind park development areas.
Impact on birds, including planned Apollo nature reserve area	-2	-2/-1	Birds expert has proposed compromise solution – changed development area TP 1, which can be considered also a minimising measure. Upon application of minimising measures the assessment of impact at the time of use is -1 (insignificant negative).
Impact on planned Kõpu marine reserve area	0	0	-
Impact on economic	+2	+2	New direct and indirect workplaces will be created

Type of Impact	Impact at the Time of Construction	Impact at the Time of Use	Recommendation/ Proposal/ Minimising Measures for Monitoring
development and employment			in relation to construction and maintenance of wind turbines (up to 150).
Impact on Hiiumaa tourism	+1	+1	Creation of wind park will allow to find additional aspects in marketing Hiiumaa tourism with respect to new additional opportunities.
Impact on Hiiumaa society	+1	+1	Provided that 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.
Impact of vibration	-1	-1	Impact is local.
Visual impact	-1	-1	Assessment of visual impact is more subjective and depends on the observer. The distance between wind turbines and Hiiumaa coast is enough (12 km) for wind turbines not to dominate, although there may be special opinions with respect to disturbance.
Impact on human health, welfare and properties	0	0	Significant impacts are absent, since noise, vibration, low-frequency noise and infrasound will not reach local population. In order to minimise the risk of ship accidents a plan for regulating ship traffic should be drawn up for construction period.
Impact on border guard radar system	-1	-1	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.
Impact on climate changes	+1	+1	Production of wind energy will decrease CO_2 emissions, since it is a renewable source of energy. The rated economy is about 3,5 mln tons of CO_{2eq}.
Transboundary impact	0	0	Possible negative transboundary impact on migratory birds has to be specified on the basis of monitoring results at the time of use of wind park.

Summary:

Creation of wind park may have a significant negative impact on seabed fauna on soft seabed, seabed dwelling places (shoals), fishing (trawling, in close proximity) and birds, including planned Apollo nature conservation area. Necessary minimising measures have been proposed in order to decrease significant negative impact. In order to minimise impacts on birds, birds expert has proposed compromise solution, where wind turbines will not be created in Apollo shallow (Figure 1). Compromise solution is acceptable to the developer. Upon application of compromise solution there will be insignificant negative impact on birds.

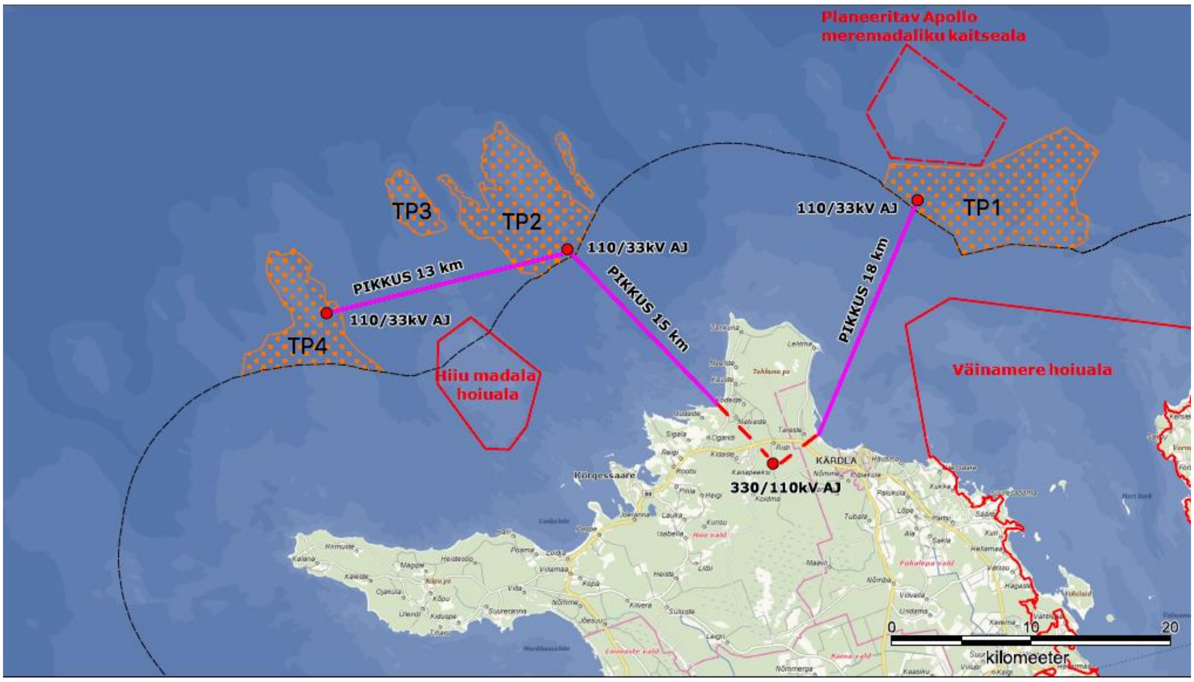

Figure 1. Compromise solution/ minimising measure for development of wind park areas

In construction phase insignificant impact may affect water quality, dispersion of suspension, fish (impact of noise and electromagnetic fields), number of fish species, seabed fauna and flora on solid seabed, grey seals and border guard radar system.

Insignificant negative impact at the time of use of wind park may affect waves, currents and mixing, fish (including number of fish species and with respect to noise and electromagnetic fields), grey seals, white-tailed eagle and border guard radar system.

Possible impacts with respect to oil spot dispersion, navigation risks, vibration and visual impact have also been assessed as insignificant negative impacts (at the time of construction and use).

Insignificant positive impact at the time of construction and use may affect fish dwelling places (creation of artificial reef), Hiiumaa tourism and society and climate changes. Positive impact at the time of use may additionally affect seabed flora and fauna on solid seabed and seabed fauna on soft seabed.

Significant positive impact will affect economic development, employment and electricity supply stability.

In case of the following areas it has been found that creation and use of wind park will not affect them: fishing (coastal fishing), seabed flora on soft seabed, seabed dwelling places (sand shallows), ringed seals, special conservation areas, projected Kõpu marine conservation area, human health, welfare and properties and ice-related risks.

In 2007 the Ministry of Environment of the Republic of Estonia has informed competent authorities of the Republic of Finland and the Kingdom of Sweden about initiation of environmental impact assessment with respect to development of wind park in north-western coastal water of Estonia. The Republic of Finland has expressed desire to participate in transboundary procedure for assessment of environmental impact. In 2011 the Ministry of Environment of Finland has been delivered EIA material for commenting. The received feedback has concentrated on birds as one of the important topics. Development may have significant impact, including on birds species dwelling in Finland, and therefore the importance of conducting profound birds survey has been emphasized in the response from Finland. The annex to this summary is a report for performed birds survey.

In case of transboundary impact it has been assessed in the summary that significant impact is absent, since the planned wind park will be located approximately 20 km away from the boundary of the Estonian territorial waters. The named distance is enough for dispersion of noise, suspension and sediments and visual impact to remain within Estonian territorial waters. Theoretically, transboundary impact may affect also fish and sea mammals, but taking into account EIA experts' conclusions, that the named impacts are insignificant, there is no significant transboundary impact foreseeable. 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. There may be possible negative impact on migratory birds at the time of use of offshore wind park, therefore the significance of the impact needs to be specified in the course of monitoring performed at the time of use of wind park.

Possible cumulative impact has been assessed in chapters on impacts by areas, e.g. impact on human health and welfare (noise, vibration, fishing etc) and properties (risks related to ship traffic), sea mammals (impact related to feeding and reproduction areas etc). Additional cumulative impact has not been discovered upon assessment.

1. OVERVIEW OF THE EIA PROCEDURE AND PARTICIPANTS

1.1. EIA participants

EIA participants are:

Developer	Decision-maker	EIA supervisor
Nelja Energia AS Regati pst 1, Tallinn 11911 Contact person: Siim Paist, phone +372 639 6610, siim.paist@neljaenergia.ee	Sea Environment Department of the Ministry of Environment Narva mnt 7a, Tallinn 15172 Contact person: Kaspar Anderson, phone + 372 626 2990, kaspar.anderson@envir.ee	Environment Organisation Department of the Ministry of Environment Narva mnt 7a, Tallinn 15172

EIA expert has been Skepast&Puhkim OÜ (*former name Ramboll Eesti AS*), 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.

1.2. EIA procedure and development of wind park areas

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.

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 1).

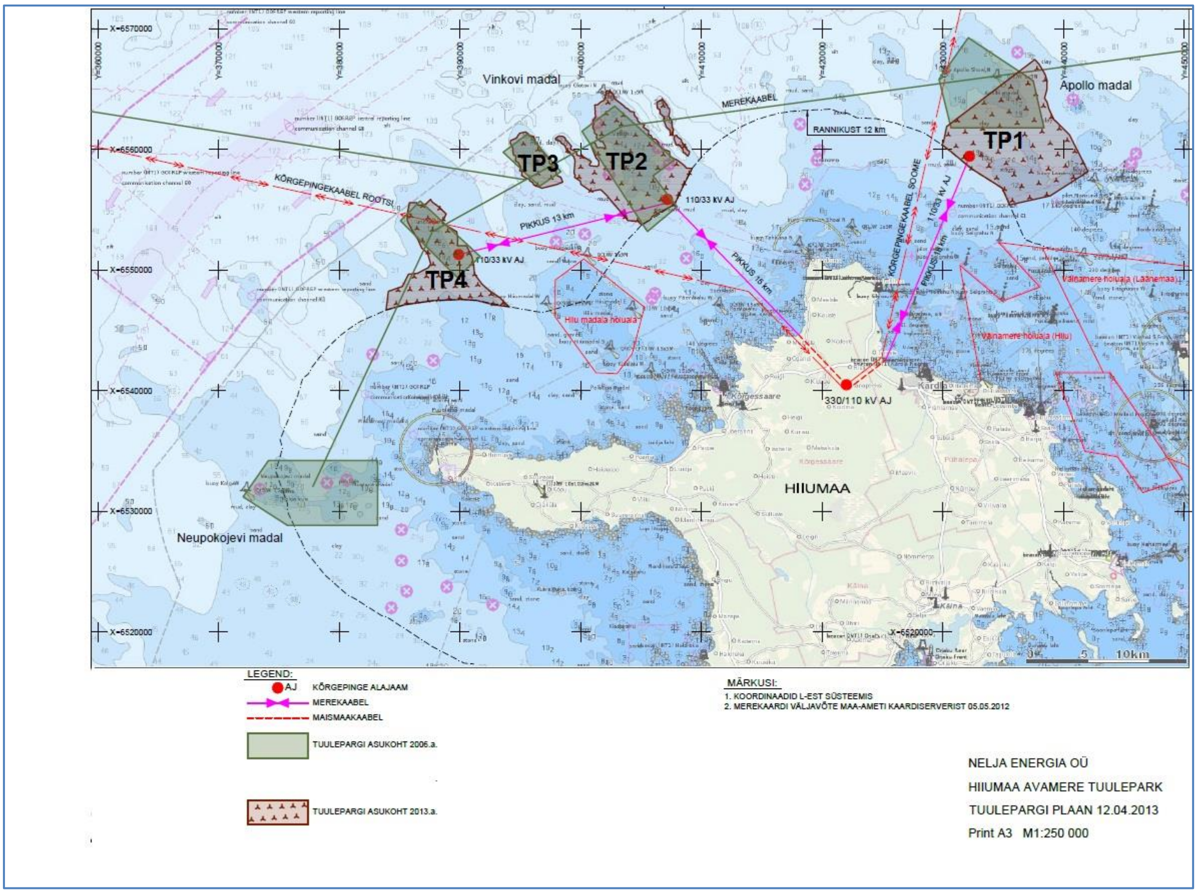

Figure 1. Location of corrected wind park areas as of 2015 compared to initial locations

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

Based on the birds survey results the birds expert has made compromise proposal in 2016, pursuant to which wind park will be created in four areas (Figure 2) – 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**.

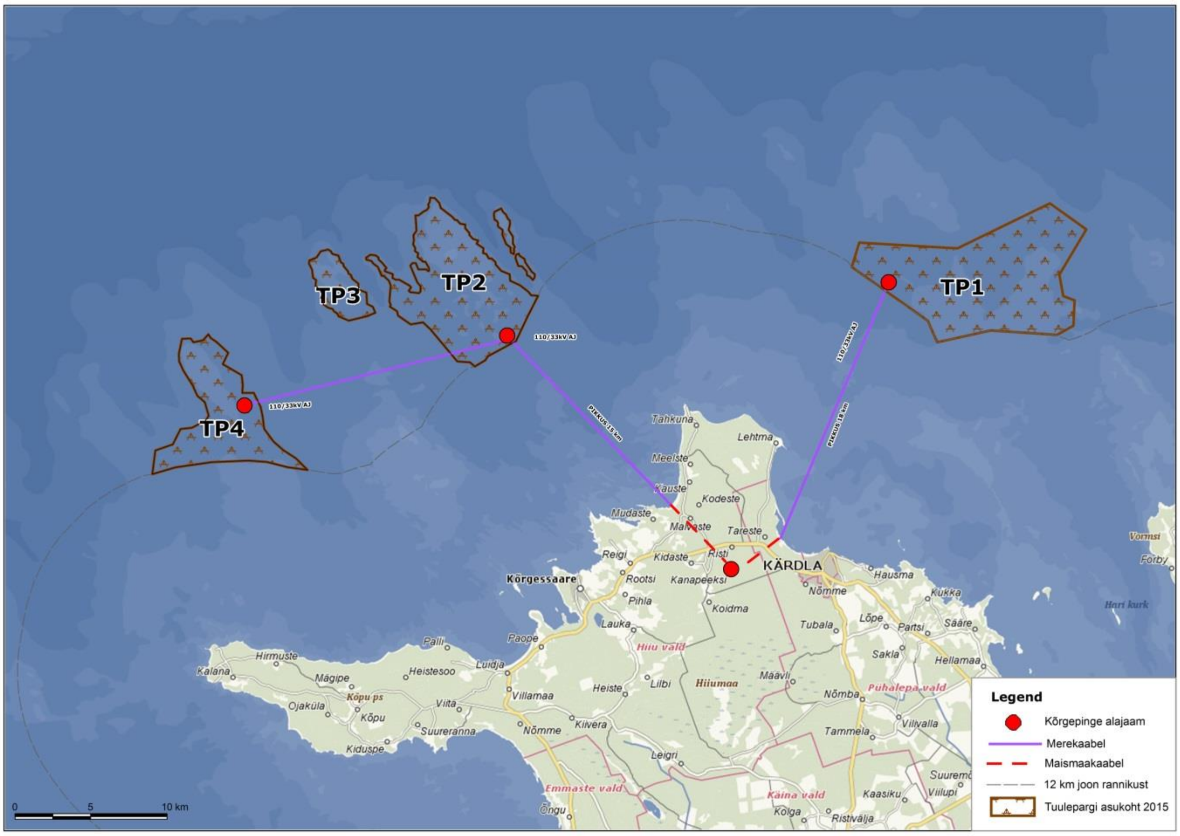

Figure 2. Compromise proposal of birds expert (minimising measure) 2016.

1.3. 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. 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. The purpose and necessity of planned activity

Nelja Energia AS (hereinafter *the developer*) is dealing with organising development of renewable energy and production of electricity. The developer desires to create an offshore wind park with capacity of up to 1100 MW with **the purpose** of producing electrical energy.

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.

2.2. 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 3). 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, which have been refused in the course of EIA procedure (see chapter 1.2).

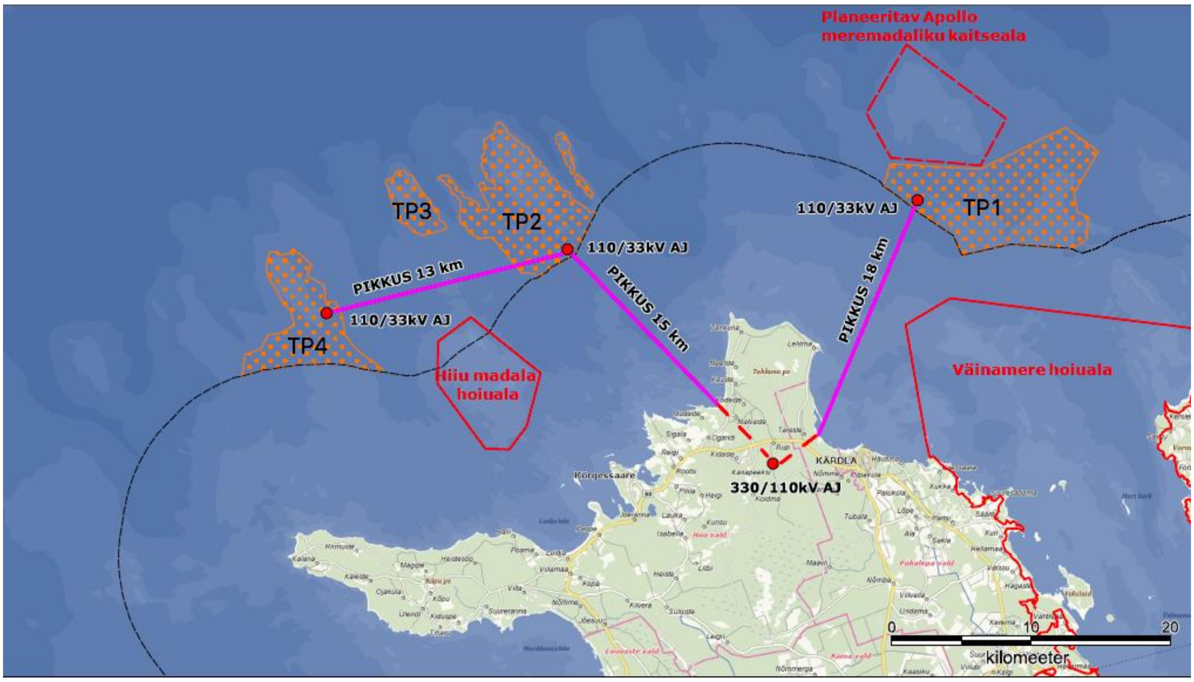

Figure 3. Areas of planned wind park

Presumed yearly productivity of the wind park will be 2,4-3,8 TWh, including productive hours in a year 3500. Depth of the sea in the wind park area may not be more than 30 m. Network connection is planned through substation, and presumed construction time of the wind park is 2 years.

For example, Siemens SWT and Vestas V type wind turbines are fit for installation of wind turbines into the sea. Nominal power of wind turbine is 4-7 MW, hub height 100-105 m and diameter of the rotor 130-164 m. Based on the seabed conditions the developer assesses the realistic capacity of the wind park around 700-1100 MW, i.e. installing approximately 166 wind turbines. If a type of wind turbine with a lower capacity is chosen, more wind turbines will be installed in comparison to choosing a type of wind turbine with a higher capacity. The distance between wind turbines is approximately 1 km.

At the moment the most powerful electrical wind turbine in serial production, which is produced in the world, has a nominal power of 7 MW. Wind turbines technical development works is going on constantly and at a quick speed, and due to this it is possible that at the time of construction of wind park it will be technically possible to use more powerful wind turbines than 7 MW. It is important that in case of use of more powerful wind turbines the dispersion of their noise should not have greater environmental impact, than the most powerful wind turbine surveyed in this work. Top height may be increased up to 10%, which will not significantly change visual impact of the wind park. It is apparent from performed visualisations that visual impact is analogous in case of wind turbines of different size, since the first wind turbines of the wind park are located 12 km away.

General details of different types of wind turbines have been presented in the following table (Table 1).

Table 1. 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 (Figure 4)	6	< 102	154	75
Vestas V164-7.0 MW	7	< 105	164	80

Parameters for Siemens SWT 6 MW wind turbine are presented in the following figure (Figure 4).

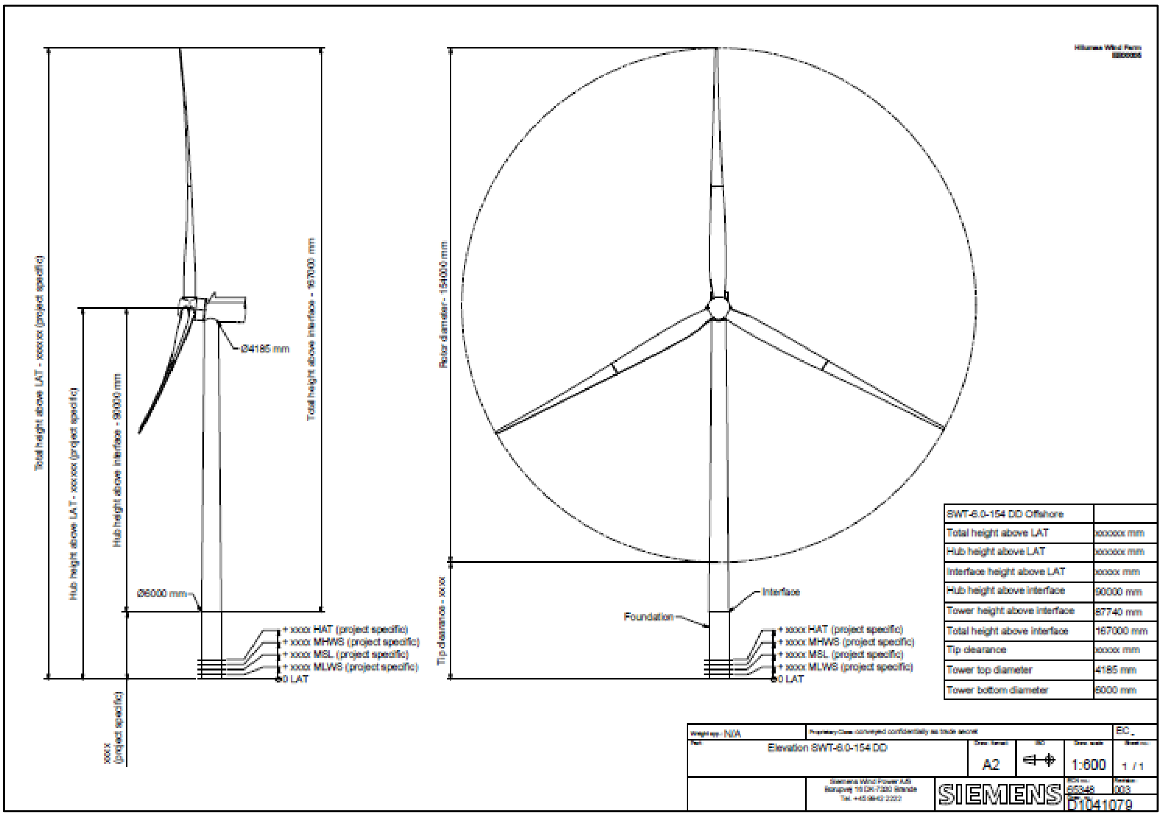

Figure 4. Parameters for Siemens SWT 6 MW wind turbine

2.3. 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 5):

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

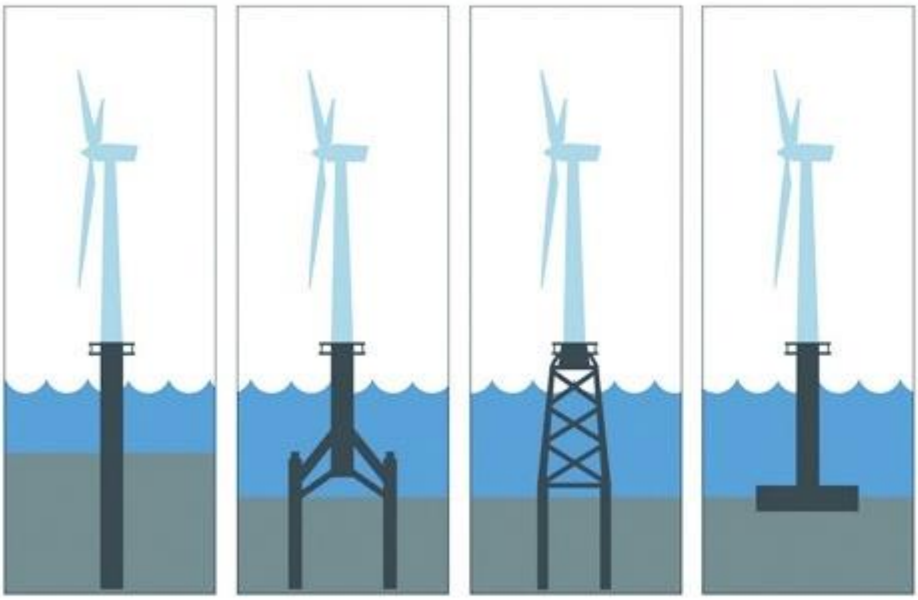

Figure 5. Types of foundations for electrical wind turbines (from the left: monopile, tripod, jacket and gravity based structure)[1]

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.

2.4. Phases of construction of offshore wind park

2.4.1. 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

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

[2] Potential of Offshore Wind Energy Industry for Estonian Companies, 2011. Garrad Hassan and Partners Ltd

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 3). 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.

2.4.2. 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. Since installation of cables (including the choice of cables) is related to several aspects and depends on concrete project solutions, more detailed impacts can be found out only within respective expert assessment or upon compiling a cabling project in the course of a separate EIA.

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 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

[3] Rødsand 2 Offshore Wind Farm Environmental Impact Assessment Summary of the EIA-Report, 2007

[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-

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 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]

2.4.3. 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 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.

2.4.4. 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.

2.4.5. 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

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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

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.

2.5. 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 the meaning of alternatives impact assessment there are different possibilities in order to achieve the purpose of the planned activity. 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. The developer has analysed different contemporary possibilities regarding the foundations for open sea wind turbines and ordered respective seabed surveys. Based on characteristics of seabed and changing ice-related conditions it is technologically possible to use only one type of foundation in the proposed area (gravity based structure) (see EIA report chapter 2.3), thus other types of foundation are not considered in EIA as real alternatives. When assessing the impacts on different spheres experts have considered gravity based structure of the foundation.

With respect to open sea wind turbines the developer has chosen three different contemporary types of wind turbines of with the newest technology and the highest parameters that are produced at the moment: Siemens SWT 4 MW, Siemens SWT 6 MW and Vestas V 7 MW. Wind turbines mainly differ by the power (4, 6 or 7 MW), rotor diameter (130, 154 or 164 m) and propeller blade length (63, 75 or 80 m). Differences in hub height from the water are not large, hub height would be 100-105 m. The distance between wind turbines should be at least 1 km. If wind turbines with lower power are chosen, it will be possible to install more wind turbines – approximately 182 (4 MW), which would make up the total capacity of the wind park 728 MW. If wind turbines with the highest power are chosen, it would be possible to install approximately 166 wind turbines with a total capacity about 1100 MW.

Dispersion of noise has been modelled for different types of wind turbines in the course of EIA. Modelling has been performed, taking into account the worst possible noise situation in the region. As a result of noise modelling it has been found, that the noise level of 55 dB will be dispersed in case of the most powerful type of wind turbine Vestas V164-7.0 MW to the distance of up to 270 m from the wind park. Noise level of 40 dB will reach approximately 1500 m from the wind park. In case of other types of wind turbines dispersion distances are smaller. Since the wind park will be created at least 12 km from Hiiumaa coast, noise will be a problem for people. Ornithologists have also considered noise impact on birds to be insignificant (see EIA report chapter 5.6). It is also the experts' assessment that wind turbines have no significant negative impact of underwater noise on fish and sea mammals (see EIA report chapters 3.4 and 3.5). Thus, considering in the EIA reports of different types of wind turbines (power and number) from the point of view of comparing the alternatives is not reasonable or necessary. It is recommended to choose wind turbines creating as little noise as possible.

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.

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 2) 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 2. 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.

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 and winter, spring and summer 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.

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 3). The most numerous species, as

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

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 3. 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 4). For less numerous species density model has not been made, since it may be not correct. Table 5 census data and assessment of number are provided for birds that stopped separately at Apollo shallow.

Table 4. 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							1800					10

	gull												
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 5. 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. 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 6).

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 5), 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 5), 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.

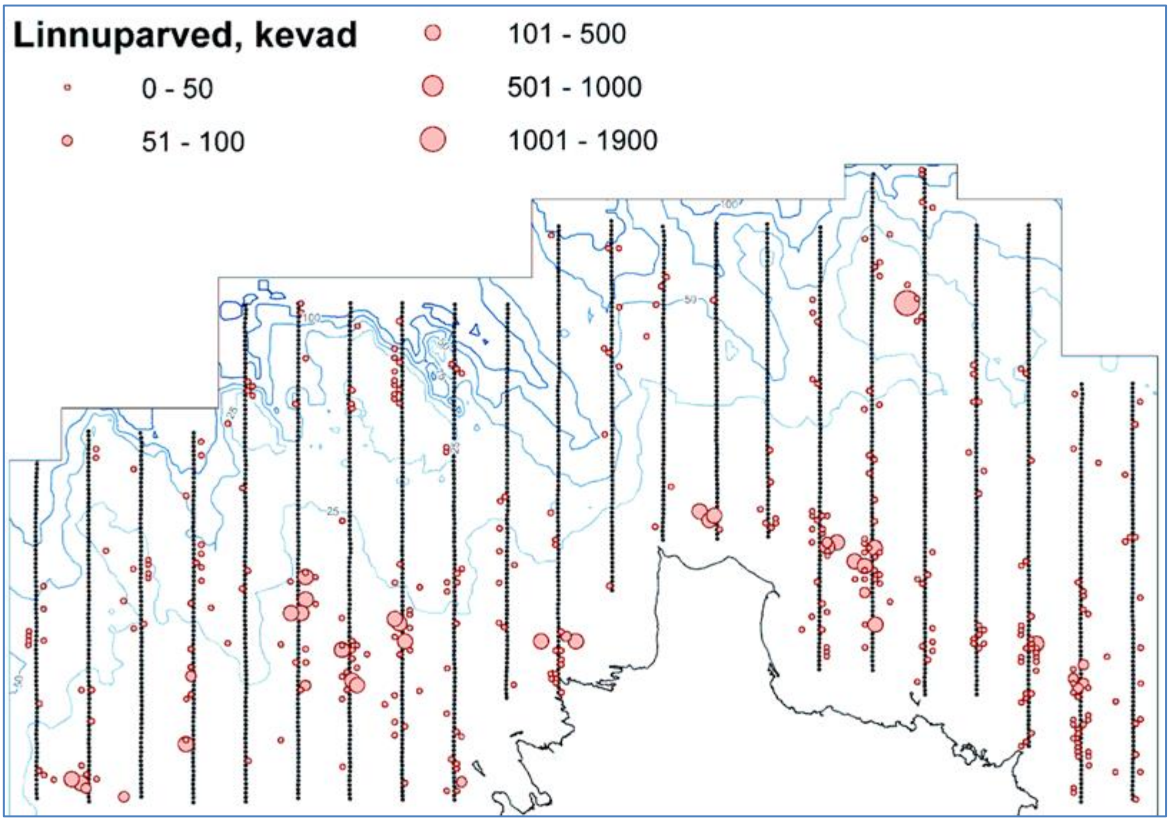

Figure 6. In spring, water birds stop in the census area (census data), 16.05.2015

3.6.2. Moulting

Moulting migration of arctic water birds occurs in July and August. Dominating species are scoters (common scoters with great majority) and charadriiformes. 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 Hiiumaam 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 7, Figure 8).

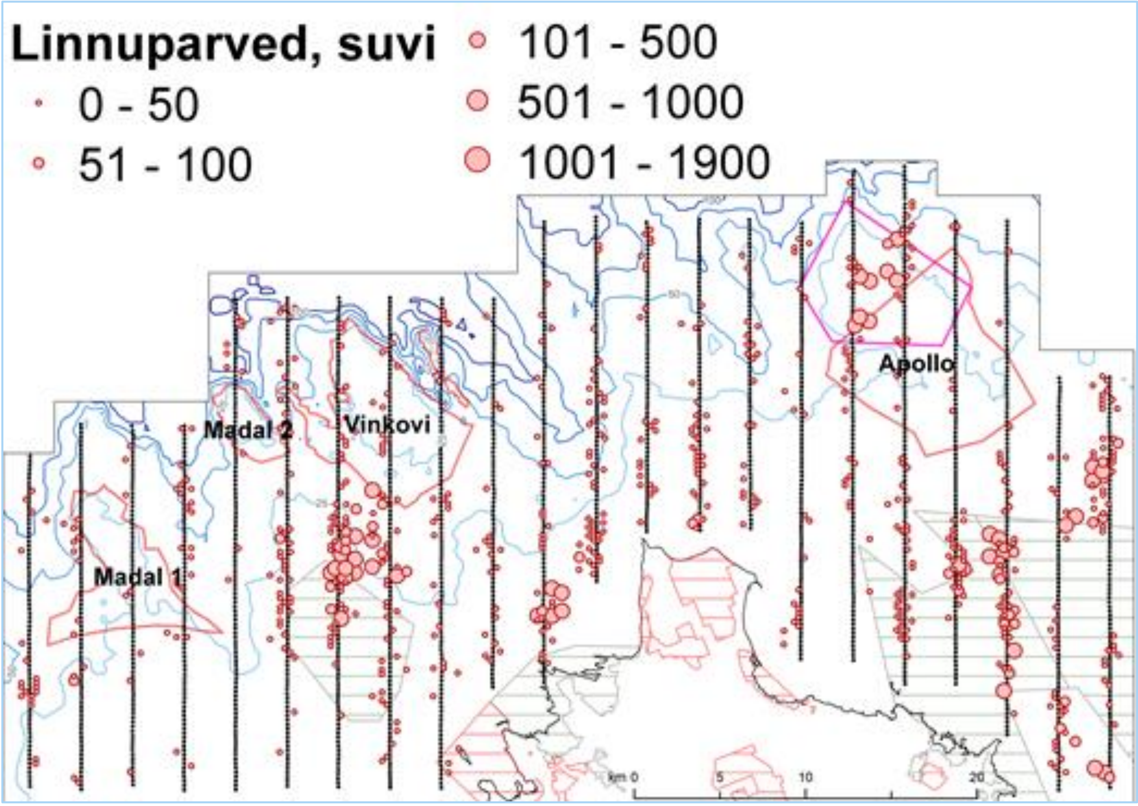

Figure 7. Location of water birds in the census area, that stop in the summer (census data), 04.08.2015 (shaded areas – conservation areas, red contour line areas in the sea – development areas, purple contour line area – planned Apollo conservation area)

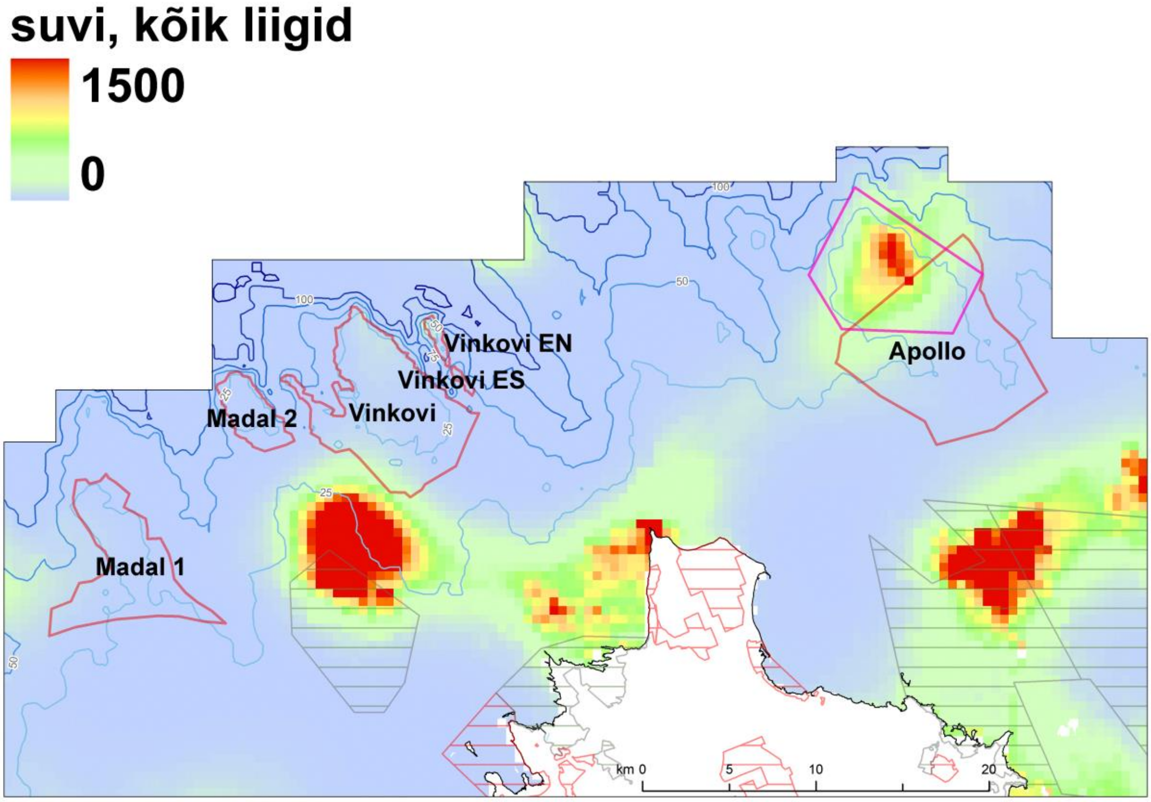

Figure 8. Summer dispersion of water birds and assessment of density amount in coastal sea of North-Hiiumaa, 2015

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.

3.6.3. 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 9). 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.

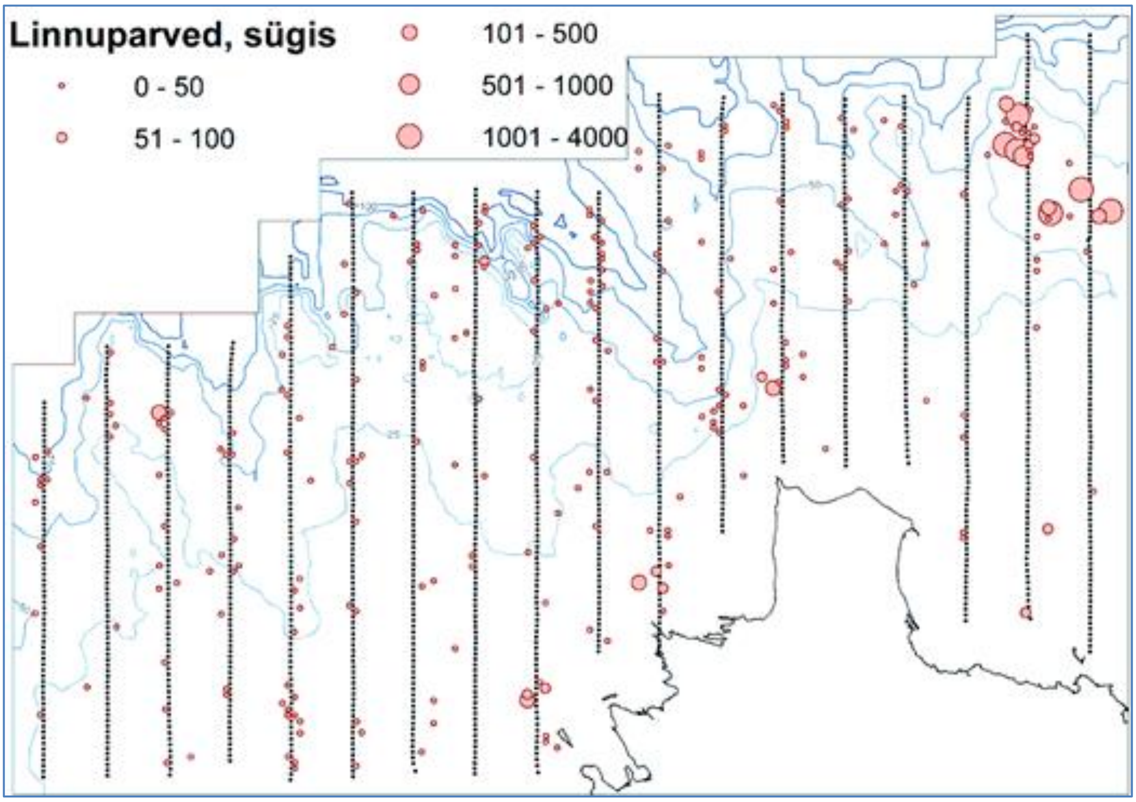

Figure 9. Water birds flocks stopping in the census area (census data), 30.11.2014

3.6.4. 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 10). 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 11).

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 12). 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 13).

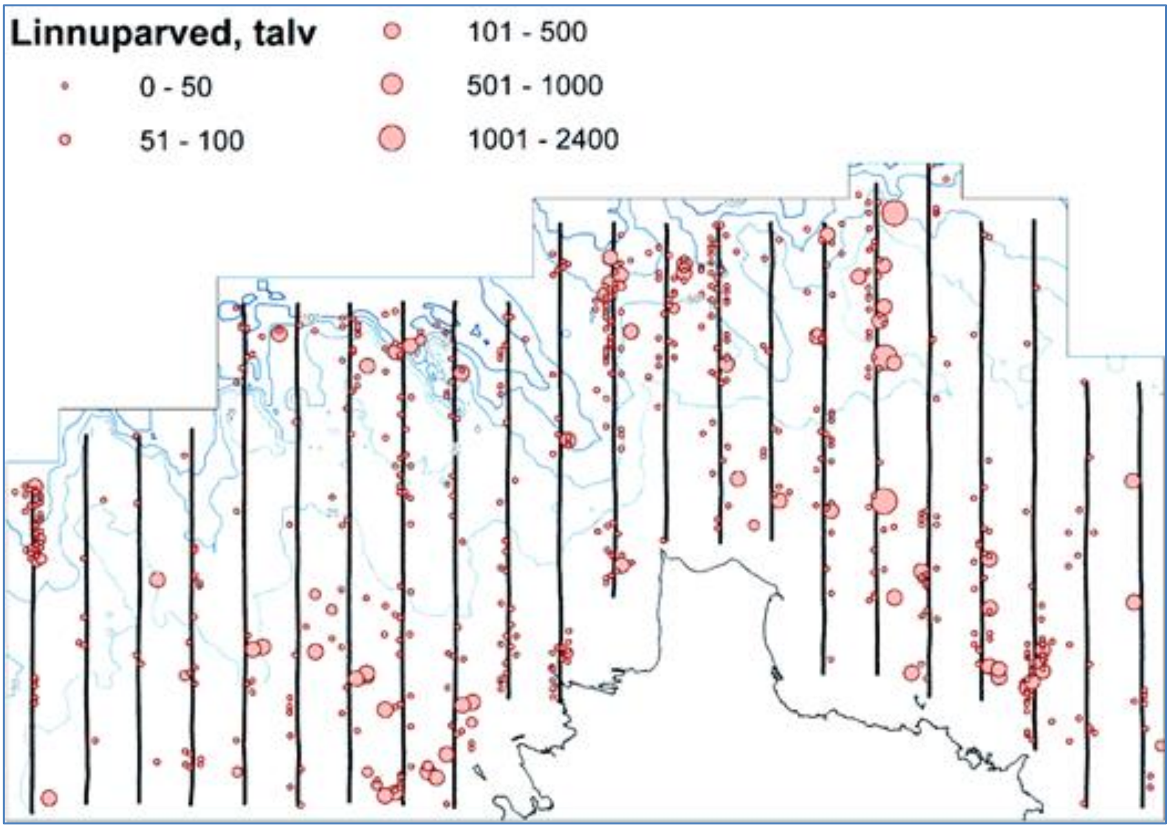

Figure 10. Location of wintering water birds in the census area (census data), 02.02.2015

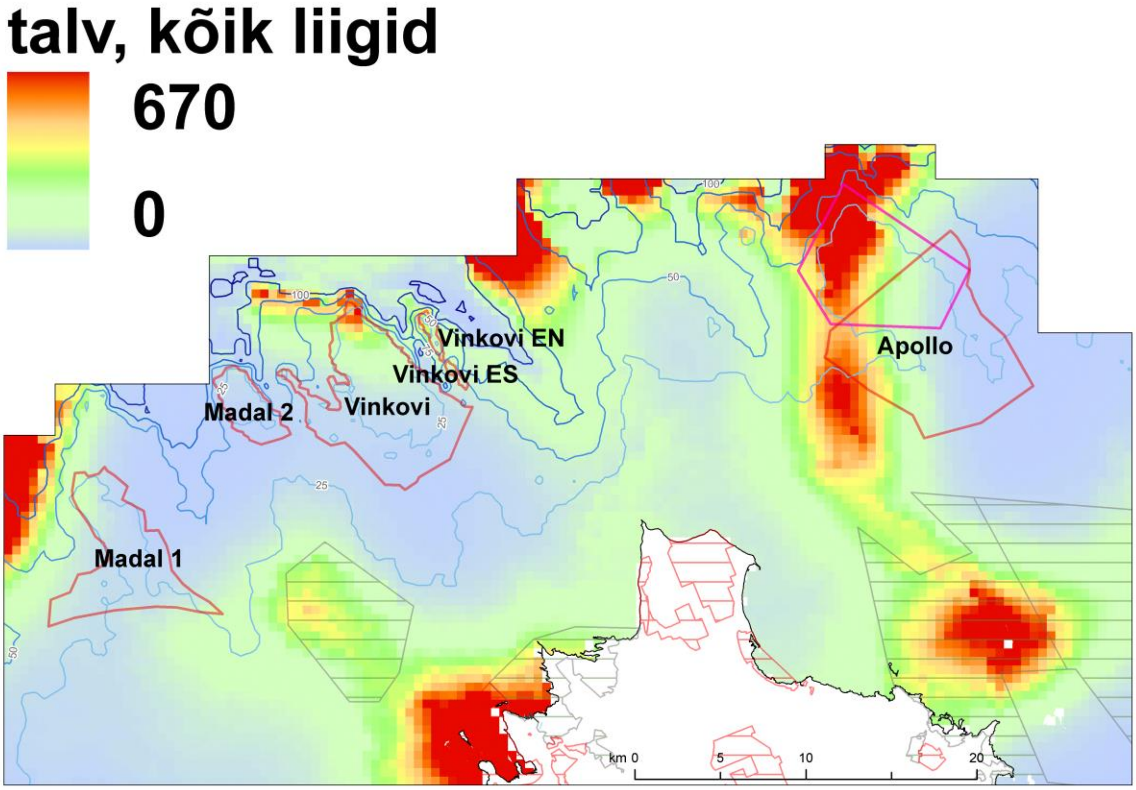

Figure 11. Winter dispersion of water birds and assessment of population density in coastal sea of North-Hiiumaa, 2015

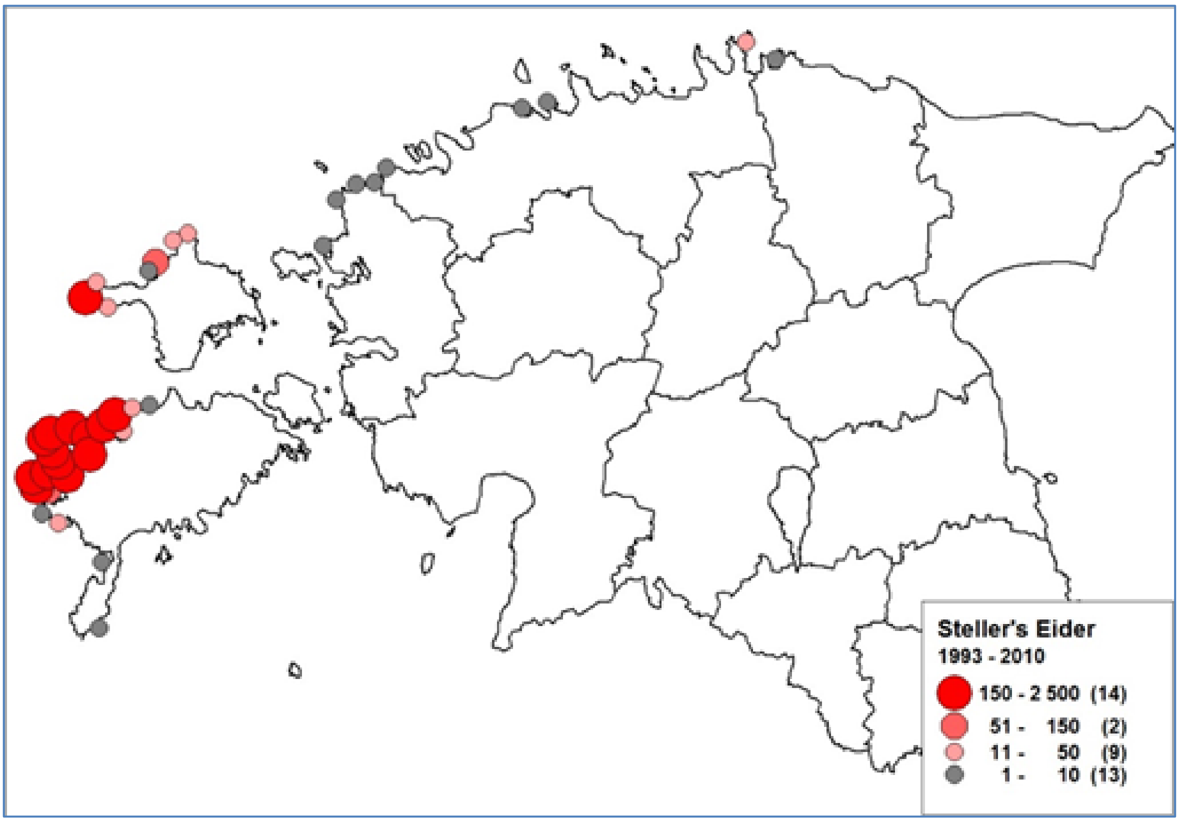

Figure 12. Steller's eider's winter dispersion according to water birds census in the middle of winter 1993-2010

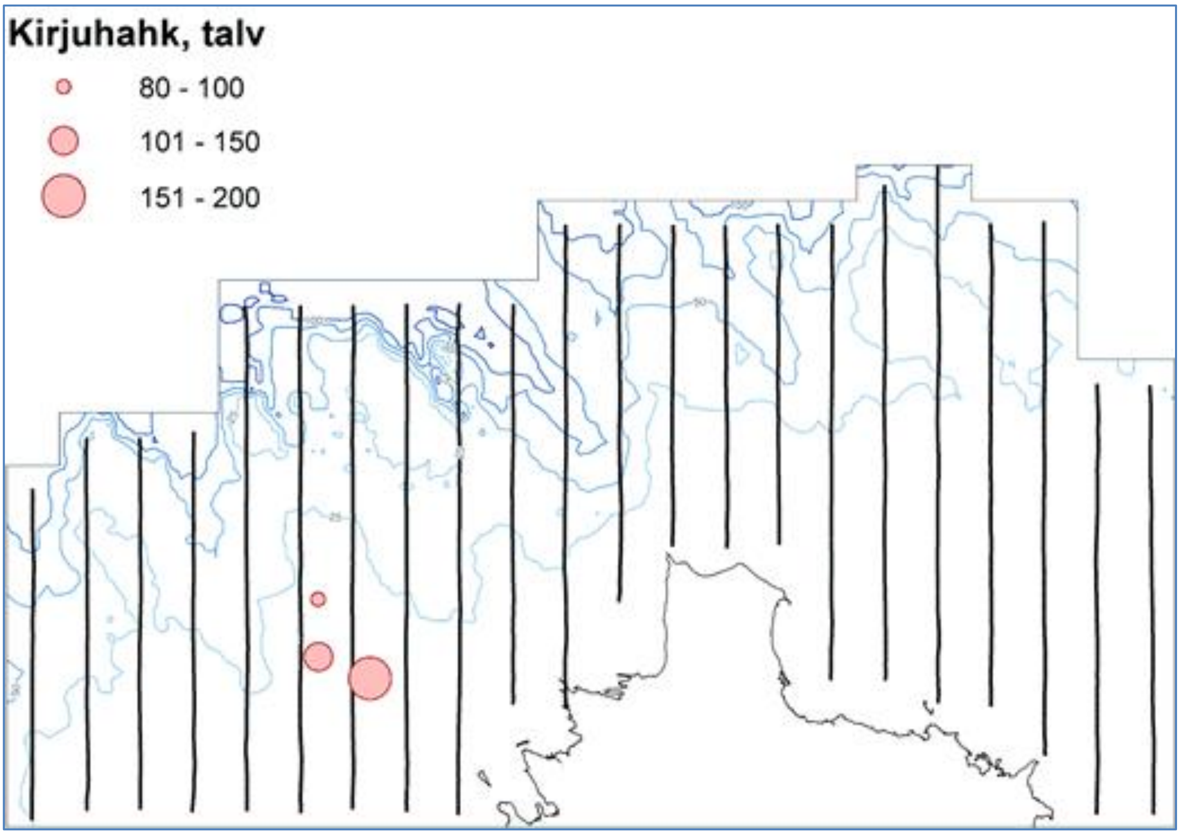

Figure 13. Steller's eider's wintering area at Hiiu shallow, winter 2015

3.6.5. 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.

3.7. Areas and objects under protection in the region

3.7.1.1. Conservation area of Hiiu shallow

Conservation area of Hiiu shallow is located 4 km away in the east from the development area TP 4 of the planned wind park and 5 km away to south-west from the development are TP 2. 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

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

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.

3.7.1.2. Conservation area of Kõrgessaare-Mudaste

Conservation area of Kõrgessaare-Mudaste is located 11 km away to south-east from the development area TP 2 of the wind park. 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.

3.7.1.3. Paope nature conservation area

Paope nature conservation area is located 12 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. 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.

3.7.1.4. Tahkuna nature conservation area

Tahkuna nature conservation area is located on Tahkuna peninsula 12 km to south-west from the development area TP 1 and 12 km to south-east from the development area TP 2 of the wind park. 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.

3.7.1.5. Väinameri conservation area

Väinameri conservation area's northern tip is located 3,5 km to south from the development area TP 1 of the wind park. 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.

3.7.1.6. Permanent habitat of Selgrahu grey seal

Selgrahu grey seal's permanent habitat is located 3,5 km to south from the development area TP 1 and at the same time intersects with Väinameri nature and birds area. Selgrahu located 3,5 km to south away from the development area TP 1 is one of 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.

3.7.1.7. Planned protection areas

According to the data from Environmental Register, two planned new protection areas are located in the region of wind park areas: Apollo nature protection area and 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.

Apollo nature protection area has been planned in the sea area of Apollo shallow with the size of 5 217 hectares. Apollo shallow is an essential place for stopping, feeding and wintering of water birds. Big gatherings of long-tailed duck stop in the regions. The purpose of protection area is to protect Apollo sea shallow and underwater sandy shallows and flocks that can be found there, that are endangered primarily by the sea pollution, but in addition they are endangered by construction activity related to wind parks at the habitat and sandy shallows are endangered by digging. Out of migrating birds in the area the following are protected: long-tailed duck with decreasing number (*Clangula hyemalis*), common scoter (*Melanitta nigra*), little gull (*Larus minutus*) and common eider (*Somateria mollissima*). Presumed deadline for formation of protection area and enactment of decree regarding protection rules is September 2017.

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 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.[15] 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.[16] 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 migration of velvet and common scoters over the sea area in July-August and summer migration of gulls and sternas occurs.[17]

3.7.2. 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.

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.[18]

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[15] http://ilmajaam.postimees.ee/807232/eestimaa-looduse-fond-soovib-kopu-merekaitseala-loomist

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

[17] 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

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

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.[19] 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.[20]

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.

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.

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

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

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[21], 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[22] 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.

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.[23]

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[21] Harbour Register www.sadamaregister.ee 08.07.2015

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

[23] 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.

Distances of Natura areas from the areas of the planned offshore wind park are the following:

- Hiiu shallow nature conservation area – 4 km;
- Kõrgessaare-Mudaste birds area – 11 km;
- Väinamere birds area – 3,5 km;
- Väinamere nature conservation area – 3,5 km;
- Kõrgessaare-Mudaste nature conservation area 11 km;
- Paope nature conservation area – 12 km;
- Tahkuna nature conservation area – 12 km.

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 (Figure 14).

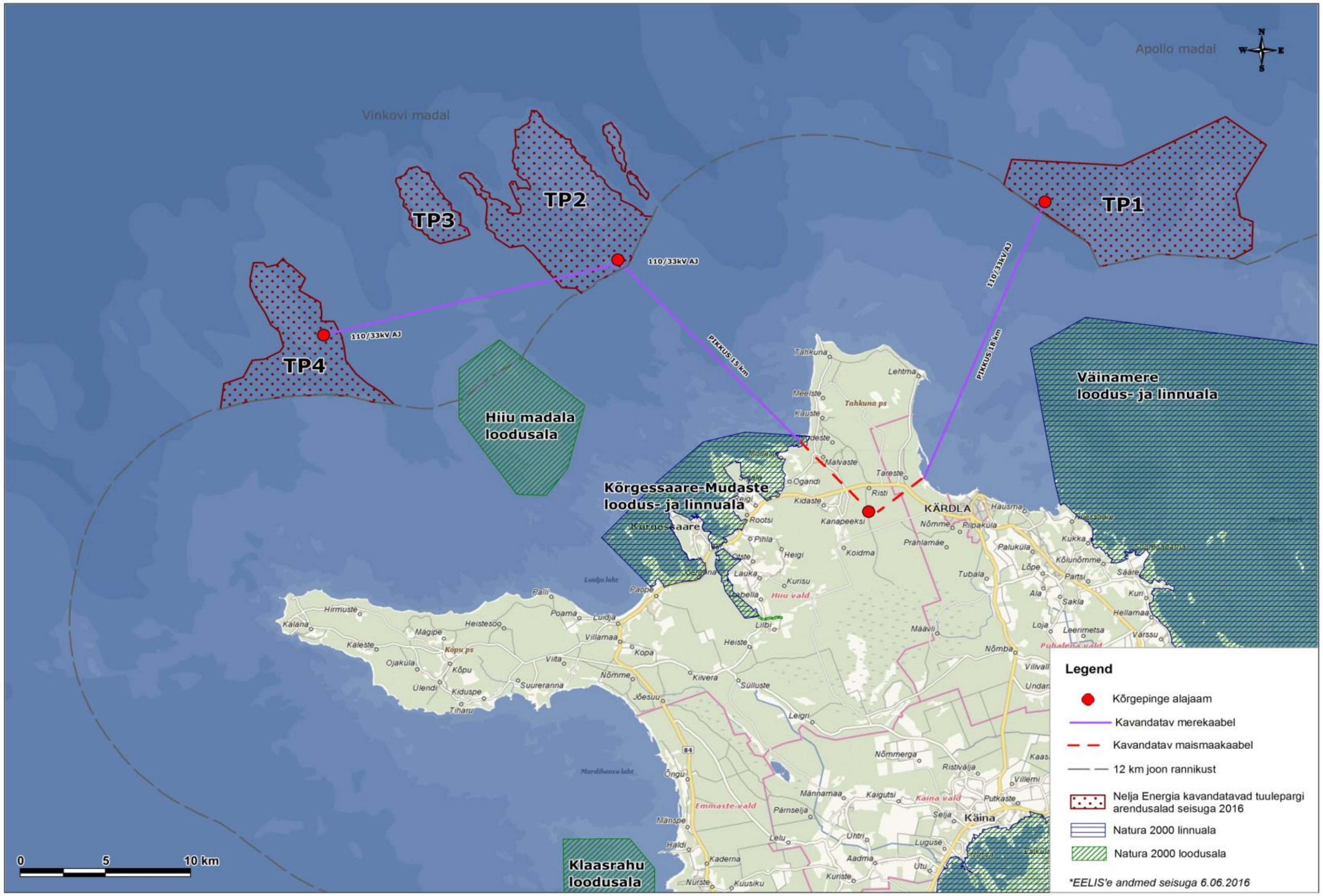

Figure 14. Natura areas closest to the project area (EELIS, June 2016)

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 an area of wind parks, 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).

In case of most impacts and impacted environmental elements significant impact is limited to on kilometre, except for dispersion of suspension, which may reach up to 3 km (in case of strong winds).

5.2. Impact on hydrodynamics

5.2.1. Impact to waves, currents and mixing

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.

The most important conclusions are as follows:

- Decrease of wind on the coast arising from using the wind parks is marginal, only in case of northern winds may a small impact be presumed. Within the wind park and in its close proximity (downwind) decrease of wind speed may be significant.
- Impact of the bodies of wind turbines on wave fields is marginal, the extent of decrease of waves height is less than 2 cm at the distance of 3-4 km. On the basis of performed theoretical calculation, impact arising from decrease of wind affects wave height through its decrease up to 10% in immediate proximity to wind park and less than 2% on the coast.
- Taking into account the planned locations for wind turbines, they will not impact wind regime in case of majority of wind directions (south-western and western) and apparently waves as well in the area important for surfers and vacationers in the coastal sea of western part of Kõpu peninsula (Ristna). Impact cannot be excluded in case of northern winds, probability of which is below 20 per cent in the region.
- Impact of wind turbines on currents and vertical mixing is local and apparently indistinguishable in the background of natural changeability.
- Impact of topography of sea bed remained to be local.

General assessment: 0 – neutral (at the time of construction); -1 – insignificant negative (at the time of use); in both cases direct and indirect (waves downwind)

5.2.2. 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 in case of usable wind turbines allegedly 700 m^3 of soil is removed (levelling the seabed and stabilising of the basis). Considering the duration of the wind park construction works period up to 2 years, the amount of sailing substance getting into water at once is relatively limited.

The results of impact assessment are the following:

- Dispersion of suspension from the works area and its impact has relatively local meaning, the extent of which will apparently not exceed 3 km also in case of strong winds (10 m/s);
- The dispersion of suspension is directed towards coastal sea from the development area TP 1 in case of strong western winds, from the development areas TP 2, TP 3 and TP 4 in case of strong north-western (also N-NW) winds;
- Taking into account immediate proximity of the part of wind park constructed in the development area TP 1 to planned conservation area, suspension would be dispersed to conservation area in case of strong southern and south-eastern winds, which are present in the regions 5% of the time;
- Upon construction of wind turbines in the areas of soft sediments the dispersion of suspension may be wider.

General assessment: -1 – insignificant negative (at the time of construction); 0 – neutral (at the time of use); in both cases indirect

Recommendations

- 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 works related to installation of wind turbines' bases in the region of development area TP 1 in case of strong (over 10 m/s) southern and south-eastern winds;
- In case if wind turbines are installed in the region of soft sediments and the amount of small-grained soil to be processed exceeds 10 000 m^3, addition assessment of suspension dispersion has to be made (if necessary, on the basis of modelling calculations);
- Prior to installation of connection cables sediment characteristics and suspension dispersion have to be assessed in the concrete region, in order to give recommendation for minimisation of environmental impact in the course of works.

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.

General assessment: 0 – impacts are absent or neutral

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 15).

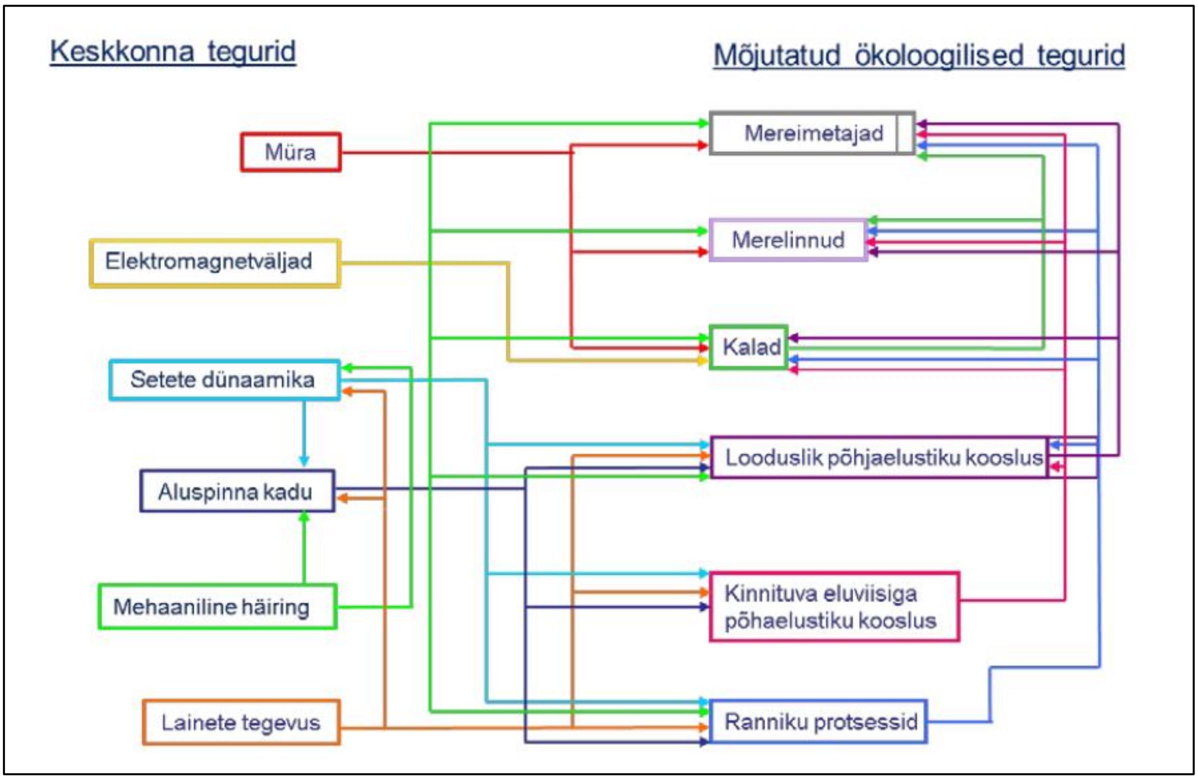

Figure 15. Impacts of environmental factors on ecology factors of sea environment at the phase of construction of offshore wind park (Hiscock et al. 2002)

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 16).

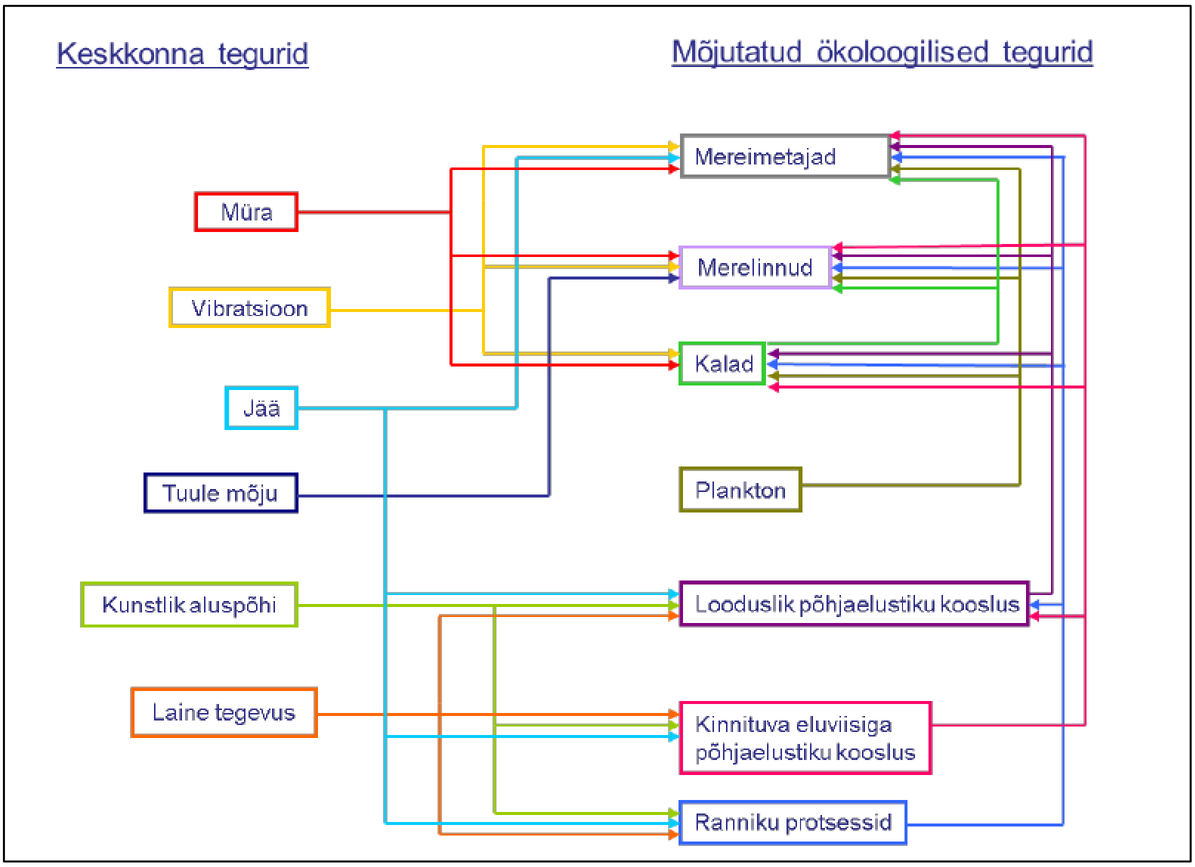

Figure 16. Impacts of environmental factors on ecology factors of sea environment at the phase of putting into use of offshore wind park (Hiscock et al. 2002)

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).

General assessment:

Impact on seabed fauna	**Impacts at the time of construction**	**Impacts at the time of use**	**Measures for avoidance or minimising of negative impact (if necessary)**
Impact on seabed flora on soft seabed	0	0	
Impact on seabed flora on solid seabed	-1	1	In case of underwater parts of wind turbines use material, which does not fit for flora in order to attach.
Impact on seabed fauna on soft seabed	-2	1	If possible, use so-called seabed preparation in case of extreme necessity. As a result, seabed substratum will change, which will in turn affect fauna (habitation will change or disappear). Against erosion, use natural material from the coast.
Impact on seabed fauna on solid seabed	-1	1	If possible, consider not to install wind turbine foundations in areas, where fish dwell in shoals.
Impact on seabed habitats (reefs)	-2	0	If possible, consider installation of wind turbines foundations outside the area of reef-type habitats, so that win turbine foundation would not be upon the seabed habitats.
Impact on seabed habitats (sandy shallows)	0	0	

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.

5.5.2. Impact on fish

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.

General assessment:

Impact on fish	Impacts at the time of construction	Impacts at the time of use	Measures for avoidance or minimising of negative impact (if necessary)
Impact on number of fish species	-1	0 or -1 (in order to give a more exact assessment scientific surveys are absent regarding the impact on the region's most significant industrial species (Baltic herring and sprats)	Upon installation of foundations, creation of cable trenches and similar construction works flatfish spawning time should be avoided (May and June)
Impact to fishing (trawling)	-2 (in immediate proximity)	-1 or -2 (the impact depends on how close to significant trawling areas wind turbines will be constructed and what limitations will be set to fishing)	
Impact to fishing (coastal fishing)	0	0 (known coastal fishing areas are not located in the majority of development areas)	
Noise impact to fish fauna	-1	0 or -1 (in order to give a more exact assessment scientific surveys are absent regarding the impact on the region's most significant industrial species (Baltic herring and sprats)	
Impact of electromagnetic fields to fish fauna	-1	-1 (at the same time, the assessment has not been well founded by scientific surveys, since the relevant literature has gaps)	Underwater cables should be used, that create as little electromagnetic field as possible (including deepening them)
Impact on fish habitation areas (creation of artificial reef)	1	1	

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

During migration Estonia is crossed by significant part of populations of different species. Migration follows often coastline, what causes massive gathering at hoe tips and narrow straits. 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. This does not create significant risk for species feeding with fish (loons, merguses) and pelagic species (gulls, sternas), since these species are able to manage also in a deep water and are not directly tied to shallows. They may gather on shallows' edge areas, where fish reserves may be richer.

In the course of performed survey it has been found that **the biggest concentration of migrating stopping and wintering water birds was at Apollo and Hiiu shallow** (Table 5). Since it is known, that water birds avoid wind turbines with working rotors – the reason is apparently vibration and noise arising from rotors' work (Petterson, 2005, Hötker et al., 2006) – **then projecting and construction of wind parks is not recommended in these areas.**

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.

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.

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) 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**.

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

The birds species with higher level of 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.

Since water birds avoid wind parks, then the risk of their collision with wind turbines is relatively low. Although it may happen in very bad weather conditions. Also in those conditions this probability is small, since no migration is usually taking place in bad weather.

Wind park lights may be very big risk especially to migrating land birds, since they attract migrating birds into wind park areas. Based on visual observations from the coast, migration corridor of land birds closest to project area is located from Dirhami and Spithami Nina over Osmussaare to Hanko and vise versa.

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).

As a positive aspect, it may be pointed out that this process is not long-term or irreversible and seabed fauna will apparently recover after time.

Operation on wind park

Since wind parks do not have a positive impact on sea birds, then with respect to this places for location of wind parks should be chosen very accurately in order to minimise negative impact. The existence of wind park and activities should be compared, which will arise with maintenance of wind park and keeping it in use, then in the latter case it will have significantly less impact than the first.

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.

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 17). That's why the amount of birds stopping in migration is significantly higher in autumn.

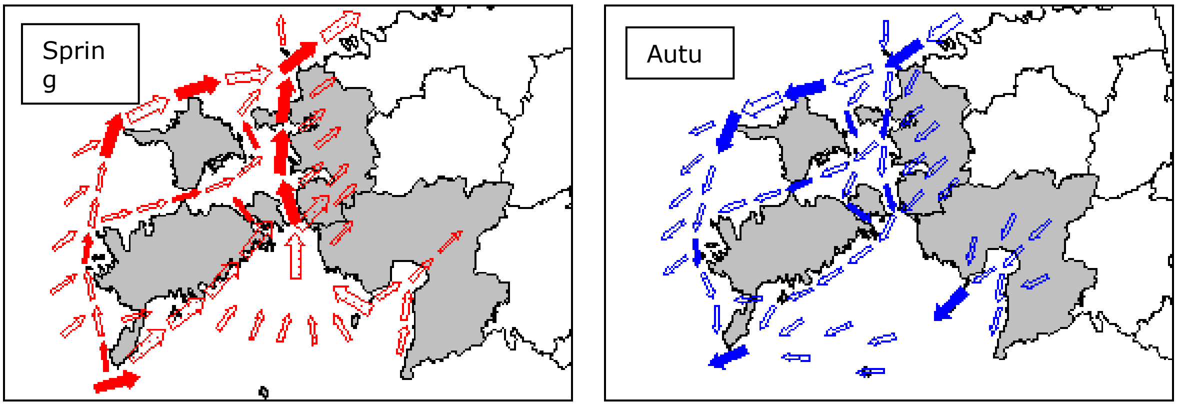

Figure 17. Transit migration of arctic water birds in coastal area of Western Estonia

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 2016 procedure has been initiated for formation of nature protection area of Apollo sea shallow, which is very important for birds fauna[24].

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

[24] Formation of nature protection area of Apollo sea shallow www.keskkonnaamet.ee/uudised-ja-artiklid/apollo-meremadaliku-looduskaitseala-moodustamine/

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.[25]

5.6.6. Compromise proposal/minimising measure

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 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) (Figure 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.

General assessment: -1 – insignificant negative impact

5.7. Impact on sea mammals

Grey seal

Wind park areas are located in the open sea in the region, which is a reproduction area for grey seal located on ice. In Hiiumaa surroundings seals reproduce in moderate or more frosty winters on hummocked ice fields in the north from Hiiumaa. Out of wind park areas, the most important areas of reproduction on ice is the region of Apollo shallow. At least in winters with moderate frost reproduction of grey seals on ice is possible apparently in all areas of wind park.

In the region of wind park areas 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 probable, since the species is widely dispersed in the area of almost entire Baltic Sea. Earlier experience shows that the wind park areas will become, especially at their construction stage, unsuitable for grey seals as habitats and possible whelping areas (Aasa, 2013). Since offshore wind parks include relatively small part of open sea areas, then the possibilities for whelping on ice will not significantly become worse for the species in the wider region. Offshore wind parks may have some impacts on the region's ice conditions, since wind turbines' relatively numerous hubs with big dimensions will prevent the movement of ice fields and may enhance creation of immovable ice in the area of wind parks, between them and to the south from them. Thus, the duration period of ice cover in the region of Hiiumaa and Väinameri may be longer and thereby conditions for seals' whelping on ice may become better.

In case if at the construction stage there are works with high level of noise, the impacts may reach significantly further from the area of wind park. Selgrahu is located 3,5 km to south away from the development area TP 1, which is one of the most important rookeries of grey seals in western Estonia. In Selgrahu, there is the most numerous grey seal rookery of the region, where in major cases 400-600 seals are gathering in spring period of shedding hair. Grey seals use Selgrahu in case of bad ice conditions for whelping as well, when whelping on ice is not possible. Creation of offshore wind park in the development area TP 1 will not directly impact grey seal's habitat, but during the wind park construction stage some disturbances may impact the species due to noise. Possible disturbances at the time of construction will be temporary and apparently will not cause irreversible impact or significant worsening of habitat quality and permanent decrease of the use of area. In case of very noisy construction works in development area TP 1 it should be considered to avoid them in the periods of whelping and shedding hair of grey seals.

Pinnipeds as a rule avoid wind park areas also at the stage of their operation, but due to the distance of 3,5 km noise arising from wind turbines work and visual disturbance in comparison to

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

immediate proximity is significantly smaller. Thus, it may be presumed that Selgrahu rookery quality and the number of seals using it will not significantly decrease. In case if due to impacts at the time of construction and due to new unusual structure Selgrahu rookery use decreases, then the previous use at the stage of operation of wind park will presumably recover during several years. The second most important seals' rookery located in the northern part of Väinameri, Kadakalaid, is located significantly further from wind park areas (17 km) and impacts during wind park construction and operation stage will not reach it.

General assessment: -1 – insignificant negative impact

Ringed seal

Ringed seal subpopulation of western Estonia has concentrated in Väinameri, the Gulf of Riga and the Gulf of Pärnu, where the whelping conditions are more suitable. There are no permanent dwelling places of ringed seals or areas or recreation areas suitable for reproduction in the region of planned wind park. Appearing of ringed seals in wind park areas is possible primarily in the course of feeding migrations, but this is rather accidental, and it is not significant dwelling place for the species. Therefore, creation and operation of wind park will not have significant impacts on population of ringed seals.

General assessment: 0 – no significant impacts

5.8. 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.

General assessment: -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).

5.9. 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 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. It may be said that the impact will remain relatively local and the transfer of sediments to heritage protection values in significant amounts is not likely[26]. Impacts on heritage protection values at the time of construction of wind park may be greater in some places, than at the time of putting into operation, but considering their short-term character the impact will still not be significant.

General assessment: -1 – insignificant negative impact

5.10. Noise, infrasound and vibration

5.10.1. 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;
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: 55 dB at day and 40 dB at night time.

As a result of noise modelling it has been found, that the noise level of 55 dB will be dispersed in case of the most powerful type of wind turbine Vestas V164-7.0 to the distance of up to 270 m from the wind park. Noise level of 40 dB will reach approximately 1500 m from the wind park. In case of other types of wind turbines distances are smaller. Hiiumaa coast is approximately 12 km away from the wind park. **From this a conclusion can be made, that noise levels exceeding the permitted normative levels will not reach residential areas.**

Generally known is the circumstance, that the wind profile affects the dispersion of noise in the external conditions. Noise levels are stronger for a listener, if the wind blows from the source of

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[26] Assessment of environmental impacts arising from construction of offshore wind parks in north-western Estonian coastal sea. Estonian Marine Institute of the University of Tartu, 2011

[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

noise (noise id downwind). In case of sidewind, where the wind blows between listener and the source of noise, presumed noise levels are approximately 2 dB lower than in case of downwind levels. In case of noise dispersion upwind (in the direction of the source of noise from the listener) noise levels may be up to 10 dB lower due to refraction of noise (listener remains in so-called hidden part of noise waves dispersion)[30].

Results on noise modelling calculate noise dispersion downwind and wind turbine technical details according to the wind speed of 8 m/s. In case of wind speed below 8 m/s and in case of different wind direction other than downwind, noise level arising from wind turbines and reaching the listener are even lower, than presented on the noise map.

General assessment: 0 – no impact

5.10.2. Infrasound

Infrasound are called sound waves, the frequency of which is below 20 Hz[31]. 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 rotating.[32] Infrasound and low-frequency sounds are dispersed almost without getting weaker into building on the contrary to sounds with higher frequency.[33,34]

Surveys show that infrasound created directly by wind turbines, have so low frequency and strength, which human ear does not register.[35] According to the measurement performed in Australia[36] 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.[37]

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.

[30] EPA, 2011. Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3). www.epa.ie/pubs/advice/noise/Wind_Turbine_web.pdf Visited on 28.06.2013

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

[32] 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

[33] 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

[34] 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)

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

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

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

General assessment: 0 – no impact

5.10.3. Low-frequency noise

Low-frequency noise are deemed soundwaves, the frequency of which is within the interval of 10-200 Hz.[38] 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 measurements performed in Finland that in two cases out of three real measurements provide lower results than the modelling of noise[39].

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)[40] 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: 0 – no impact

5.10.4. 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.[41,42]

In case of contemporary wind turbines vibration has insignificant activity and it is not transferred further outside the wind turbine foundation[43,44]. Insignificance of vibration impact is also confirmed by experience of Denmark by the example of Horns Revi and Nystedi offshore wind

[38] 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"
[39] Low frequency noise and infrasound survey. Ramboll Finland OY, 2016
[40] 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
[41] 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
[42] Preliminary assessment of environmental impact of Seljametsa-Tammuru wind park in Paikuse parish. Hendrikson&Ko OÜ, 2008
[43] EISA report of detailed plan compiled for Triine land plot and parts of Ado land plot in Esivere village. Entec AS, 2006
[44] Preliminary assessment of environmental impact of Seljametsa-Tammuru wind park in Paikuse parish. Hendrikson&Ko OÜ, 2008

parks.[45] 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.[46]

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.

General assessment: - 1 – insignificant negative impact

5.11. Social-economic impact

5.11.1. Impact on economic development and employment [47] [48]

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).

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

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

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

[48] 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

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 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. [49] [50]

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[51]. 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). IN summary, it may be concluded that the impact of the planned activity on fishing possibilities and on Hiiumaa fishing sector is neutral or absent.

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: + 2 – significant positive impact

5.11.2. 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

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[49] http://www.offshore-stiftung.com/60005/Uploaded/Offshore_Stiftung%7C2013_04SBO_SOW_tourism_study_final_web.pdf
[50] http://www.tuuleenergia.ee/2016/08/pohjamere-saar-pani-tuuleenergia-enda-kasuks-toole/
[51] Hiiumaa ecenomic review 2013

and lower interest against visiting the regions.[52] Until now the world experience has not seen or perceived negative impact on tourism with creation of offshore wind parks resulting in the decrease of the number of tourists[53]. 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.[54, 55]

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: + 1 – insignificant positive impact

5.11.3. 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.[56] 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[57].

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.[58]

Hiiu parish, Nelja Energia 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

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[52] 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

[53] 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

[54] Lilley, M. B.; Firestone, J.; Kempton, W. 2010 The Effect of Wind Power Insallations on Coastal Tourism. Energies 3, 1-22

[55] 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

[56] 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

[57] 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

[58] Karjus, M. 2011. Compensation to local societies for tolerance regarding wind parks www.riigikogu.ee/v/failide_arhiiv/Tuulepargid.pdf

not less than EUR 0,32 per each produced MWh of electricity.[59] 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[60]. 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 Nelja Energia 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: + 1 – insignificant positive impact

5.11.4. 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[61].

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 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

[59] 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
[60] Potisepp, M. 2014. Impacts of the wind park to Hiiumaa inhabitants, Hiiu Leht www.tuuleenergia.ee/2014/04/meretuulepargi-mojud-hiidlastele/
[61] MTÜ Arhipelaag 2009. Local benefit upon creation of wind parks

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.

5.11.5. 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).

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.[62]

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.[63]

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 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: -1 – insignificant negative impact

5.11.6. Impact on human health and well-being

From noise modelling results it has been found that the noise level of 55 dB (application level) will be dispersed only in proximity to wind park (max of 270 m of distance). It may concluded

[62] Hendrikson&Ko OÜ, 2010. Neugrund offshore wind park EIA report

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

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.

General assessment: 0 – no significant impacts

5.11.7. 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: 0 – no significant impacts

5.12. 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.[64] 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 named distance is enough in order for the noise (see chapter 5.10.1 of the EIA report), dispersion of suspension and sediments (see chapters 5.2.2 and 5.3) and visual impact (see chapter 5.11.5) 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), which have been examined in chapter 5.6 of this report. The significance of the named impact needs subsequent clarification in the course of monitoring performed at the time of operation of wind park;

[64] http://energiatalgud.ee/index.php?title=Elektriturg&menu-60#label-NPShind2

4. Theoretically transboundary impact may appear also on fish fauna and sea mammals. However, taking into account conclusions reached in chapter 5.5.2 and chapter 5.7 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: 0 – no significant impacts

5.13. 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 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[65].

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: -1 – insignificant negative impact

5.14. 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

[65] 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)

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.[66] In 2015, wind parks have produced a total of 693 GWh of energy.[67] 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 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.[68] 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: +1 – insignificant positive impact

[66] http://elering.ee/taastuvenergia-kattis-moodunud-aastal-167-protsenti-elektri-kogutarbimisest/
[67] http://elering.ee/taastuvenergia-kattis-moodunud-aastal-167-protsenti-elektri-kogutarbimisest/
[68] 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 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 2.3 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: 0 – neutral (if recommendations are taken into account)

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 18). 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.

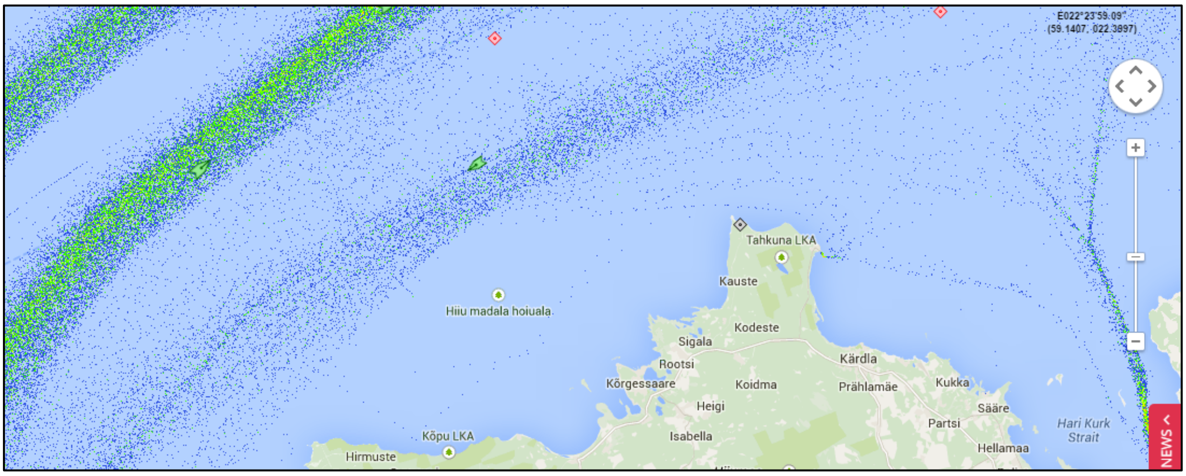

Figure 18. Intensity of ship traffic according to the data of AIS (*Automatic Identification System*) (source: Marinetraffic.com, 23.10.2014)

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: - 1 – insignificant negative, direct

6.3. Possible prognosis of the dispersion of oil spot

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: -1 – insignificant negative (not likely probable, direct)

Recommendations

First of all, upon performance of works it is necessary to follow safety rules, which exclude the arising of oil pollution. Since some risk of oil pollution is at the time of construction of wind park, it is 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 to be created 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. It will significantly decrease the probability of getting of pollution to the coast.

7. MEASURES FOR MINIMISING SIGNIFICANT NEGATIVE ENVIRONMENTAL IMPACT

Seabed sediments

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 works related to installation of wind turbines' bases in the region of development area TP 1 in case of strong (over 10 m/s) southern and south-eastern winds.

In case if wind turbines are installed in the region of soft sediments and the amount of small-grained soil to be processed exceeds 10 000 m^3, addition assessment of suspension dispersion has to be made (if necessary, on the basis of modelling calculations).

Prior to installation of connection cables sediment characteristics and suspension dispersion have to be assessed in the concrete region, in order to give recommendation for minimisation of environmental impact in the course of works.

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) 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;
3) 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);
4) 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.

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.

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.

<u>Light types</u>

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.

Fish

Temporary limitation – Avoid construction works in May and June, when flounder is spawning.

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.

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 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

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.

8. PROPOSALS FOR MONITORING

8.1. Monitoring at the time of construction

Seabed sediments

Since in different regions there are small-grained sediments and there is high probability that suspension may be created during construction works, we recommend to perform, prior to planning of works, geophysical survey with profiling sonar in order to map the dispersion area of sediments. Sonar survey will allow to map and analyse dispersion limits of sediments creating suspension and thereby to plan subsequent actions in such a way, that their environmental impact would be smaller.

Seabed fauna

Monitoring of seabed habitats and sea environment should be organised at the time of construction 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.

Birds

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.

Fish

For monitoring of fish fauna a programme should be elaborated both for construction as well as operation stage. Monitoring should include the survey in the last year prior to construction of park (fixing of exact initial situation), survey at the time of construction and survey at the work stage every two years. The exact plan of the surveys should be formulated in co-operation of the developer, MoE and survey institution.

8.2. Monitoring at the time of operation

Seabed sediments

Perform additional modelling of waving parameters, which taken into account project solution of the wind park and based on that weakening of the wind downwind wind turbines.

Seabed fauna

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.

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.

Birds

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.

Fish

See chapter 5.5.2.

9. 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.

10. USED MATERIALS

Aasa, A. 2013. Impact of constructions and disturbance on pinnipeds and their use of room. Bachelor Thesis, University of Tartu, Institute of Ecology and Life Sceinces, supervisors J. Remm and M. Jüssi

Aslund, M. L. W., Ollson, C. A., Knopper, L. D. 2013. Projected contributions of future wind farm development to community noise and annoyance levels in Ontario, Canada. Energy Policy 62: 44-50

Assessment of the environmental impacts of cables. Ospar Commission, 2009 http://qsr2010.ospar.org/media/assessments/p00437_Cables.pdf

Assessment of environmental impacts arising from construction of offshore wind parks in north-western Estonian coastal sea (EIA report). Estonian Marine Institute, University of Tartu Manager of EIA expert group Ahto Järvik, Tallinn 2011

Bojars, E. 2007. EIA for offshore wind parks – potentials for conflicts with NATURA 2000 designation. Riga

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

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

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

ENMAK 2030. Energy economy development plan until 2030. Draft (submitted to Riigikogu) http://eelnoud.valitsus.ee/main#eToX34NI

Energy economy development plan until 2030. EISA report. Estonian Development Foundation, Irje Möldre, 12.19.2014

Estonian fishing strategy 2014-2020

Estonian environmental strategy until 2030 and its programme 2007-2013

Estonian maritime policy 2012-2020 and Estonian maritime strategy

Estonian state strategy for economical development "Economical Estonia 21"

Website of Estonian Wind Energy Association www.tuuleenergia.ee/

Estonian Wind Energy Association, 2004. Handbook for assessment environmental impacts of electric wind turbines

EIA Report; Benthic Communities; Horns Rev 2 Offshore Wind Farm, 2006

EPA, 2011. Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3). www.epa.ie/pubs/advice/noise/Wind_Turbine_web.pdf Visited on 28.06.2013

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

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

Guidelines for the establishment of the Natura 2000 network in the marine environment. Application of the Habitats and Birds Directives, http://ec.europa.eu/environment/nature/natura2000/marine/docs/marine_guidelines.pdf

Programme for protection of grey seal (*Halichoerus grypus*), 2014

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)

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

Hendrikson & Ko OÜ, 2010. Neugrund offshore wind park EIA report

Hiiumaa development strategy 2020+. Hiiumaa Municipalities Union. Kärdla, 2013

Social-economic survey of increasing Hiiumaa electricity supply reliability and technical preliminary survey. Civitta Eesti AS. Elering AS, 2014

Hiiu rural municipality website http://hiiu.maavalitsus.ee/documents/180835/1011719/Hiiumaa+elektrivarustuskindluse+tostmise+sotsiaalmajanduslik+uuring+ja+tehniline+eeluuring.pdf/aed414ef-db97-4909-9dd5-fbf6eccf683b?version=1.0

Hiiu rural municipality website http://hiiu.maavalitsus.ee/arengukavad-ja-uuringud

Hiiu rural municipality website http://hiiu.maavalitsus.ee/maakonnaplaneering

Hiiu rural municipality website http://hiiu.maavalitsus.ee/merealade-teemaplaneering

Hiiumaa webiste www.hiiumaa.ee/hiiumaa-info/

Hiiumaa website www.hiiumaa.ee/transport/

Survey of fish fauna of Hiiumaa shallows region. Estonian Marine Institute, University of Tartu, Tartu 2014

Thematic plan of wind energy of Hiiu county plan http://hiiu.maavalitsus.ee/et/hiiu-maakonna-planeeringu-tuuleenergeetika-teemaplaneering

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

County plan of sea area bordering with Hiiu county and its EISA report

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

Programme of Hiiumaa renewable energy 2020. Hiiumaa Municipalities Union, 2012

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

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

Survey of fish fauna of Hiiumaa shallows region. Estonian Marine Institute, University of Tartu Tartu 2014

http://elering.ee/taastuvenergia-moodustas-2014-aastal-148-protsenti-elektri-kogutarbimisest/

http://elering.ee/elektrienergia-tarbimine-ja-tootmine-eestis/

http://elering.ee/aasta-prognoos/

http://energiatalgud.ee/index.php?title=Elektriturg&menu-60#label-NPShind2

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

http://webarchive.nationalarchives.gov.uk/+/http:/www.berr.gov.uk/files/file43527.pdf

http://www.hydro-international.com/issues/articles/id665-Offshore_Wind_Farm_Cable_Survey.html

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

Impact of wind turbines on tourism, 2013, http://www.renewablesinternational.net/impact-of-wind-turbines-on-tourism/150/505/71736/

Jüssi, I. 2011. Monitoring work "Seals – data for flight census of grey seals" (2011) of the state environmental monitoring programme subprogramme "Monitoring of live nature diversity and landscapes", MTÜ Pro Mare

Jüssi, I. & Jüssi, M. 2014. Monitoring work "grey seals flight censuses" and "grey seals' reproduction success" (2014) of the state environmental monitoring programme subprogramme "Monitoring of live nature diversity and landscapes", MTÜ Pro Mare

Jüssi, M. 2013. Monitoring work "Ringed seal flight censuses" (2013) of the state environmental monitoring programme subprogramme "Monitoring of live nature diversity and landscapes", MTÜ Pro Mare

Karjus, M. 2011. Compensation to local societies for tolerance regarding wind parks www.riigikogu.ee/v/failide_arhiiv/Tuulepargid.pdf

Kask, A. & Kask, J. 2007. Surveys of seabed sediments at shallows located in the west, north-west and north from Hiiumaa. OÜ Altakon Grupp, Tallinn, p. 220

Website of the Ministry of Environment www.envir.ee/et/analuus-ja-planeerimine

Website of the Ministry of Environment www.envir.ee/et/merestrateegia

Ministry of Environment, 2014. "Estonian environmental programme for 2007-2013" final report www.envir.ee/sites/default/files/ktk_2007-2013_lopparuanne.pdf

The decree of the Minister of Environment No. 78 as of 20.12.2005 "Taking of grey seal and ringed seal permanent habitats under protection and protection guidelines" www.riigiteataja.ee/akt/13299788

Klompamaker, J.; Lenze, B. 2008. Recent experiences in long-term performance of geosynthetics as filtration, containment or reinforcing elements in coastal structures – case studies & design requirements. In. A changing coast: challenge for environmental policies. Abstracts. 9th International Conference, November 25–28, 2008, Venice Italy

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

Attendance of museums of administrative area of the Ministry of Culture 2013 www.kul.ee/sites/default/files/copy_of_kum_haldusala_muuseumide_kylastatavus_2013.pdf visited on 08.07.2015

State Registry of Heritage Protection http://register.muinas.ee/public.php as of 17.08.2015

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

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

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

Lilley, M. B.; Firestone, J.; Kempton, W. 2010 The Effect of Wind Power Installations on Coastal Tourism. Energies 3, 1-22

Connecting of north-west Estonian offshore wind park to main network. Empower AS. January 2015

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

Nature protection programme until 2020

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

Lutt, J.; Raukas, A. (toim). 1993. Estonian shelf geology. Geology Institute of Estonian Academy of Sciences, Estonian Geology Centre, Tallinn, p. 192

Map application of Road Administration of Land Board 08.07.2015

Website of Ministry of Rural Affairs www.agri.ee/eesti-kalanduse-strateegia-2014-2020/

Moller, H., Pedersen, CS. 2004. Hearing at low and infrasonic frequencies. Noise & Health 6: 37-57

Moller, H., Pedersen, C.S. 2010. Low-frequency noise from large wind turbines. The Journal of the Acoustical Society of America 129: 3727-3744

MTÜ Arhipelaag 2009. Local benefit upon creation of wind parks

Offshore wind farms and the environment. Danish experience from Horns Rev and Nysted. Danish Energy Authority

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

Pierpont, N. 2009. The Wind Turbine Syndrome: A Report on Natural Experiment

Potential of Offshore Wind Energy Industry for Estonian Companies, 2011. Garrad Hassan and Partners Ltd

Potisepp, M. 2014. Impacts of the wind park to Hiiumaa inhabitants, Hiiu Leht, http://www.tuuleenergia.ee/2014/04/meretuulepargi-mojud-hiidlastele/

Puhkaeestis.ee www.puhkaeestis.ee/et/orjaku-linnuvaatlustorn visited on 08.07.2015

Puhkaeestis.ee www.puhkaeestis.ee/et/vanajoe-org visited on 08.07.2015

Põder, T. Environmental impact and assessment of environmental risk. Handbook. Tallinn 2005

Northern Sea island has put wind energy to work for its benefit, http://www.tuuleenergia.ee/2016/08/pohjamere-saar-pani-tuuleenergia-enda-kasuks-toole/

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

Offshore wind energy, 2010, http://www.eesi.org/files/offshore_wind_101310.pdf

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

Review of cabling technique and environmental effects applicable to the offshore wind farm industry. Technical Report, 2008

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

Harbour Register www.sadamaregister.ee 08.07.2015

The decree of the Minister of Social Affairs No. 75 as of 06.05.2002 "Ultra- and infrasound sound level limit values and measuring of ultra- ja infrasound noise levels"

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"

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

Statistics Estonia www.stat.ee/ visited on 08.07.2015

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

The impact of offshore wind energy on tourism, http://www.offshore-stiftung.com/60005/Uploaded/Offshore_Stiftung%7C2013_04SBO_SOW_tourism_study_final_web.pdf

Thortonbank, Belgium – 325 MW offshore windfarm, Geert Dewaele – Project Director, 20.11.2012 ettekanne

The impact of offshore wind energy on tourism, good practices and perspectives for the South Baltic Region,

http://www.offshore-stiftung.com/60005/Uploaded/Offshore_Stiftung%7C2013_04SBO_SOW_tourism_study_final_web.pdf

Turnbull C, Turner J, Walsh D (2012) Measurement and level of infrasound from wind farms and other sources. Acoustics Australia 40:45–50

Compensation to local societies for tolerance regarding wind parks 2011. Compiled by Marko Karjus. Analysis compiled under the order of the member of Riigikogu Annely Akkermann.

Tuuling, I. (2008). How has the Baltic Klint been created? Estonian Nature 9, p. 6-14

Tõnisson, H., Jaagus, J., Kont, A., Orviku, K., Palginõmm, V., Ratas, U., Rivis, R. & Suursaar, Ü. (2009). Consequences for nature and society at the Estonian coast of the flood arisen with January storm in 2005 (Gudrun). Kont, A.; Tõnisson, H. (Toim.). Impact of climate changes on Estonian coast (90 – 127). Tallinn: Tallinna Ülikooli Kirjastus

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)

Maritime Board, 2013

Traffic data of Maritime Board www.vta.ee/atp/?id=732

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

Westerberg, W., Jacobsen, J. B., Lifran, R. 2013. The case for offshore wind farms, artificial reefs and sustainable tourism in the French Mediterranean. Tourism Management 34: 172-183

Wind Power in Estonia. An analysis of the possibilities and limitations for wind power capacity in Estonia within the next 10 years. Prepared by Ea Energy Analyses for Elering OÜ. 2010.

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

National Spatial Plan "Estonia 2030+" http://eesti2030.wordpress.com/materjalid/planeeringu-materjalid/

EISA report of the National Spatial Plan "Estonia 2030+" http://eesti2030.files.wordpress.com/2012/01/aruanne-22-12-2011.pdf